A13

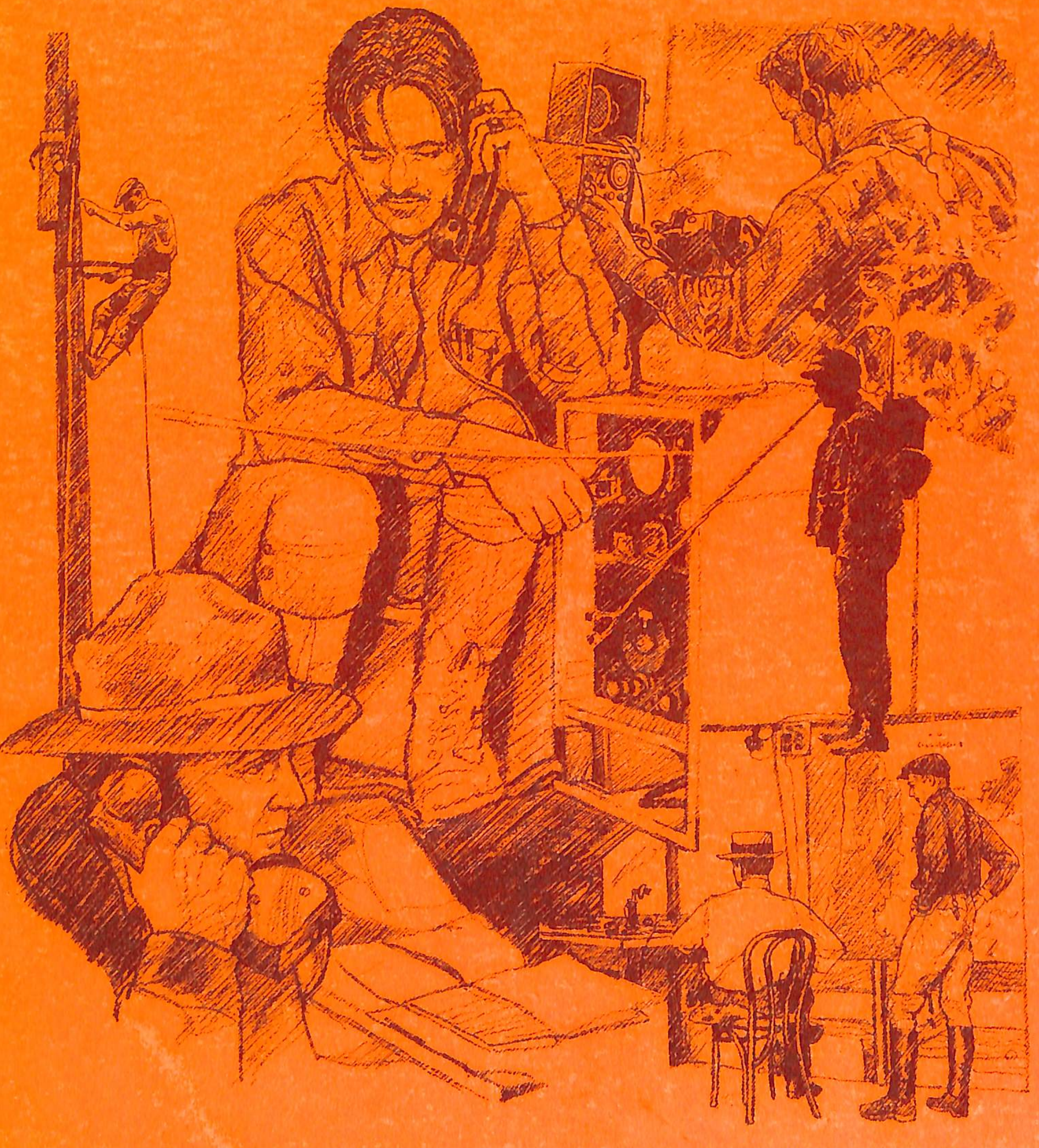
United States
Department of
Agriculture

Forest Service

FS-369

Radio for the Fireline

A History of Electronic Communication in the Forest Service, 1905–1975



RADIO FOR THE FIRELINE

A History of Electronic Communication

in the

Forest Service

1905-1975

by

Gary Craven Gray

Electronics Analyst and Historian
Formerly with Denver Research Institute

U.S. Department of Agriculture
Forest Service
Washington, D.C.

FS-369

March 1982

NOTE: Trades, firms, and corporations are named in this publication to provide the reader with a historically accurate and reasonably comprehensive account of the history of electronic communication in the Forest Service, with emphasis on radio development and applicaton. No endorsement by the U.S. Department of Agriculture of any product or service is intended.

Page

Preface v

Introduction 1

Chapter I. Telephones, Pigeons, Mirrors, Airplanes, and Balloons: Filling a Need for Communications 7

Chapter II. "Ring Bell" Adams: Using Radio Before Its Time 19

Chapter III. Dwight Beatty: Selling the Forest Service on Radio 33

Chapter IV. Tacoma and Vancouver: First Radio Laboratories 51

Chapter V. Simple, Rugged, and Reliable: Radio Policies and Practices Take Shape 67

Chapter VI. Beyond 100 Meters: Vhf and Hf Developments 87

Chapter VII. Improved Designs: Standards for the Future 99

Chapter VIII. Eat, Sleep, and Drink Radio: Administration, Cooperation, and Special Tasks 113

Chapter IX. Radio in the Regions: Reasons for Wide Variations in Use 129

Chapter X. A Dissenting Opinion: Communication Plans and Practices in Region 1 147

Chapter XI. Good Fences: Regional Networks, Portable Radios, and Interference 165

Chapter XII. Communication Bridges: World War II and the Aircraft Warning System 187

Chapter XIII. Putting the Pieces Back Together: Postwar Adjustments and FM Radio 203

Chapter XIV. Communication Leadership: Toward Consensus and Standardization 219

Chapter XV. The Electronics Center: Communication Programs After 1951 239

Page

Appendix I: Forest Service Radio Models--Photos, Diagrams, and Data 255

Appendix II: Abbreviations Used in Text and Reference Notes 297

Appendix III: Source Materials 301

Appendix IV: Early Communications on the Clearwater National Forest, Idaho 303

Preface

A significant advance in electronic communication in the Nation's publicly owned forests began early in 1905 shortly after President Theodore Roosevelt signed the act transferring responsibilities for our Federal forest reserves from the General Land Office, U.S. Department of the Interior, to the newly established Forest Service in the U.S. Department of Agriculture. Most of the telephone circuits, transportation schemes, and equipment installed by the Forest Service for its use in the field were copied from or patterned after those of the American Telephone and Telegraph Co. (A. T. & T.) or its subsidiaries or purchased from them. The unique contribution made by the Forest Service to the field of electronic communications began in 1928 when a professional forester near Missoula, Mont., demonstrated his homemade wireless transmitter-receiver to the Chief Forester and members of his staff. The demonstration led to establishment of the Forest Service Radio Laboratory in Portland, Ore. For the next 20 years, a small, dedicated, and talented coterie, with no more than amateur radio backgrounds, designed highly effective portable radio sets for the use of personnel on the National Forest firelines. This history is primarily a record of those accomplishments.

This study was funded by the History Section of the Forest Service in 1977. The contract was awarded to the Denver Research Institute, University of Denver, for which I was electronics analyst. I became the principal investigator. My tape-recorded interviews captured the voices of many who took a direct and prominent part in the growth of radio in the agency so that their recollections could become part of the historical record. Without their reminiscences, it would have been difficult for me to reflect properly upon their hopes and aspirations as they contributed to radio science.

The web of history can be analyzed and described in many ways. In this case, the History Section staff and I decided that the text should follow a narrative, chronological style, with a minimum of technical language. Many photographs from the Forest Service Electronics Center, as well as the Service's numbered collections in its Washington Office and the National Archives, were selected to enliven the text. Photographs of sets, schematic drawings, and specifications are included in Appendix I for those interested in tracing the use or evolution of radio circuitry.

Readers may order National Archives photos from the Still Picture Branch, Audiovisual Archives Division, National Archives, General Services Administration (GSA), Washington, D.C. 20408. Ask for GSA Form 6797 with the latest valid price list; prices change each year on October 1. An advance payment made out to the Cashier, National Archives, GSA, must accompany the order.

Requests for prints of photos still held by the Forest Service should be sent to the History Section, Forest Service, U.S. Department of Agriculture, P. O. Box 2417, Washington, D.C. 20013.

Please note that whenever an explanation of technical matters was necessary, I made this brief. I also adopted the convention of using current terminology for frequency, that is hertz (Hz), and frequency bands throughout the text. Where direct quotations are used that include the older classification system, I have immediately bracketed the modern designation inside the quote (i.e., uhf /vhf/). Similarly, 100-meter and 10-meter designations are used in the generic sense to indicate a range of frequencies on either side of 3 megahertz (MHz) and 30 MHz, respectively. This is an attempt to make the text more understandable for less technically informed readers who are unfamiliar with the mathematics of wavelength.

Eight former telecommunication specialists of the Forest Service consented to review the preliminary manuscript, primarily for errors of omission or commission. They are Harold K. Lawson, Gaylord A. Knight, Logan M. Belleville, W. Foy Squibb, Guy V. Wood, Francis W. Woods, W. Frederick Biggerstaff, and William B. Morton. I greatly appreciate their help. Any shortcomings that may remain in the text are my responsibility.

I am also indebted to others. Fred P. Venditti and Dale A. Steffen of the Denver Research Institute, the contractor, provided continuous support for this project. David A. Clary, former Head, History Section, Forest Service; Dr. Dennis M. Roth, who succeeded him; and Frank J. Harmon, also of that section, were of much assistance. Dr. Harold Pinkett and Helen Ulibarri, both formerly of the National Archives, Washington, D.C., and the staff at the National Archives and Records Center, Seattle, Wash., greatly facilitated my search for record materials. Kay Freeman, photographer of the Denver Research Institute, reproduced many of the pictures from the collection of the Forest Service Electronics Center. Her work was consistently of the highest quality. William "Mac" McAninch, draftsman, also of the institute, provided the 1930-1948 Forest Service radio development/time chart for Appendix I.

Gaylord A. Knight provided the primary motivation for "the radio project," that culminated in this publication, for more than a decade. In his honor, I have contributed all gathered research materials to the Forest Service to be retained, in whole, as the Gaylord A. Knight Collection.

I consider it most appropriate to dedicate this book to the radio pioneers of the Forest Service who did so much to advance the art and science of this medium. I am impelled also to acknowledge the dedicated help of my wife, Marilyn, who tolerated for many months an itinerant lifestyle, checkbooks lacking substance, and endless pages of typing and retyping.

Gary Craven Gray

Introduction

To the throngs of eager immigrant settlers and their descendants who moved ever westward in search of new land during the first years of this Nation, America's vast stretches of forest cover appeared endless and inexhaustible. To many, the forests were obstacles to be removed, and soon the lumberman's axe, farmer's plow, and cattleman's herds transformed the landscape. East of the Mississippi River, most of the forests were burned--to provide fuel and to clear land for farming. They also provided the wood to build homes, shops, factories, and farm buildings, as well as the furniture, tools, boats, carriages, and wagons of the fast-growing Nation. Where trees were cut for lumber, most of the wood was wasted, with competition among logging companies hastening the process and leaving markets glutted. As the population grew, the demands for wood, grain, meat, and milk accelerated. The occasional warning voices raised against the reckless removal of forest cover went unheeded for many years. Finally, however, toward the end of the 19th century, the widespread destruction wreaked in the East could no longer be ignored, and Congress took action before all the enormous forests of the West could be similarly mistreated.

In 1891, therefore, Congress authorized the President to create and set aside forest reserves from the vast remaining acreage of public lands, nearly all in the numerous mountain ranges of the West, in order to preserve their valuable timber and water resources. A few scattered remnants in the East were reserved under this law. Six years later, Congress directed the Secretary of the Interior to protect and regulate the occupancy and use of these reserved lands and the sale of timber thereon. Then, in 1905, Congress transferred the 60 existing reserves, then containing 56 million acres, from the stewardship of the General Land Office, U.S. Department of the Interior, to that of the U.S. Department of Agriculture. The Secretary of Agriculture created the Forest Service in the Bureau of Forestry to manage the reserves. The entire Bureau then became the Forest Service. In 1907, the reserves were renamed National Forests to emphasize that they were to be managed to insure a steady supply of various minerals and a continuous yield of all renewable resources for the benefit of all the people.

Conservation through wise use of forest land became the watchword of the Forest Service, which pursued its mission with dedication and zeal. Early guidance and impetus were provided by the first Chief Forester of the expanded agency, Gifford Pinchot, and the Agriculture Secretary, James Wilson, with the strong support of President Theodore Roosevelt. To insure prompt action and due consideration of local interests--the concept characteristic to this day of Forest Service administration--a major decentralization program established six western Districts (now called Regions) in December 1908, each with a high degree of autonomy and delegated authority. Separate Regions for the rest of the country developed gradually after passage of the Weeks Law of 1911.

Meanwhile, the Forest Service had established the positons of District (Regional) Foresters and staffs, Forest Supervisors and staffs, District Rangers and assistants, and Forest Guards to oversee the National Forests. These people dealt with the wood products, fire protection, mining, ranching, water supply, power, transportation, communication, and later the recreation and wildlife interests of the Forests. They provided leadership for fire crews during the hazardous hot, dry season. In 1907, shortly after he approved the first uniform, Pinchot described the requirements for District Rangers and Forest Guards in a circular seeking applicants:

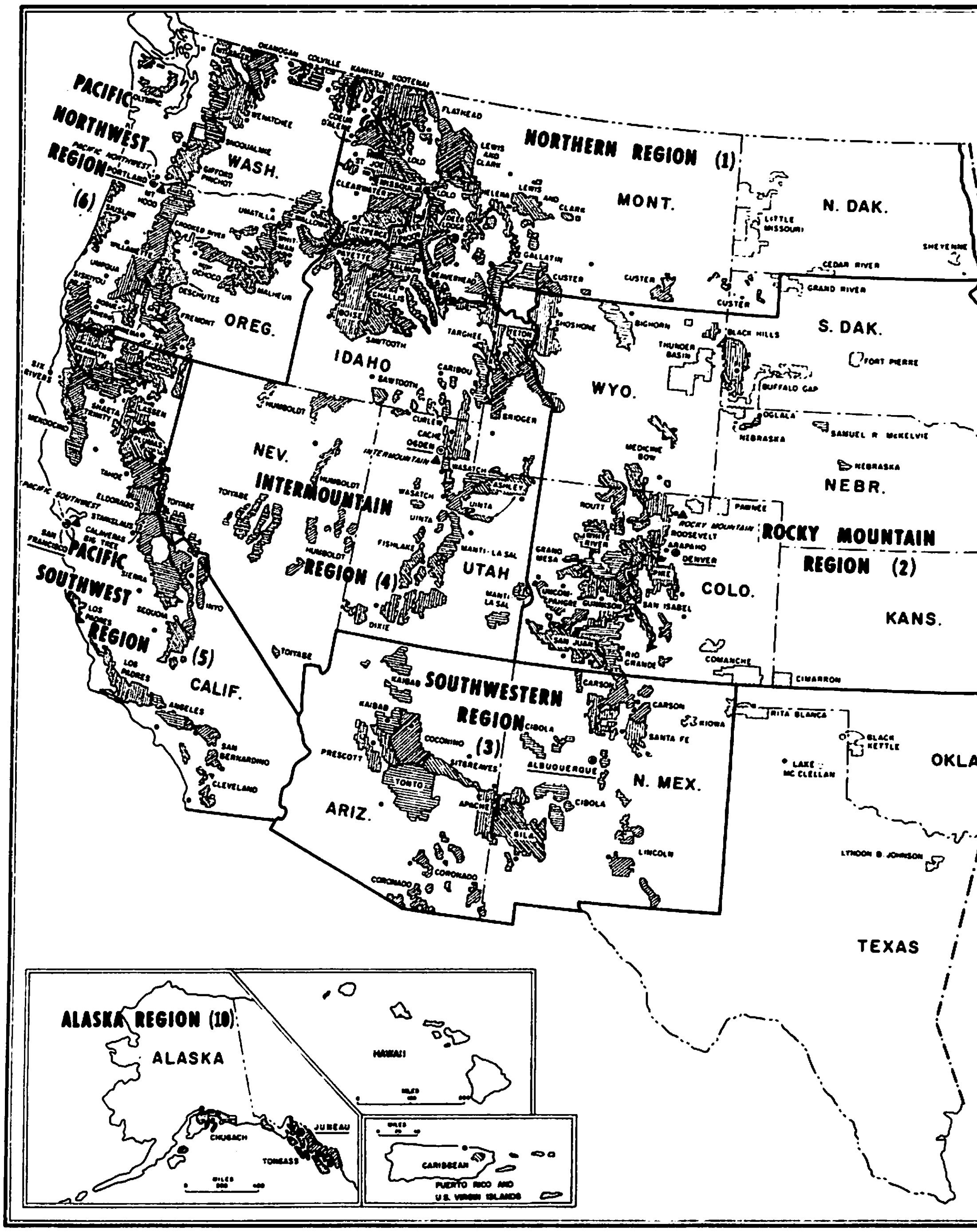
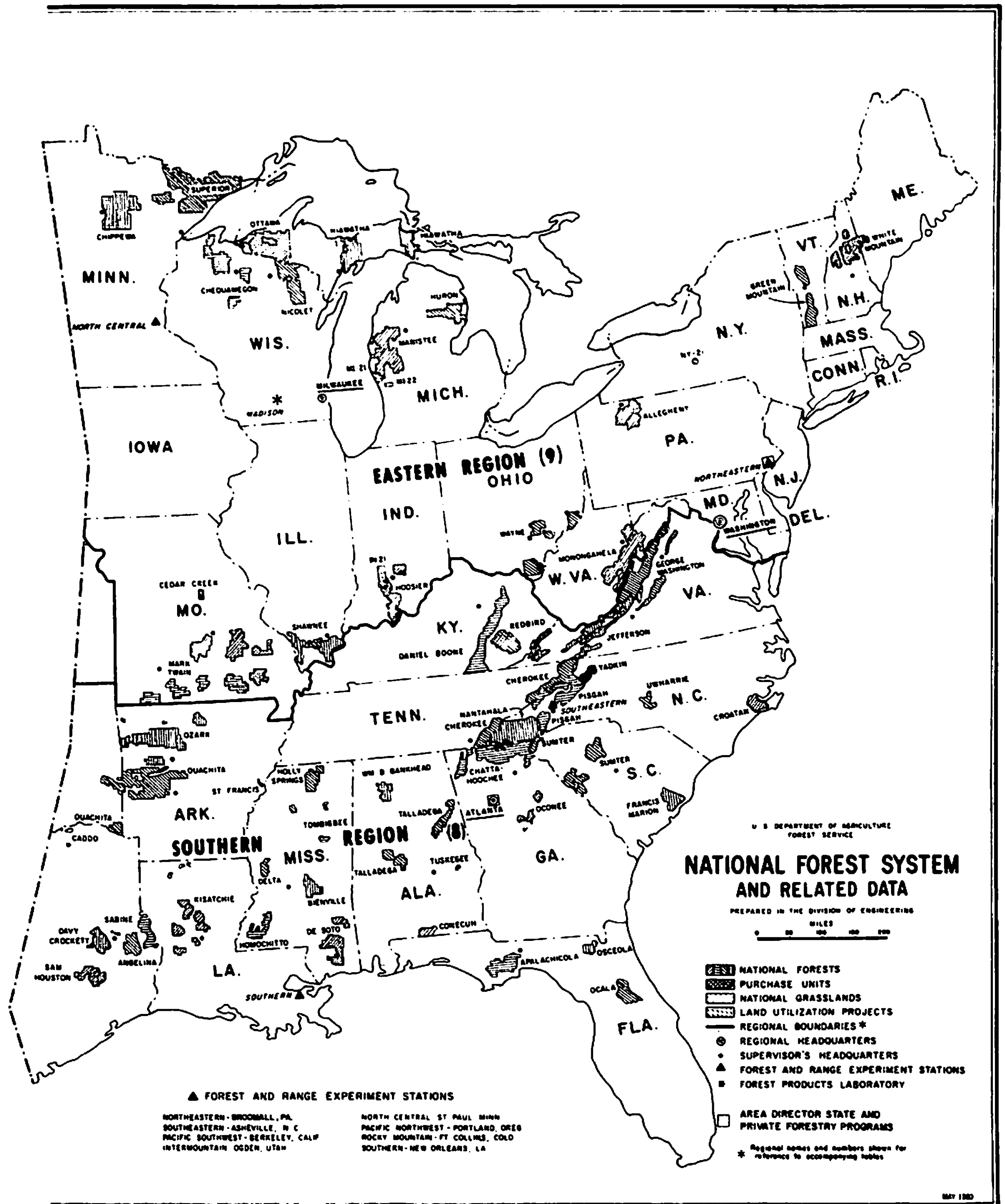


Figure 1. Map of United States showing the National Forests and the Regions of the National Forest System, Forest Service, U.S. Department of Agriculture. (Forest Service photo, Engineering Staff)

The Rangers are the men who carry out the work on the ground. They are directly under the Supervisor. They must thoroughly know the country, its conditions, and its people. They live in the Forests, often in localities far from settlement and sources of supply. The Ranger must be able to take care of himself and his horses under very trying conditions; build



trails and fight fire without losing his head. He must know a good deal about the timber of the country and how to estimate it; he must be familiar with lumbering and the sawmill business, the handling of livestock, mining, and the land laws. All this requires a very vigorous constitution. It means the hardest kind of physical work from beginning to end. It is not a job for those seeking health or light outdoor work. Rangers are now paid from $900 to $1,500 a year. They have to furnish and feed their own horses. The Government builds

> them cabins to live in and fences pastures to keep their stock in.
>
> The duties of Guards are similar to those of Rangers, but they are usually temporary men on duty during the summer only, to assist in fire patrol and construction work. They are paid at the rate of from $720 to $900 a year.[1]

Fire control became the number one priority of the "men in green," as they were sometimes called. (The uniform, including wide-brimmed hat, jacket, trousers or breeches, and boots, varied in style and color over the years from olive green to forest green to bronze green and then to a combination of forest and sage green.) Each season, extra guards and "smokechasers" were hired to scout the National Forests in search of telltale wisps of smoke. Upon sighting a fire, these men took off on foot, horseback, railroad speeder or motor vehicle; they knew that minutes could make the difference between a light burn and a major conflagration.

In exceptionally dry years, electrical storms set off roaring infernos in parched timber. These fires consumed thousands of acres, with winds often fanning the flames to hurricane speeds. Numerous towns in the paths of these fiery holocausts were destroyed, with scores of lives and millions of dollars lost. The Rangers lived and worked in the forest and with the local people. They came to look on firefighting not only as a battle to preserve the Forests' natural wealth and beauty, but also as insurance of the continuity and growth of their communities and the safety of their families and friends.

Firefighting, with its physical and emotional strains, became a war of good against evil that required total commitment without thought of clothing filthy with soot, soil, and sweat; hours worked; bodies exhausted; eyes and lungs aching from smoke; skin burned by flying embers; or bellies frequently empty and growling. Often unable to determine changes in wind direction or fire speed in time, and without rapid communication with people at better vantage points, fire crews could unknowingly place themselves in critical situations. If they did not find an outlet, a body of water, a cave, or a natural barrier, their charred remains would be located days later by searchers.

Recalling his experiences during his 39-year tenure as Forest Ranger, Forest Supervisor, and Regional Fire Control Officer, Elers Koch, long associated with Region 1, wrote in 1944, "The 1910, 1917, 1926, 1929 and 1931 fire seasons each have a character of their own, and in each year there are individual fire campaigns which the forester remembers as the soldier recalls the separate engagements of the war."[2]

The relationship between man and nature is highly personal and complex, and becomes more intense in the presence of extreme danger. The manner in which each individual chooses to perceive of his or her role under such circumstances takes on its own unique character. Walter Donaldson conveyed his feelings in his remembrances of a long career in Region 1:

> The years of our lives go swiftly by and, from where I sit, the sun is approaching the western horizon and I can see the Everlasting Twilight. The Old Man with the whiskers and scythe is standing in the shadows, just waiting for my number to come up, when I will be on my way to the place where Forest Rangers will no longer fight forest fires.[3]

The task of administering and protecting the National Forests was complicated by increasing and often conflicting pressures from logging companies, ranchers, miners, hunters, campers, and the general public. The steady growth of timber sales meant that Rangers were constantly involved in estimating the volume and areas of timber open to harvest; marking sale boundaries; checking compliance during cutting; authorizing and building roads and trails into remote areas; following up harvests to insure that timber residue, or slash, was burned in an approved, safe manner; and seeing if new growth was satisfactory.

Issuing forest grazing permits was also an important part of the Ranger's job. Millions of acres of grass and browse were included within the boundaries of the National Forests. For nominal fees, cattlemen and sheepmen who qualified under the regulations were able to graze their stock beyond the property lines of their ranches, and thus enlarge their herds. A renewable permit, adjusted annually, was based on the Ranger's estimate of the number of livestock that could graze in an area without serious damage to soil, streams, and regrowth. Rangers spent many days each season riding the range to insure compliance.

With the fast growth of automobiles, leisure time, and income after World War I, providing camping facilities became a major function of the National Forests. The general public began to demand more roads, trails, fireplaces, picnic tables, and sanitary facilities in the National Forests. Unfortunately, many campers damaged the camping areas by overusing the axe and allowing their fires to escape. Although the Forest Service warned that "persons who start fires intentionally or through carelessness will be prosecuted to the full extent of the law,"[3] violators were hard to catch and harder to convict. Not until the Forest Service humanized fire prevention through Smokey the Bear did most of the public begin to be more careful with fire in the woods. Yet, even today, stripped-off lower tree branches, scarred and scorched remnants of tree groves, and firepits dotting the campgrounds show that many still abuse the privileges of camping.

The Forest Service's numerous responsibilities and public contacts over vast areas with slow transportation made it clear early that communications were vital to successful administration of the Federal forest reserves.

Reference Notes

1. U.S. Department of Agriculture, Forest Service, *The Use of the National Forests* (Washington, D.C.: Government Printing Office, 1907), p. 33.

2. Elers Koch, "The Lochsa River Fire," *Early Days in the Forest Service* (Missoula, Mont.: U.S. Department of Agriculture, Forest Service, Region 1, 1944), 1:114.

3. Walter A. Donaldson, "Remembrances," *Early Days in the Forest Service*, 3:55.

4. Forest Service, *Use of the National Forests*, p. 31.

Chapter I

Telephones, Pigeons, Mirrors, Airplanes, and Balloons:

Filling a Need for Communications

> *...take horses and ride as far as the Almighty will let you and get control of the forest fire situation on as much of the mountain country as possible. And as to what you should do first, well, just get up there as soon as possible and put them out.*
>
> - Instructions to an Early Ranger.[1]

From the beginning, the Forest Rangers' great variety of duties and frequent traveling impelled the Forest Service to develop good field communications. It was hard-pressed to handle all the work, and staff was limited. Communications could help. Rangers out supervising trail-building crews, off on a timber cruise, or taking herd counts could be diverted to other urgent tasks only if they could be contacted readily. Even their offices, which were usually the cabins in which they lived, were often some distance from the nearest town.

The telephone was the first administrative aid employed by Forest Supervisors to keep in daily contact with their Rangers. Although the telephone's usefulness was limited by the location of telephone lines, the Forest Service was quick to adopt this handy tool. The dictum that "in fire fighting, a minute may mean millions"[2] meant that the telephone became "the instrument of salvation."[3]

It is not certain when the Forest Service first provided its Rangers with the telephone. The earliest surviving record of construction of a line after the transfer of Forest Reserves to the Forest Service was on the Siskiyou Forest Reserve in Oregon in 1905, but this was completed by a private logging corporation.[4] Certainly, a Ranger or Guard would use a local telephone exchange if available rather than make an all-day hike. The first Forest Service-owned telephone line was constructed in 1906 over a 109-mile stretch of the Big Horn Forest Reserve in northern Wyoming. The Weather Bureau, then also in the Department of Agriculture, supervised the work, and instruments were leased from the Bell Telephone Co.[5] To extend its use of the telephone, the Forest Service developed the unique practice of entering into private telephone contracts; the arrangement was not unlike that of bartering. It allowed miners, ranchers, farmers, and logging

Figure 2. Ranger stringing telephone wire and setting poles on the Big Horn Forest Reserve, northern Wyoming, August 1906, for the first Forest Service telephone line, 109 miles long. (National Archives: Record Group 95G-69555)

supervisors living in the hinterland to obtain free timber for telephone poles and to build lines across National Forest lands on the condition that National Forest officers have free use of the lines for official business. In turn, the Forest Service allowed residents to use the Forest Service telephone lines in exchange for their services as per diem fire patrol personnel.[6]

Variations of these agreements were added over the years. One of the most common was connecting Forest Service outposts to private company telephone systems and central exchanges. In some remote districts, this might entail several independent exchanges connected by Forest Service lines in a daisy-chain fashion.

One reciprocal, unwritten practice that evolved was the maintenance, repair, and construction of private lines, which the Forest Service could use, by Forest Rangers. Many Rangers performed such services because they recognized the value of keeping in close, friendly contact with the people

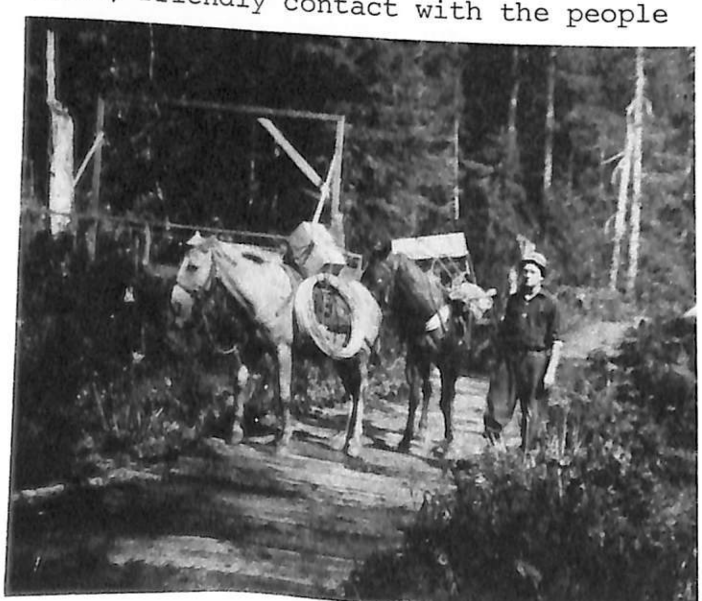


Figure 3. Ranger carrying telephone equipment and wire by pack horse along trail, Snoqualmie National Forest, Wash., 1911. (NA: 95G-31509A)

living within or along the perimeters of the National Forests. These efforts not only increased good will, but also provided the Forest Service with additional volunteer staff. The cooperators might be isolated ranchers, a clan of mountaineers, or general store owners at obscure road crossings; contact with them kept the Ranger in touch with local activities and served as the first line of defense against fire and illegal activities.

The value of these lines for fire-fighting was easily recognized and often publicized. Following the disastrous 1910 fire season in the Northwest, Charles J. Buck of District (now Region) 6 in Portland, Ore., who played an important role in Forest Service communications and later served as Regional Forester, wrote an article entitled

Figure 4. Ranger hanging telephone insulators on a dead tree, Olympic National Forest, Wash., April 1921. (NA:95G-157284)

"How Telephones Saved Lives" for the *Oregon Sunday Journal*; it was subsequently reprinted in *American Forestry*.

Assigned the task of fire boss, Buck traveled by train to Medford, Ore., where he found seven fires ranging out of control. Confusion reigned. Immediate reports indicated towns were being engulfed, crews were being trapped, and flames were spreading in every direction. Using 60 miles of Forest Service telephone lines constructed earlier between various outposts on the old Crater (now Rogue River) National Forest, and whatever private telephones were available, Buck gathered the latest information and marshalled his forces where most needed. "In 24 hours, the situation was under control," he reported. "Had messengers been trusted to bring the news, and other messengers been necessary to gather up the men and send them to the fire front, the blaze *might* have spread beyond all control."[7]

The telephone was also a morale booster for Forest Service employees located miles from any other contact. Bristow Adams of the Washington Office noted this in a 1906 article for *The American Telephone Journal*. Enforced isolation, he wrote, often created a "terrible nervous strain" on families. He anticipated that the telephone, as it already had in rural areas, would go a long way towards relieving anxiety and preventing serious emotional disturbances among field personnel. Adams also believed that the telephone would help the lone smokechaser who came upon a fire in its early stages. A chaser knowing he had to fight a fire alone might not be motivated to put out his greatest effort. But the chaser who could quickly telephone word to a supervisor and then return to the fire knowing help was on the way, would "... work harder, longer, and with less fatigue if he sees relief or a reward ahead."[8]

Figure 5. Silhouette of a young woman, ca. 1918, dramatizes the isolation of remote fire lookout stations of the Forest Service on mountain peaks in the West during the early period when many lookouts did not even have a telephone link to a Ranger station. *(NA:95G-38785A)*

In general, the technical expertise to construct a telephone network was "borrowed" from the American Telephone and Telegraph Co. (A. T. & T.) and published, beginning in 1912, in *Instructions for the Building and Maintenance of Telephone Lines in the National Forests*. Various other handbooks and trouble books followed. Most handbooks were replete with specifications for A. T. & T. transposition schemes, wiring, insulators, brackets, and soldering techniques. Adopting these specifications was usually the most expeditious means of completing lines that eventually tied in with A. T. & T. circuits.

This approach may also have developed as a result of long-term telephone agreements with A. T. & T. First signed in 1915, these leases gave the Forest Service up to a 50-percent discount on toll calls if the Service did not construct systems in competition with A. T. & T.[9]

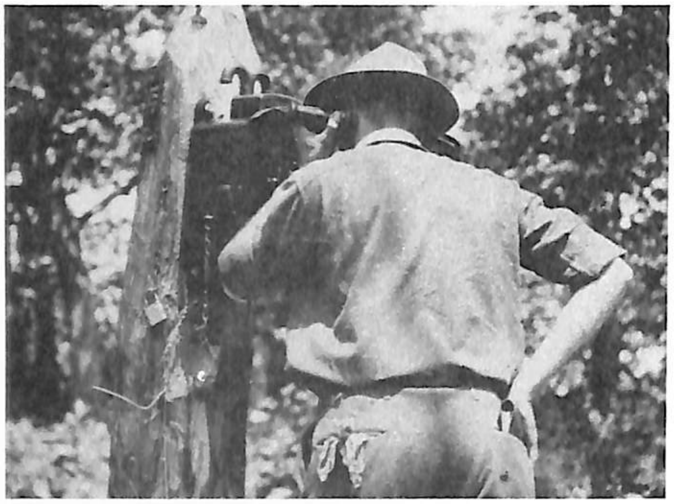


Figure 6. Francis Kiefer, Supervisor, Ozark National Forest, Ark., receiving a telephone message during a fire on Kitcherside Mountain, 1911. The outdoor phone box is mounted on a pole at a lookout site. Also see phone closeup, figure 7. (NA:95G-52645)

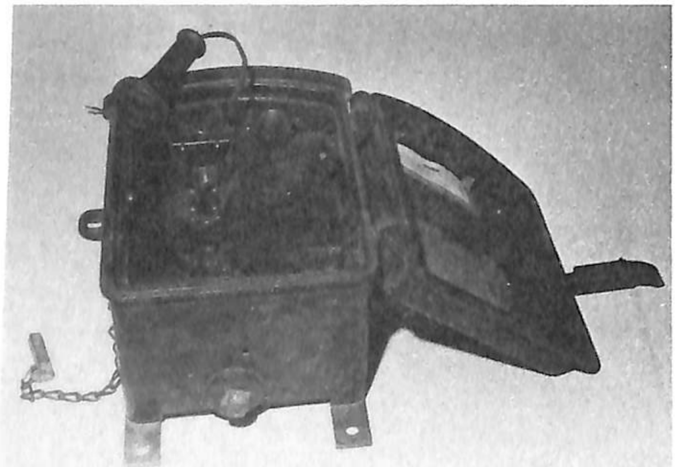


Figure 7. Heavy, very rugged cast-iron telephone box used at exposed permanent field locations, such as lookout points, in the early days of the Forest Service. This Western Electric Co. model labeled Mine Type, was made for use in mines and was resistant to explosions and vandalism. (Forest Service photo, History Section)

Early Forest Service Tree Lines

Forest Service modification of standard A. T. & T. telephone line installation occurred over the years; many such changes stemmed from scarce funds or temporary needs. Dr. H. Barringer Cox, for example, worked out an early ground-return line, or single-wire construction, for Region 5's Santa Barbara (now Los Padres) National Forest in southern California. It was a practical and economical alternative to the more costly, if quieter, double-line metallic circuit.[10] Special brackets and insulators, which proved stronger for the numerous lines hung from trees, also evolved through necessity, and newer lightweight field phones benefitted field personnel, often overburdened by other equipment.

If one person gave the Forest Service telephone systems a unique quality it was R. B. Adams, telephone engineer in District (now Region) 1 at Missoula, Mont. He was known throughout the Service as "Ring Bell," and early manuals credit him with several diagrams and most instructions for tree-line construction.[11] The *Telephone Trouble Book* for Region 1 was prepared by Ring Bell in 1923 and expanded for all the Forest Service in 1925.[12] Two of Adams' most significant technical contributions were the design of a hand-held, portable phone, that could be clipped on the telephone line, as well as a "howler" that notified far-flung crews that someone was trying to get through to them.[13]

Another Forest Service telephone engineer of some note was Clay M. Allen of District (now Region) 6. Although he received less publicity than Adams, he was often consulted on telephone improvements and changes. One of his technical contributions was a vine maple telephone bracket that held the line away from the tree and prevented crippling loss of current during wet weather. This device was so strong that a technician could suspend his entire weight from the installed bracket.

The telephone was an extremely useful and welcome tool, but it had several inherent disadvantages. The most obvious limitation was that it could be used only where lines had been installed. Temporary lines could be constructed in an emergency, but the process was time-consuming, costly, and not always effective. In addition, it was uneconomical to construct telephone lines to the many remote areas secluded behind miles of rugged terrain. Lines might burn down at the most inopportune time, such as when a fire was being fought. These limitations greatly encouraged the study of reliable alternatives.

The Forest Service borrowed communication techniques from other Government agencies. It picked up the idea of using carrier, or homing, pigeons from the Navy. Tests recorded flights of 600 miles a day. Pigeons were bound to be effective in mountainous regions where travel was difficult, and during the 1919 fire season in Oregon, limited attempts to convey messages from firelines to headquarters were successful. Encouraged, Forest Service officials arranged with the Navy for more pigeons and equipment in 1920.[14]

Tests with carrier pigeons continued in Idaho during 1921 with equally impressive results. In one case, a bird was carried by pack horse into a remote area, kept overnight, and released the next day. Within 30 minutes, the pigeon was back at its cote after covering 18 miles of rugged terrain. In another instance, a Ranger took two birds to the scene of a fire and released one to call for help. Then, when the crew successfully brought the blaze under control, the

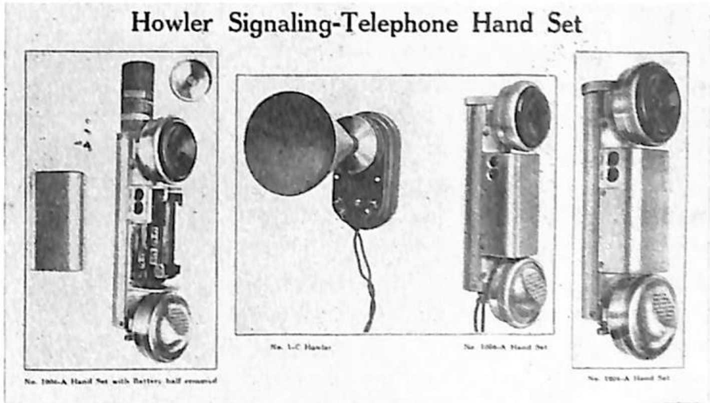


Figure 8. Portable telephone handset and "howler" signaling device, both designed by R. B. Adams, first Northern Distric (now Region) telephone engineer. The handset, first perfected about 1914, was clipped onto telephone wires for use. The howler emitted a loud noise to get the attention of work crews in the vicinity of a telephone. This photographic plate appeared in a Forest Service telephone handbook. (Forest Service photo, History Section)

Figure 9. Wooden bracket for Forest Service field telephone lines, designed by Clay M. Allen, Pacific Northwest District (now Region) telephone engineer, to hold the wire away from the trees and thus prevent leakage of current, which would be extensive in the wet weather so common on the west side of the Cascade Mountains in that Region. 1921 photo. (NA:95G-158323)

other was sent to cancel the call. A report in the *Forestry Kaiman*, said, "As a means of quick and certain communication with the Ranger out on the fireline and headquarters, the carrier pigeon has no competition."[15] As a result of such successes, plans were made to place carrier pigeons at all protective camps on the Forest by the next season. But for reasons no longer in the record, the experiment was quietly dropped.

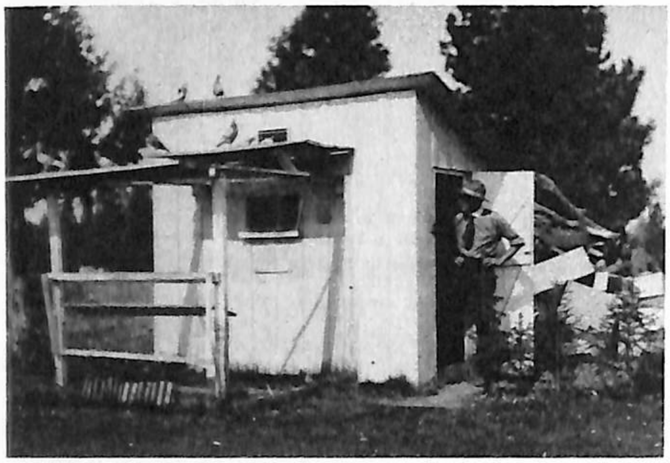


Figure 10. Carrier pigeon cote used by the Forest Service on Deschutes National Forest, central Oregon, ca. 1920, for fire messages. Though successfully used on a small scale in the Northwest from 1919 through 1921, carrier pigeons were abandoned by the Forest Service in 1922. (NA:95G-48244A)

The Army's use of the heliograph in the campaign against the Indians in the Southwest led to more Forest Service experiments. The heliograph was based on two mirrors that reflect sunlight, plus a shutter device that can be flipped at a tempo resembling the dots and dashes of the Morse Code. The Forest Service placed them at remote stations where lookouts could receive messages from fire patrols and relay them, usually by telephone, to headquarters.

A major problem was the heliograph's dependence on sunlight. Heat waves also often confounded the code by

Figure 11. Ranger ready to release carrier pigeon with a fire message on Deschutes National Forest, Ore., ca. 1920. (NA:95G-47460A)

breaking up the longer dashes into a series of dots. After experiments during the 1915 and 1916 fire seasons, an enterprising Ranger came up with a new code made up only of dots. This variation, however, could not be used between sundown and sunup, or when electrical storms or heavy smoke cover shut out the sunlight. Solar vagaries, one lookout reported, meant he never got a message through.[16]

Recalling his experience with the heliograph, another lookout, Red Stewart of the Clearwater National Forest, in Idaho, called it the "invention of the devil." Assigned to Mallard Peak, a remote location bordering the St. Joe National Forest, Stewart explained how the single-tripod version worked:

> You aimed the machines at your object and adjusted the mirrors

> to get the proper sun reflection. Then, with the shutter, you send flashes and hope that the other guy would be alert enough to see and acknowledge. Then you would proceed to transmit your message. In about 2 minutes, you could almost bet that your receiver would interrupt your transmission with the universal signal that either you were out of focus (the sun left you) or were behind a cloud or that you were using your own code instead of Morse.[17]

The *Forestry Kaiman* also reported that the Forest Service experienced "great convenience" with the heliograph.[18] Stewart, however, related an additional incident, which probably explains the demise of this communications tool. In late August 1915, he sighted smoke over on the St. Joe. After several attempts, he finally got the attention of the lookout on Pole Mountain. He keyed: "Fire on ..., " when he was interrupted by flashes signalling that he was out of focus. Realining the heliograph, he got as far as "Fire...," before clouds covered his position and shut off transmission. Despite several more attempts, he got no further than, "Fire on the north slope of...," when he said to himself, "To Hell with it!" and set out to deliver the message on foot, some 13 miles distant.[19]

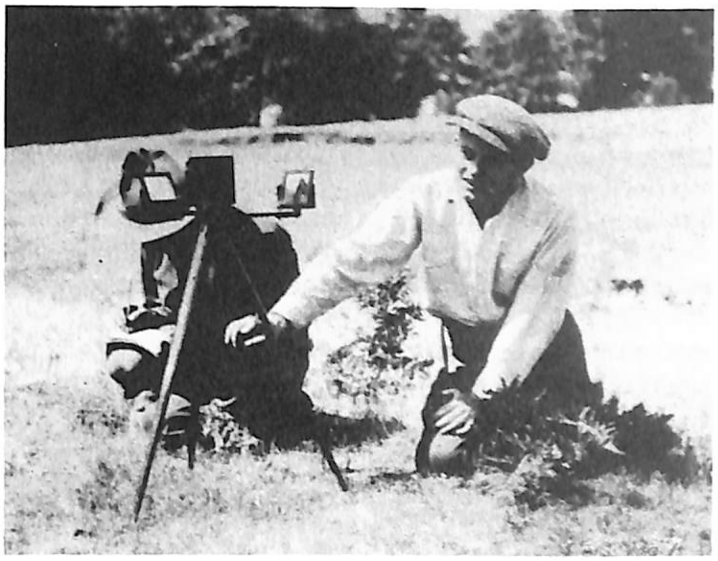


Figure 12. Sending messages to and from lookout points by heliograph. Above, single tripod type, Klamath National Forest, northern California, October 1921. Below, double tripod heliographs in use by the Forest Service on a peak in the West, ca. 1915. (NA:95G-159767, 30847A)

Airplane Fire Patrols

In spring 1919, the California District, R-5 (now the Pacific Southwest Region), inaugurated airplane patrols, using the Army pilots, mechanics, and planes that were in ready supply with the ending of World War I. At first they patrolled the Angeles, San Bernardino (then part of the Angeles), and Cleveland National Forests in the south; the Eldorado, Stanislaus, and Tahoe National Forests in the central Sierras; and associated

State and private lands. In August, the patrols were expanded to cover most of the remaining major forested areas of California, the six National Forests west of the Cascades in Oregon, and most of the eleven remaining National Forests. This ambitious Forest Service venture to improve communications and early fire detection linked the two young professions of forestry and aviation in a lasting partnership that eventually led to revolutionary developments in successful, worldwide control of forest fires.

The air patrol project was undertaken by the Air Service Branch (later the Army Air Corps) at the request of the Forest Service. The impetus came from a meeting of Coert duBois, District (Regional) Forester, who had just returned from military service in France, and Col. Henry A. "Hap" Arnold, officer in charge of the Western Division of the Air Service. Arnold later became Commanding General of the Army Air Corps. He was enthusiastic, and Secretary of War Newton Baker quickly authorized the project on March 24. Operation plans were approved at a conference with the Air Service Branch in Washington on March 27; Albert F. Potter, Associate Chief, and Alpheus O. Waha, Forest Inspector in the Chief's Office, represented the Forest Service. The patrols were to be funded mostly by the Air Service, which would supply its pilots, mechanics, equipment, fields, and fuel.

At first, six patrol routes were laid out. Twice each day during June, July, and August, six Curtiss JN-4D "Jennies" (single-engined biplanes) covered 4 to 6 million acres of rough, mountainous terrain in central and southern California. This patrol was then replaced and expanded at the height of the fire season by eight British DeHaviland biplanes of longer range covering some 16 million acres of National Forests and 4 to 5

Figure 13. British DeHaviland-4 plane, of World War I vintage, flown by Army Air Service on aerial fire patrol, in cooperation with the Forest Service, over southern California, April 1921. This patrol began in 1919. (NA:95G-152349)

million acres of private forests, twice daily during September and October.[20]

From Mather Field near Sacramento; March Field near Riverside, east of Los Angeles; and Rockwell Field near San Diego, flights departed at elevations sufficient to give the pilots a 50-mile-wide field of view. Army mechanics or forest officers acted as observers in the planes. The airplane observers were supplemented by other observers in an Army balloon tethered 2,000 to 3,000 feet above Ross Field at Arcadia, near Pasadena, and connected by telephone to the ground.[21]

The lack of wireless in the planes was a major handicap. The pilot notified the Forest Supervisor of a fire in a number of cumbersome ways. He lowered a parachute drop with a 3-foot red streamer over a town or Ranger Station; the message instructed the finder to telephone the message to the Forest

Service. He made a special landing to report by telephone. Or he returned to the field; in most cases, the landing fields at the far ends of the patrol routes were provided by city or town authorities or some local booster organization. Carrier pigeons were also released from the airplanes with messages, but this method proved too slow.[22]

The patrol was extended to Oregon, part of District (now Region) 6, on August 1 in response to appeals from the Governor and forestry officials after forest fire outbreaks in late July. The two Curtiss JN-4D's from Camp Lewis, Wash., were reinforced on August 6 with five more; one JN-4H was also added. They were all from Mather Field. Twice-daily flights covered 15 million acres of rich Douglas-fir timberland west of the Cascade Mountains from bases at Salem and Roseburg; the area extended from Salem north to Portland and south to Eugene, and from Roseburg north to Eugene and south to Medford in the mountains of southern Oregon.[23]

With the start of the hunting season and a big increase in fires soon after mid-August, the patrols were reorganized and enlarged to cover fifteen instead of five National Forests in California. The Rockwell and March Field patrols were consolidated at March Field and extended to the Santa Barbara National Forest (now Los Padres) and to all of the San Bernardino. The Curtiss planes at March Field were replaced by 16 reconditioned DeHavilands. Eight were used one day and the other eight the next.

A new patrol base was set up at Redding, Calif., at the northern end of the great Central Valley; five DH-4's replaced the Curtiss planes from Oregon, and four were used to make two daily flights from a new field at Eugene with one kept as a spare. Within a week the Curtiss planes at Redding were replaced by five DH-4's and the base was shifted south to Red Bluff. Another new base was set up at Fresno, in the southern part of the Central Valley, starting with two Curtiss planes and then four that were then replaced by three DH-4's for the rest of the season. At Mather Field, the Curtiss planes were used all season because the flights to Oroville and Chinese Station were shorter.

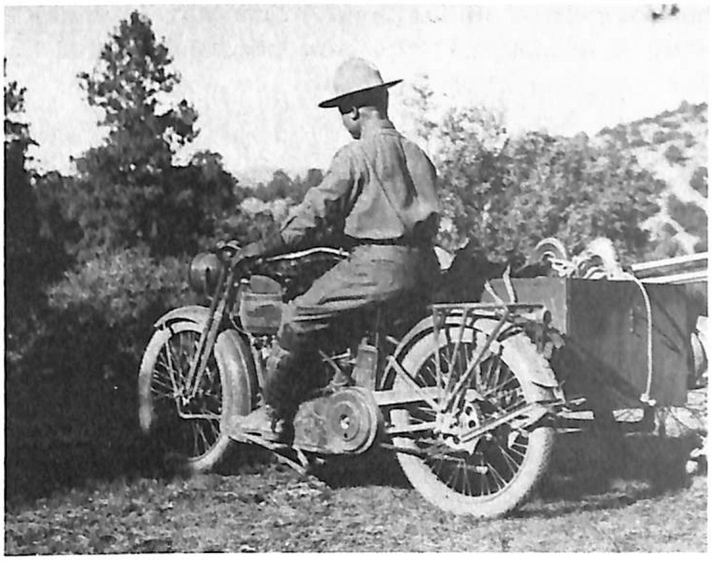


Figure 14. Ranger on motorcycle, side-car loaded with firefighting tools. One method of "getting there as soon as possible," ca. 1915. (NA:95G-32684A)

According to one report, the combined air patrols were covering 35 million acres of forest land each day at the end of the season.[24] These first flights were well-publicized and supported by the press, and were very exciting. The rumor that each plane was equipped with a telescope and machine gun proved a powerful deterrant to arson. For a while, fires in the Cleveland National Forest and in northern California decreased. Yet, the net effect of the patrols fell short of some foresters' expectations. Despite 745 flights logging 93,000 miles in Region 5, only 23 out of the season total of 118 fires were first sighted by the patrols.

In a review of the 1919 program in California, Richard F. Hammatt, District (now Region) 5 Information Chief, noted that the total cost of the air patrols would be too high for the Forest Service to bear alone. He noted, however, the "wonderful results" of fire detection by the pilots "entirely new to the country and equipped with mighty poor maps." He concluded that the project was a "huge success." He said that the patrols were unsurpassed for War Department training of the new personnel and for keeping them in practice, and pointed out that their effectiveness could be greatly improved if the airplanes had wireless to communicate with strategic ground stations.

"The only reason why more fires were not reported *first* by the Air Patrol," Hammatt said, "was because neither ships nor ground stations were equipped with wireless." The consensus favored continuation of the patrols.[25]

The advantages of using wireless to complement the airplanes were obvious. Landing a plane or dropping a parachute with a message lost valuable time. Radios could keep continuous contact with fire dispatchers, who could relay immediate word of forest fires to standby fire crews.

The concept of using radio communication for fire control was not a new idea. Some foresaw the day when radios might provide the convenience and margin of speed that telephone systems often lacked. Since 1909, several independent experiments had been made to use this communication device for the National Forests. The state of the art of radio was the major handicap.

Reference Notes

1. B. M. Huey, "The First U.S. Forest Ranger," *Journal of Forestry* 45, No. 10 (October 1927): 765.

2. "Use of Telephone Lines in Fighting Fires," *American Forestry* 27, No. 8 (August 1911): 468.

3. Bristow Adams, "Telephones and the Forest Reserve," *Forestry and Irrigation* 12 (October 1906): 463.

4. Adams, "Telephones," p. 468. A picture of a Siskiyou telephone box is included in the collection of Forest Service negatives in the Still Picture Division, National Archives, Washington, D.C. No. 95G-61222. The caption reads: "Telephone box showing facilities of a private corporation scheme of forest fire protection. Siskiyou National Forest, California. December 3, 1905."

5. Adams, "Telephones," p. 468. At the same time, work was also starting on Forest Service lines in Colorado, throughout the Pacific Northwest, and under private contract.

6. See the early form of this contract in U.S. Department of Agriculture, Forest Service, *Telephone Construction and Maintenance on the National Forests* (Washington, D.C.: Government Printing Office, 1915), pp. 75-80.

7. C. J. Buck, "How Telephones Saved Lives," *American Forestry* 16, No. 11 (November 1910): 649. National Forest Districts were renamed Regions in 1930.

8. Adams, "Telephones," pp. 463, 464.

9. Roy Headley, U.S. Department of Agriculture, Forest Service, Washington, D.C., to Regional Forester, Portland, Ore., 7 December 1935, National Archives, Washington, D.C., Record Group 95,

Records of the Forest Service, Division of Operations, Box 15, O- Improvements.

10. Newspaper clipping (undated) in the possession of Morris Willis, Santa Barbara, Calif., showing two rangers assisting Cox in his experiments. Ground-return lines were also developed and used by the armed forces in this era.

11. Forest Service, *Telephone Construction*, p. 7.

12. See R. B. Adams, *Telephone Trouble Book* (Washington, D.C.: Government Printing Office, 1923) and U.S. Department of Agriculture, Forest Service, *Handbook on Construction and Maintenance of the National Forests' Telephone Systems* (Washington, D.C.: Government Printing Office, 1925).

13. Between 1915 and 1919, R. B. Adams, through the Forest Service, applied for a patent on the portable telephone. Each of these applications was denied on the grounds that Adams had used known circuits and technology. Only the packaging was unique. See R. W. Williams, Acting Solicitor, U.S. Department of Agriculture, to the Forest Service, 23 January 1919, Gaylord A. Knight Collection, Records of the Forest Service Related to Electronics Communications. As I stated in the Introduction, the Gaylord A. Knight Collection initially included several notebooks of material provided to me by Mr. Knight. During the succeeding months I added to this collection of documents and copies of documents obtained from various sources. These have been catalogued in chronological order, except in cases when the document has no date, or was published and, in those cases, it is filed alphabetically under "Miscellaneous Items." The total collection consists of three file boxes, including tape recordings with the participants listed in the bibliography. Currently, the Collection is maintained by the U.S. Department of Agriculture, Forest Service, History Section, Washington, D.C.

14. "Carrier Pigeons Aid Foresters," *American Forestry* 25, No. 11 (November 1919): 1504 and "Pigeons for Forest Fire Fighting," *American Forestry* 26, No. 2 (February 1920): 122.

15. "Rangers Use Carrier Pigeons," *Forestry Kaiman* 4 (1922): 35.

16. Jack A. Parsell, "More Heliograph Nostalgia," *Northern Region News* (Missoula) 32 (May 31, 1968): 2.

17. Red Stewart, "Communicating the Hard Way," *Northern Region News* (Missoula) 31 (8 April 1968): 2.

18. "Heliograph in Protective Work in the Sawtooth," *Forestry Kaiman* 4 (1922): 31.

19. Stewart, "Communicating the Hard Way," p. 3.

20. R. F. Hammatt, "Airplane Forest Fire Patrol in California," *American Forestry* 25, No. 12 (December 1919): 1531, 1532 and Malcolm E. Hardy, "The Use of Aircraft in Forest Fire Control" (Master of Forestry thesis, University of Washington, Seattle, 1946) pp. 9-12.

21. Hardy, "Aircraft," pp. 10-12, and "Airplane Patrol in Natonal Forests," *American Forestry* 25, No. 7 (July 1919): 1244.

22. Hammatt, "Airplanes," p. 1532.

23. Hardy, "Aircraft," pp. 12, 13.

24. Hammatt, "Airplanes," pp. 1531-1533; Hardy, "Aircraft," pp. 13-15; and "Report on the Oregon Aerial Forest Fire Patrol--Fire Season of 1920," typewritten, /n.d./, National Archives and Records Service, Seattle, Wash.,

File 66742, "USFS - Region 6, F - Co-operation."

25. Hammatt, "Airplanes," pp. 1531, 1533 and Hardy, "Aircraft," p. 15.

Chapter II

"Ring Bell" Adams:

Using Radio Before Its Time

Cranking the phone or picking up the receiver to talk to the Ranger during an electrical storm was about as hazardous as reaching for a rattlesnake in a gunny sack.

- David S. Olson[1]

The potential of radio to detect and report forest fires had not gone unnoticed in the Forest Service. As early as June 1909, the Vermont State Forestry Department had secured "... Government money in hope that this method of reporting fires will prove workable and prove more economical than building telephone lines throughout forest regions."[2] Under the direction of Federal Border Patrolman W. P. Powers, the department experimented with a 500-watt, fixed-base station at Proctor, Vt. Two other units were placed on Killington Peak and Equinox Mountain. The results were sufficiently encouraging for Powers to devote "...some little attention to the assembly of a portable set."[3] He came up with an 8-pound receiving set and a 50-pound transmitter, including batteries, that could transmit signals 4 miles and receive over a distance of 20 miles.

In his experiments, Powers had to determine the best aerial-ground system for the solid rock formations on Killington. First he tried to secure a ground source in a flowing spring, but he found the source of the water was superficial and of no benefit. The practice of burying metal ground plates in the rock proved no better, so Powers resorted to inductive grounding by using six steel wires, each 240 feet long, placed down the peak at 60-degree angles to each other. The antenna was of the "umbrella" type, similar to the ground system, because he did not have enough room to construct an inverted L.[4]

The Vermont experiments demonstrated the ability of the radio to transmit signals between fixed points; they also demonstrated the considerable effort and expenses involved in constructing and maintaining fixed-base stations. It was a major job to transport heavy, expensive transmitters, and the antenna-ground system was too complex to put up quickly.

In his reports, Powers also indicated that the portable set had severe limitations. At least two people were needed to carry the 58-pound radio and the other equipment needed for a camp. He also noted that the "storage batteries are not to be relied upon," and that this adversely affected long-distance transmission.[5] If radio were to replace the telephone, it would be when the overall cost and effort were less expensive and time-consuming than stringing telephone lines.

One day in the summer of 1916, at the remote Baseline Ranger Station on the Apache National Forest in eastern Arizona, Ranger William R. Warner left on horseback for his weekly 38-mile trip to Clifton, N. Mex. About midway to town, he noticed an amateur radio antenna at a local ranch installed by Ray Potter, a high school student. Because he knew it was too expensive to build a telephone line into Baseline, "Mr. Warner became greatly enthused ..." about the possibility of radio for the Apache and detoured to the Potter ranch. Before the day was out, young Potter had helped Warner order a similar set from a mail-order house.[6]

While waiting for the equipment to arrive, Potter and Warner constructed an antenna across the adjacent canyon, a distance of 1,625 feet, at a maximum height of 557 feet. They used everything from copper wire to barbed wire, including the side frame of an iron bed for a ground rod. They reported the final product "...could have been raised to a height of nearly 200 feet (low end) but the strain on the barb wire began to show ..."[7]

Warner's work caught the attention of Southwestern District (now Region /R-3/) Telephone Engineer, R. V. Slonaker, who had recommended in fall 1914 that experiments with radio be conducted on the Carson National Forest in northern New Mexico. Initially approved and followed up by several of his supervisors, the trial was discarded because of expense and lack of skilled operators.[8]

By November 26, 1916, Warner had received the radio apparatus, consisting "... of a receiving set, a set of head receivers, jump spark coil, transmitting condenser, stationary spark gap, transmitting key and buzzer, three switches, a lightning arrester, fifteen dry cells, and the necessary wire." At a low, total cost of $115.45, including the labor of Ray Potter, Warner was ready for his first experiment.[9]

That night, in the company of Slonaker and District (Regional) Forester Paul Redington, a message was prepared for transmission. Aware of the importance of the event, Redington composed the following note for Warner to tap out on his key:

> Forestry, Albuquerque, New Mexico. This message by wireless from Baseline Ranger Station, Apache National Forest, Arizona, to Clifton, Arizona, distance 40 miles. First of its kind sent in this district. Probably first from any Ranger Station in the United States. Project conceived by Ranger William R. Warner, apparatus installed by him and Ray Potter. Cost $75.00. This method should render possible large decrease in construction and maintenance cost Forest communication systems. This message being sent to all Districts /Regions/ and Washington.

The message was received by a Mr. Harriman of Clifton, who could not respond because of lack of power, but Redington and his party received acknowledgement by telegram from the Army Signal Corps when packing out the following day.[10]

Warner made three significant findings. First, the location of the antenna did not have to be within the line of sight of a receiving station. It could even be deep in a canyon. With Baseline at 4,482 feet, Clifton at 3,464 feet, and the area between them rising to 6,000 feet, it was apparent that radio waves could get through. Second, after a few weeks of practice, Warner was

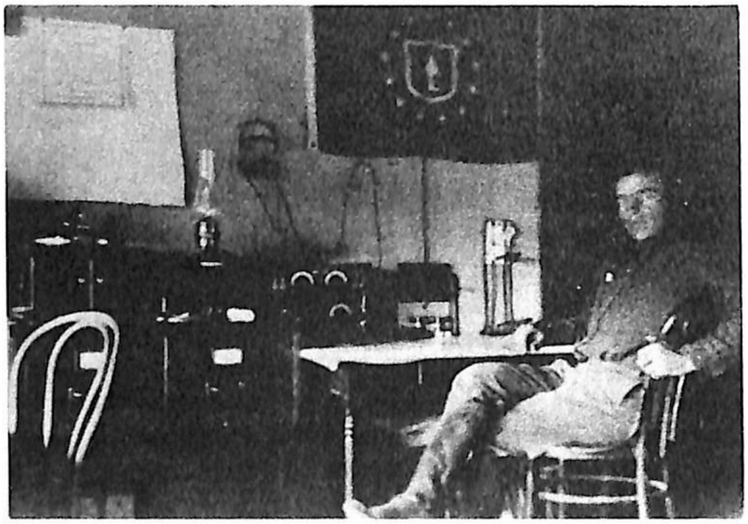


Figure 15. Ranger William R. Warner at wireless telegraph transmitter-receiver that he built at Baseline Ranger Station, Apache National Forest, eastern Arizona. He sent the first official Forest Service wireless message, by telegraph key, on this set on November 26, 1917. Note Forest Service flag on wall. (Forest Service photo, History Section)

sending and receiving code at 12 words per minute, "...thus showing that wireless telegraphy codes do not require years of practice and study to master sufficiently for practical use." Third, radio need not be expensive.[11]

Warner's experiment was sufficiently successful to encourage District (Region) 3 to conduct further tests. By the time of the final report, Telephone Engineer Slonaker was already recommending wireless-telephone and getting price quotes from manufacturers. He cautioned, however, that "it is not proposed at present to parallel any existing system of communication by the installation of wireless equipment but to use it where the maintenance of a line which is already built is more expensive than the installation and cost of operation of the wireless equipment."[12]

Air Patrols Use Radio

After this initial trial, the Forest Service-Army Air Service patrols were resumed on the Pacific Coast in 1920--this time with radio transmitter sets installed in all planes. Pilots and foresters in the air fire patrol program also attended a pre-season short course.

The radios and the instruction were recommended by Colonel Arnold on November 22, 1919, to the Airplane Patrol Committee of the Western Forestry and Conservation Association in Portland. At the urging of Senator Charles McNary of Oregon, Congress provided $50,000 to the Forest Service for patrol costs.

The flying fire observers were hired by the Forest Service, which also paid for outlying landing field maintenance, ground transportation, telephone and telegraph messages to report fires, and guards for aircraft and buildings--substantially the same practice as in 1919. The same general two-State area was covered, and in Oregon, Curtiss planes were used again. Tentative plans were made for patrols in western and northeastern Washington, but shortages of planes, personnel, and funds precluded flights until 1921.

Figure 16. Army Air Service airplane on forest fire patrol, Olympic National Forest, Wash., 1921. (NA:95G-162658)

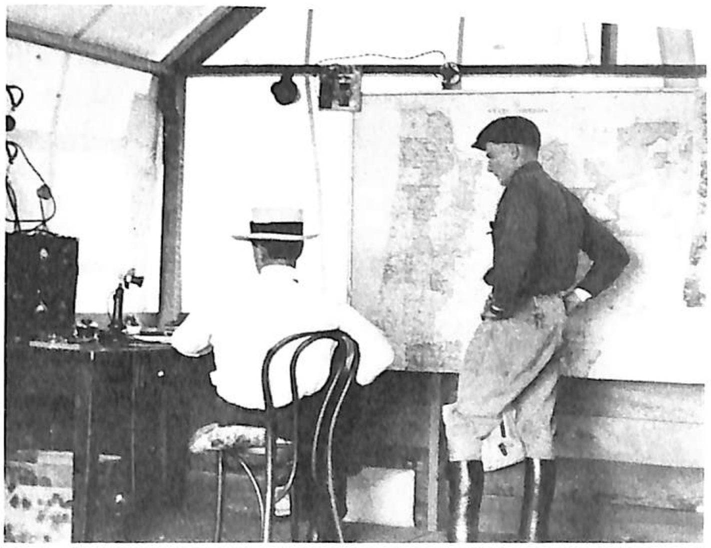


Figure 17. District (now Region) 6 Inspector Shirley Buck with W. E. Naylor of Army Air Service at command post of the joint Forest Service-Air Service aerial fire patrol in the operations building of Aviation Field, Portland, Ore., August 1920. (NA:95G-47880A)

To keep in closer contact, pilots radioed location reports to ground stations every 10 minutes. Nine ground stations were set up in California at the four patrol bases, Santa Barbara, Alturas, and three other points. Three stations were set up in Oregon at Portland, Eugene, and Medford. Radio operation was uneven at first, but improved considerably by the height of the fire season. Nearly half, or 741, of the patrol's 1,632 smoke discoveries were reported by radio. Most were reported by special landings and only a few by drops.

Apparently this scheme failed to provide an adequate network. In an activities summary for the season, the Air Service concluded that more SC-59 radio sets installed along specific routes were needed to make the patrol more effective. "This would mean that every fire sighted could be reported immediately to a receiving station which was in direct contact by wire telephone with the rangers and wardens." The 26 planes used in California and the 11 in Oregon flew 476,085 miles, nearly twice that in 1919, and covered 16.3 million acres. A test flight with a "pony" blimp and a Forest Service observer aboard was made over the Angeles National Forest. For the first time, special air patrols were launched to get a better view of fires.[13]

In 1921, at the urging of the Air Service, the Forest Service assisted greatly in expanding the ground radio network from 9 to 20 stations in California and 3 to 4 in Oregon, and in setting up 2 for the first time in Washington.

The Air Service stations in California were located at Alturas, in the northeastern corner; Corning, south of Red Bluff; Visalia, south of Fresno; and at Mather and March Fields. The Oregon stations were at Zig Zag, near Mt. Hood; Fish Lake, east of Albany; Wolf Creek, east of Roseburg; and Johnson Mountain, near Powers. The Washington stations were at Port Angeles and Lake Quinault on the Olympic Peninsula. The Forest

Figure 18. Northwest forest air patrol radio in operation at Army Air Service command post, Aviation Field, Portland, Ore., August 1920. (NA:95G-47879A)

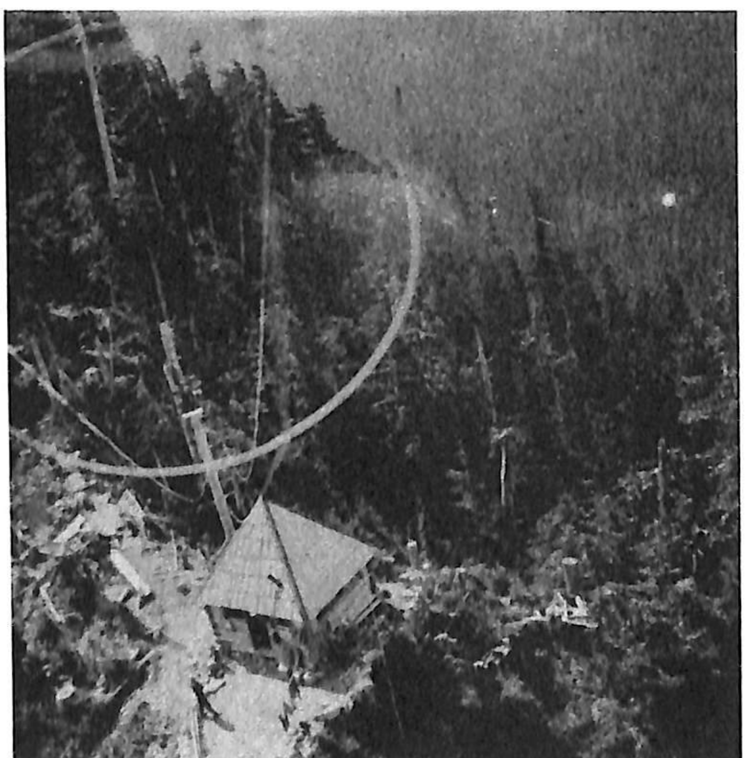


Figure 19. Wireless station used to receive messages from airplanes in Northwest forest-fire air patrol, 1920-21. Finley Lookout, Olympic National Forest, Wash. (NA:95G-158369)

Service itself provided 15 stations in California: Happy Camp, Yreka, Orleans, Sisson, Weaverville, Mineral, Quincy, Alder Springs, Nevada City, Placerville, and Sonora in northern California; and Hot Springs, Northfork, Los Angeles, and Santa Barbara in southern California.[14]

This time, Congress appropriated $50,000 for the 1921 air patrol, all for the Air Service[15] with nothing for the Forest Service. The Air Service, therefore, made the necessary ground installations for the Forest Service, and the Service borrowed the SCR-74 sets from the Navy. Many Forest Service stations in California were staffed by 16- to 25-year-old radio amateurs, who were paid $80 to $95 per month by the Forest Service, with no allowance for field expenses. The rest were staffed by the Signal Corps and Air Service. With few exceptions, all stations gave satisfactory service. Only "the Los Angeles station had trouble because of interference, and it was necessary to request through newspapers that the many amateurs keep quiet during the period of day when the planes were in the air."[16]

The Air Service set up a regular schedule of daily radio reports to Crissey Field at the Presidio Military Reservation on the Golden Gate. From Crissey, they were telephoned to Army Headquarters and to the District (Region) 5 office in San Francisco. Radio Engineer Richard and Sergeant Lange from Mather Field installed radios in the planes and spent the summer servicing the radios in the planes and on the ground. Thus, the planes were within communication distance of Forest Service stations at all times. Confirmation reports were telephoned or telegraphed from the bases and subbases right after the planes landed.[17]

The airplane transmitters were equipped with coils for sending messages on nine different wavelengths and five different tones were available for each wavelength, so interference of reception could be kept at a minimum. Each sub-base had a radio receiving set for voice so that aerial supervision over a fire could be instantly obtained.[18]

During the 1921 fire season, the number of planes almost doubled, from 37 to about 70. There were 25 crashes or forced landings. At the end of the season, 7 planes were in use in Washington, 10 in Oregon, and 33 in California. The original plans had called for 87 planes. One source states that the patrols reported 1,248 forest fires, of which one-third, or 373, were the first reports received of the fires.[19] Another source states that the patrols reported 1,632 fires, of which 818 were reported ahead of ground detection.[20] At any rate, the advantage of radio during the season is apparent from these figures, and appears to justify R. B. Adams' claim that the experiment was a "decided success."[21]

Air Patrols Curtailed

By the 1922 season, however, both radio and the daily patrols were abandoned. Instead, special flights were made during periods of high fire hazard. State and Forest Service fire observers rode in the planes, obtained firsthand knowledge of the fires, and made direct reports after landing.[22]

Advance notice had been given of curtailment of the program. In September 1921, Secretary of War John W. Weeks announced that forest air patrols would be discontinued because of "large reductions" in appropriations for Army aviation as voted by Congress.[23]

Congress did not provide funds for patrols, but the Army consented to make special flights during periods of severe hazard. In Oregon, 294 flights were made; 258 fires were located, of which 114 were "first."[24] The radios from the previous season were stored during 1922 in Eugene and used only to broadcast music and lectures by the Forest Service--an activity that met with "huge success" because there were many radio amateurs and only one commercial station in Eugene.[25]

The reasons for the demise of radio in the air patrol programs were varied and controversial. First Lt. W. C. Goldsborough suggested that radio would have been successful if a more complete pattern of ground radio stations had been established.[26] His argument implied that the radio failed because of Forest Service omission rather than commission. On the other hand, Lt. Col. W. E. Gilmore, Goldsborough's commander, was highly critical of the level of cooperation received from the Forest Service. In his report he advised "... that there appeared to be an attitude of criticism against, if not actual opposition to, this activity on the part of many field officers of the Forest Service, due in part to objections which, as a rule, follow in the wake of innovations along any line of accomplishment--the tendency to cling with jealous tenacity to the established order of things."[27]

According to the Forest Service, radio's demise resulted from the technological state of the art. Radio was a relatively new tool, and its price did not often justify its performance. Lieutenant Goldsborough had also hinted at this by placing some of the blame in the air rather than on the ground. In his recommendations, he called for development of an airplane radio with a range of 150 miles capable of communicating with local radio stations.[28]

Inadequate aerial-ground systems in airplanes were undoubtedly one major cause of poor communications in the experiments of the early 1920's. The Forest Service, however, did see promise in the air patrols, as shown by the resumption of the patrols, again without radio. Any further experiments in improved air fire patrol radio performance would have been at the mercy of uncertain funding. The Washington Office was aware of Adams' experiments and may have decided that radio was not advanced enough to warrant other trials either on the ground or in the air.

Little if any patrolling was conducted in 1923. In 1924, a prolonged dry winter and spring led State and Federal forest officers in Oregon to secure the services of two Air Service planes and pilots for emergency fire patrols out of Eugene, as needed. The requesting officer flew as observer, and the modest costs of fuel, quarters, and subsistence were shared by the Forest Service and the Oregon State Department of Forestry.[29] The special air patrols were reinstated over all three West Coast States for the summer of 1925 and also covered northern Idaho and western Montana (Region 1) for the first time. The planes flew out of Los Angeles and Sacramento, Calif.; Eugene, Ore.; and Vancouver and Spokane, Wash. Ten DeHavilands were provided by the Army Air Service, but the pilots, mechanics, and observers were hired by the Forest Service under a special appropriation of $50,000. At some locations, Forest Service fire control personnel directed the flights and flew as observers.

Patrols were made only when visibility by lookouts was low and during dry lightning storms. Scouting flights were made on large going fires. The 421 flights covered 75,615 miles.[30] The $50,000 appropriation was renewed for 1926, and 429 special flights were made from five bases, with fields at Glendale, Calif., and Seattle replacing those at Los Angeles and Vancouver. Similar patrols were resumed in 1927, but only 247 flights were made; an airfield at Missoula, Mont., replaced the field at Seattle, and two National Guard pilots were hired for the two planes based there.[31]

Except briefly in emergencies, the 1927 season was the last to see military planes or pilots used for fire patrol.[32] The early years had showed that they were justifiable only during times of poor visibility and high fire hazard in areas well covered by ground lookouts. Planes could also detect and locate fires in "blind" areas that could not be seen from stationary lookout points. They were also valuable in scouting fires, locating "spot" fires ahead of main fires, locating natural barriers, finding best routes to back-country fires for fire crews, and carrying supervisory personnel.[33] Beginning in 1928, the Forest Service made flying contracts with commercial air services for air fire patrols. (State forestry agencies also followed this practice.) Congress again provided the Forest Service with $50,000 for this purpose in 1928.[34]

A decided difference of opinion persisted about the use of aircraft within the Forest Service. In 1926, the Northern District (now Region, R-1), for example, strongly favored aerial observation, even requesting its own planes. Its headquarters in Missoula, Mont., explained that its 208 primary lookout towers and locations used only 3 months each year were spread across Montana and northern Idaho, and cost $125,000 to build and $80,000 to staff. Viewing the air patrol as a decided economic advantage, the office also pointed out that "with the number of individual fires in District /Region/ 1 during the past season, with costs as high as $50,000 each, it is apparent that any device, which by prompt discovery or other service, averted one such fire was worth what the Air Patrol cost for the entire United States."[35]

On the other hand, District (Region) 6 (Pacific Northwest) whose dry eastern forests border the western forests of District (Region) 1, found the reverse situation. It was the contention of the Portland headquarters that same year that the air patrols, with or without radios, were of no value because standard fire protection methods discovered and reported all fires before they could be spotted and reported by aircraft. "For the last season," the Assistant District (Regional) Forester adamantly stated, "we cannot sight /sic/ a single case of original discovery on National Forest areas by the Patrol."[36]

This decided difference of opinion between neighboring jurisdictions undoubtedly confounded the Washington Office. Although their personnel had similar backgrounds and training, the two could not have been more at odds. While both were using airplanes with identical preparation and equipment, Portland was inclined to retain its system of lookouts, while Missoula seemed ready to phase them out. In retrospect, the only factor that sheds light on these contradictory stances was that the Pacific Northwest, more heavily populated than the Northern Rockies, probably had a more refined telephone system connecting its lookouts. With more open space and fewer roads and trails in its territory, the Missoula office undoubtedly found a number of remote areas where early air patrol discovery was valuable.[37]

Radio Experiments, 1916-1928

Between 1916 and 1928, a number of other radio experiments were conducted, usually by individuals who claim to be the first on the National Forests. Except for the early experiments in Vermont and Arizona, they got little attention. One worth mentioning was conducted by Dr. H. Barringer Cox in 1916 on the old Santa Barbara National Forest. Though the experiment was not recorded, Assistant District (Regional) Forester T. D. Woodbury inspected the work and reported to the Chief Forester that "Dr. Cox's /wireless/ experiments, while not conclusive, show progress in the right direction and it seems clear that only time and money are required for him to work out some solution that will be eminently practical and decidedly useful to the Forest Service."[38]

The first documented efforts to demonstrate the usefulness of radio on a large scale were completed by R. B. Adams. Ring Bell Adams' interest in radio was coincidental with his interest and background in telephone. G. M. DeJarnette recalled that Adams, who gave him "so much hell" for the way he built his first telephone line, was also "... the first man I ever heard predict the /routine use of/ radio for our communication, and that was almost before 'radio was'."[39] Adams recalled that it was not until the spring of 1917 that he "... felt that there were strong possibilities in the use of ground radio ..." on the National Forests.[40] Because of the absence of radio-telephone (voice radio), which had to wait for an improved vacuum tube, Adams did not urge wireless for general field use until the winter of 1919,[41] after the success of radio during World War I. He then decided to broach the subject to the Chief Forester, Henry S. Graves, and was subsequently invited to Washington to confer with the Signal Corps and the Navy Department. Through the courtesy of Graves, Adams was able to borrow four SCR-67A's for experimental work. He shipped two to District (Region)

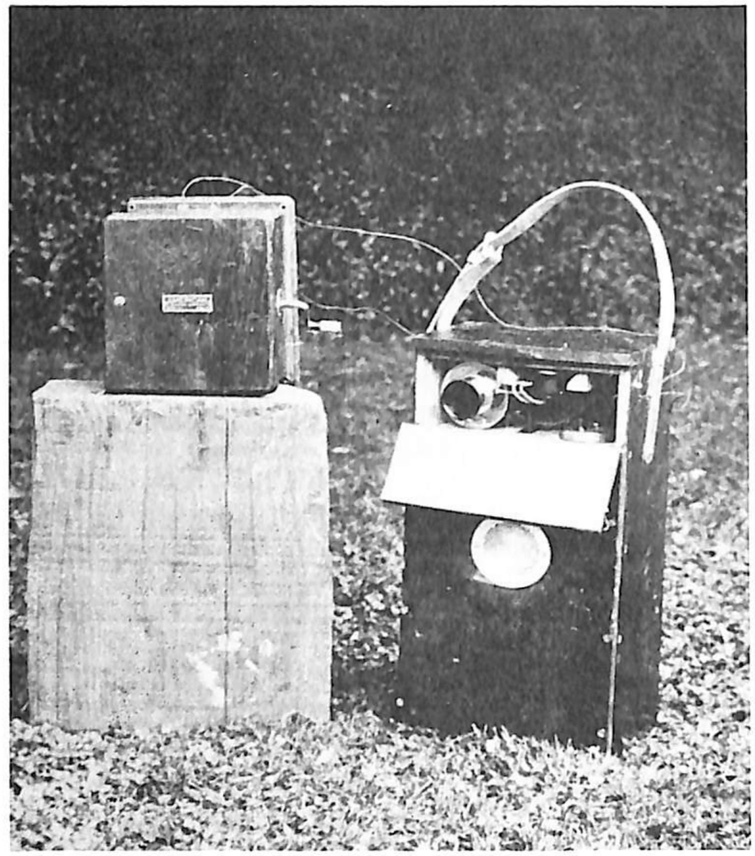


Figure 20. U.S. Army SCR-67A radio used by Forest Service in trial on Mt. Hood National Forest, Ore., 1919-20. (NA:95G-38733A).

6 for Clay Allen to use between Mt. Hood and the Zig Zag Ranger Station 12 miles away.[42] He kept the others for his experiments.[43]

Preliminary tests at Mt. Hood, Ore., proved satisfactory after a bamboo antenna mast was constructed to withstand wind speeds of 70 to 80 miles per hour and frequent sleet storms. In the conversations between the sets approximately 10 miles apart, "... the voice carried very clearly and was about as loud as over a wire line."[44]

In the meantime, the radios were set up to test the efficiency of the sets between Mud Creek Ranger Station near Lolo Hot Springs, Mont., and Beaver Ridge, Idaho, an airline distance of 12 miles.

Adams was worried by predictions that radios would be adversely affected by the proximity of "mineral zones," timber, and terrain, so the sites, separated by the Bitterroot Mountains Divide, promised an adequate challenge.[45] Adams called for a moratorium on other Forest Service radio experiments and purchases until the tests were complete. Then, with Everett Cutting assisting at Mud Creek, he set about transporting the equipment by a train of pack horses to the selected sites.[46]

One of the most trying tasks was moving 270 number 2 Burgess batteries necessary for the 350 volts of required plate potential, along with an Adams-designed dynamo for recharging, over 30 miles of trail. The trip proved the near undoing of the project. Quoting from Cutting's diary, Adams recounted the experience:

> July 8, 1919. Started out 7:30 A.M. with storage batteries, Beaver Ridge, over trail 30 miles long. Ate dinner Brush Fork then started up ridge. Had awful time. Windfalls very bad and rocks were everywhere predominate /sic/. The slope was unreasonable. After about an hour's time we had made very little progress. One pack horse (the last one) started pulling back. She kept pulling until she pulled the rest of the horses over and all rolled down the mountain about 100 feet to where a tree stopped them. Finally righted them again and started up. In a short time the horse repeated the performance, and this roll completely put the storage batteries out of commission, the electrolyte having completely run out.[47]

One week later on July 14, a set of new batteries arrived, and communication was established the following morning. These sets were operated continuously and amply demonstrated the practicality of radio during the 1919 summer fire season. One important incident occurred in late August when fire surrounded Beaver Ridge and threatened destruction of Cutting's radio camp. Perhaps recalling the difficulties encountered in the earlier stages, Cutting built a small raft, floated the set to the middle of the lake, and then beat a hasty retreat. When the fire was under control, he returned the set to the lookout and reestablished immediate communication. "An interesting constrast is shown here," reported Adams, "by the fact that a telephone line on the Clearwater Forest was destroyed by fire the same day, and it was not possible to restore telephone service for several days, even temporarily, due to the fire along the trail and the necessity of using a large crew to accomplish the work ..."[48]

In summarizing the results of the 1919 fire season, Ring Bell was very optimistic about the future of radio in the Forest Service. He pointed out the problems of static interference, transportation, battery recharging, and the necessity of leaving the sets on to receive signals. But he believed further experimentation could eliminate these inconveniences. After obtaining "excellent results" between the two stations which had 6 miles of heavy vegetation between them, he became satisfied that radio could be used in timber. Radio signals also provided "excellent" results over intervening high ridges. He gave similar praise to operation of the SCR-67A's in "mineral zones."[49]

However, Adams was still hesitant to recommend the total replacement of telephones by radio. He recommended a study of the 27,000 miles of Forest Service telephone lines to determine where it would prove economical to

Figure 21. Completing final splice on antenna jib at supervisor's office of Idaho (now Payette) National Forest, McCall, Idaho, 1921 or 1922. (NA:95G-170649)

replace them with wireless, and also continued tests the following season. Adams prepared for the tests by shipping the four high-powered sets to Thunder Mountain in District (Region) 4 where "... it is believed that the hardest possible test that could be given the radio telephone will be carried out ..."[50] Similarly, he forwarded a copy of his report to the Signal Corps along with a request for the loan of 24 additional sets. He planned to distribute these additional sets among Districts (Regions) 1 through 6 with the intention of inaugurating radio on a Servicewide basis.[51]

Not only did the Signal Corps deny his request--Adams ended up with five SE-1370 transmitters and five SE-1414 receivers from the Navy--but his plan to use radio in the six Districts (Regions) fizzled before it began.[52] The chief problem proved to be improper wiring of the SE sets. Pressed for time, Ring Bell could not figure out the error before the fire season was underway. In addition, the previously operable SCR-67A's on Thunder Mountain took a beating in shipment and needed repair. Without trained operators to get the "delicate equipment" working, there was little to do but wait for the 1921 season.[53]

The tests for the 1921 fire season were conducted with the Navy's SE equipment between Moore's Ranger Station on the Nez Perce National Forest and the town of Warren, Idaho, a distance of 43 air miles. A third set was also installed at Edwardsburg, Idaho, but operated for only a short period before it had an "unfortunate accident." The remaining sets operated effectively during the entire fire season, "... and the results obtained were all that could be desired" during the handling of some 200 official messages.[54]

Forest Service Cools Toward Radio

Although "R. B. provided it would work over reasonable distances,"[55] the Washington Office had decided that any further schemes for improving fire detection with radio including Air Service patrols and Adams' tests, would be difficult to justify. In fact, Roy Headley, Chief of Operation, was a little put out at the results. When District (Region) 3 requested either telephone or wireless on the Prescott National Forest, Headley said no to both. The Thunder Mountain Project, he resoundingly declared, had, "... demonstrated conclusively that wireless is a pretty complete failure in any ordinary scheme of Forest administration and protection." While he might agree to the transfer of equipment, Headley warned District (Region) 3 that he would "... be inclined to regard any money spent on the transportation and use of this equipment as good money thrown after bad." If this were not strong enough for anyone in the Forest Service who might still harbor positive thoughts about wireless, Headley pointed out that the Washington Office wanted no more "good money" spent until electrical engineers and electrical equipment companies developed wireless beyond its present limitations.[56]

The main lesson learned by the Washington Office during the 1919, 1920, and 1921 fire seasons was that radio as a communications tool was expensive--at least on a limited Forest Service budget. To demonstrate that two complete wireless stations could be installed, as Adams had said, for $2,000 to $2,500 less than a comparable telephone line[57] was of no significance if "unfortunate accidents," "delicate equipment," and "mis-wirings" resulted in inoperable equipment. Similarly, radio air patrols were of no benefit if, after 3 years, they "... were not found to produce results in first discoveries of fire great enough to justify the burden of keeping it up."[58]

Thus, by early 1923, Headley was in no mood to overlook the realities of radio use. In what amounted to a minor hand slap for the Intermountain District (R-4), he requested a "permanent record" be kept of the problems encountered at Thunder Mountain. "It is a pretty sad story if we allow the incident to drop out of sight without the making of any permanent record which can be used in future to guard against similar expensive projects," he wrote.[59]

In retrospect, the Washington Office probably took radio about as far as it could go in the late teens and early twenties. With two decades of development behind it, telephone had the advantage of being a proven, reliable instrument for point-to-point communication in spite of its shortcomings. The Adams demonstration that a relatively powerful, heavy radio set could transmit messages paralleling telephone lines was not of particular significance to the Forest Service's first line of defense. Smokechasers would still have to make their way to a fixed-base radio. Airplanes did show greater potential for filling the void between the time of first sighting and immediate action, but air-to-ground radio technology left too much to the imagination in 1921 and promised to be a very expensive tool to develop. Another serious barrier was the lease agreements with A. T. & T. that forbade competition, wireless or otherwise, for point-to-point communication.

Thus, the Forest Service considered further experiments potentially harmful, if not economically damaging, to a host of other Forest programs. Until technology could provide a communication device that was as economical, portable, speedy, and rugged as a carrier pigeon, the Forest Service would remain cool to any new radio schemes. As Roy Headley told the District (Regional) Forester in Albuquerque, "So much money that we need for other things has gone into wireless that I am not inclined to be open-minded on the subject at the present time."[60] The present time, for the Washington Office, lasted 5 years.

Reference Notes

1. David S. Olson, "Fords Come Into the National Forests," *Early Days in the Forest Service* (Missoula, Mont.: U.S. Department of Agriculture, Forest Service, Region 1, 1976), 4:171.

2. W. P. Powers, "Wireless Experimenting in Reporting Fires," *Fourth Annual Report of the /Vermont/ State Forester* (1912) typed copy, (n.p., n.d.), Gaylord A. Knight Collection.

3. W. P. Powers, "Wireless Experiments for Lookout Stations," *Fifth Annual Report of the /Vermont/ State Forester* (1913) typed copy, (n.p., n.d.), Gaylord A. Night Collection.

4. Powers, "Wireless Experiments."

5. Powers, "Wireless Experiments."

6. R. V. Slonaker, "Report on the Baseline Wireless Station, Apache National Forest, Arizona, and Wireless Investigations in the Southwestern National Forest District." Report prepared for U.S. Department of Agriculture, Forest Service, Washington, D.C., 18 January 1917. Typewritten (U.S. Department of Agriculture, Forest Service, Electronics Center /n.d./), p. 2.

7. Slonaker, "Report," p. 5.

8. Slonaker, "Report," p. 10.

9. Slonaker, "Report," p. 7.

10. Slonaker, "Report," p. 8. The Signal Corps also acknowledged receipt of the message, by telegram.

11. Slonaker, "Report," p. 13.

12. Slonaker, "Report," p. 9.

13. Malcolm E. Hardy, "The Use of Aircraft in Forest Fire Control" (Master of Forestry thesis, University of Washington, Seattle 1946), pp. 19-24. Also see "Report on the Oregon Aerial Forest Fire Patrol--Fire Season of 1920," typewritten (n.d.); untitled, typed report covering fire season of 1920, and "Report of Aerial Forest Fire Patrol for Season of 1920," by Air Officer, 9th Corps Area, San Francisco, typewritten (n.d.), all National Archives and Records Service, Seattle, Wash., File 66742, "USFS - Region 6, F- Cooperation."

14. U.S. Department of Agriculture, Forest Service, *Service Bulletin* 5, no. 21 (27 June 1921): 13.

15. "Radio Helps Fight Forest Fires," *Radio APCO Bulletin* (Association of Police Communication Officers) 29, no. 4 (April 1963): 14.

16. R. B. Adams, "The Use of Radio Telephone in the Forest Service" (Paper presented at the Missoula Section, Society of American Foresters, Jan. 22, 1923), pp. 15-16; Forest Service, *Service Bulletin* 5, no. 21 (27 June 1921): 13; and typed report, no title or date, National Archives and Records Service, Seattle, Wash., File 66742, "USFS - Region 6 - Cooperation."

17. Forest Service, *Service Bulletin* 5:21, 13.

18. Hardy, "Aircraft," p. 26.

19. Hardy, "Aircraft," pp. 25, 27.

20. Erle Kauffman, "Flying Foresters," *American Forests and Forest Life* 26, no. 4 (April 1930): 198. This was also reported as 772 preliminary sightings in the August 1921 issue of *Radio News*. A single daily flight was also conducted over the Coronado National Forest in

Region (District) 3, between the Army base at Nogales and Tucson, Ariz. It was arranged by the Tucson Chamber of Commerce, beginning May 25, 1921. Radio communication was to be maintained by the plane throughout its flight. See Forest Service, "Aerial Patrol in District," *Service Bulletin* 5, no. 20 (6, 13, 30 June 1921): 14.

21. Adams, "Use of Radio Telephones," p. 15.

22. W. C. Goldsborough, 1st Lt.-Air Service, and recommendations by Lt. Col. W. E. Gilmore, "Airplane Forest Fire Patrol Report--Season of 1922." Typed copy, (n.d.) National Archives and Records Service, Seattle, Wash., File 66742 and Hardy, "Aircraft," p. 31.

23. Robert W. Ruhl, "Fighting Forest Fire From the Sky," *Leslie's Illustrated Weekly*, 24 September 1921, p. 412.

24. Hardy, "Aircraft," p. 31.

25. Goldsborough and Gilmore, "Airplane Forest Fire Patrol Report."

26. Goldsborough and Gilmore, "Airplane Forest Fire Patrol Report."

27. Kauffmann, "Flying Foresters," p. 198. This might have been Kauffman's paraphrase or summary of Gilmore's remarks. Hardy, "Aircraft," p. 31.

28. Goldsborough and Gilmore, "Airplane Forest Fire Patrol Report," p. 10.

29. Hardy, "Aircraft," pp. 32, 33.

30. Hardy, "Aircraft," p. 33.

31. Hardy, "Aircraft," p. 34.

32. Hardy, "Aircraft," p. 36.

33. Hardy, "Aircraft," p. 37.

34. Hardy, "Aircraft," p. 38.

35. "Air Patrol Program-1926," Dec. 15, 1926. Typed copy under signature of Assistant District (Regional) Forester A. O. Waha, C. J. Buck's supervisor (R-6), National Archives and Records Service, Seattle, Wash., File 66742, "USFS - Region 6, F-Cooperation."

36. "Air Patrol Program-1926."

37. This theory was suggested by communication officers of a decade later. See my interviews with Wilbur Claypool and William Apgar: Wilbur Claypool, interview with author in San Antonio, Tex., July 1978 and William Apgar, interview with the author in Sun City, Ariz., January 1978.

38. T. D. Woodbury, "Monthly Report for April, 1916," to the Forester, April 1916 (National Archives, Washington, D.C., Record Group 95G, Records of the Forest Service, Row 1, Section 17, Drawer 103, "File D-5.").

39. G. M. DeJarnette, "Recollections," *Early Days in the Forest Service* (Missoula, Mont.: U. S. Department of Agriculture, Forest Service, Region 1, 1976), 3:60.

40. Adams, "Use of Radio Telephones," p. 2.

41. R. B. Adams, like many others, held the belief that telegraphy required expert operators. See Adams, "Use of Radio Telephones," p. 20.

42. *American Forestry* 25, no. 7 (July 1919): 1244.

43. (R. B. Adams), (n.p., n.d.), Gaylord Knight Collection. The author is purported to be R. B. Adams. The text, however, suggests a Washington Office document intended for publication

and written, or rewritten, by other than Adams. The contents are consistent with other accounts of the time.

44. "Foresters Test Wireless Phones," *American Forestry* 26, no. 4 (April 1920): 254.

45. Adams, "Use of Radio Telephones," p. 3 and (Adams).

46. R. B. Adams to District (Regional) Forester, 28 June 1919, National Archives, Washington, D.C., Record Group 95G, Records of the Forest Service, Row 3, Section 20, Box 12, "Division of Engineering, Records of Regional Office, #7."

47. Adams, "Use of Radio Telephones," p. 3.

48. Adams, "Use of Radio Telephones," p. 5 and R. B. Adams, "Memorandum for the Forester," 14 February 1918, National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS - O, Improvements, Telephone."

49. Adams, "Memorandum," p. 3.

50. Adams, "Memorandum," p. 3.

51. J. R. Riggs, Acting Secretary, U.S. Department of Agriculture to Secretary of War, 23 March 1920, National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS - O, Improvements, Telephone."

52. R. B. Adams to Roy Headley, 13 April 1920, p. 6, Gaylord A. Knight Collection. General Electric modified these sets for 800 to 1,000-meter use.

53. U.S. Department of Agriculture, Forest Service, *Service Bulletin* 5, no. 28 (15 August 1921): 2, 3. The comments on the inoperable sets were in Roy Headley to Lt. Rash, Camp Alfred Vail, New Jersey, 17 January 1923, National Archives, Washington, D.C., Record Group 95G, Row 3, Section 20, Box 22, "USFS - F, Control, Equipment, N-R."

54. Adams, "Use of Radio Telephones," p. 5.

55. Clyde Fickes, interview with the author in Missoula, Mont., May 1978. Mr. Fickes assisted Adams in the 1921 experiment.

56. Roy Headley to District (Regional) Forester (R-3), 28 November 1922, National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS, O-Improvements, Telephone," By the following spring, Headley had softened somewhat and allowed an experiment with the SCR-67A's on Medicine Bow Peak, Wyo. See Roy Headley to W. A. Wheeler, USDA Bureau of Agricultural Economics, 27 April 1923; and M. L. (Loveridge) to R. H. (Headley), 18 April 1923, both National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS, O-Improvements, Telephone."

57. Adams, "Memorandum," p. 12.

58. Headley to Rash.

59. Roy Headley to District (Regional) Forester, Ogden, Utah, 17 February 1923, National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS, O-Improvements, Telephone."

60. Headley to District (Regional) Forester (R-3), Albuquerque, N.M., 17 February 1923, National Archives, Washington, D.C., Record Group 95G, Row 2, Section 14, Box 18, "USFS, O-Improvements, Telephone."

Chapter III
Dwight Beatty:
Selling the Forest Service on Radio

> *Late one afternoon, in a park-like grove of timber near Missoula, Montana, during the spring of 1927, a small group of men studied with interest a crude little contraption of coils and condensers built around a single 199 radio receiving tube. Attached were a couple of small copper wires, one stretched some 20 feet high by cords thrown over convenient limbs and the other stretched between trees close to the ground. These wires served as an antenna system for the apparatus which in spite of its small size was a fairly efficient radio receiver and code transmitter. The author had constructed it to check-up the possibilities of extremely low-power radio communication in the woods with the idea of using it to supplement the regular Forest Service telephone communication system.*
>
> \- Dwight L. Beatty[1]

This description, the opening paragraph in Dwight L. Beatty's lengthy 1931 report, "Radio Communication in the National Forests," recounted the demonstration that rekindled Roy Headley's interest in wireless. The author, a 20-year veteran of Region 1, had acquired an interest in radio while progressing from Forest Ranger, Deputy Supervisor, and Supervisor of three National Forests to the rank of Inspector in the Office of Operation at Missoula.[2] Convinced that ultralight radio could serve as a valuable communication tool for ground personnel, Beatty had set out in 1925 to educate himself on the intricacies of radio and to design a lightweight code transmitter-receiver.[3] This interest culminated in the impromptu demonstration in mid-August 1927 of the "crude little contraption" for Headley, Washington Office Chief of Operation; Colonel William B. Greeley, Chief Forester; Earl W. Loveridge, Headley's assistant; and several District (Regional) personnel attending a fire conference in Missoula.

Beatty was remembered as a pleasant, impressive individual, large in stature and with a good husky build. He was described as meticulous about Forest Service regulations, although he was not averse to a roaring night on the town with a close friend. His attention to detail is reflected in a number of his studies and experiments and in his penchant for considering every possible situation that might affect an outcome. To him, such details as turning a vehicle around "just in case a fire started and you came out in a hell of a hurry," were not matters to be overlooked.[5] Always curious about the ability of firefighting crews to control a major conflagration, he sought to design and construct aids that provided an improved margin of effectiveness. One of his designs, a trail grader, eventually proved to be "... an advantage on practically all trail construction projects at a great savings in trail construction costs in comparison with hand labor."[6]

At Missoula, Beatty had selected a wavelength of approximately 200 meters for "an old 5-watt army phone" at his residence and the "crude little contraption" a short distance away.[7] This home-built set--complete with batteries, phones, antenna, and counterpoise--weighed less than 7 pounds. After taking about 15 minutes to set up the rig, Beatty "... tuned up the transmitter and began pounding out the call with the /telegraph/ key mounted on the baseboard of the set."[8] After sending the call several times to a partner, he switched over to receive and was notified that the call was going through. Colonel Greeley, Headley, and Loveridge took turns listening to transmissions from Beatty's partner and then adjourned to the house where they talked briefly with Beatty. The foresters were favorably impressed with the results and discussed the matter further after returning to the fire conference. "It was the conclusion that the matter should be followed up during the coming fall or winter and the author /Beatty/, regardless of his protests and much to his dismay, was assigned the job of 'follow up.'"[9]

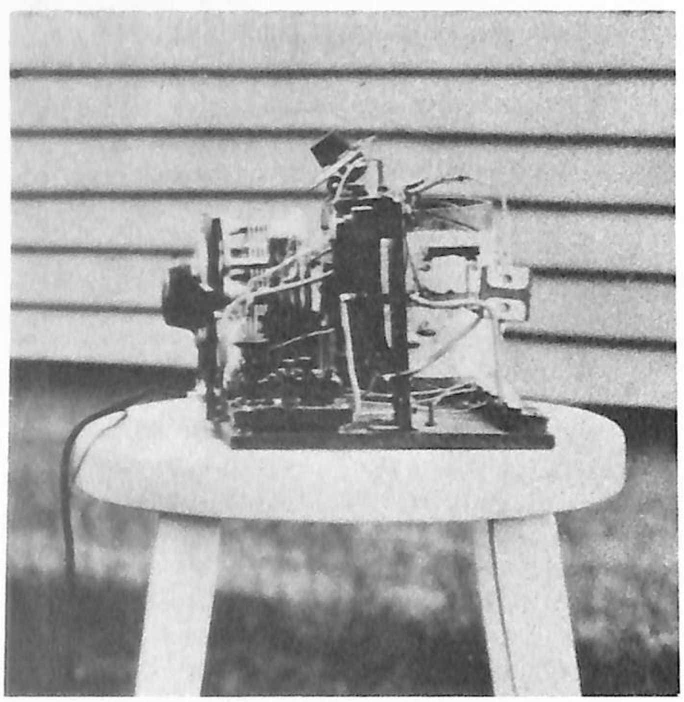


Figure 22. Dwight Beatty's "crude little contraption of coils and condensers...a fairly efficient radio receiver and code transmitter," which was demonstrated to Forest Service leaders at the 1927 Fire Conference in Missoula, Mont. As a result, the agency again encouraged the use of lightweight radios in the field for fire control. (Forest Service photo, History Section)

Beatty concluded that two types of sets were required for the project. In the ultralight category, he conceived of a code transmitter-receiver rugged enough to be included in a firefighter's backpack. A second type, perhaps a larger version of the ultralight, would have to be transportable by pack animal, quick to assemble, and useful to small crews continually on the move and away from telephone lines. This larger set, on the order of 50 watts and between 50 and 100 pounds, could also be used to send information about large fires when it was not feasible to connect into the telephone system.[10]

At this early date, Dwight Beatty had established the three primary types of radio communication that would prove most beneficial to the Forest Service. Starting from the smallest set and working up, he had effectively defined a portable radio, semiportable radio, and temporary or field-base station. For at least 2 decades, these three classifications were used for all radios designed and developed by Forest Service communication experts. These sets had no equal in their classes during the 1930's.

Beatty also defined specific design and construction practices that were of lasting value. Recognizing that the sets had to stand up under rough usage, he decided to substitute rugged components for those that were adequate under less demanding circumstances. He considered essential to the success of the mission such alterations as "a good grade flexible wire rather than stiff bus wire," plug-in meters that rode in sponge rubber compartments, and frequency adjustments that could be "set and locked" before the apparatus went to the field.

Knowing that R. B. Adams had failed largely because the commercially produced Army and Navy sets were not reliable under rugged field use, Beatty made a mental note to guard against any construction practices that would make the sets vulnerable to unusual treatment.[12]

Simplicity of operation was also important to Beatty. "Since the sets would usually be operated by inexperienced men, tuning controls and adjustments should be reduced to the minimum and simplicity should rule in the design of the entire apparatus from power supply to antenna system."[13]

Beatty established three watchwords for radio design in the Forest Service: Simple, Rugged, Reliable. Between 1932 and 1952, no Forest Service prototype left the laboratory without being subjected to tests insuring that each criterion was met.

Beatty Starts Project

After the Missoula demonstration, Beatty set off on a tour of the West Coast to consult with the Army Signal Corps, leading radio amateurs, and prominent people in commercial radio to determine the feasibility of his plan and to make certain that similar work was not underway or completed somewhere else. The most fruitful discussions were held with a Mr. Mason of the Seattle Radio Laboratory, former Chief Radio Operator for the 1926 and 1927 Wilkens Arctic expeditions and former department editor of the amateur radio magazine *QST*. Though not entirely encouraging, Mason informed Beatty that practically no work had been done with lightweight, low-power equipment, primarily because there was no demand for it. But Mason considered the project feasible if the problems of dense timber and rough topography could be overcome without affecting weight and power limitations.[14]

Returning to Missoula, Beatty spent several months perfecting the contraption, altering it to transmit and receive on the same selected wavelength. "The set was designed to work at high frequencies," he wrote, "and voice reception tests were made on distant stations, using KDKA, [Pittsburgh] ..."

"Regeneration control is smooth," he continued, "and the set goes into oscillation smoothly so the reception of c.w. (continuous wave) [code] is excellent."[15]

Experiments with the antenna proved more troublesome. In using a "tuned antenna" with counterpoise, the frequent movement of the wires changed the transmitted wavelength. Height changes also had a small effect; but wind, which caused the wires to sway, provided the most noticeable change in frequency. Beatty reasoned that "an untuned comparatively short antenna, tighter coupling and loading coil will remedy this to a considerable extent, but this less efficient method may result in too low an output even when using the maximum power available under our conditions."[16]

While waiting for weather conditions to improve, he considered many of the experiments that should be conducted during field tests. Beatty's talent for scientific inquiry is apparent from his list of important experiments, which reveal a comprehensive grasp of the problems and scope of the project.

A suitable wavelength for Forest Service use headed the list of his priorities.[17] The importance of wavelength--the frequency at which messages can be transmitted and received--had a decided effect upon many future decisions, including the success or failure of the project, because frequency has a direct relationship to every component in a communication device. Beatty had to balance the following technical considerations: The lower a frequency selected for the operating range, or band, for example, the longer the antenna wire, the more space required for installation and the greater weight of that component.

Higher frequencies provide other weight savings. As a general rule of thumb, the higher the frequency, the less output power required to transmit a message over short distances. With output power directly related to the power supply, which is the battery pack in portables, a decrease in power nets a corresponding decrease in battery weight. If transmitter output power is halved, only half the number of batteries is usually required. With this in mind, it would appear that Beatty's task of selcting a frequency would be the relatively simple matter of selecting the highest possible one. But radio technology in the 1920's was not advanced enough, and suitable high-frequency components were often neither available nor reliable. Tradeoffs between components and frequency required considerable experimentation before Beatty could select a satisfactory frequency medium.

Beatty was equally attentive to other practical details, such as a quick and efficient method for using tree limbs for antenna supports, the advantage of various power supplies, testing other simple and dependable circuits, trying varieties of vacuum tubes, and radiophone or voice radio transmission.[18] Before these tests could be completed, Roy Headley called Beatty to Washington.

The immediate reason was for Beatty to testify before the Inter-Department Radio Advisory Committee (IRAC) on the need for assigning frequencies to the Forest Service. IRAC has regulated use of radio by Government agencies much like the Federal Communications Commission (FCC) has done for many years for private industry.

The intragovernmental counterpart of the Federal Communications Commission (IRAC) was formed in 1923 by joint agreement of the executive agencies in a move to bring order to the assignment of radio frequencies within the Federal community. According to IRAC bylaws, this action was necessary because "... the demand for radio frequencies greatly exceeds the supply, and to make the most efficient and orderly use of the spectrum in the national interest, action by the IRAC is predicated on consideration of all available data, including international regulations, availability of other possible communication facilities, and technical aspects.[19]

Initially the committee was agreeable to a blanket assignment between 2,000 and 4,000 kilohertz (kHz), but after considerable discussion the members settled on the four fixed frequencies of 3,114, 3,172, 3,250, and 3,286 kHz (approximately 100 meters in wavelength), with the understanding that the Forest Service might need other assignments.[20]

Beatty took advantage of the trip to travel the East Coast seeking the advice of all who would talk with him. The results were not encouraging. Manufacturers were not interested in producing sets with the size and weight limitations he imposed. In addition, no work was being conducted in either the Government or commercial sectors on radiation in mountainous, heavy timber. Some experts believed inexperienced personnel could not operate the sets, that low power would not reach more than a mile, and that topography would cause a loss of radio energy. Others were sure that transmissions above 4,000 kHz would be absorbed by timber, while transmissions under 3,300 kHz would be handicapped by antenna length. The list went on.[21] Reported Beatty:

> The net result lowered /my/ spirit and enthusiasm ... to well below the zero mark. It appeared that no attempt had ever been made to use lower power, short wave radio communication in rough topography and green timber, and that there was no agency likely to initiate such a venture. Further, it was the majority opinion that the proposition was not feasible and the most optimistic termed it, at best, a gamble. There was a bewildering conflict in opinion and advice. /I/ ... learned that there was no equipment on the market suitable for even the check-up work necessary to determine whether or not short wave, low power signals could be transmitted any worthwhile distance, under the obviously difficult conditions.[22]

Amidst all the contradictory opinions, Beatty found two encouraging voices at the National Bureau of Standards (NBS). Though not firm, they gave Beatty the incentive to go on alone. Drs. J. Howard Dellinger and Charles B. Joliffe of the NBS Radio Section, two prominent radio pioneers, offered their expertise in a constructive manner; although somewhat in agreement with the skeptics, they tempered their opinions and admitted that Beatty might find the results not as bad as generally accepted theory indicated. They advised Beatty the experiment was "... a gamble but you are risking a comparatively small amount of money in view of the returns if successful."[23]

With this encouragement, Beatty departed for Missoula after having secured call signals 7XAP and 7XAQ for the Forest Service work.[24]

Forest Service Approves Experiment

In the meantime, the Washington Office concerned itself with how to pay for Beatty's work. With more than a casual interest in the outcome, District (Region) 6 was putting pressure on Roy Headley to involve Clay Allen in the study and to form its own committee to keep track of the progress.[25] Roy Headley agreed and wrote Chief Forester Greeley on April 5, 1928, that "Beatty's work on radio has gotten to the point where we should drop the matter or go ahead with the deliberate intention of spending up to a maximum of $15,000 or $20,000 on the radio project."[26]

Assuring the Chief that Beatty could develop a portable radio, Headley proposed relieving Beatty of other duties and funding the project through fire equipment funds maintained by the Regional Office in Ogden, Utah. This meant that the Forest Service would "... have to depend very largely on Beatty's judgment," but Headley pointed out that three District Foresters (1, 3, and 6) and Clay Allen had confidence in Beatty's ability. He added, "I am convinced this is right."[27] Recognizing that the project was a gamble, he asked the Forest Service to be "... prepared to go cheerfully to a $15,000-to $20,000-limit, win or lose."[28] Chief Greeley concurred, and Beatty prepared for experiments to be conducted during the 1928 fire season.

To get to the field as soon as possible, Beatty ordered two combined transmitters and receivers from the Aero Company. When they arrived, he was dismayed to find them not only heavy and bulky, but not built to specifications. Pressed for time, he set out to rewire them. With the snow season approaching, he gave up on the receivers in these units and opted for some "breadboard" models he had previously built.

The experiments took place outside Newport on the Kaniksu National Forest in eastern Washington State and were sufficiently encouraging to Beatty. Before the weather got rough, he concluded "... that a low powered radio signal *would* 'get out' of the tall timber and have considerable pep left even after it had travelled several miles."[29]

With this success behind him, Beatty spent the next few weeks considering the next course of action. The main problem was the Aero set's relative bulk and weight; it severely restricted frequent relocations and prohibited the use of many promising test sites. A set designed in the semiportable class would greatly facilitate moving from regions of flat, heavy timber to areas of rugged topography. This move was important to the experiment. Independent tests on the "shadow" effects of terrain and the "absorption" characteristics of green timber were important so that the effects of each could be distinguished and separated. Design of a semiportable also would be a logical step toward determining the final design characteristics of a set to be used in the second year of the program.[30]

During the 1928-29 winter, Beatty made a thorough review of radio principles and practices. Displaying an untiring interest in self-education, he also undertook a complete study of construction materials. Most urgent was a receiver design, which consumed much time:

> Various circuits and arrangements were built up and compared. Considerable attention was also devoted to a monitor scheme whereby the detector tube could be used to tune the transmitting antenna to resonance. This was worked out successfully and included in the receiving apparatus...to enable checks to be made in the field of the accuracy of the proposed tuning method and also to determine whether or not it would be reliable in the hands of comparatively inexperienced men.[31]

Beatty used the knowledge gained during this off-season to design a set that would facilitate many different experiments. His selection of a suitcase-style enclosure with hinged front and back panels indicates that Beatty was mindful of the need to experiment with several combinations of tubes and coils. Beatty completed construction in time for experiments during the summer of 1929. He dubbed the set SP-1929, for "semiportable" and the year.

The test site selected was 18 miles south of Tacoma, Wash. The area was flat, heavily timbered, devoid of streams and overhead wires, and a short drive from the rugged, heavily timbered Cascade

Figure 23. Dwight Beatty operating the SP-1929 set he designed -- the first successful lightweight low-power radio receiver-transmitter tested in heavy timber. (NA:95G-250701)

Mountains. With his usual exacting, tedious care, Beatty set out to find the answers to questions posed the year before. "Every detail such as time of day, condition of batteries, antenna height, direction, size of wire, insulation, chances of error due to mistakes in operating equipment, adjustment of equipment, etc., required thoro /sic/ attention."[32]

The most important question was what happens to radio signals in green timber? To determine the effects, he set up two identical transmitting systems 1/4 mile apart--one in a clearing and the other surrounded by timber 200 feet tall. He paid close attention to the length and height of the wire. The two sets were laid out identically by compass. He set up a recording station 6-1/2 miles due north and placed a backup unit on the outskirts of Tacoma. Both receivers at the recording stations were without radio frequency amplification and were identically shielded. Broadcasting was conducted on wavelengths of 72 and 91 meters, and the signal strength measured with a vacuum tube voltmeter.[33]

The results were most heartening. Signals at the closest station showed an average loss of about 30 percent, while recordings near Tacoma indicated that the losses were not noticeable to the ear.[34] Of equal interest to Beatty were the different performances on the three selected frequencies. He discovered that both static and electrical interference and swing and fading of the signal appreciably affected reception, depending on the frequency used and the time of transmission. This phenomenon, he observed, was the result of both normal vertical incidence return from the ionosphere and the absorption and shielding of the signal by timber.[35]

Beatty then measured the shadow effect of mountains. He approached the task with the same attention to detail. The results of the tests were similar to the preceding ones. The 91-meter band proved superior at night and the 55-meter band operated best during the day.[36] Beatty, therefore, conceived a set using both channels, but expressed concern that it might be too complex and difficult for inexperienced operators.[37]

Beatty's Radio Is Successful

Following a brief experiment with a microphone in the circuit of the SP-1929 and successful transmissions over 5 to 8 miles, Beatty concluded, "These results indicated clearly that the project was feasible and the next step was the design and construction of a field set for use with improvement crews."[38]

For the first time in nearly a decade, Roy Headley began to relax when the subject of wireless was discussed. Despite his disapproval of earlier efforts, he was a firm believer in the great potential of radio for the National Forests. He undoubtedly found it difficult to wait for technology to catch up with his expectations and hopes. In a brief article for the *Service Bulletin* after Beatty's successful experiments, he immediately displayed his enthusiasm and, no doubt, relief. He wrote, "The net result of the general check-up which Mr. D. L. Beatty of District 1 has been making on low power radio communication for the last two years indicated that our faith in its possibilities will be fully justified."[39] A few months later he wrote to Beatty about the coming experiments and voiced his thanks and esteem. "... You already know," he freely admitted, "how much confidence I have in you for carrying through our program."[40]

Beatty tried to interest various radio manufacturers along the West Coast in building a suitable code transmitter-receiver. Much to his dismay, he found that "commercial concerns could not seem to obtain a sufficiently thoro /sic/ grasp of requirements and limitations to enable them to design portable transmitters and receivers suitable for our use."[41] In addition, he found that West Coast electronic firms were not in a position to both design and build sets in time for use during the 1930 fire season.[42] Once again Beatty returned to the drawing board; once again he set out to educate himself.

He needed a prototype that a manufacturer could copy piece by piece and measurement by measurement, so he had "... to study materials such as aluminum alloys, castings, bakelite type products, methods of working them (bending, cutting, drilling, etc.), electrical characteristics, liability of breakage, etc."[43] Because he also wished to have a set devoid of meters, "... and incorporating features that I had never seen in radio equipment, considerable work of an inventive character was required which is especially difficult when working against time."[44] The search for standard radio parts that would withstand abuse, and quantity production methods and techniques, as well as developing circuit and working drawings, consumed more of his time. But the most perplexing problem was to accomplish all this while remaining within Government procurement regulations. He vented his frustrations to Roy Headley:

> Considering the other demands of my time the correspondence, memorandums, field notes, vouchers, preparation of bids, expenditure records, and other office work, has been of sufficient volume to seriously embarrass me. Added to this is the extreme difficulty of purchasing the special parts and materials needed (and usually needed immediately) without violating the Fiscal Regulations. To purchase things one *may* need would be extravagance, yet to explain clearly why a need could not have been anticipated is many times almost impossible when dealing with men who have little or no understanding of a creative job of this character. It is simple enough to secure the best price for the article needed but quite a different matter to buy it and comply with Fiscal Regulations when one is limited to a $50 purchase of a single concern in an month; this doesn't mean much buying groceries on short notice but tis a real problem when purchasing unusual radio parts. I have prepared bids for many things but never found anything so difficult to handle as radio parts, tubes and batteries."[45]

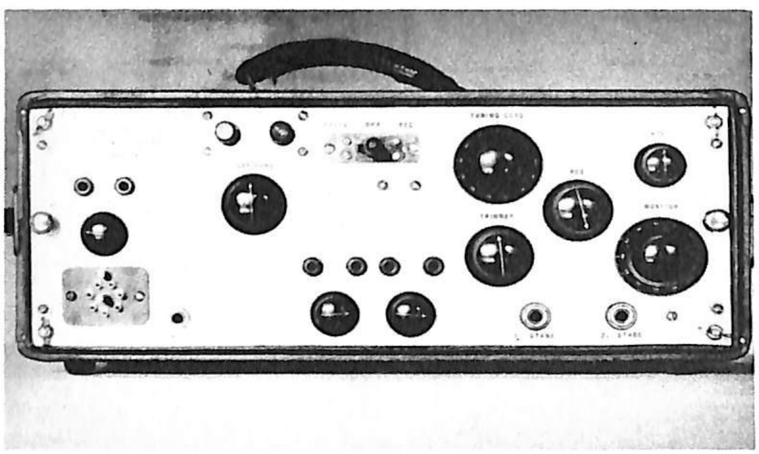


Figure 24. Front view of the SP-1930 set built by Dwight Beatty. The code transmitter-receiver proved a great success in mountainous terrain, even at distances of 40 miles, earning high praise from Government radio experts. Enclosed in a leatherette-covered night-case for easy carrying, it weighed just under 17 pounds. (NA:95G-249752)

The semiportable prototype (SP-1930) was complete by February 1930. It was a "strictly conventional" transmitter-receiver design employing a keyed oscillator and simple regenerative detector.[46] A monitor was included in the circuit to help the operator hear the code as it was transmitted. The only meter was a plug-in voltmeter carried in a sponge-rubber-lined compartment.

The emphasis was on simplicity. Access to the interior was obtained by removing four wing nuts. The use of a screw-driver for a reel mount to wind the antenna indicates each part was extended to its maximum application. Beatty had the frequency set and locked before the unit went to the field. Enclosed in a leatherette-covered nightcase, the SP-1930 with batteries and antenna appeared lighter than its 79 pounds, 5 ounces. It was 20 pounds less when outfitted with smaller batteries for emergency use.[47]

With the SP-1930 under his arm, Beatty left for the East Coast to consult with the authorities at NBS and the Naval Research Laboratory (NRL) on the merit of his design. At NRL, Dr. Lynde P. Wheeler examined the model and told Beatty, "You are to be congratulated; you have done an excellent job. It is the best looking job that has been brought in here in a long time."[48] At NBS, Harry Diamond reported to Dr. Dellinger, "... that he was very favorably impressed with the model radio set, that it showed very care-ful study, and every detail was an efficient arrangement from an engineer-ing standpoint."[49] (Diamond was an ordnance expert who developed the military proximity fuse and later formed his own company.)

Armed with this heady information, Beatty informed a meeting of Regional Foresters in Washington, D.C., of the status of radio on the National Forests. Based on the information gathered during his trip, he was certain that radio was on the verge of becoming a

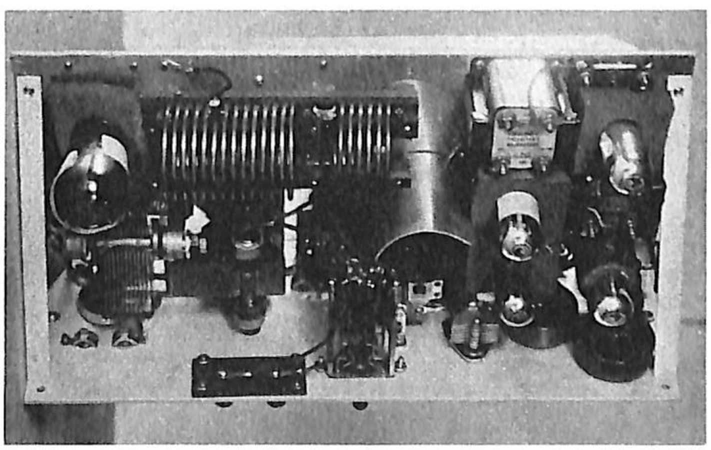


Figure 25. Top view of SP-1930 with cover removed. Note sponge rubber at base of tubes for protection from rough handling. Battery, antenna, and other equipment brought total weight to just under 80 pounds. See also figure 29. (Forest Service photo, History Section)

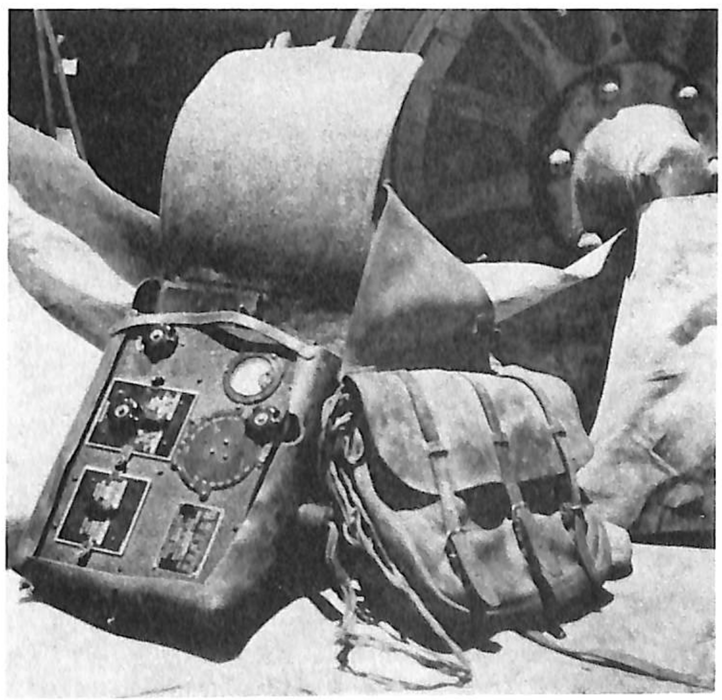


Figure 26. U.S. Army Signal Corps portable radio used on Coconino and Lincoln National Forests in Arizona and New Mexico in 1921. (NA:95G-259786)

Figure 27. The SP-1930 packed for travel. At left, equipment case, 11 pounds, 11 ounces. Center, battery case, 44 pounds, and sack of antenna equipment, 5 pounds, 12 ounces. At right, transmitter-receiver, 17 pounds, 14 ounces. (NA:95G-249318)

valuable tool for the foresters in spite of all that remained to be done. He said, "My personal slant is this: If we feel that radio communication is an important factor in the solution of the fire problem, ways and means can be found to use it however difficult it may appear from some angles." The information Beatty was undoubtedly most pleased to pass on to the gathering was the cost of one SP-1930. Contrary to estimates of $400 to $500, Spokane Radio Co. bid the job at $110.35.[50]

The only questions remaining concerned actual field use and the capability of untrained personnel to operate the set. Beatty returned to the Pacific Northwest to supervise the final experiment.

His Field Set Is Tested

The site chosen for the 130 tests was the Columbia (now Gifford Pinchot) National Forest, east of Vancouver, Wash., and north of the Columbia River.[51] The Northern Electric Co. of Seattle provided a fixed-base, 50-watt phone (voice) transmitter, operating at 3,265 kHz. Beatty used the call letters W7XAQ, which he had been authorized to use 2 years earlier. This unit served as the dispatcher's headquarters at Hemlock Ranger Station, but a small, nearby hydroelectric power plant often drowned out reception and restricted communications to intermittent use during periods of low water level. An SP-1930 was provided for backup. Six semiportable sets were distributed to work crews who had no other means of communication, and a seventh set was permanently located in the lookout station on Dog Mountain. The distance between Hemlock and Dog Mountain was 12 air line miles; the distance between Hemlock and the crews ranged from a few to 40 miles.[52]

Dog Mountain was the site of a temporary lookout position for a vast expanse of Forest parallel to the Columbia River Highway. It had no telephone. Because of its importance and its proximity to public use, this stretch of Forest had a high fire danger during the summer months. For these reasons, Supervisor John R. Bruckart and Beatty had concluded that Dog Mountain would be an ideal location to test the SP-1930 in a fixed-base situation, since the stringing of an emergency telephone line was estimated to be a 3-day job for three men and a pack string.[53]

The individuals selected as operators were given instruction on the fundamentals of the SP-1930 and provided with a 13-page manual[54] that included a code chart. They were shown how to make dots and dashes with the telegraph key. Messages were to be written out in these dots and dashes before transmission; the person at the receiving end was then expected to reverse the process, referring to the code chart for translation. In addition to the standard amateur radio "Q" abbreviations to represent words, actions, questions, and statements, a series of key letters and numerals were combined to represent the most common messages expected for transmission. For instance, the message "N6MT5GB" meant, "Need (6) more men with tools, grub for 5 days and blankets."[55] As might be expected, "The system was slow, but it worked."[56]

The semiportable sets proved a resounding success during the 1930 fire season. "The records," Beatty wrote, "show a 94% or better message transmission reliability ... working over distances up to 40 miles and across the roughest topography."[57]

The operators also demonstrated that experience was not essential. From the start, these young men could order supplies and reports, and in a couple of weeks were sending six to eight words per minute clearly.[58] None, however, probably outdid Fred Good on the Lewis River. "Within one week he was putting out an order for groceries, canvas gloves and 'snoose' for the Swedes."[59]

Radio communication during the Dog Mountain fire illustrated the importance of radio in the Forest Service, amply rewarding Dwight Beatty for the many months he had searched for a communication device to improve upon the

Figure 28. Dwight Beatty testing the SP-1930 in the field. (NA:95G-256905).

Figure 29. Hemlock Ranger Station, Columbia (now Gifford Pinchot) National Forest, Wind River, Wash., September 1920. Note antenna towers in background, used for transmitting the fire dispatcher's voice to fire crews in the field with SP-1930 sets. (NA:95G-249760).

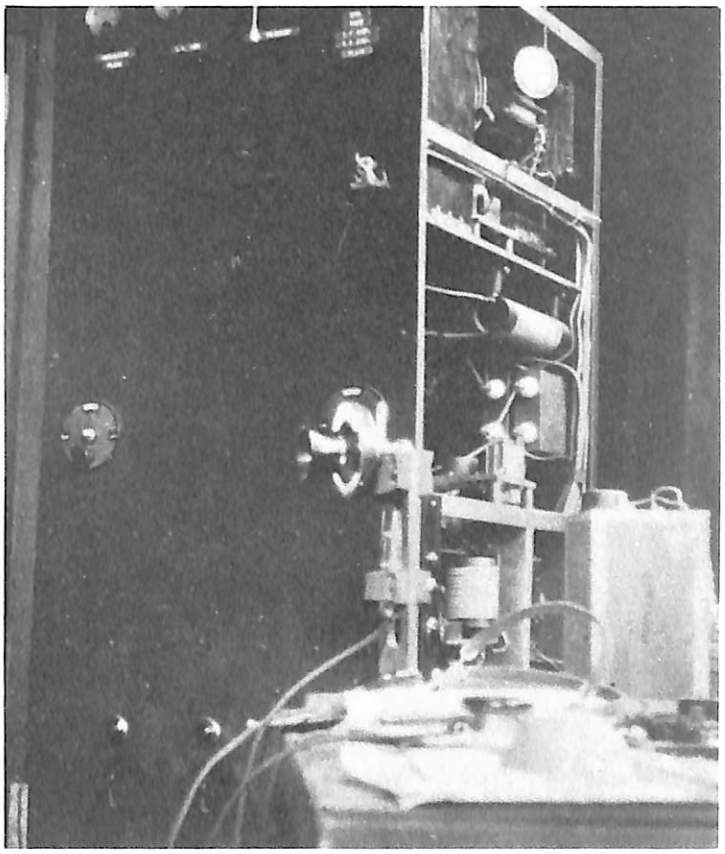


Figure 30. Radiophone transmitter of the Northern Electric Company, used by the Forest Service at Hemlock Ranger Station, Wind River, Wash., in a field test in 1930. (Forest Service photo, History Section).

telephone. On July 4, a fire was spotted by the lookout, Bob Walker, and reported to Hemlock. Soon a Ranger arrived at the scene with an additional SP-1930 to direct firefighting operations. By the third day, as Federal and State crews fought to contain the blaze, personnel at the distant fire base called

Figure 31. Fire crew on Columbia (now Gifford Pinchot) National Forest, Wash., watching Dwight Beatty demonstrate the SP-1930 set. They learned to operate the sets themselves on fires during the 1930 season. Note counterpoise antenna at waist level. (Forest Service photo, History Section).

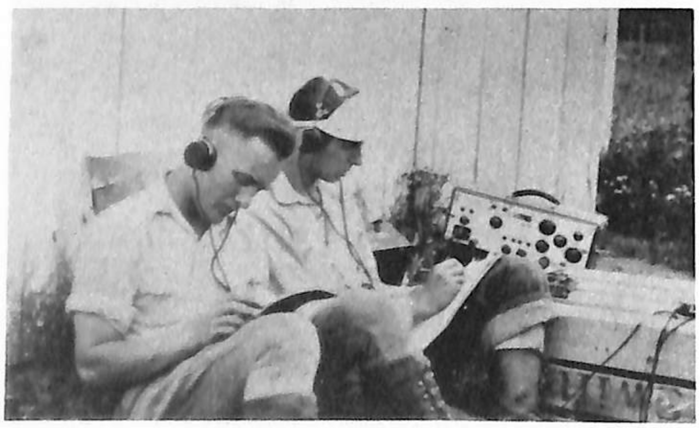


Figure 32. Code practice session for fire crew operating the SP-1930 set (in background) on the Columbia (now Gifford Pinchot) National Forest, Wash., 1930. (Forest Service photo, History Section).

for a third SP-1930. On the 10th day of the fire, Bob Walker frantically sent off a coded message to Hemlock requesting instructions as the fire headed for his observation post. He was instructed to wrap the radio equipment in a blanket, bury it, and get off the mountain. "This he did and came off the mountain in record time and, by the way," recalled a Mr. Mann, "a goat which he has for company and also for milk was right at his heels bleating every jump."[60] The fire burned for 2 weeks across 1,800 acres. After the fire danger passed, Walker returned to his camp, presumably with the goat, dug up the radio and continued making radio contact through the summer--a feat impossible to duplicate with the telephone.

Test Confirms Worth of Low-Power Radio

The Columbia National Forest tests answered the remaining questions about Forest Service radio communication. The operation of radio in the field and the ease with which inexperienced operators were able to adapt to the new tool signaled an end to the first phase of Beatty's work. "From the results obtained," he stated in his 1931 report, "it seems reasonable to conclude that low-power radio communication may be successfully used in mountain and timbered regions and that it may be expected to be of national aid in the protection and administration of large forest areas."[61]

By the fall of 1930, 3 years after the demonstration of the contraption near Missoula, Dwight Beatty sold his idea to the Forest Service. The personal effort required to achieve this goal was monumental. Beginning with only a rudimentary knowledge of electronics, Beatty had followed through on every necessary aspect of self-study. He matched his many hours spent with books with lengthy travel in search of more comprehensive knowledge.

Tests at the workbench undoubtedly grew tedious and commonplace during the months as countless experiments on alternative circuits, parts placement and selection, troubleshooting, material use, and construction taxed his patience. But through it all, Beatty never wavered from the enthusiasm that originally sparked his curiosity. His dedication was no less than that which had led him to conclude 5 years before that radio had a place in the arsenal of fire-fighting weapons, and that he, a former mule-skinner, could build and demonstrate a useful, economical, light-weight, portable code transmitter-receiver.

Despite Beatty's success with the SP-1930, his contribution to the overall science of radio theory and technology was probably elementary at best. Certainly, R. B. Adams deserves credit for the first organized wireless experiment on the National Forests, but the Army and Navy were largely responsible for the technology that made those experiments possible, and others in the private sector worked on portability.

William S. Halstead and Royal V. Howard, for example, designed and constructed a portable set weighing 60 pounds that was successfully demonstrated in 1928 on Mt. Rainier for the National Park Service. Although it was touted "... as the greatest advance in forest fire control since the initial use of the portable force-feed pump,"[62] the Forest Service did not take notice. By placing a fixed transmitter 10,000 feet higher than a fixed receiver and broadcasting messages down over that distance, it repeated the tests made at Killington in 1909 and on Mt. Hood in 1920. Obviously, the technology was available; Beatty did not invent anything in the strict sense of the word, and perhaps any one of a hundred amateur radio enthusiasts could have duplicated the effort.

The significance of Dwight Beatty's contribution must be considered in the context of the Government agency in which it took place--the Forest Service, U.S. Department of Agriculture. In 1930, the Service's communications needs were different from those in other Government sectors. In the military, public broadcasting, law enforcement, private corporations, and most other agencies, the established markets were large, and fringe demands relatively insignificant; the communication industry, therefore, could ignore them. The unique needs of the Forest Service promised limited financial return in terms of the technological innovation that had to be tested before a product could be produced. Private industry largely ignored these needs, and the Forest Service was forced to rely on itself to determine the practicality of radio as a forest firefighting tool. In this way, an opportunity was provided for someone within the ranks of the Service to rise to the occasion. Wrote Beatty:

> My experience in the field has been widely varied. I have, and still can, equip and handle a pack string of mules. I take off my hat to no one on pack or saddle equipment for I knew this job long before I entered the service. I know how supplies and equipment can and should be packed and how they are generally packed. Much of my field time has been spent on large fires either in charge or on inspection work. Hundreds of fire, trail and fire protection guard camps on the Clearwater, Selway, St. Joe, Flathead, Kaniksu, etc., crowd my memory. Their location with reference to timber and high ridges is important to me now. The personnel, organization and duties of improvement crews in fire Forests are very

> familiar to me. In short, I can dig out of my memory a representative picture of any field condition where radio communication might be used and can therefore set up a very comprehensive list of requirements and limitations for every phase of the radio development work.[63]

Beatty constructed sets that met the criteria of simplicity, ruggedness, and reliability. More important, the SP-1930 was economical. At a time when all branches of Government had to limit spending and services--even the highly respected NRL was facing hard times[64]--the concept of radio as a supplement to the telephone would have fallen on deaf ears had it been priced beyond the means of the Forest Service.

Beatty's Forest Service experience counted for a great deal in formulating the components of success. When he wrote to Roy Headley that he could visualize "...any field condition where radio communication might be used..." and could describe in detail the needs and scope of practical radio development there,[65] he not only showed confidence in himself, but gave a clue to his motives in pioneering the portable radio. In short, he was recalling his own experiences on the fireline and the tools he would like to have had when a message meant the difference between a minor fire and extensive loss of resources and lives.

Credit clearly belongs to Dwight Beatty for demonstrating that a lightweight, low-power, portable radio was technologically and economically feasible and for providing the information necessary for a crucial independent Forest Service effort at a time when many knowledgeable persons "laughed at the whole idea."[66] To argue that others were capable of duplicating the effort overlooks the relationship between perception of a need and development of the concept to meet that need. Many ideas have languished because the inventor compounded the problem with too complex a solution. This would have happened if Beatty had followed current trends in 1930 and opted for high-power, fixed-base transmitters at hundreds of strategic sites throughout the National Forests. This more technologically acceptable alternative at the time would have ignored the strict limits of the Forest Service budget and seriously delayed its development and use of radio.

Roy Headley of the Washington Office also deserves credit for the development and success of the initial Forest Service radio program. His administrative support of Beatty, his insistence on providing the funds, and his willingness to go to the point of "win or lose" required far more personal commitment than many other administrators in his position may have rendered.

Considering that "...even the car broadcast radio did not make its appearance until 1930,"[67] Headley's support assumes its proper context. General H. H. "Hap" Arnold, for example, who served as the commander of Army Air Service patrol flights from March Field in 1919 and 1920, also considered radio an effective aid to air navigation and transmission of weather information. But he could neither get support nor demonstrate the utility of this tool until 1934, when he led a flight of 10 Martin B-10 bombers from Washington, D.C., to Alaska and back again.[68] If Roy Headley had waited for the development of commercial radio rather than supported Beatty, radio would probably not have taken its place on the Forest Service firelines until after World War II, well over a decade after Beatty actually made the units available. The value of his contributions is incalculable.

Reference Notes

1. Dwight L. Beatty, "Radio Communication in the National Forests," June 1931, typed, p. 1, Gaylord A. Knight Collection.

2. Beatty, "Memorandum for Mr. Headley," 25 May 1930, Gaylord A. Knight Collection. Beatty joined the Forest Service in 1911 as Forest Ranger in the Bitterroot National Forest and served in turn as Deputy Supervisor of the Absaroka, Clearwater, and Missoula National Forests, then as Supervisor of the Lewis and Clark, St. Joe, and Helena National Forests, before coming to the Operation Branch in the Regional Office as Forest Examiner in charge of improvements, in the same office as R. B. Adams, telephone engineer, in 1920. (See Field Programs, Forest Service.)

3. Beatty, "Memorandum," 10 February 1928, National Archives, Washington, D.C., Record Group 95G, Row 3, Section 20, Box 12, "USFS-O, Improvements, Radio Communication."

4. Beatty, "Radio Communication," p. 2.

5. W. Foy Squibb, interview with the author in Ramona, Calif., January 1978 and Harold K. Lawson, interview with the author in King City, Ore., May 1978.

6. Roy A. Phillips, "Recollections," *Early Days in the Forest Service* (U.S. Department of Agriculture, Forest Service, Region 1, Missoula, Mont., 1955), 2:23. Phillips says that Beatty "gave up in despair" over getting the grader accepted and that Phillips eventually demonstrated its efficiency on large fires in 1920.

7. Beatty, "Radio Communication," p. 1 and Beatty, "Memorandum," 10 February 1928, p. 1.

8. Beatty, "Memorandum," 10 February 1928, p. 1.

9. Beatty, "Radio Communications," p. 2.

10. Beatty, "Radio Communications," p.3.

11. Beatty, "Radio Communications," p. 3.

12. Beatty was aware of Adams' tests and that "Mr. Adams did some additional work with ultralight equipment ... before he left the service, but," he continued, "I did not learn what he had accomplished and he did not leave any written record." See Beatty, "Memorandum," 10 February 1928, p. 1.

13. Beatty, "Radio Communication," p. 4. For a review of telephone and readio activities in Region 1, see J. M. "Bud" Coats, "Communications in the National Forests of Region One," unpublished manuscript, Region 1, March 1980, 88 pp.

14. Beatty, "Memorandum," 10 February 1928, pp. 1, 2.

15. Beatty, "Memorandum," 25 June 1928, p. 1, Gaylord A. Knight Collection.

16. Beatty, "Memorandum," 25 June 1928, p. 1.

17. Beatty, "Memorandum," 25 June 1928, p. 1.

18. Beatty, "Memorandum," 25 June 1928, p. 2.

19. E. M. Webster, "The Interdepartment Radio Advisory Committee." (Address delivered in New York City at the Winter Technical Meeting of the Institute of Radio Engineers, 26 January 1945, p. 11.)

20. Beatty, "Memorandum," 25 June 1923, p. 3. Beatty had apparently experimented before the trip on 2950 and 3050 kHz.

The selection of 100 meters resulted from his own studies and suggestions by other individuals, principally of the Department of Commerce. See Fred Biggerstaff, "Design and Use of Forest Service Radio," ca. 1950, typed draft, Gaylord A. Knight Collection.

21. Beatty, "Memorandum," 25 June 1928, pp. 2-5 and Beatty, " Radio Communications," pp. 5-8.

22. Beatty, "Memorandum for Mr. Headley," 25 May 1930.

23. Beatty, "Memorandum," 25 June 1928, p. 5.

24. Beatty, "Radio Communication," p. 8.

25. C. M. Granger to the Forester, 3 March 1928, Gaylord A. Knight Collection.

26. Roy Headley to the Forester, 5 April 1928, Gaylord A. Knight Collection.

27. Headley to the Forester.

28. Headley to the Forester.

29. Beatty, "Radio Communication," p. 9.

30. Beatty, "Radio Communication," p. 9. The design of a semiportable, as opposed to a lightweight portable, was selected by Beatty because he had reservations about his ability to build a "Feather-weight." Given his own knowledge and the technology of the time, such a set "... presented an almost impossible problem with the present stage of development of radio and power supply ..." Likewise, a set in the semiportable class would fill the need for use both as a pack set and fixed-base station. See Beatty, "Radio Communication," p. 3 and Headley, "Memorandum for the Forester," 5 April 1928.

31. Beatty, "Radio Communication," p. 10.

32. Beatty, "Memorandum to Mr. Headley," p. 20.

33. Summary of Beatty, "Radio Communication," pp. 11, 12.

34. Dwight L. Beatty, "Paper Presented at a Meeting of District Foresters in Washington, D.C.," March 1930, typed, Gaylord A. Knight Collection.

35. Beatty, "Paper," March 1930, pp. 3, 4.

36. Beatty, "Radio Communication," p. 13.

37. Beatty, "Paper," March 1930, p. 4.

38. Beatty, "Radio Communication," p. 13.

39. Roy Headley, "Radio Communication on the National Forests," 11 November 1929, Gaylord A. Knight Collection, p. 5.

40. Roy Headley, Assistant Forester, to D. L. Beatty, (n.d.). National Archives, Washington, D.C., Record Group 95G, Row 3, Section 20, Box 12, "USFS - Engineering, R-7." The date of Headley's remarks, based on internal evidence within the document, was in early 1930.

41. Beatty, "Memorandum for Mr. Headley," p. 3.

42. Beatty, "Memorandum for Mr. Headley," p. 3.

43. Beatty, "Memorandum for Mr. Headley, p. 3.

44. Beatty, "Memorandum for Mr. Headley, p. 3.

45. Beatty, "Memorandum for Mr. Headley," pp. 4,5.

46. Squibb, interview with author.

47. Beatty, "Radio Communication," p. 14.

48. Beatty, "Memorandum for Mr. Headley," p. 6.

49. Beatty, "Memorandum for Mr. Headley," p. 6. R. W. Dunlap, Acting Secretary, USDA, wrote to thank Dr. A. Hoyt Taylor, NRL superintendent of radio, and the NRL staff for the "invaluable assistance" provided Beatty on his visit. See R. W. Dunlap to Acting Secretary of the Navy, 17 May 1930, National Archives, Washington, D.C., Record Group 95G, Row 3, Section 20, Box 12, "USFS - Engineering, R-7."

50. Beatty, "Memorandum for Mr. Headley," p. 7. This price was without cases or antenna equipment--which Beatty figured would add $20 to each set.

51. The Columbia National Forest was renamed Gifford Pinchot National Forest in 1949.

52. Beatty, "Radio Communication," p. 15.

53. Beatty, "Radio Communication," p. 17.

54. No title or date, but identifiable as an SP-1930 operator's manual by references to the set and tuning procedures, Gaylord A. Knight Collection.

55. Unittled SP-1930 operator's manual (n.d.), Gaylord A. Knight Collection.

56. A. G. Simson and F. V. "Jack" Horton, "Radio on the National Forests," typed draft of article submitted to *American Forestry* per cover letter, F. H. Brundage to the Forester, 20 April 1935, p. 5, Gaylord A. Knight Collection.

57. Beatty, "Radio Communication," p. 16.

58. Beatty, "Radio Communication," p. 16.

59. Beatty, "Radio Communication," p. 18.

60. Beatty, "Radio Communication," p. 18.

61. Beatty, "Radio Communication," p. 19.

62. The *Sunday Oregonian*, (n.d.), photocopy. Included in correspondence, William S. Halstead to Gary C. Gray, May 14, 1979. Halstead's set accompanied the Byrd Anarctic expedition in 1928-29.

63. Dwight L. Beatty, "Memorandum for Mr. Headley," 25 May 1930, p. 5, Gaylord A. Knight Collection.

64. L. S. Howeth, *History of Communications Electronics in the United States Navy* (Washington, D.C.: Government Printing Office, 1963), pp. 399, 400.

65. Beatty, "Memorandum to Mr. Headley," p. 5.

66. Beatty, "Memorandum to Mr. Headley," p. 2.

67. Dan Noble, "The History of Land-Mobile Radio Communications," *Proceedings of the IRE* 50, no. 5 (May 1962); 1402.

68. J. D. O'Connell, A. L. Pachynski, and L. S. Howeth, "A Summary of Military Communication in the United States," *Proceedings of the IRE* 50, no. 5 (May 1962); 1245.

Chapter IV

Tacoma and Vancouver:

First Radio Laboratories

Not so many years ago, when the Model T Fords came on the market they were hailed as the last word for that type of car. Radio is just passing out of its infancy and none of us can predict or even guess the numerous uses to which it can be placed, especially so in the Forest Service which is opening a new door in the field of radio.

- William B. Apgar[1]

The 1930 field experiments did not satisfy Dwight Beatty. To him, radio communication with Morse code did not make the most of this new technology. Voice communication seemed far more practical if it could be incorporated without unduly complicating the transmitter circuitry. By extending its use to all personnel with a minimum of training, this modification would enhance the acceptance of radio in the National Forests. After the type '30 tube was introduced, Beatty saw a way to convert to a "featherweight" set using voice transmission.[2] He considered hiring an assistant to help him do this, because of his own commitments.

In the early 1920's, Harold K. Lawson was attending classes in engineering at Oregon State University. His interest in electronics dated back to high school when he secured amateur licenses 7UZ, 7SR, and 7FW, the latter strictly for an assignment for portable radio operation. Although he enjoyed designing and building gear, he usually lost interest in an experiment once it worked. He would then move on to some other modification or design that caught his attention. His advisor pointed out to him after his first year of college that electrical engineers often could only get jobs as trolley operators. He urged him to transfer to forestry, a field that fit in with the Lawson family's logging business. But after 3-1/2 years of forestry study, the difficulty of supporting himself on a part-time job led Lawson to drop out. After several years of working for his father in logging near Stevenson, Wash., he went into electrical contracting with a partner down the Columbia River in Vancouver. As a member of the Vancouver Chamber of Commerce, he went to Washington, D.C., in April 1930 for the national Chamber's convention.[3]

For some time, Harold Lawson had thought it unusual that the Forest Service was not using portable radio communication. He had enough firefighting experience to know that radio could prove a boon to the Service. He took this opportunity to approach the agency's leaders about the possibility. He spoke to Roy Headley, who told him: "You have just left the part of the country where we are doing something about it. Go back out to Tacoma and look up a man by the name of Dwight Beatty. He's actually doing some field work."[4]

Lawson was too busy to follow up on the advice for several months. In early 1931 he had occasion to travel to Tacoma and over lunch he discussed employment with Beatty. A month later, he received Beatty's approval; he moved to Tacoma in March.[5]

The working conditions in Tacoma were far from ideal. The Radio Laboratory, located in a "little ramshackle house" at 4001 East B Street, had very few of the tools required for experimental work: one or two voltmeters, a homemade ohm meter, a hand-operated drill press, a tin snips, and some screwdrivers and pliers. "To call it a lab was something of a joke," recalled Lawson.

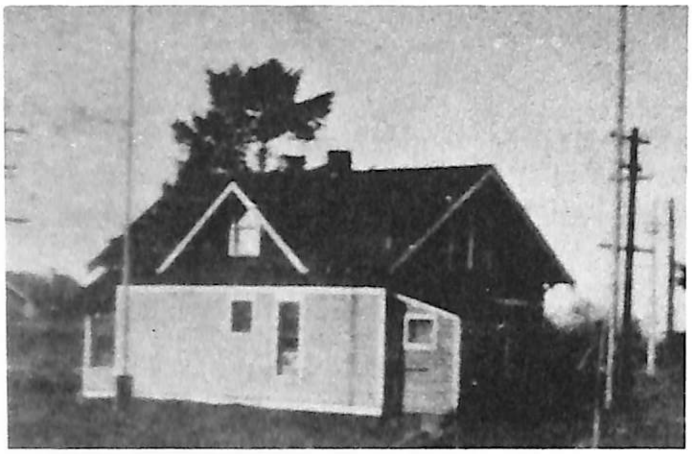


Figure 33. This house at Tacoma, Wash., served as the first Forest Service Radio Laboratory, from late 1929 to the summer of 1931. Note antenna poles. (Forest Service photo, History Section)

He saw little of his new supervisor during the next few months. After driving Lawson to the Laboratory, Beatty provided him instructions for designing a portable voice radio, handed him a purchase book, and told him to go to Tacoma or Seattle for the needed parts. Beatty asked Lawson to keep him posted by writing up a summary of his work every day or two and leaving it on the desk. Lawson was not expected to keep track of his time or work specific hours, but Beatty did ask him to draw the shades and throw a sheet over any experimental work each night.[7]

Lawson Designs Transmitter

By May 1931, Lawson had completed a working model semiportable code/voice transmitter--the PCL-1. The complete unit weighed about 60 pounds and was tested by Lawson along with an SP-1930 receiver.[8] He made contact with several amateur radio operators in the Region and received reports of excellent reception.[9] The set contained the type '30 and '31 tubes, which had only recently been placed on the market, and used common amateur radio circuits at 1-1/2 watts. The PCL-1 had a tested daytime range of 11 miles; evening contacts extended to Olympia, Wash. 25 miles west.[10]

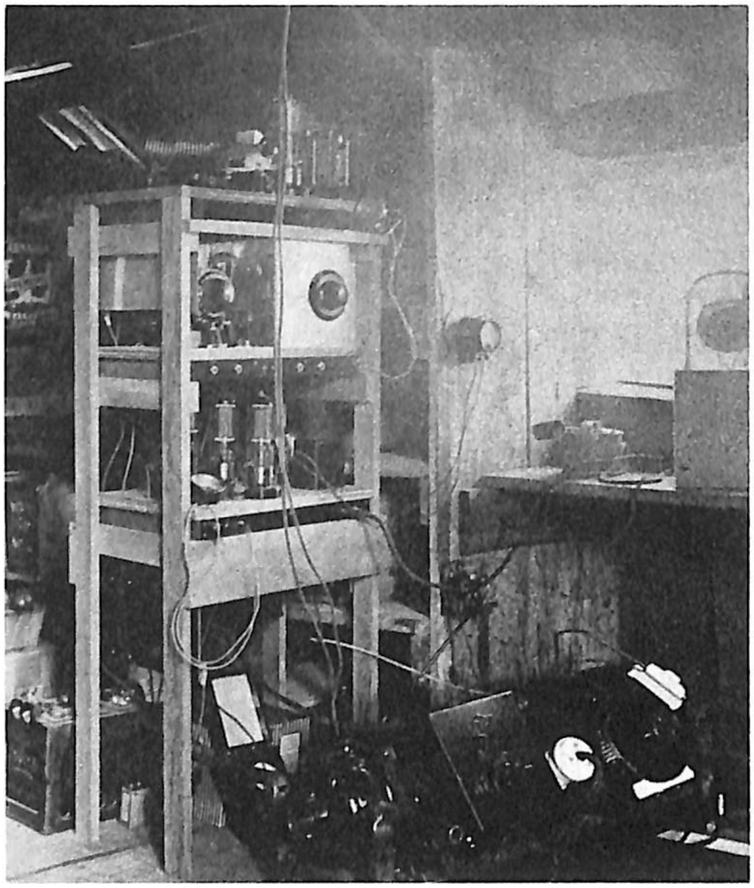


Figure 34. The 50-watt voice transmitter built by Harold Lawson to replace the borrowed Northern Electric unit first used at the Hemlock Ranger Station field test in 1930. With the same call letters (W7XAQ), Lawson's set operated from the Forest Service's new Radio Laboratory near Portland in Vancouver, Wash. It was also used for several years to communicate with Civilian Conservation Corps (CCC) camps operated in Region 6 by the Forest Service. The unit on the floor was the power source. (Forest Service photo, History Section)

By late May or early June, Harold Lawson was becoming uneasy over the lack of a working relationship with

Dwight Beatty. Beatty seldom made an appearance even if Lawson stayed at the Laboratory until 1 or 2 a.m. Yet the work summaries Lawson left on the desk were always gone by the time he returned. One morning, Lawson entered the building to find the shades still drawn and Beatty sitting at the desk with a bottle of whiskey. "Let me ask you," queried Beatty, "has anyone come here during the day, or have you seen anyone sitting outside in a car apparently observing this place?" After saying he had noticed nothing, Lawson learned that Beatty suspected Washington Office "gumshoes" of checking up on his operation.[11]

Shortly thereafter, when it appeared that everything was once again in order, Beatty rehired W. Foy Squibb as the chief technician for the design of a voice-operated portable. Squibb, no stranger to the program, had originally come into contact with Beatty in early 1930. He was an electrical engineering student at Washington State University. His background as a radio amateur (W7CT, W7TG, W7AUX) had proven valuable to him in securing a temporary job at Spokane Radio while the SP-1930 sets were being built. He was interested in the project, approached Beatty for a summer job, and was appointed operator of Beatty's Northern Electric base station at the Wind River Experiment Station (Hemlock Ranger Station) during the 1930 summer field tests.[12]

It appeared to Harold Lawson that whatever the cause of Beatty's suspicions, the radio project was about to take on a new dimension with the hiring of Foy Squibb. But near the end of June, he arrived at the Tacoma Laboratory to find a disheartening note from Dwight Beatty:

> Friday
>
> Dear Lawson:
> Sure sorry you have been ill$_x$
> See you when you get to feeling better$_x$ Bad news for you I am afraid$_x$ I've resigned and it looks like job cracking up$_x$
> I hoped and tried to arrange so you could go on, but afraid I can't make it$_x$ See you$_x$
>
> D L B
>
> Am still trying for you to go on with work$_x$[13]

The cause of Beatty's resignation was not directly connected with his efforts to perfect radio for use on the National Forest--few, if any, had qualms about his capability. Rather, it was a personal problem, which for some time had remained in the background. However, because Beatty could not be induced to cooperate or change his ways, the Washington Office finally exerted enough pressure so that Beatty had to resign.

It is not known when the problem first surfaced. What is known is that as early as the demonstration in Missoula, the collaborator on Beatty's radio project was Margaret Ward, a resident of the valley where the demonstration took place.[14] Although Beatty had a family in Missoula, Margaret Ward accompanied him to Washington. In Tacoma they lived some distance away from what eventaully became the Laboratory, and remained in seclusion. Margaret Ward was seldom seen by those in the radio experiments, but she apparently had a direct role in the effort. Correspondence addressed to "Mr. M. Ward" from Spokane Radio was often received at the Laboratory.

The decision to pressure Dwight Beatty into a resignation was undoubtedly distasteful to those who had shared in his early success. For the last 4 years, he had invested considerable effort in developing radio for the fireline, and he would have been a decided asset to the program in the future. But the Washington Office could not look the other way once the program reached the application stage. Beatty's violation of a fundamental code of conduct could have been a psychological factor in Beatty's desire to succeed, but the behavior could not be justified or ignored once the program moved into the open, certainly not in those days.

Several months after resigning, Beatty went on a well-earned fishing trip off the Oregon coast. One day a severe Pacific storm unexpectedly came up. Neither the boat nor its passengers were ever found.[15]

During the time Beatty was conducting tests near Tacoma and on the Columbia (now Gifford Pinchot) National Forest, he was technically out of the jurisdiction of Missoula, Region 1, but apparently still under its administrative control.[16] But because of Region 6's early interest, the location of the laboratory at Tacoma, and the 2-year history of the program in that Region, the Chief Forester asked Portland to "... submit recommendations as to the continuation or abandonment of the radio project."[17]

Region 6 sent Floyd V. (Jack) Horton, Chief of the Division of Lands and Recreation, and A. Gael Simson from the Wind River Experiment Station to confer with Lawson in Tacoma.[18] Both Horton and Simson investigated the project progress and the plans. Horton believed it would be a shame to drop the program because one man was leaving, and together with Simson he recommended that the program be continued.

Horton, Simson Put In Charge

Chief Forester Robert Y. Stuart concurred and placed the project under the Regional leadership of Horton, with Simson directly responsible for the administration of the Radio Laboratory.[19] As Horton related to the author, Stewart Holbrook, the two men then proceeded in an attitude of "intelligent ignorance."[20]

The selection of Jack Horton was especially good for the future of the Laboratory. Although he had no radio experience, he was somewhat of a gadgeteer who saw the practical benefits that could accrue from radio. Harold Lawson remembered him as "just a believer" who had no engineering training, but a person who found the subject of radio for fire control a "natural."

"It was indeed," said Lawson, "a pleasure to work for Horton. I never had a better boss in my life. You knew precisely where you stood, knew what was expected.

"If I did something right I got a pat on the head; if I stepped out of line I got a kick in the pants."[21]

If Horton proved to be a worthy selection for the program, the appointment of A. Gael Simson was invaluable. During the next 16 years, "Ags," as he was known at the Laboratory, quietly provided the type of administrative leadership that carried the program through its infancy into a position of decided prominence. Few men who came in contact with Ags disputed his leadership abilities, foresight, or intellectual acumen. His interests were far-ranging, and included paleontology, writing western outdoor stories, and electronics. He was a "pretty sharp" administrator, a "good politician," operated very well in the "upper echelons," and had a comfortable demeanor that made those under his supervision fond of him.[22]

Many anecdotes are pleasantly remembered by Simson's contempories. Logan Belleville recalled that Simson used to come in and "raise hell" about the appearance of the Laboratory every time dignitaries were due to arrive. To cure the usual disorganization among research groups, Simson threatened to attach the work benches to the wall with hinges and to knock the props out promptly at 5:05, sending everything left on top crashing to the floor.

Around the corner from the Laboratory at Murphy's Diner, Simson was remembered as the one who like to play the pinball machine and who consistently ordered black coffee with two ice cubes and a side order of burnt toast.[23] Gaylord Knight, the first Region 8 communications officer in Atlanta, remembered the numerous trips Simson made there, always with the so-called Simson's suitcase among his baggage. This device, a hefty 50-pound combination transmitter-receiver, was built at the Laboratory so that Simson could test various frequencies around the country. Upon arriving in a town, Simson would request a room that was open to the street and adjacent to a tree or other suitable fixture. While the "Chief" remained in his room with a tall, cool drink, Knight would climb the tree or pole to affix a wire antenna, which would then be strung back to the room and connected to the "suitcase."[24]

Unlike Horton, Gael Simson had a background in electronics. Before joining the Forest Service as a scientist, he had served in the Navy as a radio operator during World War I.[25] Some time before 1929, he had undertaken tests to track lightning storms at the Wind River Forest Experiment Station on the Columbia (now Gifford Pinchot) National Forest. The purpose of these tests was to determine if a way could be devised to ascertain which types of lightning started forest fires, and if a pattern could be detected for predicting fires during such storms. Results were inconclusive. While there in 1929 and 1930, he had served as advisor to Dwight Beatty.[26] When it came time to select an administrator for the radio program, Simson was a logical choice.

Radio Laboratory Moved to Vancouver

The first decision made by the new administration was to move the Laboratory nearer to Region 6 headquarters at Portland. A house was rented across the Columbia River in Vancouver, Wash., at 3201 Drummond Avenue. Though little better than the one in Tacoma, it served its purpose as a home for the Laboratory for the next few years.

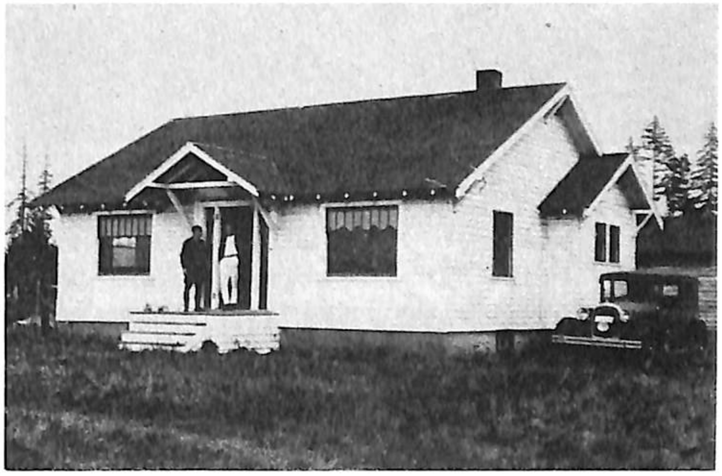


Figure 35. The Forest Service Radio Laboratory at Vancouver, Wash., established in 1931. (Forest Service photo, History Section)

Harold Lawson and Foy Squibb completed the move, and continued to work on semiportable and portable design. By July, Lawson was obtaining excellent results with the type '30 tube, and the crystal-controlled unit, now dubbed the "SP," was reported to be comparable in performance to Beatty's SP-1930.[27] He conducted tests at Wind River during the summer, and the results were ready by early fall.

Optimism over the set's performance ran high. Weighing between 25 and 40 pounds, depending on battery selection, the SP, Roy Headley wrote, vindicated "Beatty's confidence that it is possible to transmit voice by such sets."[28] Production was scheduled for January 1, with some 50 units intended for trial use in Regions 1, 4, 5, and 6 in 1932.

Figure 36. Harold Lawson testing a semiportable model he designed at the Radio Laboratory in Vancouver, Wash., late in 1931. In the corner is his 50-watt transmitter model; it was also used as the control station on the Columbia (now Gifford Pinchot) National Forest during the 1931 fire season. (NA:95G-262294)

Squibb continued work on the fully portable model. Given the designation of type P for "portable," the unit was virtually a lighter SP-1930 modified to transmit code and to receive voice and code with a minimum of electronics.[29] In the transmitting circuit, Squibb slightly altered the High C Hartley Circuit of the SP-1930 to eliminate the RF choke and the variable grid-leak resistance. He used an "inductively wound resistance" in its place to obtain "practically identical" results. He reported:

"One part is thus eliminated in the portable set."[30]

Figure 37. Gael Simson demonstrating the first type SP (semiportable) model, 1931. (NA:95G-262289)

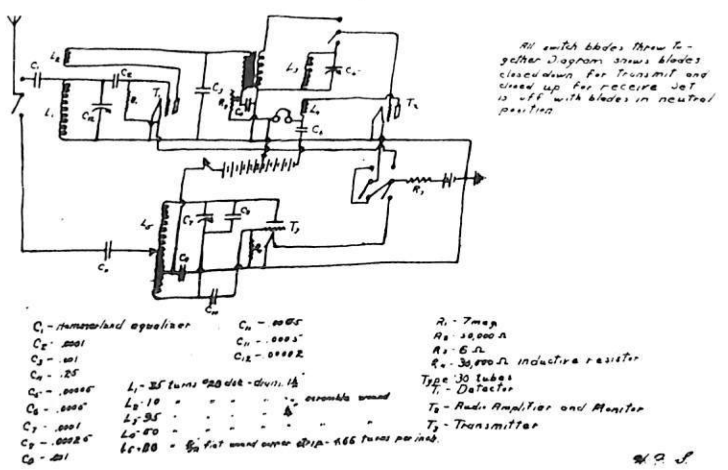


Figure 38. Foy Squibb's laboratory diagram for the first type P (portable) set, which he designed for the Forest Service in 1931-32. (Forest Service photo, History Section)

In the receiving circuit, he used a simple series feedback regenerative detector and one stage of af amplification. This arrangement eliminated the adjustable feedback condenser and the RF choke, which had provided a shunt-fed system in the SP-1930. Replacing a potentiometer with a fixed resistance for regeneration control saved even more weight. Squibb had thus ingeniously reduced the weight to 12 pounds, producing a truly portable transmitter-receiver at 1-1/4 watts. Production of 150 sets was scheduled for April 1, 1932, to complement the previous run of type SP sets.

One of the outstanding improvements in both the P and SP was a simpler single-wire antenna. All Beatty's experiments had been conducted with a high, single-wire antenna, which was parallel to a ground-wire counterpoise 3-1/2 feet high. The large clearing required for setup, the effect of wind on frequency, and excessive time required for installation were weaknesses of the counterpoise system. "It was, therefore, decided to make a special effort to develop a single wire antenna and the result is a power-feed antenna of very simple design," reported the *Radio News*.[31]

The length of the single-wire antenna was made to correspond to the frequency of the transmitter, approximately 70 feet. Fitted with a loading coil somewhat off-center, the feeder wire was always fixed. In addition to compactness, this simplified installation. It also had the advantage of being several pounds lighter than its predecessor, "... an important contribution to the success of the project."[32]

To demonstrate the practicality of the P set, Region 6 selected an "average man" from a road crew. After an operating demonstration, including a setup and take-down, the operator was given 1 hour to practice. Starting on a given signal, he set up the equipment in 18 minutes and sent a coded message requesting eight men, with location and type of fire. He then waited while the receiving station copied the message,

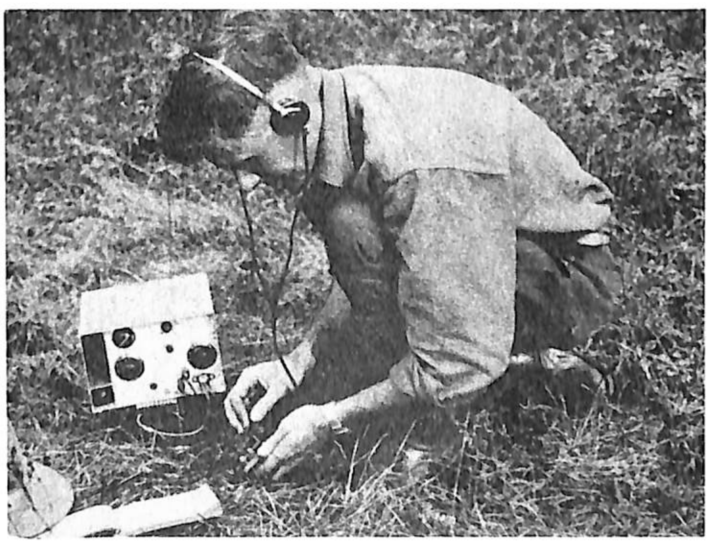


Figure 39. Gael Simson operating an early version of the type P (portable) set in 1931. (Forest Service photo, History Section)

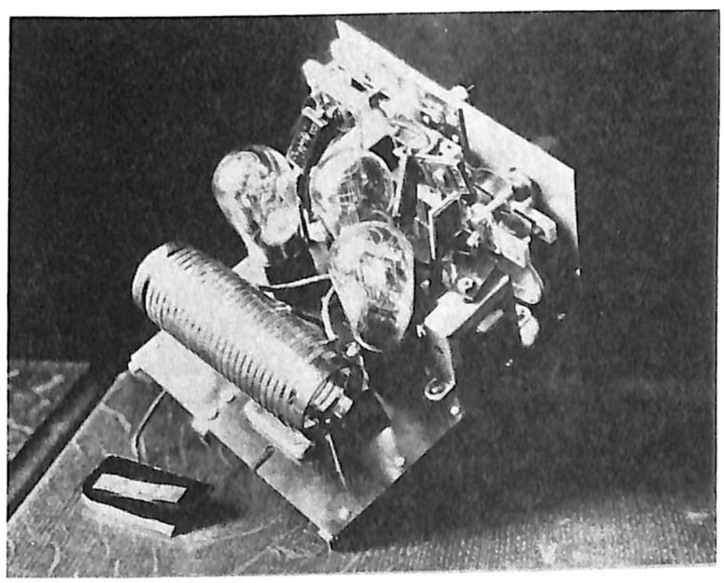


Figure 40. Interior view of the first type P (portable) set, 1931. (Forest Service photo, History Section)

phoned it to headquarters, received a reply, and retransmitted the reply to the road man, at which time he disassembled the equipment. The total elapsed time was 44 minutes.[33]

This demonstration conclusively established the value of radio for the National Forests. Headley's main worry, now that the units were scheduled for production and testing, was "... where is the money coming from?" Suspecting that radio could become so fashionable in the Forest Service that demand would expand out of proportion to the real need, he also cautioned all of the Regions:

> As always when a new tool or device comes to the front, it is important to remember its limitations. Radio has a legitimate use in forest protection and a worthwhile contribution to make to our production objectives. Let us hope that we fit radio into its proper niche as rapidly as practicable but that in doing so we carefully refrain from going off half cocked with any cure-all or panacea type of thinking. Radio will not put out the fires, as some excited newspaper stories seem to indicate, nor will it replace telephone lines to any material extent. It does not need to do anything like this in order to make a worthwhile contribution to forest protection.[34]

Before the scheduled P and SP field tests, during the 1932 fire season, Lawson and Squibb completed their designs. They made minor modifications, primarily to simplify production. Lawson altered the SP front panel, adding a cabinet and putting the microphone inside the cabinet door. This allowed space to mount a meter on the front panel to facilitate tuning. Using the same small cabinet for the P set, Squibb placed the storage compartment under the unit and rearranged the controls. Both had an advertised operating range of 15 miles on voice and 20 miles on code. The low bids of $147.00 for the SP by the Northern Electric Co. and $49.00 for the P, by the Spokane Radio Co., were accepted.[35]

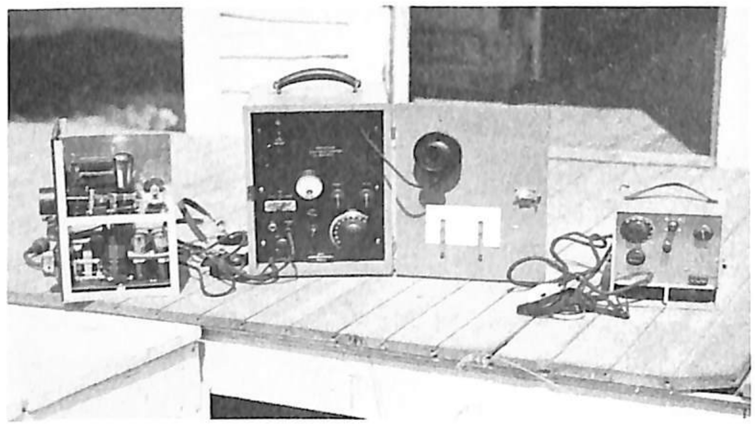


Figure 41. Left, interior view of the final SP set. Center and right, final exterior views of the SP set and of the P set, respectively. (Forest Service photo, History Section)

147 Sets Field-Tested in 1932

During the summer, 43 SP and 104 P sets were installed on National Forests in Montana, Idaho, Washington, Oregon, and California. Their operation was seldom deficient. On the Umpqua National Forest in Oregon, for example, a few sets were placed on the Tiller District to assist in coping with a bad incendiary situation. "For the first time in years incendiary fires on this district have not been a problem," it was reported.[36]

Harold Lawson made an extensive installation of the two sets in the Calder District of the St. Joe National Forest in north Idaho. During 63 days of record, 2,663 radio calls were placed. The reliability of the 1,511 calls between SP sets was estimated to be 99 percent effective; 1,152 messages between SP and P sets rated 84 percent reliability.[37]

A number of fire traffic calls from northern California were also intercepted in the District, but the most extensive tests were conducted in western Montana at the Savenac Nursery near Haugen. William Apgar, the Assistant Forester at Savenac, was an amateur radio buff with license W7CRU. When the new sets became available, Lewis C. Stockdale, Chief of Operation in Region 1, ordered two of each and put Apgar in charge of testing. Because the nursery was close to St. Maries, Idaho, where Lawson was stationed, arrangements were made for daily communications at 7 and 9 a.m. and at 5 p.m.[38] The schedule started August 10.

The Savenac Nursery station was located in the house used by visiting Forest Service officers. It had a permanent 139-foot antenna, 40 feet in height. With this antenna, the temporary one supplied with the sets at 20 feet, and Apgar's National SW5 receiver, he was able to carry out "extremely satisfactory" tests. Except for the nursery power plant that caused considerable interference after dark, the other stations reported the Savenac signals "coming in stronger" than other SP sets.[39]

The period of operation lasted some 3 months and included 1,832 hours of actual operating time. Two temporary employees trained as operators kept a complete station log, and Apgar devised a full schedule of contacts to keep them busy. In addition to the St. Joe, regular schedules were maintained with the Chelan National Forest and the Radio Laboratory (W7XAQ) at Vancouver, both in Washington, far to the West, and the nearby R-1 headquarters at Missoula. But Apgar's penchant for thoroughly testing the 1-1/4-watt P sets on 3,385 and 3,445 kHz also took him out to the hills, mining dumps, and heavy timer. Covering a large area around Savenac, Apgar was able to find only one instance "... where a [700-foot] hill masked the signals."

"It was surprising to note how well the sets were able to work thru [sic] fairly heavy static," he commented.[40] Even their capability to cover distances of 50 miles or more pleased Apgar.

Portable signals between Savenac and Missoula were rated as "very strong" and the ability of the sets to get through nearly 400 miles from St. Maries to Vancouver was significant, though rated "very weak" in signal strength. Apgar concluded his report on the portable set with a casual note; "These long distance tests are interesting but have little value in actual work other than to show what the sets are capable of doing."[41] This statement would eventually become a major lasting point of contention between the Laboratory and Missoula.

Although Bill Apgar would become decidedly disenchanted with sets of low output power in a few years, his support in 1932 for the use of radio in the National Forests probably matched that of the most optimistic radio enthusiasts. A highly outspoken individual thoughout his Forest Service career, he was less inclined, with his amateur radio background, to heed the caution of Roy Headley to go slowly in adopting radio. Apgar was satisfied that the difficult tests to which he had subjected the P and SP radios proved their potential for the Forest Service. "We all admit they are not perfect," he wrote, "but they do fill a need and their usefulness will increase as time advances."[42]

Apgar was equally confident, though more restrained, about the future of radio *versus* telephone communication. By posing a series of questions, he reminded his bosses of familiar shortcomings of the telephone in the field:

> Aside from the humorous arguments advanced, what would be the result if the telephone conversation on a district were rated during the field season with an audibility scale such as the radio calls are rated? Would they show over 90% satisfactory service? How many times have you had trouble getting a call thru a small local central, or been bothered with static on mountain lines, could not call the Ranger station from the lookout, could hardly understand the other party or have been annoyed at the telephone operators' favorite expression of 'just a moment, please' after you have been standing at a wall phone for over half an hour trying to get a call thru? I am afraid that a strict rating of the two systems would show that the present system of telephone communication is not as perfect as we generally consider it.[43]

In Vancouver, Harold Lawson was pleased with the summer's results. But the use of code in the P sets had troubled him for some time. After Squibb's return from college in 1933, the two men set out to complete the design of a voice/code portable that would equal the P set in size and performance. The result was the type PF portable phone contained in a 4- by 5- by 16-inch enclosure and weighing a scant 15 pounds, including hardware and batteries. The ultimate in lightweight, portable technology, the PF used "common ham [amateur] circuits" to transmit a nominal 1-1/2 watts.[44] Sometimes advertised as the "Portable Fireman," the type PF used a regenerative detector, two stages of af, and a crystal-controlled voice transmitter. At a reproduction cost between $60 and $75, it proved popular, and some 450 units were sold before it was replaced by an improved type.

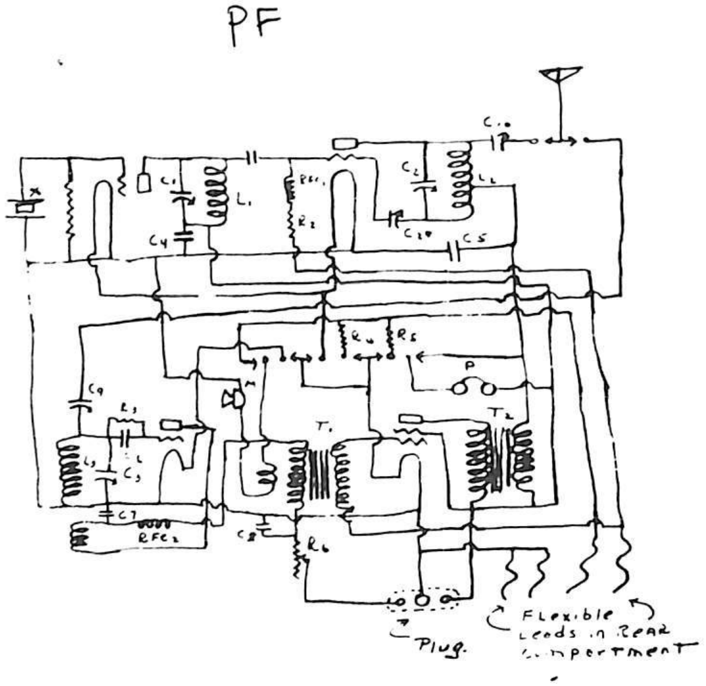


Figure 42. Working drawing for the type PF radio, by Harold Lawson. (Gaylord A. Knight Collection)

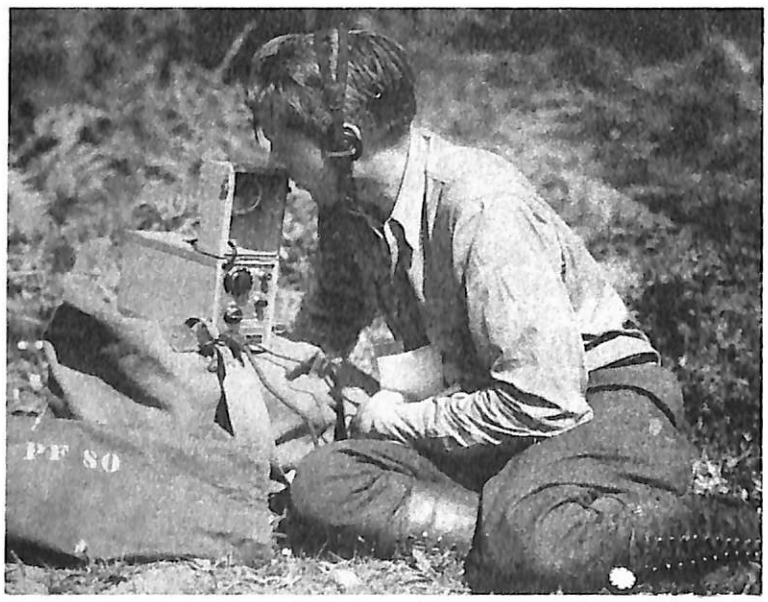


Figure 43. Demonstration of the type PF voice radio set, developed in 1933 by Squibb and Lawson at the Radio Laboratory. (NA:95G-280931)

Fixed-Base Transmitter Designed

One of the final tests to be completed by Lawson before the 1933 fire season was the design of an a.c.-operated, fixed-base transmitter. This unit, which would operate at more power than the smaller sets, was intended to serve as a central location. The location would theoretically be a Ranger Station surrounded by lookout structures. With 1-1/2-watt PF sets in the field, 1-watt SP sets at the lookouts or fire camps, and a larger wattage, fixed-base station at Ranger and Forest headquarters, the triad of Forest Service radios would be complete.

Because of the Depression, the design of a fixed-base transmitter had to be achieved by a circuitous route. When Simson ran out of money for a technician on the payroll, he laid off Lawson and then contracted with him to complete the design for "big money"--$125.[45] With Simson supplying the material, Lawson was able to complete the type M (medium power) set before the summer.

The type M transmitter was a conventional design and was used in conjunction with a commercial radio receiver, usually a Hammarlund Comet Pro or, in a few instances, a $17 Simplex converted to a standby receiver by the Laboratory. Rated at 20 watts nominal and 40 watts peak, the type M had the capacity to serve the intended function of a control station. Originally it consisted of a separate transmitter and receiver. With further design improvements it was also made available in a single cabinet with either Rice, Garco, or Weco gas-driven generators for field use. It had an advertised range of 50 miles and would become a mainstay in the 100-meter range of Forest Service radio equipment.

The use of the Hammarlund Comet Pro receiver indicates that the Laboratory was receptive to commercial products when they could find products on the market that suited a particular need. The Comet Pro was considered an excellent receiver for its day. At a price of $100 to $150, it could not be improved upon except for minor refinements. Because it was too selective for standby service, the Laboratory devised a sweep device that allowed the tuner to scan over a narrow band of channels twice each minute.[46] Another refinement added at the Laboratory (its absence had irked Gael Simson) was a standby switch in the receiver B supply line. In a letter to Lewis Winner, Simson cajoled Hammarlund-Roberts into including this switch in future models in return for receiving information on Forest Service radios to be used in Winner's radio program, "The Human Side of Science."[47]

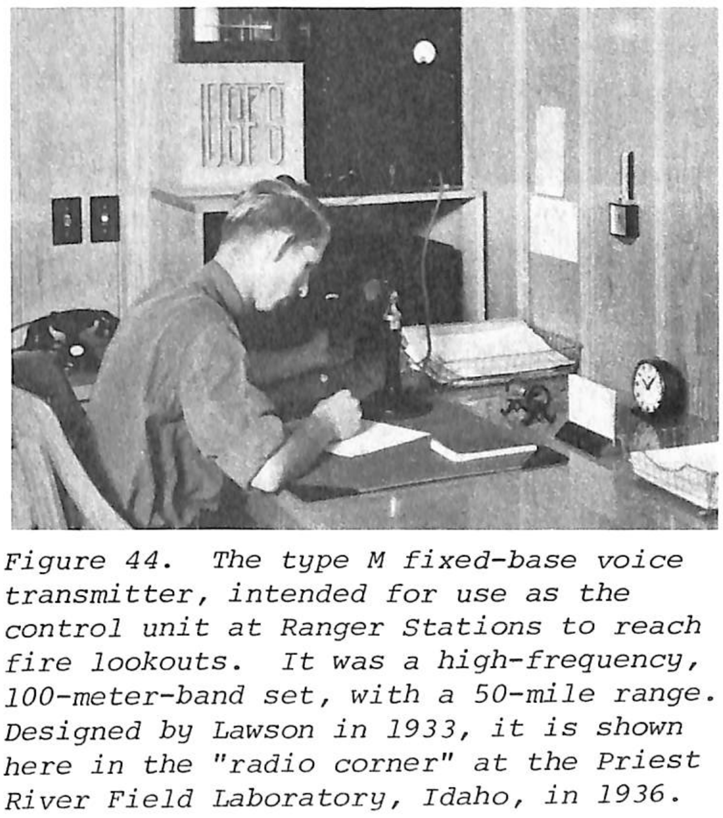


Figure 44. The type M fixed-base voice transmitter, intended for use as the control unit at Ranger Stations to reach fire lookouts. It was a high-frequency, 100-meter-band set, with a 50-mile range. Designed by Lawson in 1933, it is shown here in the "radio corner" at the Priest River Field Laboratory, Idaho, in 1936. (NA:95G-350671)

The 1933 field tests were an extension of the previous year. Regions 1, 4, 5, and 6 were most interested in developing fire networks and purchased a number of additional radios through the Radio Laboratory. Region 1 now had 49 radios: 3 M sets, 31 SP sets, 18 PF sets and 7 P sets.[48] Although the P sets were then considered obsolete and placed in storage, Bill Apgar still had 50 radios to distribute for testing in a variety of situations.

The 1933 Savenac records revealed a "satisfactory" 96.2 percent completion rate for Regional calls analyzed. In addition to test calls, experimental work, and the relaying of traffic, the nursery also used radio to communicate with planting camps in the area; "This made for very efficient cooperation ..." A PF set was used to "excellent advantage" on the St. Joe Forest by a survey crew doing triangulation from peaks where there was no communication. Over on the Clearwater Forest, several sets provided communication between headquarters and road construction and CCC camps. Two M sets handled all communication that normally required long-distance phone calls between Pierce and Orofino.

Apgar established a radio network among the Clearwater, St. Joe, Lolo, and Flathead Forests, the Savenac Nursery, and the Priest River Experiment Station during the winter. "The volume of business necessitated scheduling all transmissions," he reported, "and although no record is available it seems safe to say that the sets have more than paid for their use in the decrease of long distance toll charges."[49]

By the 1934 fire season, some 700 sets had been distributed throughout the National Forests, primarily in Montana, Idaho, Washington, Oregon, and California. The Navy; the Interior Department's National Park Service and Indian Service; and the Bureau of Lighthouses, then in the Department of Commerce and since 1939 under the U.S. Coast Guard, purchased sets for their own use.[50] Although these purchases were a significant demonstration of the acceptance of the Radio Laboratory's products, they were but a fraction of the needs of the Forest Service and other Government agencies. Considering that only 4 years had elapsed between the design of the types SP and P, 2 years for the types PF and M, and the subsequent manufacture of some 700 sets of these types, the accomplishments of Simson, Lawson, and Squibb assume added importance. In this relatively short period of time, they had formulated a plan, tested several configurations of a concept previously unknown, provided prototypes for manufacturers, had working models in the field for testing by relatively inexperienced personnel, made changes and alterations in time for orders to be placed, and kept the price at an acceptable level.

Foy Squibb and Harold Lawson continued to be very modest about their accomplishments. In later years, both emphasized the experience they gained in amateur radio, voiced their pleasure at the opportunity to turn a hobby into a vocation, and downplayed their significance in the design of lightweight, low-power, portable equipment.[51] In fact, Squibb would say, "Maybe *designed* isn't a good word, we *adapted* conventional circuits to weight and size limitations."[52] But the events during the next decade suggest that much more was involved in their initial efforts than mere "adaptation." Perhaps Gaylord Knight was correct in saying that Simson, Lawson, and Squibb constituted a "godsend."[53]

Reference Notes

1. William B. Apgar, "Report on Radio Activities at Savenac Nursery--1932," 30 November 1932, typed carbon copy, p. 15, Gaylord A. Knight Collection.

2. Beatty, "Radio Communication," pp. 18, 19.

3. Harold K. Lawson, interview with the author in King City, Ore., May 1978.

4. Lawson, interview with author.

5. Lawson, interview with author.

6. Lawson, interview with author.

7. Lawson, interview with author. Lawson never learned the reasons for this security practice.

8. H. K. Lawson to W7ARZ [Wally Guthrie], Salem, Ore., 29 May, 1931, Gaylord A. Knight Collection. Attached is a draft photocopy report, H. K. Lawson, "Portable Transmitter PCL-1," 29 May 1931, Gaylord A. Knight Collection.

9. The contacts were with Bill Claypool (W7UV), Wally Guthrie (W7ARZ), and two others (W7APE in Marshfield, Ore., and W7KZ in Olympia). See Lawson, "Portable Transmitter PCL-1," p. 30. Claypool enters the picture later as an employee of the Laboratory and Wally Guthrie was employed for many years by Bill Sanders of the Oregon State Department of Forestry.

10. Lawson, "Portable Transmitter PCL-1," pp. 2, 3, and Lawson, interview with author. The antenna system was an 80-foot wire with counterpoise.

11. Lawson, "Portable Transmitter PCL-1," pp. 2, 3 and Lawson, interview with author.

12. W. Foy Squibb, interview with the author in Ramona, Calif., January 1978.

13. Original handwritten message in the possession of Harold Lawson, King City, Ore.

14. Clyde Fickes, interview with the author in Missoula, Mont., May 1978. Clyde Fickes was Beatty's supervisor at the time.

15. The details of Beatty's departure from the Forest Service were supplied to me by two sources who chose not to be identified; both believed that these details would detract from Beatty's fine work. I disagreed because I believed that Margaret Ward rightly deserved recognition. I also maintained that Beatty's accomplishments were heightened, rather than lessened, by his personal difficulties. Finally, no matter its path, historical accuracy must not be abridged in the interest of evading conflicts with perceived contemporary social values. As a final note to this portion of the history, it is interesting to note that one of the principals received a call from Margaret Ward some 4 decades after Beatty's death. She wanted to see if this individual was interested in purchasing Beatty's early prototype equipment. He was not. My attempts to locate Margaret Ward since that time have not been successful.

16. Lawson was using Region 1 stationery at Tacoma (author).

17. D. S. Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, p. 1, Gaylord A. Knight Collection.

18. Lawson, interview with author. As a Division Chief, Horton was one of six Assistant Regional Foresters. He later became R-6 Chief of Operation.

19. Nordwall, "Radio Laboratory Inspection," p. 1.

20. Stewart Holbrook, "Radio for the Fire Line," *American Forests* 39, no. 2 (February 1933):59.

21. Lawson, interview with author.

22. This characterization of Simson is mine, based on my interviews with a number of individuals who knew him.

23. Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

24. Gaylord Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, and April 1979.

25. George A. Duthrie, "Radio Fights Forest Fires," *Radio News* 14, no. 3 (September 1932):174.

26. Headley, untitled article, *Service Bulletin* 13, no. 45 (11 November 1929):5; Holbrook, "Radio," p. 59; Lawson, interview with author; and Squibb, interview with author.

27. W. F. Squibb, "Working Plan for Portable Radio Transmitter-Receiver Study," 10 July 1931, typed, p. 5, Gaylord A. Knight Collection; and W. F. Squibb, "Progress Report on the Portable Radio Transmitter-Receiver," 3 December 1931, typed, p. 8, Gaylord A. Knight Collection.

28. Roy Headley, "Radio," *Service Bulletin* 15, no. 47 (23 November 1931):1.

29. There is some evidence that Beatty had Squibb working on the type P set during 1930. A 1932 *Radio News* article by George Duthrie, "Radio Fights Forest Fires," p. 174, mentioned that Beatty had both an 80-pound and 20-pound set in the field during 1930. Likewise, Squibb's working diagram of the type P is dated "September 10, 1930," although its file designation is also R-6 and Vancouver, Wash. Because the working drawing is the same as that of the manufactured model, the move to Vancouver occurred in 1931, and Squibb's two progress reports on the type P were dated July and December, 1931, it is assumed that the 1930 date is incorrect and that the P set did not take shape until Squibb returned to the Forest Service in 1931.

30. Squibb, "Progress Reprot," pp. 3, 4.

31. Duthrie, "Radio Fights Forest Fires," p. 174.

32. Duthrie, "Radio Fights Forest Fires," p. 174.

33. Headley, "Radio," p. 1.

34. Headley, "Radio," p. 2.

35. Forest Service, Region 6, "Forest Service Radio," 15 November 1932, p. 3, Gaylord A. Knight Collection.

36. Forest Service, Region 6, "Forest Service Radio," pp. 3,4.

37. Forest Service, Region 6, Forest Service Radio," p. 2.

38. Frank J. Jefferson, "Memorandum for William Apgar," 6 August 1932, Gaylord A. Knight Collection.

39. Apgar, "Savenac."

40. Apgar, "Savenac," p. 2.

41. Apgar, "Savenac," p. 3.

42. Apgar, "Savenac," p. 15.

43. Apgar, "Savenac," p. 15.

44. Lawson, interview with author; Squibb, interview with author; and

W. Foy Squibb, "Application for Federal Employment, Form 8, Part 19 (b)," ca. 1940, photocopy provided to author by W. F. Squibb, Gaylord A. Knight Collection.

45. Lawson, interview with author. Lawson did not recieve a Civil Service appointment until 1934. Before then he was kept on the payroll under the various titles of laborer, chief of party, technician, etc.

46. U.S. Department of Agiculture, Forest Service, "U.S. Forest Service Radio Equipment," 2 January 1935, mimeographed bulletin, Gaylord A. Knight Collection.

47. Lewis Winner to A. G. Simson, 2 July 1934, Gaylord A. Knight Collection; and A. G. Simson to Lewis Winner, 12 July 1934, Gaylord A. Knight Collection.

48. William Apgar, "Radio Report-1933," 27 February 1934, typed, p. 1, Gaylord A. Knight Collection.

49. Apgar, "Radio Report-1933," p. 1.

50. Simson and Horton, "Radio on the National Forests," typed draft of article submitted for publication to *American Forestry* per cover letter, F. H. Brundage to the Forester, 20 April 1935, Gaylord A. Knight Collection.

51. Lawson, interview with author and Squibb, interview with author.

52. Squibb, interview with author.

53. Knight, interview with author.

Chapter V

Simple, Rugged, and Reliable:

Radio Policies and Practices Take Shape

> *If radio waves only went out to the boundary of a forest and stopped there, we could toss out equipment as ordered, but radio waves don't do that. Even in California a radio wave behaves just as it does elsewhere.*
>
> \- Jack Horton[1]

The administration of a successful Forest Service communication program required much more than establishing radio as a new communications concept. Success depended on how radio was accepted by the personnel in charge in the field. Even though the Washington Office could order this new tool for use throughout the Forest Service, Laboratory staff never forgot that many headstrong Forest Supervisors could resist its incursion. The technical, logistical, and administrative decisions made at all levels, from the Washington Office to the Radio Laboratory, had to be tempered with the understanding that workability was one thing, and acceptance and implementation were something else.[2]

To maintain the momentum of the radio program, the Washington Office allowed Region 6 to assume administrative control during the 1930's. The Portland Office was in the best position to do this because of its past experience. (Certainly, the Washington Office was far removed from the forests.) As a result, Region 6 was able to "suggest" programs to Washington, often getting them approved and circulated as Forest Service policy, a method perhaps more palatable than having radio policy dictated to the Regions directly by the Washington Office.

This rubberstamp policy was reflected in early correspondence between Roy Headley and Ernest N. Kavanaugh, Assistant Regional Forester for Range Management, Region 6, after Headley requested in the fall of 1932 that this Region submit suggestions to the Chief Forester for extending radio use in the administration and protection of all the National Forests.

Kavanaugh outlined several short, specific guidelines. They gave Region 6 the responsibility for the purchase, inspection, and approval of all radio equipment, and authority to arrange for sets and parts to be stocked by manufacturers. The Radio Laboratory in Vancouver was to provide technical assistance to the Regions so that it would be aware of their needs. The Regions would then purchase radios on a "pay-as-you-go" basis and pay the salaries of technical personnel hired to install and maintain them. Headley approved Kavanaugh's outline on November 15 and distributed almost an exact copy of the suggestions to the Regional Foresters, instituting the first Servicewide radio policy based on the "suggestions" of Region 6.[3]

Portland Retains Control of Program

The decision to retain control of the radio program in Portalnd was unusual for the Forest Service and proved to be somewhat of a handicap for the Radio Laboratory. Each Region, working within overall policies and guidelines established by the Washington Office, had always been allowed considerable autonomy in managing the National Forests within its boundaries. The *Forest Service Manual* or "Green Book" disseminating Washington policy to the field, did not spell out in detail the exact procedures by which Forest Service goals were to be achieved, so that Regional Foresters, Supervisors, and District Rangers had a certain amount of discretion based on their analyses of priorities and local attitudes. If a field officer could justify and support an exception to the rules, his decision was usually given due consideration and accepted at the higher administrative levels of the Forest Service.[4]

By leaving Portland theoretically in charge of Servicewide radio development, Washington created the possibility for interregional conflict over such centralization of communication policy; each Region could be expected to consider Radio Laboratory guidance binding only insofar as it pertained to an individual Region's needs. If a Region determined that its needs were unique or contrary to a decision made in Portland, it was free to deviate from Portland's recommendations or even to choose commercial equipment over the products designed and produced at the Laboratory. Regional autonomy further complicated the work of the Radio Laboratory because the Washington Office did not give anyone the authority or duty to arbitrate inevitable deviations by any of the Regions. Real, as opposed to implied, direction was lacking.

Earl Loveridge, for example, told the Regions that "...all apparatus such as radio sets, transmitters, receivers and test equipment should be purchased through the Radio Unit..." in order to insure some semblance of centralized radio development, provide for the coordination of activities, and take advantage of quantity purchase discounts. But there was no directive in this correspondence that *required* the Regions to purchase *only* Forest Service-designed equipment.

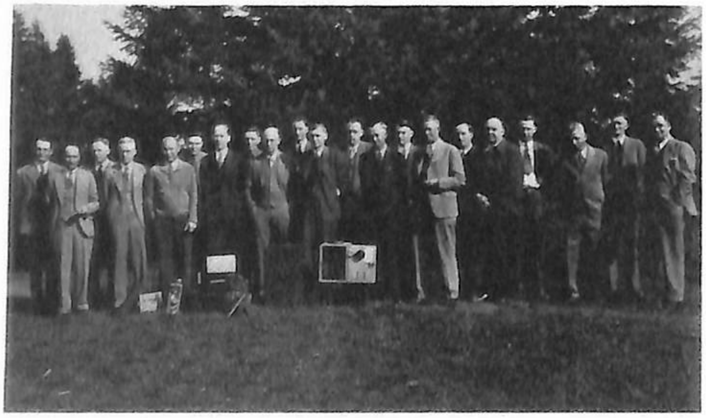


Figure 45. Men from the Regions who attended a radio course held at the Radio Laboratory, Vancouver, Wash., March 1934. (NA:95G-287881)

This situation naturally left officials like Jack Horton in a quandary when rebuffed by Regional Foresters in other Regions whose authority equalled that of the Region 6 Regional Forester, who was nominally in charge of national radio practices. Horton, removing himself from consideration, asked Roy Headley to appoint a "radio dictator" who could keep each National Forest from devising its own independent communications plans. This committee or person, Horton suggested, should have a clear picture of the total needs of the Forest Service and the

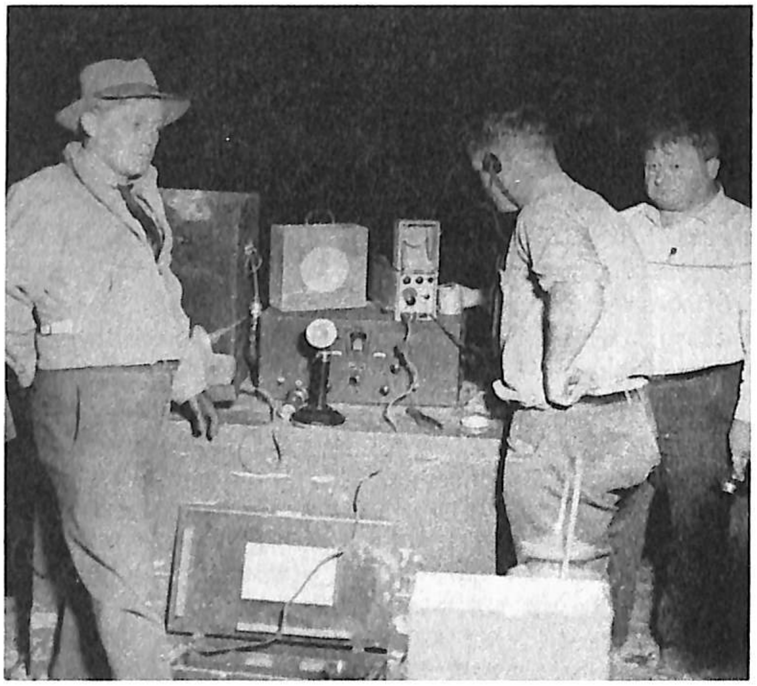


Figure 46. The Forest Service's small type PF set with speaker is on top of a Hammarlund Comet Pro commercial receiver in this photo. The receiver was used in conjunction with the Forest Service type M radiophone transmitter, which is visible behind Forest Supervisor William V. Mendenhall at left. This night photo was taken at the radio center on the Barley Flats fire, Angeles National Forest, southern California, in 1936. (NA:95G-341689)

authority to develop a firm Servicewide policy based on those needs.

Alarmed lest one or two aggressive Regions outdistance the others, Horton cautioned Headley about insurmountable problems "...if we give one unit the cream and let the other starve."[6]

Washington, however, did not waver from its inclination to allow wide freedom for each Region and avoid strong direction in radio communications policy. Through most of the period between 1932 and 1948, the Chief Forester's Office continued to acknowledge the technical leadership of Portland, saying, "We make no pretense as to being authorities in radio matters...",[7] while denying the Laboratory real authority over the Regions.

In an attempt to provide some centralized leadership, promote the use of radio throughout the National Forests, and lend substance to Portland's implied control of the program, the Radio Laboratory held radio schools for Regional- and forest-level personnel. This approach brought together those responsible for purchasing and budgeting. It also gave Simson, Lawson, and Squibb an opportunity to educate those who might be suspicious of the value of radio. Using a simplified course in electronics fundamentals, the sets were presented to personnel as logical, straightforward devices with a practical application in suppressing forest fires. Setting up a field demonstration of a typical communications operation, they effectively demonstrated the operation, provided hands-on experience, and reduced resistance to this new technology.

Undoubtedly, this formal approach proved more beneficial in promoting the cause of the Laboratory than earlier forms of indoctrination. In one instance, while finishing up an installation on the St. Joe National Forest, Lawson was giving a demonstration to Charles Scribner when a call came over the speaker. Lost in the

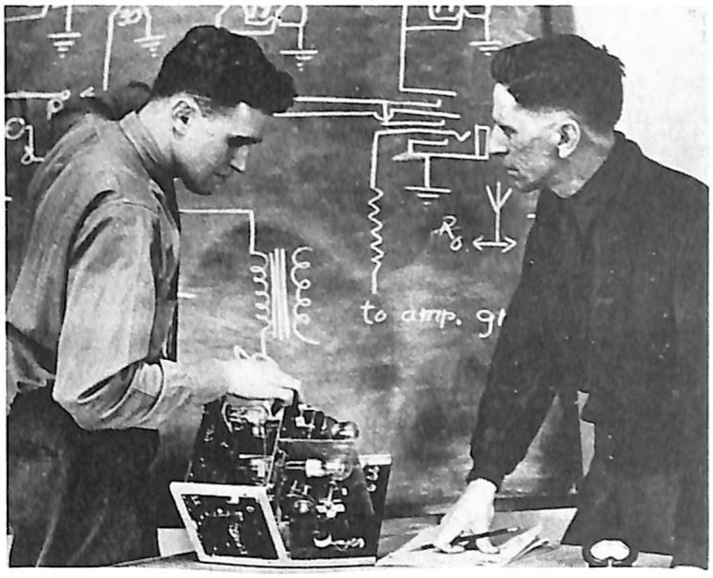


Figure 47. Radio familiarization course held at the Radio Laboratory, Vancouver, Wash., March 1934. Above, Harold Lawson pointing out to R. W. Shields, an inspector for the old Eastern Region (R-7), the relationship of components to the schematic drawing on the blackboard. Below, W. Foy Squibb identifying radio sections for Fritz J. Poch, technical assistant, San Isabel National Forest, Colo., Region 2, center and Leonard D. Blodgett, timber sales specialist, Olympic National Forest, Wash., Region 6, during the 1934 radio course. (NA:95G-287885, 287886)

details of correct procedure, Scribner had set aside his unlighted pipe to pick up the microphone. Before responding, he absentmindedly struck a match, stuck it under his nose, and uttered a hyphenated expletive that was received without difficulty back at headquarters.[8]

Patent Infringement Question

The question of patent infringement was one of the first administrative tangles encountered by the Radio Laboratory staff in their pursuit of lightweight portables. In the early 1930's, many circuit designs were protected from commercial production by manufacturers holding the patents. While they were unable to curtail the use of these circuits, they often received a royalty fee from the secondary manufacturer. Uneasy over their responsibility, as well as the potential liability of the Radio Laboratory and increased costs, Simson raised the possibility of patent infringement. He asked Jack Horton to obtain the opinion of the U.S. Department of Agriculture legal staff before completing bid specifications on the P and SP sets.[9]

Horton passed this request on to the Chief's office and received a short, blunt reply from Earl Loveridge. According to Loveridge, who had sought the opinion of the well-informed radio expert, Dr. J. Howard Dellinger at the National Bureau of Standards, who had earlier encouraged Dwight Beatty, "...the radio patent situation is so hopelessly involved that it is almost impossible to determine who the owners of 'good' patents on radio equipment are."[10] Dr. Dellinger had also pointed out that other Government agencies "...disregarded the patent situation in drawing up specifications for radio equipment and have specified the type of equipment desired in exact and detailed terms."[11] On this advice, Loveridge recommended that the Radio Laboratory proceed with bid specifications.

When the first run of radiophones was completed one year later, Spokane Radio Co. (SRC), the contractor, questioned the possibility of infringing on patents held by the Radio Corporation of America (RCA) and Lee DeForest, and voiced its worry that it might be held liable for royalty payments at a later date. Jack Horton decided to research the subject further in the U.S. Codes. In his letter to Frank Prince of SRC, Horton cited page and reference on the obligations of non-patent licensees and unlicensed manufacturers. He concluded that SRC was required by the Government to use patented circuits and could not, therefore, be held liable for infringement. If a licensed manufacturer chose to seek redress against a contractor for the Government, it would have to first sue the Government before the Court of Claims after the sets were constructed.[12]

But the issue of nonobligation by non-licensed manufacturers was not easy to quell. As more and more Forest Service radios were constructed, manufacturing contractors became more and more uneasy about involvement in court suits. Perplexed by what he thought a closed issue, Jack Horton once again wrote Washington. He said that the Forest Service faced no more than an increased cost of about 7 percent for royalties or a suit in the Court of Claims. Admitting that the circuits in question were patented, and that both RCA and De-Forest were receiving "tribute" from other manufacturers, Horton questioned their claim to credit or compensation. "Personally," he told the Forest Service Chief, "I doubt the validity of these patents and believe both these outfits have a rather uncertain hold on them."[13]

As a suggested strategy, Horton asked the Washington Office to continue to include a contractual release from patent infringement for contractors of Forest Service sets. He believed this would quiet their concern over lawsuits from RCA--"a big concern with plenty /of/ money and legal talent"--and close the issue of the Forest Service paying royalty fees that small, local companies would require if the Government did not intercede between them and the larger corporations.

Horton, however, was reasonably certain from his "review of court decisions" that if RCA or DeForest should challenge the Forest Service in the Court of Claims, they would get no more than the usual 7 percent for their trouble. In that event, the Government would be out no more than if they had made the smaller companies liable for patent infringement and paid the 7 percent on the front end. In spite of this possibility, Horton did not take RCA or DeForest seriously. "I believe that RCA or DeForest would be very reluctant to ask for a show down in Federal court ...,"[14] he told the Chief. With a gambler's resolve, acquired perhaps from his experience in the Forest Service, Jack Horton was willing to call the bluff.

The response from the Washington Office arrived in Portland nearly a month later. Its tenor was decidedly legalistic and included a copy of a decision provided by the U.S. Comptroller General in a similar case.[15] After covering historical and legal precedents, Edward A. Sherman, acting in the capacity of Chief Forester, gave Horton authority to proceed as he had requested. "In this case, since you state that the alleged patent rights are probably not valid and since to ask the contractor to carry the entire risk would increase the price about 7 percent, it is believed advisable for the United States to assume the risk rather than pay the increased price."[16] The Forest Service was putting its money on Jack Horton.

Ten years later, after some 5,000 sets had been put into use by the Forest Service, David S. Nordwall, Alternate Director of Operation in the Washington Office, made an inspection trip to the Radio Laboratory. His final report reviewed the earlier Forest Service patent controversy and recalled that RCA, in particular, had challenged the use of the Armstrong oscillator circuit in Forest Service radios. Because RCA had declined to seek recourse in the Court of Claims, "for obvious reasons," Nordwall concluded that "since no further complaints have been received during the past 10 years, it is believed safe to assume that this is a closed issue."[17]

On the other side of the patent controversy, because of the confusion over ownership, the Radio Laboratory submitted several ideas for patent consideration. A representative of General Electric Co. (GE) had informed them this procedure was necessary to protect the Forest Service should an enterprising individual or company make separate application, obtain a patent through default, and require royalty payments from the Forest Service at a later date.[18] "In other words, if we simply develop the apparatus without securing a patent in the Government, anyone could patent it and thus be able to charge all subsequent users a royalty,"[19] Jack Horton succinctly pointed out.

With this in mind, the Laboratory staff searched for mechanical and electrical innovations necessary to the mission of the Radio

Laboratory. The first was submitted for patent in mid-1931 and described as a "power-feed antenna" invented by Harold Lawson. Before submission, however, the Bureau of Agricultural Engineering, U.S. Department of Agriculture, again consulted Dr. Dellinger and also Elmer L. Hall of the NBS Radio Section, finding "... that antennas very similar to the one in question are in use at the present time by amateurs."[20] A few months later the Laboratory also submitted material to the Chief Forester for patent application on the type P and SP sets. But this time, the cover letter pointed out, the patentability of either device was doubtful. "We claim nothing new in circuits," cautioned the Radio Laboratory, "but the arrangement and combination of parts and circuits ... in the design of portable and semiportable apparatus."[21]

Complexities of Designing Portables

The patent applications for these radiophones never went beyond the U.S. Department of Agriculture. On the one hand, as the issue of patent infringement and royalties slowly subsided, it was no longer necessary; on the other hand, Lawson and Squibb had difficulty claiming complete originality for their work. Willing to protect the Government's interests in developing portable, lightweight equipment, both men, however, were aware of their debt to amateur radio and the practice of utilizing existing circuits as needed. The task, however, was not simply one of duplicating the work of others. It required the adaptation of "... known radio principles and circuits to the very specialized and exacting requirements of forest protection communication."[22] Most amateurs of the day could construct a battery-operated portable whose weight would test the endurance of any man. The trick was to make the same set weigh half as much, but still do the same job.

To succeed, Lawson, Squibb, and those who later joined the staff had to be aware of the advantages and tradeoffs of many different circuits, each with its own peculiar and unique advantages. Some circuits might provide greater sensitivity or fewer external controls, require less power, or have more volume or fewer expensive parts. It was not simply a matter of clipping a few components or attempting to compromise quality in the interest of lighter weight. Each concept had to be tested on the bench, incorporated into the rest of the circuit, and tested again.

Then, too, there were the relative merits of alternative design: Would capacitive or inductive coupling provide greater benefits? Could a newly designed single tube be made to work in place of the current two? Were certain parts common to reception and transmission, and, if so, could they be effectively switched back and forth if that component were used in both circuits?

Climatic effects were also a concern in the design of lightweight sets. Knowing that the success of their product depended on consistent operation in both the humid forests of Washington State and the arid deserts of the Southwest, as well as at altitudes ranging from sea level to the Continental Divide, the Laboratory conducted environmental tests, albeit primitive, on each radio type.[23]

Under Gael Simson's constant urging to keep the sets "simple enough for a mule to operate,"[24] each detail in the design was evaluated. When decisions on enclosures were necessary, the Laboratory determined experimentally how many rivets and gussets would be required to make a chassis withstand the shock and weight of a packhorse tumbling over the side of a mountain. To measure the effects of this type of abuse, Lawson climbed to the roof with a set, held it at arm's length, and, in what his coworkers called an "unfair" test, watched as the unit crashed to the pavement below.[25] Even though the set worked after replacing a tube, Lawson had special tube sockets designed that allowed the tubes to rest on a foam compound and be held in place with spring clips attached to the chassis. Lawson remembered his own near brush with death while fighting a forest fire and strove to keep operational procedures clear and concise. The outcome of his detailed consideration to the person trying to send an urgent message resulted in the Laboratory adopting Beatty's watchwords--simple, rugged, and reliable--as design goals.

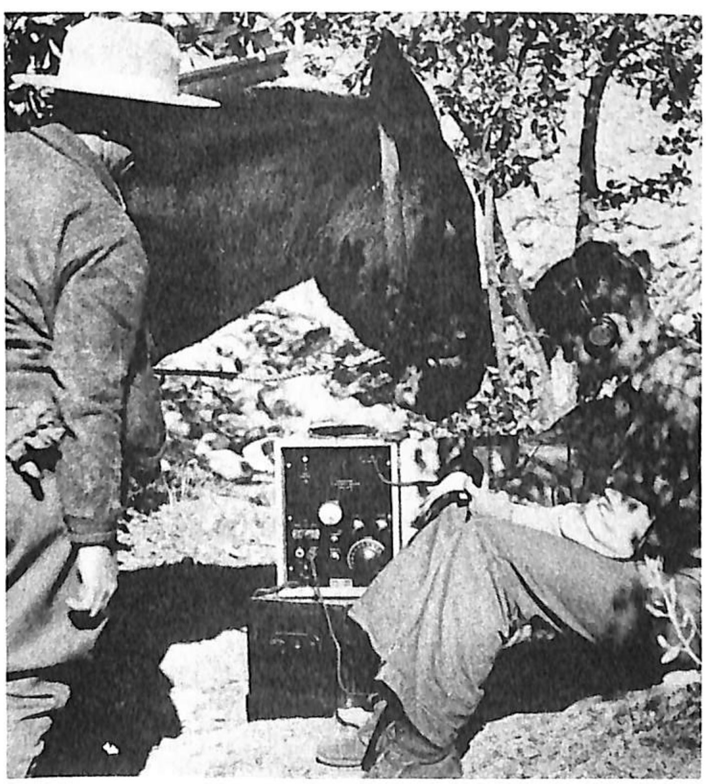


Figure 48. Type SP radio set "simple enough for a mule to operate." (NA:95G-285343)

The success of their efforts is amply illustrated by a number of Forest Service anecdotes. Among common occurrences were the recovery of a radio from the bottom of a canyon after a packhorse lost its footing, resurrecting a set that had fallen from a moving vehicle, and surviving abuse during a grueling fire season. Some paid the lightweight sets high compliments by relying on them as they would an axe, Pulaski tool, or shovel. When needed, they worked.

A railroad crash provided the ultimate proof of the simplicity, ruggedness, and dependability of the sets. A Ranger and his railroad speeder car on fire patrol came face to face with a Chicago, Milwaukee, St. Paul & Pacific locomotive on a blind curve. With only enough time to dive off the car, he watched as it was demolished by the train roaring an arm's length from his body. When the dust settled, he searched for anything salvageable and collected the pieces of equipment for which he was accountable. In a bedsheet, he threw a mangled PF Kitbox and radiophone. At headquarters, the box and radio were photographed, the set examined, batteries replaced, and the unit tested. It came through with flying colors. It was returned to service with minor cosmetic repairs.[26]

The staff found attention to minute differences in weight just as important, as Colin Fletcher, considered the major spokesperson for modern-day backpackers, does today. He tells has proteges that if they watch the ounces, the pounds will take care of themselves. The

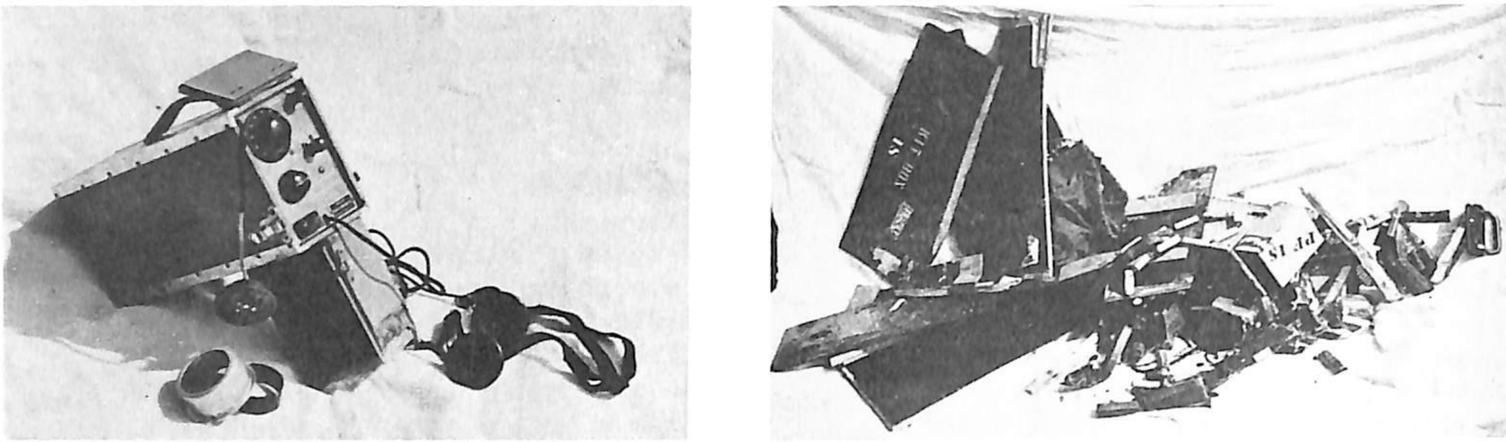


Figure 49. Type PF radiophone, left, and kitbox, right, after collision with a railroad locomotive. When the batteries were replaced, the set worked perfectly. Following minor repairs at the Radio Laboratory, it was returned to field service. (Forest Service photos, History Section)

Radio Laboratory wanted to design a smokechaser's set that could be carried by one man with firefighting tools and other paraphernalia up mountainsides, across valleys and rockslides, over downfalls and through dense timber, and still arrive at a fire with a useful communications tool.

To go a few pounds above the unknown, optimal weight might make a man ditch his burden in the interest of speed or comfort, yet in the mountains the radio signals had to be able to traverse rugged ground. If the weight of the batteries was decreased in the interest of portability, the output power would be decreased. If the staff increased the output power, they would pay a penalty in greater battery weight. Somewhere in between was an acceptable compromise that would allow the person in the forest to comfortably pack in his burden and successfully send out his message.

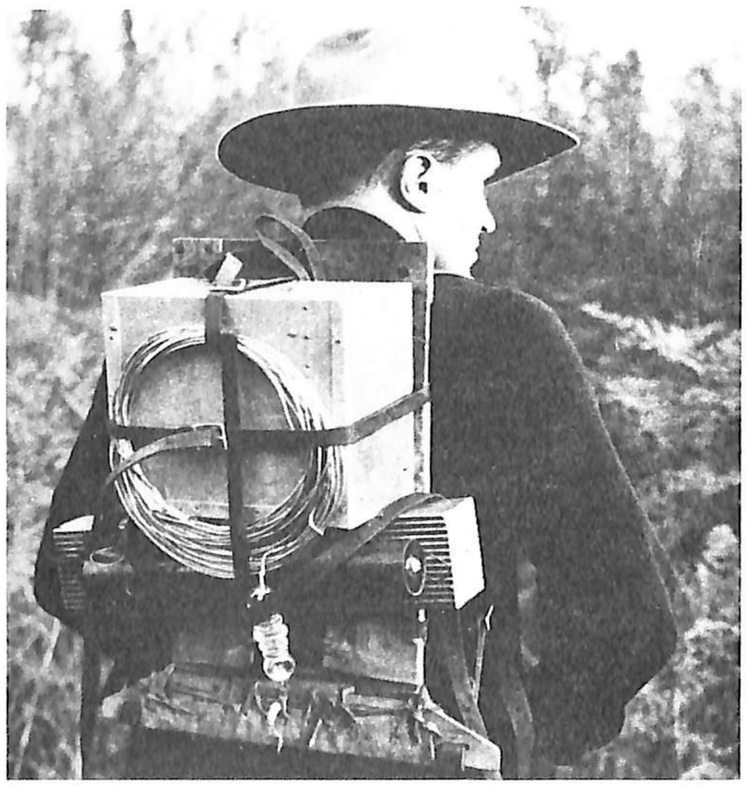


Figure 50. Portability of the type P radio is demonstrated by Harold Lawson of the Radio Laboratory. Note antenna loading coil and battery under container. (Forest Service photo, History Section)

Costs Had to Be Kept Low

As design efforts progressed at the Laboratory and the number of sets in the National Forests increased, the staff began to learn that factors other than reliability, simplicity, and ruggedness were important. Unit price and maintenance costs were significant determinants of attitudes to radio. Field men had limited budgets and could not afford an effective communication system if it meant cutting back on other essential projects. Even though one $50 radio might avert a million-dollar fire, the decision to cross out some items from the budget and substitute "Radios" was an agonizing decision for those with limited resources to spend on roads, bridges, trails, telephone lines, lookout towers, buildings, labor, and a host of other needs.

The cost also helped swing many skeptical Rangers over to deciding that this new technology was not worth their investigation; along with many others, some were loath to accept a new idea. Accustomed to packing beans, flour, ammunition, and perhaps a bottle of whiskey for an extended trip into the forests, a Ranger could be out of contact for weeks while on his duties. To tell him to carry an expensive radio in his duffel for daily contact with headquarters was not a good way to make a radio convert out of a grizzled veteran accustomed to solitude.

The unit price of each radio was also important in planning future Laboratory projects. Perhaps beginning with Beatty's early experimental work, the staff recognized that even in the 1930's, rapid technological progress in parts and theory meant that one design was

Figure 51. The solitude and beauty of a Ranger's extended trip into the back country is reflected in this scene at Trappers Lake, White River National Forest, Colo., Region 2, ca. 1918. This is now part of the Flat Tops Wilderness. (NA:95G-43141A)

barely through field tests before it was necessary to return to the drawing board or workbench to keep up to date. The design procedure at the Radio Laboratory allowing for this planned obsolescence was straightforward: First, begin with all known circuits and existing components. Second, construct and test a modern, compact, reliable, and practical set that is not expensive. Third, on completion, gather up everything learned and revealed throughout the industry in the meantime and start improving on past performance. If an initial design effort had been overly expensive, it would have been difficult to justify rapidly replacing existing units only because of improved technology. "In the interest of economy," Gael Simson pointed out, "nothing is spent on beautifying the sets as it is felt that rapid obsolescence makes such attention unjustifiable."[27]

To someone unfamiliar with radio, this planned obsolescence could appear to be fiscally unsound. But the pace of technology was swift and relentless. "Almost daily," the *Radio Handbook* pointed out about 1938, "new tubes, parts and technique are being developed."[28] In a profession where the evolution from vacuum tube, to transistor, to integrated circuits took place within the span of a single career, the Laboratory staff could not succeed in their mission by standing still. They had to search continually for new tubes that might take less current, antenna changes that would enhance performance, batteries that improved duty cycles, and circuits capable of stabilizing performance of lightweight equipment.

This quest was aided by an infant but highly innovative, fast-growing, and competitive electronics industry that sought constantly to devise sophisticated circuitry and develop technically improved equipment and components. Spurred by competition, they produced products at a bewildering pace, and the men at the Laboratory had a near-ideal, almost unprecedented opportunity to provide the men in the field with equipment that was always up-to-date.

As a pioneer in lightweight, low-power, radio development, the Radio Laboratory was often tempted to add too many features to Forest Service radios. The decisions, not unique to electronics, require careful judgment by the design engineer, who must often choose between adding features to solve a problem or trying to solve it by other means. Additional investigation of the literature or discussions with other specialists, for example, might reveal that a problem could be eliminated by substituting component values, altering physical layout, or even abandoning "nice-to-have" features. A second closely related, perhaps more important factor, stems from the human tendency to equate design with creativity. This can blur the distinction between pragmatic, or practical, design and overdesign. When producing an item that does not yet exist, the professional design engineer is tempted to create an object reflecting mastery of the subject as well as ability to assimilate new developments.

Radio Amateurs Ran the Laboratory

The Forest Service did avoid the problem of overdesign. Beatty, of course, literally came out of the woods to demonstrate the viability of a concept. With no more than an elementary background in electronics, he acquired and used only that knowledge necessary to demonstrate the concept. When he had to employ assistants, he turned to radio amateurs--who were also self-taught. Actually, Beatty would not have had much luck locating qualified graduate engineers. In 1930, nearly all holders of E.E. degrees were well trained in design of power plants and the erratics of high-voltage transmission lines, but electronic circuit theory and design was not yet a substantial part of the university curriculum.[29]

At the upper levels of Forest Service administration, this preference for self-educated engineers was based on the long and deeply held creed--only recently modified--that foresters could better determine the needs of the Forest Service than graduate engineers or other specialists. "Early in the history of radio development for forest protection communication," Gael Simson told the readers of the *Journal of Forestry* in 1938, "it became apparent that best results could be obtained by placing foresters, who also had a technical knowledge of radio, in charge of development work; rather than depending on radio engineers who were not familiar with forest protection problems."[30]

The Forest Service's tenacious belief in this general, fundamental principle was reinforced by the successful efforts of Beatty, Simson, Lawson, and Squibb during the formative years of radio development. This policy protected the emerging Forest Service communication program from radio design that was too refined, too expensive, or too fragile for use under the rugged field conditions and, that, thereby, might have caused the radio program to fail in its infancy.[31]

Once the Laboratory's design goals for a model were established and a prototype developed and thoroughly tested, a method for manufacturing the model in quantities had to be devised. Initially, Beatty and the Laboratory had sets made by private shops from a working model. As the program took shape, Regional Forester Charles J. Buck, brought up the possibility in 1931 of establishing a production line at the Radio Laboratory.[32] Undoubtedly fearful of treading on private enterprise, the Washington Office suggested with little hesitation in a return letter that the Laboratory produce small numbers during the winter to keep "key men" productive, but did not believe "... the Forest Service should go into the business of constructing radio sets on a large scale."[33]

Lacking instrumentation accurate enough to determine circuit performance and tolerances required to guide a manufacturer through production, the Laboratory continued the model-bid practice. Potential manufacturers were invited to view a working laboratory model and submit bids on a fixed quantity of identical units. Theoretically, a business with no knowledge of electronics could be awarded the contract. But this did not turn out to be the case. The successful bidders were usually located within a few hundred miles of the Portland office and had previous experience in electronics manufacturing. Such companies as SRC in Seattle, and the Radio Specialty Manufacturing Co. and Oregon Electronics in Portland, consistently bid on and obtained Forest Service contracts.

The smaller local concerns not only lent their expertise to preliminary design considerations, but they also were cooperative when units were coming off the production line for testing. They provided valuable assistance in suggesting or completing the necessary changes between the prototype and final product, or incorporating alternatives that would improve performance.[34]

No administrative problem associated with the advent of radio in the Forest Service could bring a faster knee-jerk response from the Washington Office than the subject of "administrative" radio, or point-to-point communications. Even before radio had a chance to prove its effectiveness in putting down fire, the advocates of wireless communication were imagining benefits from "invisible wires" strung throughout the National Forests.

"For example," read a 1932 report, "on a newly acquired ranger district which was without telephonic communication, practically the entire administrative and protective communications was handled by radio."[35] But before work crews could roll up telephone wires and forget about the annual springtime chore of maintaining miles of telephone line after a winter's abuse, someone reminded the visionaries of the lease agreements between the Forest Service and A. T. & T. The arrangements gave the Forest Service up to a 50 percent reduction in toll call rates if it did not use any device in competition with telephone.[36] Unable to justify the expense incurred by loss of these telephone leases, the Chief Forester's office overruled those who favored more radio. He required personnel to emphasize the use and importance of telephone "in order to forestall needless alarm on the part of A. T. & T. that Forest Service radio is unnecessarily infringing on their utilities..."[37] Personnel were to make certain that "...newspaper correspondents are given to understand that, in general, radio will not be used in the ordinary administrative work of the Forest Service."[38] The result was a series of carefully worded statements emanating from the Radio Laboratory during the 1930's:

> We use radio to supplement the telephone system--*not to replace it.*
>
> \- A. G. Simson (July 12, 1934)[39]

> This radio net, if it can be so called, has not replaced the telephone, nor is it intended that it should.
>
> \- A. G. Simson and F. V. Horton (April 20, 1935)[40]

> Radio is used in the Forest Service primarily as a supplement to the telephone. In most instances it cannot replace the telephone. Instead radio furnishes communication where the telephone is impossible or impractical.
>
> \- A. G. Simson (April 11, 1936)[41]

> ... each has its place in the forest communication system. Where the use is not heavy, where telephone line maintenance is difficult or expensive, and in areas of heavy static, such as where a telephone line covers territory with radical changes in elevation, the radio may furnish more satisfactory and dependable communication than the telephone. On the other hand, for 24-hour service and where it is necessary to have community outlets, as in cities and villages, the telephone is usually more useful than the radio.
>
> \- A. G. Simson (April 1938)[42]

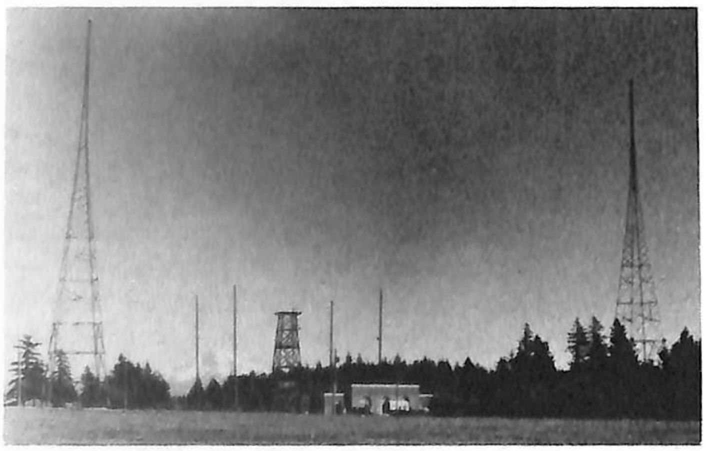


Figure 52. The Radio Laboratory and transmitter towers for control station KBAA on the outskirts of Portland, Ore., national headquarters for Forest Service radio from 1933 until 1952. Mt. Hood appears in left background. (Forest Service photo, History Section)

Figure 53. At work in the Portland Radio Laboratory are, left to right, Harold Lawson, Ralph Kunselman, and Foy Squibb. (NA:95G-302659)

Figure 54. George Barrett of the Portland Radio Laboratory communicating with Civilian Conservation Corps (CCC) camps operated by the Forest Service in northern Oregon and southern Washington, 1935. (NA:95G-302663)

> In general good telephone will furnish better communication than radio, though there are many exceptions to this generalization.
>
> - *Radio Handbook* (April 1938)[43]

Radio Laboratory Is Moved to Portland

Once the principle was established that lightweight, low-power, low-cost radio could be a part of the arsenal of forest protection devices, establishing permanent and improved facilities became the next priority. The rented house in Vancouver was not much of an improvement over its predecessor in Tacoma. It lacked adequate space, security, and amenities. When a defunct radio station, KEX (at 122d Avenue and Glisan Streets, on the outer limits of Portland) became available in 1933, the Forest Service took a 3-year lease on the property and then acquired the site, covering 5 acres.[44] It served as the headquarters of Forest Service communication development for the next 18 years. Located within view of Mt. Hood some 40 miles to the east, it was ideal for Laboratory development programs. It was not only large enough, but also was equipped with the dream of radio experimenters--two 220-foot steel towers. After building on to the rear, and adding four tall telephone poles and a lookout tower, the Forest Service found that most situations could be duplicated and tested at the site.

During the first few years of Forest Service radio development, a significant difference of opinion inherent to radio acted as a divisive force within the Regional communications sections of the Forest Service. This issue was the effective relationship of transmitter output power, or wattage, to the distance that a transmission must travel. The proponents of "brute-force" propagation were ever ready to argue the merits and minimize the drawbacks of shifting Forest Service transmitters to higher levels of output power. They based their stand on the debatable assumption that if an existing 5-watt transmitter is on the fringe of adequate performance, then a 10-watt version is preferable because it should significantly improve performance.

In retrospect, this situation, was probably partly attributable to the lack of positive leadership from the Washington Office. But it also resulted from the efficient design efforts and planned obsolescence policy of the Radio Laboratory. With new weight-saving models appearing each fire season, communication heads in the field who championed increased power had two effective ways of influencing final design specifications. Each year, they were invited by the Radio Laboratory to submit their suggestions for improved performance. They also often had authority from the Regional Forester to purchase what they wanted when they wanted it. If the Radio Laboratory refused to go along with pre-design suggestions or ignored opinions from the field, a Regional communications officer could resist the expansion of radio communication, at least the Laboratory's models, into "his" National Forests by delaying purchase of planned or existing Laboratory radios. In this way, he could influence the Radio Laboratory in its consideration of Regional needs.

Power Issue Difficult to Resolve

The issue of output power was difficult to resolve for several technical reasons. Perhaps the most apparent was associated with the expected performance of the batteries. During the 1930's, battery cost and longevity had a noticeable influence on radio design. A radio requiring a high current source could decrease the effective operating life of the batteries too quickly. Frequent replacement of the batteries could also make field maintenance cost prohibitive. The Laboratory, therefore, geared each set's power requirements to the intended use of the set and predictable battery performance. The rule of thumb was: "If you double the power, you must double the batteries, and hence, double the weight."[45] An existing 3-watt radiophone weighing 25 pounds, for example, would need to be replaced with a 6-watt unit weighing about 50 pounds--hardly the smokechaser's idea of portability.

The Radio Laboratory saw a second technical point as crucial to the issue of output power. It arose from the widely varying patterns made by radio waves in the atmosphere. Such factors as antenna dimensions and location, topography, weather and climatic conditions, receiver quality, and ionospheric and sunspot activity are of critical importance in determining the effective range of a radio signal. Early experiences in the Forest Service often reflected these peculiarities. Quite frequently, while testing the relative performance of two different units, the signal of a transmitter with only one-tenth the output power of another was received at some distance at a strength equal to that of the much more powerful set.

An example of this phenomena was the some 200-mile air distance between the Radio Laboratory in Vancouver and Lake Chelan. Using a 1 1/2-watt SP set at Lake Chelan, Washington, Ranger Roy Weeman was able to establish regular two-way communication schedules with the 50-watt station at the Laboratory. This link was valuable to the Laboratory in evaluation tests, even though the staff might question the propriety of Weeman taking part in some discussions not intended for him. In one embarrassing instance, Simson wanted to demonstrate the effective range of low power to a Chinese businessman and his son. He located a portable radio several miles from town, and after establishing contact with Lawson and the younger visitor, turned the controls over to the businessman, who started to talk with his son in their native language. Weeman, who missed the first part of the contact, broke in during a pause to ask, "What the hell are you guys doing down there? You sound like a bunch of '*#?&! Chinamen!"[46]

These anomalies of propagation also worked in the opposite manner. At times, nothing could get through. This usually happened when the transmitter was located at or near its designed fringe area. Recognizing that any transmitter, especially in the portable class, effectively has an undefined boundary for satisfactory performance and a fairly wide region beyond this where performance is questionable, the Radio Laboratory cautioned operators that "a set designed for a 10-mile range very probably will not operate satisfactorily over a 100-mile range."[47] To the proponents of "brute-force" propagation, the staff of the Laboratory would also point out that effective range was determined less by output power than by effective communication planning.[48] Rather than try to use a portable at some fringe distance or under conditions for which it was not intended, they advised supervisors to plan accordingly and suggested that operators alter locations if they found a transmitter or receiver not operating properly within its advertised range. Most radio publications distributed by the Radio Laboratory emphasized this point, and most radio operators familiar with their territories soon learned the optimum locations for effective communications with Ranger stations and lookout towers.[49]

In addition to these technical arguments for staying with low power, Gael Simson also knew that unlimited output power might have a serious and detrimental effect upon the long range communication plans of the Forest Service. As the IRAC representative for the U.S. Department of Agriculture,[50] Simson could see clearly that the number of assignable frequencies was limited and that pressure to relinquish some frequencies would increase as radio expanded into other Government agencies and the military services. Simson pointed out as late as 1936 that the Forest Service had but 11 "fire" radio channels and that it was necessary to assign the same frequencies to National Forests in the West no more than a few hundred miles apart.[51] Even at minimum power levels, the potential for crowding and serious conflict was significant.

Laboratory Insisted on Low Power

Harold Lawson, who fully supported the technical arguments against the use of increased power and was in total agreement with Simson's conclusions on frequency crowding, often became the target for the frustrations of the proponents of brute-force transmission. They often called the Laboratory "Horton's Hobby Shop," and the attitudes of Simson and Lawson "stubbornness."[52] Communication meetings almost invariably digressed into the merits of particular power limitations.

Jack Horton and Harold Lawson never wavered from their position. From the beginning, Horton insisted "... that low-power was essential."[53] To those who would listen, Lawson recounted his experience with the first National Forest radio network where he learned a lesson on the bad effects of unlimited power. Following installation of a type M set at the St. Joe National Forest headquarters in St. Maries, Idaho, he had distributed an SP set to each of the Forest's five Ranger Districts. While tuning up for a test at the last location, one of the California forests, which had purchased high-power, commercial gear for experimentation, came on the channel and effectively blocked out communications on the St. Joe. Drawing on this situation, Lawson depicted an Idaho smokechaser in the same position attempting to notify headquarters that a fire was out of control. If the smokechaser had to cool his heels while a lookout in California called in his next month's grocery list, the radio would have been rendered ineffective for the very person for whom it was intended.[54]

This argument, of course, was challenged in many ways by those who perceived the administrative structure of the Regions not as a totem pole with the field man at the top, but as a complex of varied services, all with unique requirements and all in need of adequate and equivalent radio communication capabilities (see chapter 15). If this structure required levels of output power threatening the most important link in the fire-control chain, then other agreements, understandings, regulations, and communication plans would need to be devised. Before these differences of opinion could be resolved, however, technology provided a temporary distraction.

Reference Notes

1. F. V. "Jack" Horton to Roy Headley, 26 January 1934, Gaylord A. Knight Collection.

2. Herbert Kaufman has outlined the administrative structure of the Forest Service in the traditional triangular manner and suggested that from the viewpoint of the Forest Ranger this triangle was inverted. The result was that the men in the field believed Washington policy came about because of input from the local level. See Herbert Kaufman, *The Forest Ranger: A Study in Administrative Behavior* (Baltimore: Johns Hopkins Press, 1960), pp. 67, 68.

3. E. N. Kavanaugh to Roy Headley, 20 October 1932, Gaylord A. Knight Collection and Roy Headley to Regional Foresters, 15 November 1932, Gaylord A. Knight Collection.

4. Kaufman, *The Forest Ranger*, pp. 75-80.

5. E. W. Loveridge to Regional Forester, 6 December 1935, Gaylord A. Knight Collection.

6. "Jack" Horton to Roy Headley, 26 January 1934, Gaylord A. Knight Collection.

7. Earl Loveridge to "Jack" Horton, 22 October 1935. In this instance Horton had apparently questioned this practice in an earlier memorandum and Loveridge was responding with an explanation. In turn, Horton wrote Loveridge an apology and asked that they "... continue to work on the basis we have in the past, of being perfectly frank and thick-hided." "Jack" Horton to Earl Loveridge, 22 October 1935, Gaylord A. Knight Collection.

8. Harold K. Lawson, interview with the author in King City, Ore., May 1978.

9. A. Gael Simson to "Jack" Horton, 30 November 1931, Gaylord A. Knight Collection.

10. E. Loveridge to the Regional Forester, Portland, Ore., 9 December 1931, Gaylord A. Knight Collection.

11. Loveridge to Regional Forester.

12. F. V. Horton to Frank Prince, 7 February 1933, Gaylord A. Knight Collection.

13. F. V. Horton to the Forester, 12 January 1934, Gaylord A. Knight Collection.

14. Horton to the Forester.

15. J. R. McCarl, Comptroller General, to the Secretary of Commerce, 21 December 1933, Gaylord A. Knight Collection.

16. E. A. Sherman to the Regional Forester, Portland, Ore., 31 January 1934, Gaylord A. Knight Collection.

17. D. S. Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, p. 2, Gaylord A. Knight Collection.

18. C. J. Buck to the Forester, 6 April 1932, Gaylord A. Knight Collection.

19. F. V. Horton to A. G. Simson, 1 December 1931, Gaylord A. Knight Collection.

20. W. M. Hurst, U.S. Department of Agriculture, Bureau of Agricultural Engineering, to I. G. Menikheim, U.S. Department of Agriculture, Office of the Solicitor, 4 June 1932, Gaylord A. Knight Collection.

21. C. J. Buck to the Forester, 6 April 1932, Gaylord A. Knight Collection.

22. A. G. Simson, "Radio as a National Forest Protection Tool," *Journal of Forestry*, 36, no. 4 (April 1938): 366. A reprint copy is in the Gaylord A. Knight Collection.

23. The environmental chamber at the Radio Laboratory consisted of a used oven which doubled as a humidity chamber with the addition of a few wet sponges. Lawson, interview with author.

24. Belleville, interview with the author in Saratoga, Calif., January 1978.

25. Lawson, interview with author, and W. Foy Squibb, interview with the author in Missoula, Mont., May 1978.

26. Lawson, interview with author, and description on Forest Service photo in Still Picture Division, National Archives, Washington, D.C., Record Group 95G, negative No. 322283.

27. Simson, "Radio as a Forest Tool," p. 368.

28. U.S. Department of Agriculture, Forest Service, *Radio Handbook*, (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation, ca. 1938), p. 7. Mimeographed.

29. Gaylord Knight, communications engineer in Region 8, had attempted to strengthen his self-acquired electronics background by enrolling in a college of engineering. After canvassing several southern universities, including Georgia Tech, he gave up after traveling to the University of Texas where he was told that he already knew more than they could teach him. Harold Lawson had a similar experience at Oregon State. Enrolled in an electrical engineering program, he switched to forestry on the advice of his advisor, although he continued to find a few courses to support his interest in radio. Gaylord Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, and April 1979, and Lawson, interview with author.

30. Simson, "Radio as a Forest Tool," p. 367.

31. On two occasions the Laboratory hired a qualified graduate electrical engineer. Both times the Laboratory had problems assimilating the men into the development projects. Schooled

in theory, both engineers later sought employment with companies which utilized this background and went on to successful careers outside the Forest Service.

32. C. J. Buck to the Forester, 1 December 1931, Gaylord A. Knight Collection.

33. Earl Loveridge to the Regional Forester.

34. Lawson, interview with author; Belleville, interview with author; and Claypool, interview with the author in San Antonio, Tex., July 1978.

35. U.S. Department of Agriculture, Forest Service, Region 6, "Forest Service Radio," 13 November 1932, unpublished, Gaylord A. Knight Collection.

36. U.S. Department of Agriculture, Forest Service, Region 6, "Forest Service Communications Conference," Summary of meeting, Portland, Ore., 20 February to 2 March 1935; Roy Headley to Regional Foresters, 25 April 1935; A. G. Simson, "Report of Radio Committee--Spokane Fire Equipment Conference," 19 February 1936; and Carl Ewing to Forest Officers, Umatilla National Forest, Ore., 7 December 1938, all in Gaylord A. Knight Collection.

37. Simson, "Report of Radio Committee."

38. E. W. Loveridge, Acting Chief, to Regional Foresters, All Regions, 3 September 1936, Gaylord A. Knight Collection.

39. A. G. Simson to Lewis Winner, Hammarlund-Roberts, Inc., 12 July 1934, Gaylord A. Knight Collection.

40. A. G. Simson and F. V. Horton, "Radio on the National Forests," typed draft of article submitted to *American Forestry* for publication per cover letter, F. H. Brundage to the Forester, 20 April 1935, Gaylord A. Knight Collection.

41. A. G. Simson, "The Role of Radio in National Forest Communication," 11 April 1936, Gaylord A. Knight Collection.

42. Simson, "Radio as a Forest Tool," p. 366.

43. Forest Service, *Radio Handbook*, p. 9.

44. Nordwall, "Radio Laboratory Inspection." The purchase was made from the National Broadcasting Company and the Oregonian Publishing Company, joint owners, for $2,500. The address of the Laboratory was 340 N.E. 122nd Avenue, Portland, Ore. (now 97230).

45. Belleville, interview with author, and Lawson, interview with author.

46. Lawson, interview with author.

47. U.S. Department of Agriculture, Forest Service, Region 6, "Forest Service Radio," 15 November 1932, typed copy, p. 5, Gaylord A. Knight Collection.

48. Forest Service, Region 6, "Forest Service Radio," p. 3.

49. A. G. Simson, *Manual for Operating Radio Set Number P-__*, (Portland, Ore., U.S. Department of Agriculture, Forest Service, 1932); A. G. Simson, *Manual for Operating Radio Set Number SP-__*, (Portland, Ore., U.S. Department of Agriculture, Forest Service, 1932); and *Forest Service Radio Handbook*, p. 7, to name a few.

50. Earl Loveridge was the designated representative, but he had selected Simson for attendance at all IRAC meetings. See Gael Simson, Memorandum, 27 January 1939, Gaylord A. Knight Collection.

51. Simson, "The Role of Radio."

52. Both of these terms were used by William Apgar (Region 1, retired) in an interview with the author. See William Apgar, interview with the author in Sun City, Ariz., January 1978.

53. Horton to Headley.

54. Lawson, interview with author.

Chapter VI
Beyond 100 Meters:
Vhf and Hf Developments

From work carried on in Germany and other countries, it has become known that prolonged exposure of the human being within an ultra-short wave field will produce sterilization.

- Francis R. McCabe (1934)

Now I find out!

- Guy V. Wood (1958)[1]

Selection of a frequency range occupied a significant portion of time in Dwight Beatty's 1928 and 1929 field experiments. Selecting a frequency directly affects battery power, antenna length, signal-to-noise radio, transmission characteristics, and other diverse needs. The time of day and the terrain also must be considered before a frequency range is selected. The scarcity of commercial components for sale restricted the scope of Beatty's experiments. If "an optimum frequency exists ... which will provide the best signal/noise ratio at the receiver under a given set of conditions,"[2] then the complexity of Beatty's task, and his preoccupation with frequency, may be better understood.

To insure the effective transmission of daytime signals in timbered and mountainous terrain, Beatty narrowed his frequency criteria to three: What frequency would be the least susceptible to interference under these conditions? What frequency would result in a radio set light enough to be carried? What available components could accomplish all of this without resulting in a set too sophisticated or delicate for adverse conditions? From his consultations with NBS, NRL, commercial manufacturers, amateurs, and his own experiments, Beatty selected the region of 100 meters (between 3 and 4 MHz) as the most promising. This band was used for the SP-1930, SP, P, and M sets.[3]

A worldwide interest in the lower end of the 10-meter, very high frequency (vhf), spectrum began to occur about the time of Beatty's earliest field trials. On March 7, 1928, the 28- to 30-MHz region was reserved and authorized for both code and voice amateur use, as it still is today, more than 50 years later.[4] Almost immediately, numerous reports of trans-Atlantic broadcasts and receptions were received.[5] In spite of the success experienced by "hams," vhf was found useful for consistent transmissions only over so-called "line-of-sight" distances. Transmission of these higher frequencies over the horizon is due to radio wave reflection, or "bounce," from the ionosphere. This process is highly vulnerable to sunspot activity; it was considered erratic and resulted in fading of signals and wide variations between the quality of day transmissions (often poor) and night transmissions (usually better). Signals received hundreds of miles away might not be detectable only a few miles distant. For these reasons, the vhf spectrum at that time found little favor with users needing consistent performance. Such Government agencies as the Weather Bureau and the Navy, which relied on long-distance (DX) broadcasts, left the development of early vhf largely to radio amateurs.[6]

Early Radio Laboratory interest in vhf development was due to a combination of circumstances. Harold Lawson and Foy Squibb were aware of the advantages and peculiarities of the 10-meter band through their professional involvements, which included Lawson's membership in the American Radio Relay League.[7] Gael Simson was in a position to recognize and encourage their field experiments and to secure operating frequencies. Because other Government agencies in IRAC found no useful purpose in vhf, Simson was able to acquire an abundance of these channels for use in the Forest Service.[8] Although his motives in acquiring a large number of 10-meter frequencies are not recorded, Simson probably recognized the relationship between line-of-sight transmission and its application to Forest Service use. Because National Forests were then covered by a network of fire lookout towers, each one usually in sight of several others, line-of-sight radio transmissions had the potential for useful application.

Another benefit, and perhaps Simson's primary consideration, was that vhf was above the frequency spectrum for electrical interference during lightning storms. If vhf (10 meters) could be developed in the same manner as hf (100 meters), its ability to provide static-free transmission during lightning storms would aid forest firefighters during conditions that produced static interference and forest fires.

In addition to line-of-sight performance and static-free reception, vhf offered several other advantages. Because shorter wave lengths require shorter lengths of antenna wire, a transmitter-receiver operating at 10 meters can use an antenna about one-tenth the length required for 100 meters. This shorter wire is also relatively simple to install, especially when it became possible to incorporate an antenna of this length (approximately 7.5 feet) in the set as a telescoping rod.

Because vhf also required lower levels of power for line-of-sight transmissions, a corresponding decrease in battery weight was possible. The lower battery drain meant the operator could leave the receiver on for standby operation rather than rely on intermittent schedules of operation that often had receivers "Off" when they needed to be "On."

A final advantage of vhf low-power requirements was the possibility for duplex operation, that is, transmitting and receiving simultaneously.[9] With this feature vhf could more closely approximate telephone performance, as well as function as a relay for the immediate transfer of messages from point A to point C via point B.

A major reason for the lack of commercial development in the 30- to 40-MHz region was the relative absence of components that could operate at these shorter wave lengths. Amateurs have traditionally considered this a challenge. A ham inclined to conquer unexplored horizons will find suitable components either by combining unusual parts into a unique design or by raiding the "junk box" of a fellow ham. The end result is usually a unique product too complicated in parts and labor for profitable duplication by large-scale manufacturers.

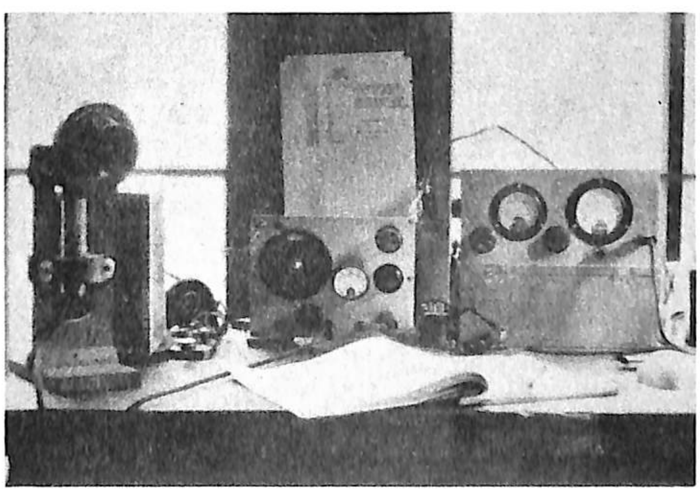
This tendency to produce a custom design worked to the advantage of amateurs and was a logical approach for the Radio Laboratory. In fact, Beatty, Lawson, and Squibb designed Forest Service radios as if they were one-of-a-kind units intended for their own personal use. In the best of amateur traditions, their experimentation was based on a few articles read here, a conversation with other hams there, a few of their own ideas thrown in for good measure, and a lot of work. Within the limitations of space and size, they sought to package a unique concept for a specific situation--fire fighting.

Viewed in retrospect, this approach precluded early involvement by manufacturers in the design of hf or vhf portable radios. The Forest Service market was at best to be only several thousand units. As in any new endeavor, the cost of research was considerable. The demands of consumers for other products such as broadcast radios, military transmitters and receivers, and large fixed-base communication systems was real. Major corporations are geared to mass markets; the techniques of amateur radio enthusiasts have no place in their board rooms, production lines, or sales territories. Firms like RCA, De Forest, Radio Telephone and Telegraph Co., Westinghouse Electric Corp., and Zenith Radio Corp. were hard-pressed to duplicate Forest Service units of comparable size, price, or function at a profit.

Work Begins on Vhf in 1932

The work on very high frequency (vhf) began at the Radio Laboratory in 1932, shortly after the move to Vancouver.[10] Following the successful 100-meter development plan, a high-power 10-meter transmitter was constructed for fixed-base use. A prototype portable design was installed at Wind River for field tests during 1933. These tests proved satisfactory and led to the production of a small number of portables that were distributed to selected Regional locations for intervisible communication, "one of the most intriguing uses of radio ..."[11]

A 5-meter set, designated type V (for Roman numeral five), was also completed in time for the 1934 fire season. Two units were shipped to Bill Apgar at Savenac Nursery. Apgar tested the equipment and found it lacking. "I eventually believe the equipment will be of use," he wrote of the 60-MHz set, "but in its present state of development and in view of its limitation, I should hesitate to acquire more than enough for experimental purposes."[12]



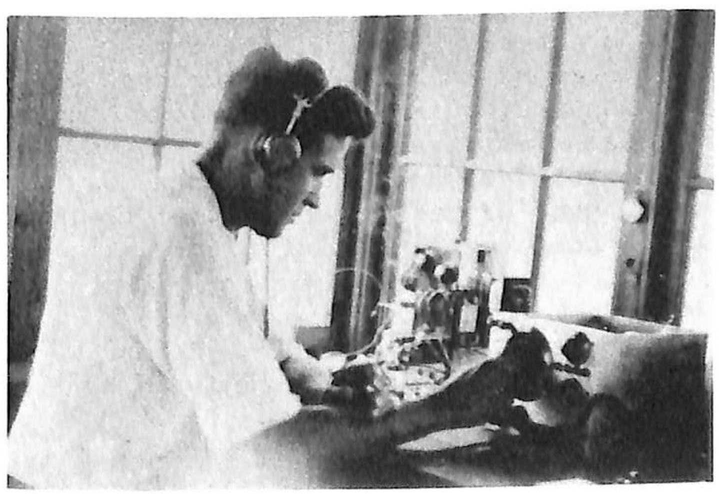


Figure 55. Photo at left shows an early version of Harold Lawson's 10-meter-band vhf portable radiophone, center, at Wind River Forest Experiment Station, Wash., 1933. Photo at right shows Harold Lawson testing a later version, also at Wind River. Note the absence of the panel meter that is on the front panel of the set in the photo at left. (Forest Service photos, History Section)

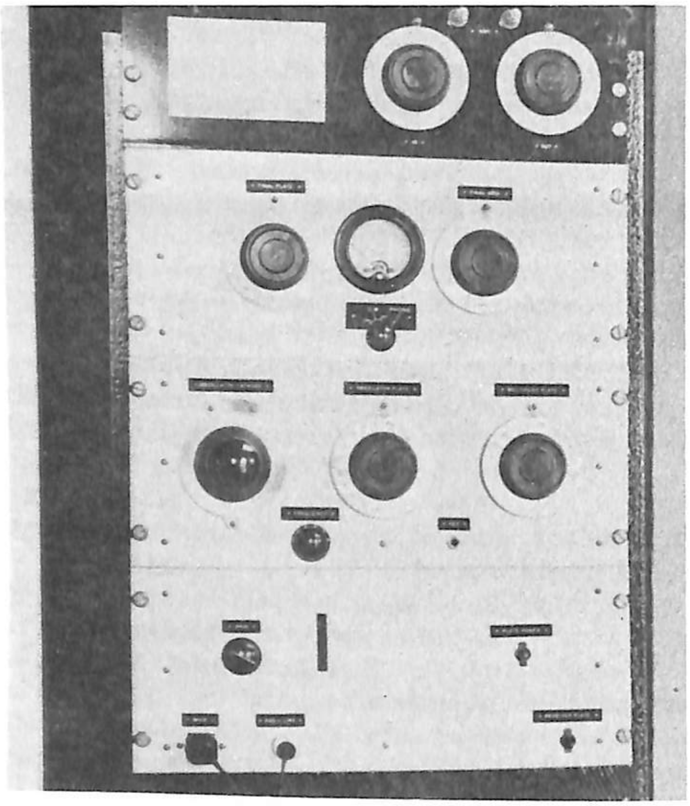


Figure 56. High-power, fixed-base vhf transmitter begun at the Radio Laboratory in Vancouver, Wash., in 1932 and installed at Wind River in 1933. (NA:95G-302664)

The type V failed to perform as expected largely because the receiver could not operate satisfactorily at 60 MHz.[13] An example of pushing components beyond their limits, it could not make the transition from test bench to field use, and the 5-meter band was abandoned for the less demanding range of 10 meters. With a triad consisting of portables, semiportables, and fixed-base radios, each phase of Forest Service vhf fire-radio needs would be met. The working plan for the 10-meter models was identical to that of the previously successful 100-meter units. By early 1934, Harold Lawson had completed the design of the portable type S set (superregenerator) and Foy Squibb, who had returned from field tests and installations, completed design of the semiportable type T sets (ten meters). Calling again for bids on working models, the Radio Laboratory had vhf units available for Regional testing by late 1934 and subsequently produced for the 1935 fire season.[14]

Like their 100-meter counterparts, these vhf units represented the best portable and semiportable design. The T set, for example, transmitted and received voice only and weighed between 30 and 100 pounds, depending on battery selection. It cost \$50 to \$60, was rated at a working range of 50 miles "over optical paths," designed for standby operation, and could be operated duplex.[15] While lacking the capability to operate duplex, the S set redeemed itself with a low initial price tag of \$26 and a mere 10-pound weight. The set-up time of under 2 minutes provided smokechasers, scouts,

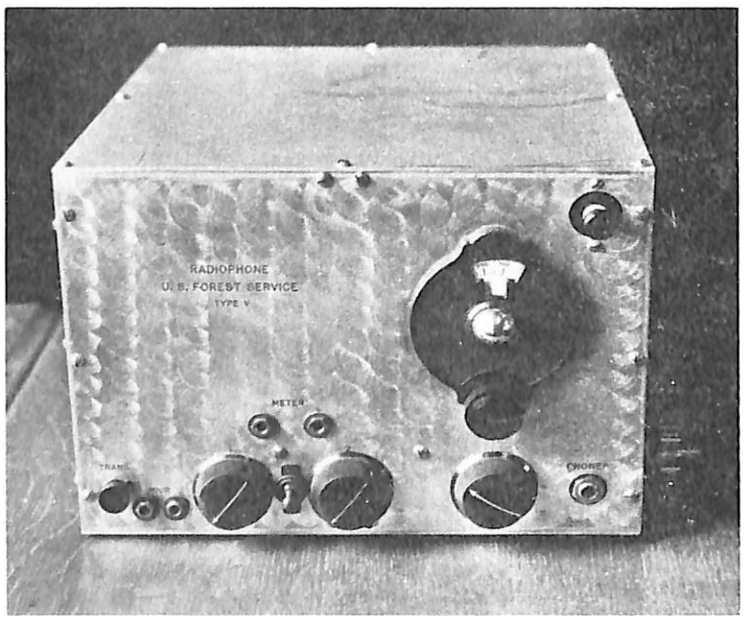


Figure 57. Experimental type V 5-meter-band radiophone field-tested during the 1934 fire season in Region 1 and found deficient because the receiver could not operate satisfactorily at 60 MHz. The 5-meter band was then abandoned for the less demanding range of 10 meters. (NA:95G-274974)

and fire chiefs with an adequate tool for ranges of 50 miles "over optical paths."[16]

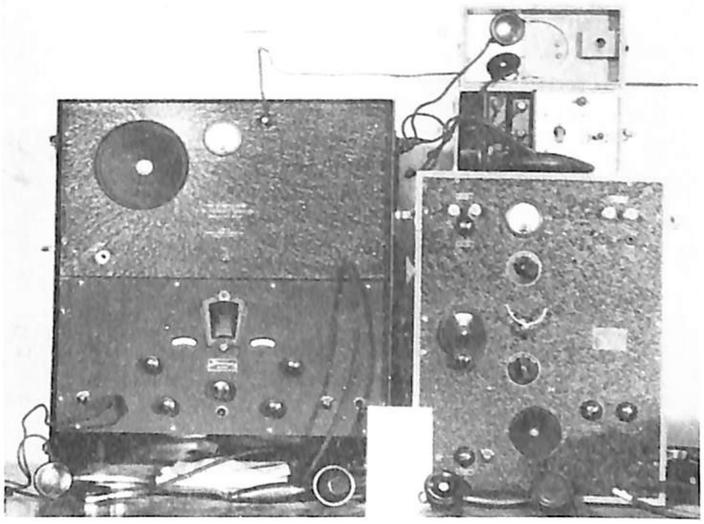


Figure 58. Type S (superregenerative) portable (10-pound) vhf set atop a later type T semiportable set, at right. Both of these 10-meter-band sets were designed and tested in the Regions in 1934. They were produced in volume for the 1935 fire season, when they received some mobile testing. Both were voice transmitter-receivers with a working range of 50 miles, line of sight. At left is a type M set mounted in a field cabinet. (NA:95G-362772).

In addition to experimenting with the S and T sets in mobile communications during 1935, the Radio Laboratory also worked to complete a vhf/lf receiver-transmitter for airplane use. The result was the type A (Airplane) designed for quick installation and capable of sending and receiving "...satisfactorily from plane to ground, even in unshielded planes."[17] It weighed about 25 pounds, and operated from a 6-volt battery that also lent itself "...to automobile installation for two-way communication from moving vehicles under favorable topographic conditions."[18]

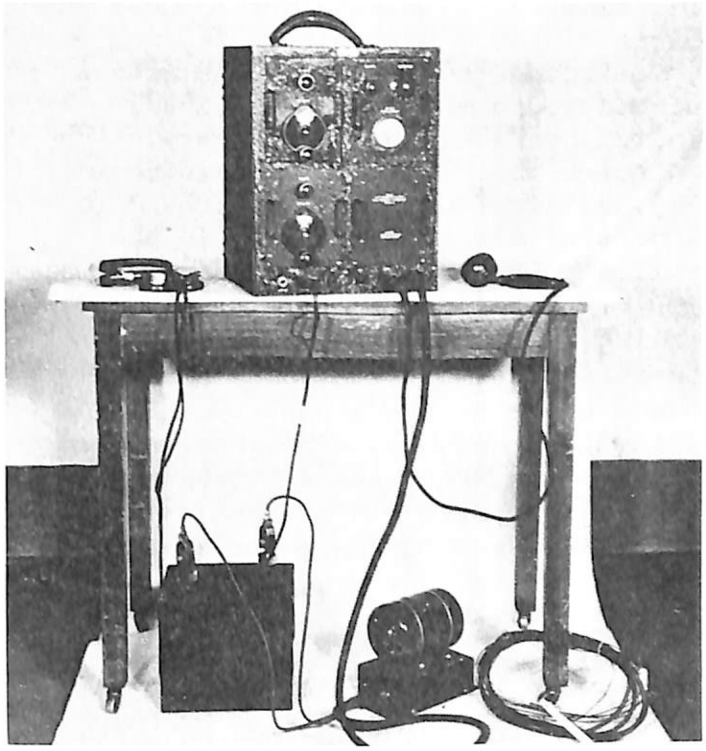


Figure 59. Type A set, a vhf receiver-transmitter, was designed for use in airplanes for air-to-ground communication, but was also operable in moving automobiles. It became available early in 1936. (Forest Service photo, History Section).

Spokane Firm Gets Contract

The workload at the Radio Laboratory was heavy, so Simson decided to have the initial model of a fixed-base, vhf transmitter constructed by an outside source. Preliminary schematic drawings had already been completed by Lawson. Spokane Radio Co. was low bidder for building the set.

SRC, of course, had "manufactured" the first eight sets of Beatty's SP--1930. The firm had also successfully bid on other units and played a significant, advisory role in the Forest Service program between 1931 and 1934.[19] Started as a local parts and repair facility for commercial radios, it had entered a wide range of electronic activities. The founder was Morris Willis. With his uncle, A. F. "Speed" Horton, and Frank Prince and Ted Young as engineers, plus a handful of regular and temporary employees that included Foy Squibb in 1930, Willis made SRC one of the more successful electronics firms in the Pacific Northwest.[20]

Working with Lawson's drawings for a moderate-power 10-meter set, Prince, Young, and a new employee, Logan Belleville, began to experiment with circuits that "...were a little bit of this and a little bit of that."[21] Belleville assumed the major share of the design, and the U set (for UHF) began to take shape.

In its final form, the type U was enclosed in a 4-foot, 9-inch console and weighed about 300 pounds. Like its hf counterpart, the M set, it used a commercial receiver, a National SW3 superregenerative. With an output power of 20 watts, the type U, priced at $400, rounded out the vhf triad.

Because of Belleville's knowledge of vhf and acceptance of the U set, Simson arranged to borrow Belleville from SRC during August 1936. He was placed temporarily as a junior radio engineer, and paid out of CCC and WPA (Civilian Conservation Corps and Works Progress Administration) funds. Belleville later achieved permanent Civil Service status.[22]

Logan Belleville had acquired radio background much as Lawson and Squibb had. As a young boy in Twin Falls, Idaho, he "was kind of a loner;" he did not get along easily with most others of his age. Instead of conventional youthful activities, he found tinkering in electronic communications exciting. With a young friend down the street, using cracked-off bottle tops for insulators,

Figure 60. Logan Belleville, who designed it at the Radio Laboratory in 1936, is at the controls of a type U-30-25 fixed-base vhf radiophone with output power of 20 watts, in the Region 6 headquarters in Portland, Ore. (Forest Service photo, History Section).

salvaged wire, and whatever parts that could be found, he devised a workable communication device between their two homes. Later, Belleville decided to attempt the same feat with wireless. He learned what parts he needed for an amateur set from library books. His product, though workable, could receive only a local amateur because the electric power lines into Twin Falls passed directly over the Belleville home.[23]

Encouraged by his father, who gave him a vacuum tube for his birthday and a set of double earphones for his success in using the tube, Belleville became an astute follower of radio developments. With the attitude that "...if it ever worked, I could make it work again," he started to repair broadcast radios for the local residents.

A year after high school graduation, Belleville caught a ride to San Francisco, where his repair experience landed him a job with a local radio company. Duties included service calls "from Chinatown to out in the ocean," but he returned to Twin Falls after becoming homesick.

Spirits refortified several weeks later, Logan decided to try his fortune in Los Angeles. His first job was as a department store technician repairing sets before they went on the shelf. Next he worked at the service desk for a major radio manufacturer, repairing sets that dealers could not fix. At his third job, identical to the one in San Francisco, he again found the lure of home irresistible.[24]

Belleville found employment as a radio announcer back in Twin Falls. Encouraged by the station owner, he obtained a commercial first-class radio license and an amateur license (W7CFX). He operated a radio repair shop during off hours. At the shop he came into contact with A. F. "Speed" Horton, who was on the road selling electronic components for SRC. Because of Belleville's demonstrated knowledge of radio, Speed put him in contact with Morris Willis who put him on the SRC customer service desk. There, Willis recognized Belleville's potential and promoted him to help develop the Forest Service type U set.[25]

Before Belleville came to the Radio Laboratory, Gael Simson had obtained authorization to add a few other employees to the staff. He hired Ralph H. Kunselman before the move to Portland. Carl B. Davis joined the staff a year later. These two technicians constructed the prototype of most Laboratory sets. About this same time, Foy Squibb was temporarily assigned to install a number of his type T sets on the Cumberland (now Daniel Boone) National Forest in Kentucky. Lack of funds prevented his return to the Radio Laboratory after the installation was complete.[26]

In an effort to overcome the inability of the M sets to perform on the Forest Service patrol boats along Alaska's southeastern coast, Harold Lawson offered Wilbur "Bill" Claypool temporary employment. Claypool accepted, and the personnel count at the Laboratory remained near six through 1936.

Bill Claypool came to the Forest Service from a job as regional service manager for a Portland firm handling Stewart-Warner refrigerators and radios.[27] He had been familiar with Lawson's radio work for some time. He had acquired his amateur license in high school (9DDV, and then 7UN, NU7UN, W7UN, 3UN, XEUN and, "hopefully," XE1UN) and had "ham sessions" with Lawson in 1931 when the PCL-1 was under test.[28] In 1936, Lawson and Claypool became closely acquainted while serving with six others on the organizing committee for the American Radio Relay League (ARRL) convention in Portland.

B2 Set Designed for Alaska

Claypool suspected that the failure of the Alaskan type M was due to the 100-meter frequency selection and a low power output. To test his theory, he drew up plans for a dual-channel transmitter that would operate above and below the 3-MHz type M. After beefing up the output by a factor of 10 and adding a Hammarlund Comet Pro receiver, Claypool dubbed the new design the type B2 (Boat) and headed for Alaska. He discovered almost immediately that the 200-watt B2's were enough to make "the sparks begin to fly."[29]

Without an effective gound system, however, everything on the patrol boats was "hot"--the power shaft, propeller, and control room. After drydocking the boats, Claypool had large copper plates installed on the bottoms and then insulated the antenna footings. This cured the problem and the B2 set, operating at 2.3 and 4.6 MHz (130 and 64 meters, respectively), provided adequate communications until a small 100-watt version was completed a few years later.[30]

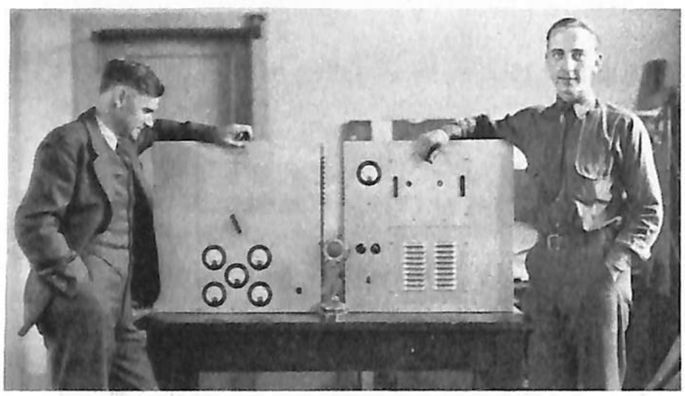


Figure 61. The B2 200-watt, dual-channel transmitter (130 and 65 meters), designed by the Radio Laboratory, worked well for forest patrol boats in the Alaska Region. Builder Wilbur Claypool of the Laboratory is shown on right and Gael Simson on left. (NA:95G-305778)

Other experiments in vhf were also conducted during this phase of Laboratory work. In an attempt to determine the relative performance of various vhf operating frequencies, Simson, long a believer in the utility of establishing a Servicewide radio network, traveled the country with the soon-familiar "Simson's Suitcase" built at the Lab. With the suitcase, he could effectively test four channels. It started on a fundamental frequency; then the press of a button would give the second, third, and fourth harmonic (the fundamental x2, x3, x4). Morning and evening, no matter where he was, he would try to contact Portland. (By 1941, Simson was up to 4.5, 9.0, 13.5, and 19.1 MHz, respectively, but he never succeeded in finding a satisfactory all-Service frequency.)[31]

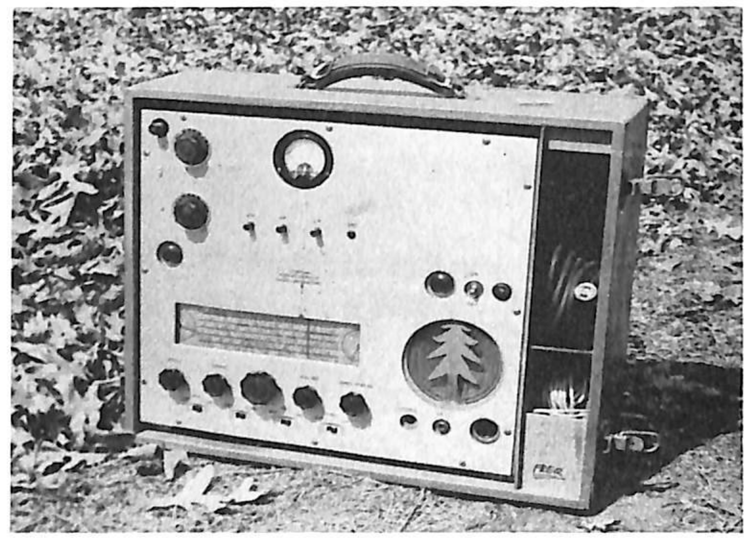


Figure 62. "Simson's Suitcase," which was carried around the country by its builder, Gael Simson of the Radio Laboratory, in an unsuccessful effort to find an optimum Servicewide frequency channel for a potential national radio network for the agency. (Forest Service photo, History Section)

The Radio Laboratory's progress in producing up-to-date radios was paralleled by physical improvements to the facilities. The brick exterior got a fresh coat of paint and a new addition put on the rear of the building. The appearance of a more modern facility was heightened inside, where the changes were equally impressive, with a separate room set off for communications. Here Logan Belleville led the group in designing a 250-watt transmitter--"a beautiful thing"--that kept KBAA at the Laboratory in contact with the men while they were on various assignments around the Pacific Northwest.[32]

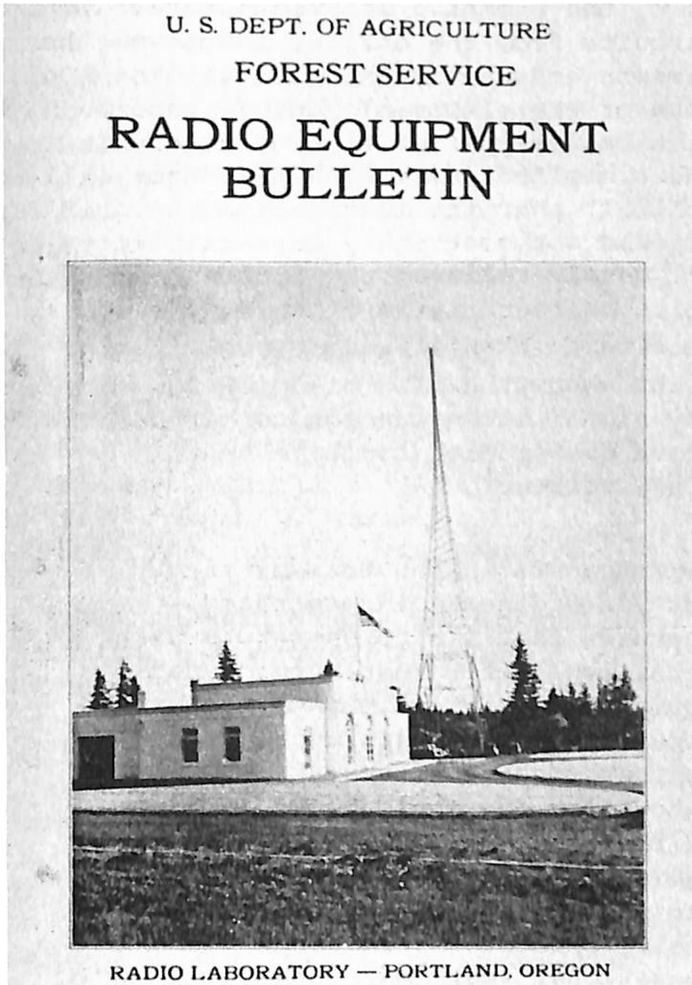


Figure 63. The Forest Service Radio Laboratory at Portland, Ore., in 1939, appeared on cover of "Radio Equipment Bulletin." (Forest Service photo, History Section)

With a full complement of vhf and hf radios in the portable, semiportable, and fixed-base classes, activities at the Radio Laboratory might have been expected to subside. This was not the case. In addition to improvements brought about "almost daily [by] new tubes, parts and technique..."[33] and the problems experienced with the commercial vhf receivers, the men recognized that their initial design efforts needed constant updating. "By modern standards," Harold Lawson was to recall, "we had some pretty sad pieces of hardware. For their day

Figure 64. Transmitting and receiving equipment at the Radio Laboratory's Station KBAA, Portland, Ore. A new 250-watt transmitter installed about 1939 kept the Laboratory in close touch with personnel on field assignments. (Forest Service photo, History Section)

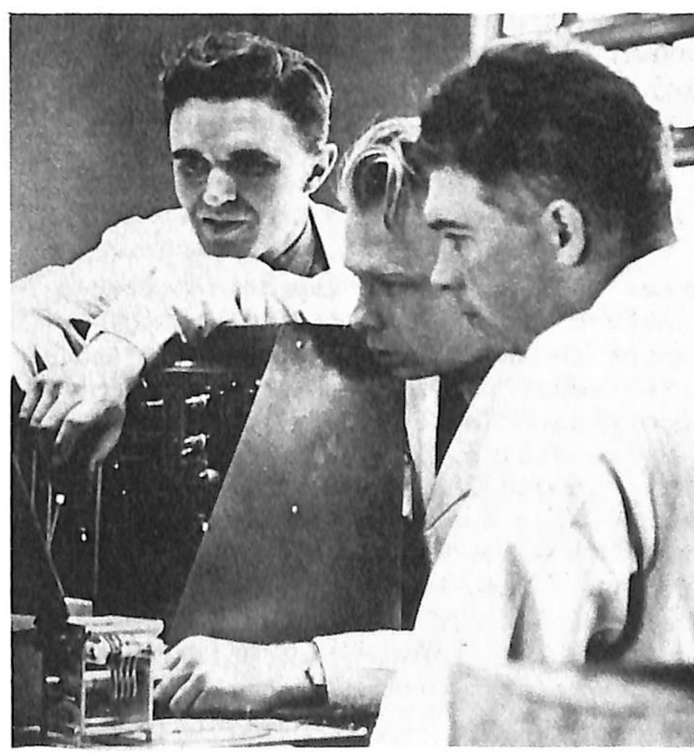


Figure 65. Checking the performance of a new vhf prototype at the Radio Laboratory. Left to right are Harold Lawson, Logan Belleville, and Carl Davis. (Forest Service photo, History Section)

most of them were pretty good, but we had a few 'dogs'..."[34]

Their desire to leave nothing to chance spurred them to tackle every identified problem. They experimented with variations that would improve the product and conducted studies on every new concept. For minor changes, a model change was made. For major changes, a new design was undertaken.

As a result, a significant number of Laboratory model changes were made before 1941. The M set, for example, went through variations that included the models B, C, and D. The T set had three model changes, the SPF and T/D each had five, the I had three, and the Relay Repeater Station (RRS) eventually had six variations.[35] Some of the changes involved only minor alterations intended as "fixes" for particular problems. In other cases, the modifications altered the physical appearance of the unit and changed the original function of the sets.

KA Model for Airplanes

After the Laboratory improved portable receiver design, the new M sets no longer included a separate Hummarlund or National receiver. Instead, each incorporated a receiver of Forest Service design. The end product not only changed the appearance but also changed the specifications so much that the M set could conceivably drop from the fixed-base class to that of the semiportable. Improvements found beneficial in a number of different sets were also grouped together with a few other new ideas in updated designs; this was reflected in the type KA (Kar-Airplane) in early 1940.

The type KA was intended to be the vhf (34.22-MHz) airplane counterpart of the S, T, and U sets. It incorporated circuits from the earlier mobile vhf version and was intended to eliminate much of the electronic noise associated with spark-type ignition systems. It had a new feature called the "squelch control" that the instructions pointed out did not contribute to sensitivity but merely relieved the constant hissing noise characteristic of this type of receiver. When it was set only to the point where the hiss disappeared, any signal strong enough to be heard above the squelch could be heard "full volume."

Improvements in the transmitting section of the KA incorporated features familiar to operators using other types of Forest Service radio equipment. Having learned through experience the tuning procedures most acceptable to operators, the Laboratory designed the front panel of the type KA to be similar "to the tuning procedures for the type M radiophone."[36] By assimilating the mobile concepts of the type K and operational features of the type M, incorporating new circuits, and designing from experience gained with the previous airplane type A, the staff was able to "invent" the new composite type KA.

With only minor staff changes between 1935 and 1941, the small Laboratory coterie was responsible for 9 entirely new types of radio equipment, some 27 model changes over the full complement of Forest Service radios, inumerable "fixes," and several types of unique hardware and test equipment. Although some may have "lacked refinements by modern standards," they had a decided effect on the adoption of electronic communications, fire-control procedures, and administrative management procedures in the Forest Service. They also affected the development and design of radios in the military and private sectors.

The path to success, however, was marked by many trials and tribulations. As events were to indicate, the Radio Laboratory was more than a hobby shop.

Reference Notes

1. Francis R. McCabe, "The Use of Radio in Forestry," (Senior thesis, School of Forestry, Oregon State Agricultural College, 25 April 1934), p. 28; and penciled note in margin by Guy V. Wood, 28 January 1958, Gaylord A. Knight Collection.

2. Keith Henney, ed., *The Radio Engineering Handbook* (New York: McGraw-Hill, 1941), p. 538.

3. Wavelength in meters is found by dividing velocity in meters per second (300,000,000) by the frequency in cycles. Thus, 3,000,000 cycles, or 3 MHz, is effectively 100 meters. In the interest of clarity, 100 meters is used in the text to represent the general range of Forest Service frequencies below 4 MHz, and 10 meters for the range of 28.5 to 32.5 MHz actually used in this band by the Forest Service.

4. The classification of frequency ranges was shifted upward about the time of World War II. Hence, uhf was downgraded to vhf (30-300 MHz) and appears in more recent texts and articles as such. Because all Forest Service documentation prior to World War II used the older terminology of uhf for any frequency above 30 MHz, and vhf for the 10-meter band, a number of quotes in the text will not appear correct. The same confusion will appear over the later renaming of kilocycles (kc) and megacycles (mc) as kilohertz (kHz) and megahertz (MHz), respectively. However, in the interest of clarity, I have opted to use the present designations rather than expect the nontechnical reader to make a later transition. Where a quotation uses the older terminology the modern designation will be immediately braketed, e.g., [kHz], [uhf], etc.

5. Roland F. Spooner, "1978-Fifty Years of Ten Meters," *Ten-Ten Chapter News* 16, no. 2 (Spring 1978), p. 8.

6. L. S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington, D.C.: Government Printing Office, 1963), pp. 387, 410.

7. Lawson was on the organizing committee for the ARRL convention in Portland in 1927. See Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

8. Lawson and Squibb both agree that Simson had an "intuitive" feeling for vhf based on "inquisitiveness or foresight." Neither one recalls his own early interest, and both credit Simson with the initial impetus. See Harold K. Lawson, interview with the author in King City, Ore., May 1978, and W. Foy Squibb, interview with the author in Missoula, Mont., May 1978.

9. A. Gael Simson, "U.S. Forest Service Radio Equipment," 2 January 1935, mimeographed memorandum, p. 3, Gaylord A. Knight Collection.

10. William B. Apgar, "Report on Radio Activities at Savenac Nursery--1932," 30 November 1932, p. 9, Gaylord A. Knight Collection; and McCabe, "Radio," p. 28.

11. F. H. Brundage to the Forester, 26 January 1934, Gaylord A. Knight Collection.

12. William B. Apgar, "Radio Communications Report--1934," [nd],

[ca. late 1934-early 1935], typed copy, p. 8, Gaylord A. Knight Collection.

13. Lawson, interview with the author.

14. W. Foy Squibb, "Diary," 4 June 1934.

15. A. G. Simson, "Radio Equipment," 2 January 1935, p. 4, Gaylord A. Knight Collection.

16. Simson, "Radio Equipment," p. 4.

17. Simson, U.S. Forest Service Radio Developments," 10 April 1936, typed copy, p. 4, Gaylord A. Knight Collection.

18. Simson, "Radio Developments," p. 4.

19. Lawson, interview with author and Logan Belleville, interview with author in Saratoga, Calif., January 1978.

20. Belleville, interview with author, and Morris Willis, interview with author in Santa Barbara, Calif., January 1978.

21. Belleville, interview with author.

22. Belleville, interview with author.

23. Belleville, interview with author.

24. Belleville, interview with author.

25. Willis, interview with author.

26. Squibb, interview with author, and Lawson, interview with author.

27. Wilbur Claypool, interview with author in San Antonio, Tex., July 1978.

28. H. K. Lawson to W7ARZ [Wally Guthrie], Salem, Ore., 29 May 1931, Gaylord A. Knight Collection.

29. Claypool, interview with author.

30. Claypool, interview with author.

31. Frequency markings on the "Suit-case" now in storage at the Electronics Center, Beltsville, Md.

32. Lawson, interview with author, and various "Field Diaries" of Laboratory personnel.

33. U.S. Department of Agriculture, Forest Service, *Radio Handbook* (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation, circa 1938), p. 7, Mimeographed.

34. Lawson, interview with author.

35. See Appendix I; also chapter 7, pp. 106-108.

36. Forest Service Radio Laboratory, "Instructions for Operating Type KA Radiophone," 15 June 1940, Gaylord A. Knight Collection.

Chapter VII
Improved Designs:
Standards for the Future

Though the newspapers--and we ourselves--may be prone to treat them with no more than an off-hand respect, these sets are, even in a purely mechanical light, one of the outstanding wonders of the radio world. Improvement must still go on, but when viewed in a utilitarian way their worth--not only to the cause of conservation, but to society as well--already can hardly be evaluated either in dollars and cents or in words.

- Forest Service *Service Bulletin*[1]

By 1935, the rapid growth of radio use by Forest Service field units was complicating the administration and control of the radio project. The 700 radios available for operation, mostly in California and the Pacific Northwest, were congesting the limited frequencies allotted.[2] Using vhf had alleviated the problem somewhat by transferring part of the load to the 10-meter allocations, but the value of 100-meter radio was still important for nonline-of-sight transmissions. At a Forest Service communications conference in Portland in early 1935, "overcrowding" on the 100-meter band was discussed at length.[3]

To eliminate part of the congestion, the committee that planned the conference suggested that the Radio Laboratory staff design an intermediate-power transmitter of about 10 watts to fit between the 5-watt SP Special and the 20-watt type M.[4] The proponents argued this change '...will remove many more costly M sets from the air as well as reduce the interference between regions and forest on shared frequencies." Although "practically divided" on this point, the committee agreed "after rather exhaustive investigations" that "low power should govern" and that an improved receiver for the SP Specials would provide "adequate communication" in the semi-portable line. If this did not prove satisfactory, the committee requested that "...a new type set should be designed, but not until after an examination has been made by the technical staff at the Laboratory."[5]

The communications committee also reiterated the Forest Service policy of avoiding radio communications for all but fire control in an effort to further reduce inter-Forest, 100-meter interference. The practice of using the 3- to 3.5-MHz band for administrative business, or point-to-point communication, despite a prohibition, had been increasing steadily and was another cause of overcrowding. The committee cautioned that, "consistent with the agreement in effect between the A. T. & T system and the Secretary of Agriculture, we cannot ethically use radio for point-to-point communications where adequate private telephone facilities are available."[6]

The Laboratory staff set out to implement the conference mandate. In an attempt to provide a radio set of intermediate size and power, they sought (1) to improve the performance of the type PF (instead of that of SP Special as suggested) and (2) to lower the power of the type M.

In the meantime, Bill Claypool returned from Alaska to learn that the Laboratory temporarily lacked the funds to keep him on the payroll. He decided to open a marine radio sales and service shop in southeastern Alaska. While Claypool was in Portland to gather equipment for this venture, the financial situation improved, and Harold Lawson won him back with an assignment to improve the PF. (Claypool went back to Alaska later as an employee of the Forest Service.)[7]

The major problem with the type PF was its regenerative type receiver. It operated best when finely tuned to the point of breaking into oscillation. This made it a delight for experienced operators but proved difficult for the scarred and battered hands of a firefighter. Lacking the comfort and quiet of a lab or office, the harried men on the fireline had neither the time nor the patience to deftly locate the critical telltale hiss indicating regeneration.

Claypool set about designing a more acceptable receiver, assisted primarily by Lawson. For several months, he made many trips between books, drafting table, and workbench, attempting to master the fundamentals of superheterodynes. At one point, when neither Claypool nor Lawson could figure out the mathematics for a tracking oscillator in the 455-*if* stage, a traveling salesman came by. Learning of their problem, this graduate of "a prestigious school in the East" sat down and "whipped out" the answer for them.[8] The other circuitry was completed in due time and the newly designated SPF (Semi-portable phone) was ready for the 1936 fire season.

SPF Is Big Success

The success of the 2 1/4-watt SPF was immediate and it went on to become a legend. About one-half again as large as its predecessor, and weighing an intermediate 21 pounds, 6 pounds more, it was still light enough for smoke-chasers. With the kitbox, it was also hefty enough for temporary fire camps. Rugged in appearance and construction, it provided adequate service, amazingly, for 20 years after production stopped.

New Forest Service communication technicians continued to "cut their teeth" on the venerable SPF into the 1960's. Known on the fireline as the "short-peckered friend," it gained the respect of all who had to depend on it. Even Bill Apgar in Region 1, who found much to complain about, remembered that "those SPF's were a dream."[9]

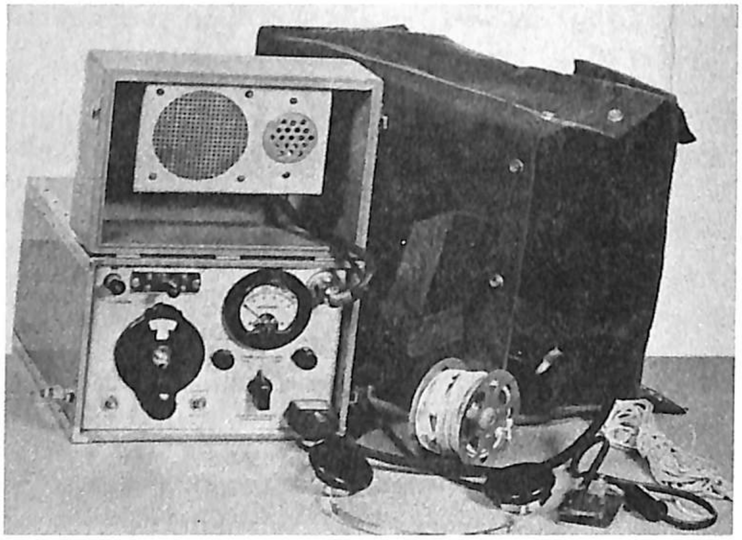


Figure 66. Front view of SPF model set up for portable use. (Forest Service photo, History Section)

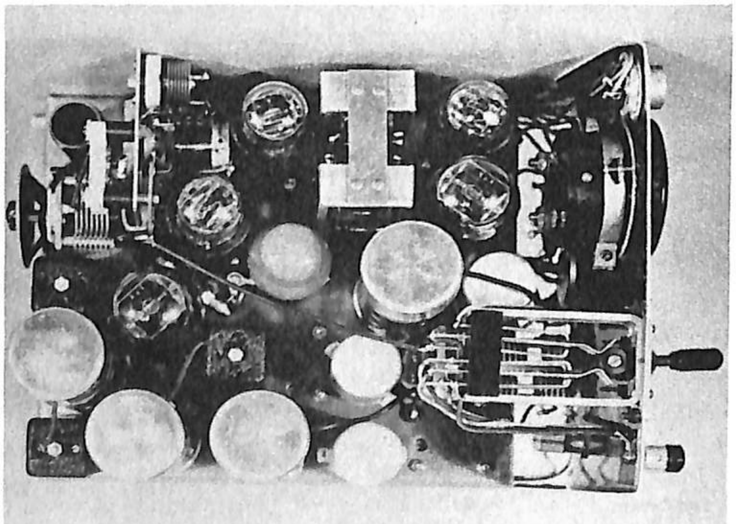


Figure 67. Interior view of SPF model. (Forest Service photo, History Section)

Figure 68. Smokechaser with SPF model set up for portable use on the Spud Hill fire, Columbia (now Gifford Pinchot) National Forest, Wash., 1937. (NA:95G-354925)

Figure 69. SPF model set up for semi-portable use at a Region 6 temporary base camp. (Forest Service photo, History Section)

The design of an intermediate-power, fixed-base, 100-meter unit followed that of the SPF. Based on the suggestions of the 1935 communications conference, the Radio Laboratory worked on altering the type M, now in its third modification, after abandoning the Hammarlund Comet Pro for the superheterodyne receiver of Claypool's SPF. Starting with the type M model D, the lower-powered version became the type I (Intermediate power). Virtually identical in appearance to the M, the type I weighed 66 pounds with all accessories, had a nominal output of 9 1/2 watts, and operated from batteries. Although the communications conference recommended it to reduce frequency crowding, its 20-watt predecessor outsold it 4 to 1.

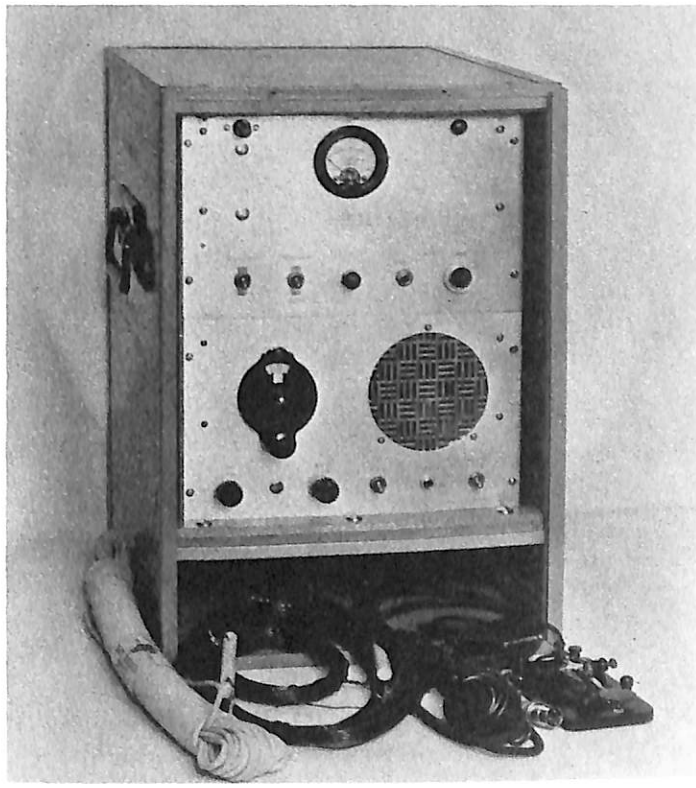


Figure 70. The type M, model D. The type I, model D, with the exception of a few switches, was identical in appearance. (Forest Service photo, History Section)

Improvements in the existing line of equipment followed a similar pattern. Criticisms had been leveled at the type S for its low power and frequently spurious signals, making it a prime candidate for replacement. Earlier changes in the type S model B had alleviated some of the problems of this 0.1-watt set, but even though over 780 sets were purchased by the Regions, the Laboratory decided to discontinue production. An updated version, the type SV (Superregenerative Variable frequency), with its output increased to 1-watt and separate oscillator circuits and tubes for both the transmitter and receiver, did not overcome all previous objections, however.

Figure 71. Type SV set at Mt. Hood, Ore., February 1941. (NA:95G-405143)

At an interregional radio meeting in Portland, January 4 to 12, 1938, a thorough review and analysis of Forest Service radio was again undertaken. Each set was evaluated on every aspect of construction and operation. Minor changes were recommended for most sets, but the type T set was subjected to major criticism. Over 35 changes were proposed. In addition to the need for greater receiver sensitivity, the conference requested crystal control for the transmitter, the use of a push-to-talk microphone, and a host of mechanical improvements.[10]

The Radio Laboratory had periodically subjected type T to model changes even before the conference. Early in its reconstruction, the T set was divided into two separate cabinets for duplex operation. With separate circuits for reception and transmission, the TH/TL (Ten-meter High frequency/ Ten-meter Low frequency) included many improvements.[11] But these modifications did not bring the type T up to the performance standards of the more successful Forest Service sets. It was "considered obsolete" following the 1938 communications conference, and was not included in later Radio Laboratory catalogs.[12] It was soon to be replaced by an improved model.

Figure 72. Type TH/TL in semiportable configuration for field use. See figure 97. (NA:95G-316855)

The naming of the type T, model D (T/D), was somewhat misleading. It was radically improved over the old type T. The type T/D incorporated "...the latest developments in ultrahigh frequency [vhf] parts and material with a view to extending the usefulness of the ultrahigh frequency [vhf] spectrum..."[13] The major change in the T/D was in the receiver. The superregeneratives in the previous type T's were inherently noisy, making continuous standby nerve-wracking for the operators. This problem was eliminated by incorporating the superheterodyne in the T/D.

The T/D illustrates the number of complexities associated with the introduction of new Radio Laboratory ideas. Many older S and SV portables in the field faced obsolescence because the transmitters could not tune to the exact frequencies of the T/D. If a forest purchased the new units for lookout towers and sent smokechasers into the field with SV sets, there would certainly be many complaints. The master oscillators in the SV's simply could not hit the exact receiving location of the crystal-controlled T/D's--at least not without a number of frustrating failures.

T/D and SX/SXA Sets Are Versatile

The Laboratory staff was aware of this problem before completing the T/D design. To overcome objections, the men incorporated a bell into the circuitry of the new sets. This adaptation permitted S and SV operators to tune the dial of their sets across the full range of the T/D receiver while transmitting. When the two frequencies matched, the T/D alarm bell would sound. Returning to transmitting frequency, the S or SV operator would then continue to transmit until the type T/D operator located the calling station.

This strategy silenced charges of "planned obsolescence" against the Laboratory. But the staff went even one better. They saw the bell already in each T/D as presenting an option for a unique call system. If several T/D sets were ordered for a National Forest, the sender could activate the bell of a single receiver by using a code signal for that particular receiver in the system. This not only provided a degree of privacy but also meant that every lookout did not have to be disturbed when a message was relayed in the middle of the night.

The introduction of the T/D speaks well for the forethought and planning of the Radio Laboratory staff. In addition to extending the usefulness of the S and SV sets, the staff also made the T/D a less demanding tool. It could be left on, tuned to "standby" when necessary. With the set on standby, the lookouts or fire bosses could go about their other duties knowing that "the entirely foolproof" bell would notify them of incoming communications.[14]

Figure 73. Type T, model D, located in base of fire finder, Pepper Lookout, Mt. Hood National Forest, Ore., July 1940. (NA:95G-397920)

Development of a mobile set for use in Forest Service vehicles proved to be a more demanding job for the Laboratory than expected. The lack of adequate commercial sets, the bumpy roads, and the ignition problems made early development of mobile radio impractical. "I am afraid," wrote Gael Simson in early 1936, that, "the day when the Forest Supervisor can ride around in his car and listen to all his radio stations will have to be deferred for a long, long time. The Forests are too big, our transmitters too small, and roads too noisy."[15]

The Radio Laboratory's first mobile radio was an adaptation of the type I transmitter, with a commercial pushbutton receiver, in late 1938. This type I-Mobile found only limited acceptance. It was then modified and renamed the type K (Kar).[16] The type K was supplied in three packages --a receiver, transmitter, and power supply. It had an output of 9 1/2 watts and operated on 100 meters.[17]

To be successful, the type I would have to provide consistent performance under adverse conditions. Almost immediately, it was learned that this second-generation mobile was unsatisfactory because of the unstable commercial receiver. Having failed to wed an available product with a modified transmitter of its own design, the Laboratory staff was "forced to begin development" of its own mobile receiver.[18] Logan Belleville received the primary responsibility for this project.

The Radio Laboratory dropped its plan to supply a 100-meter mobile and instead considered a 10-meter model. Basing the transmitter on a scaled-down version of the original type U, the staff was successful in late 1941 in providing an acceptable mobile transmitter--the KU-T (Kar uhf-Transmitter).

The task of designing a mobile receiver was much more complex. There was, as always, the problem of automobile noise, and there was no existing set to provide a starting point. Undaunted, Belleville sought his answers in the Laboratory tradition. Using books, drafting table, and workbench, his solution some months later was both unique and extremely successful.

Belleville overcame the problem without spark-plug noise suppressors or other forms of common ignition noise treatment. He accomplished this by using a variation of the "Lamb Silencer," first outlined in a 1936 *QST* magazine article.[19] This technique was similar to today's squelch control that keeps the receiver off in the absence of a strong signal. Only transmissions above the squelch setting are heard by the operator.[20]

Lawson and Belleville believed this adaptation allowed the KU-R (Kar uhf-Receiver) to compete favorably with the newly developed, commercial frequency-modulated (FM) mobile sets, which were static-free. In addition, it extended the life of other amplitude-modulated (AM) mobile sets. In an article for *Electronics* magazine, they wrote that the modification was "...good enough so that many [AM] communication systems now being discarded can be made to serve adequately."[21] Most important, the KT-T/KU-R had passed the tests which its predecessors had failed; its operation under adverse conditions far exceeded expectations. At the request of the Regions, the techniques used by Belleville were later applied to a vhf semiportable set--the U-T/U-R. While never substantiated, the word got around the National Forests that Motorola Inc. said they would have been "hard pressed" to equal the KU-R performance in the AM mobile field.[22]

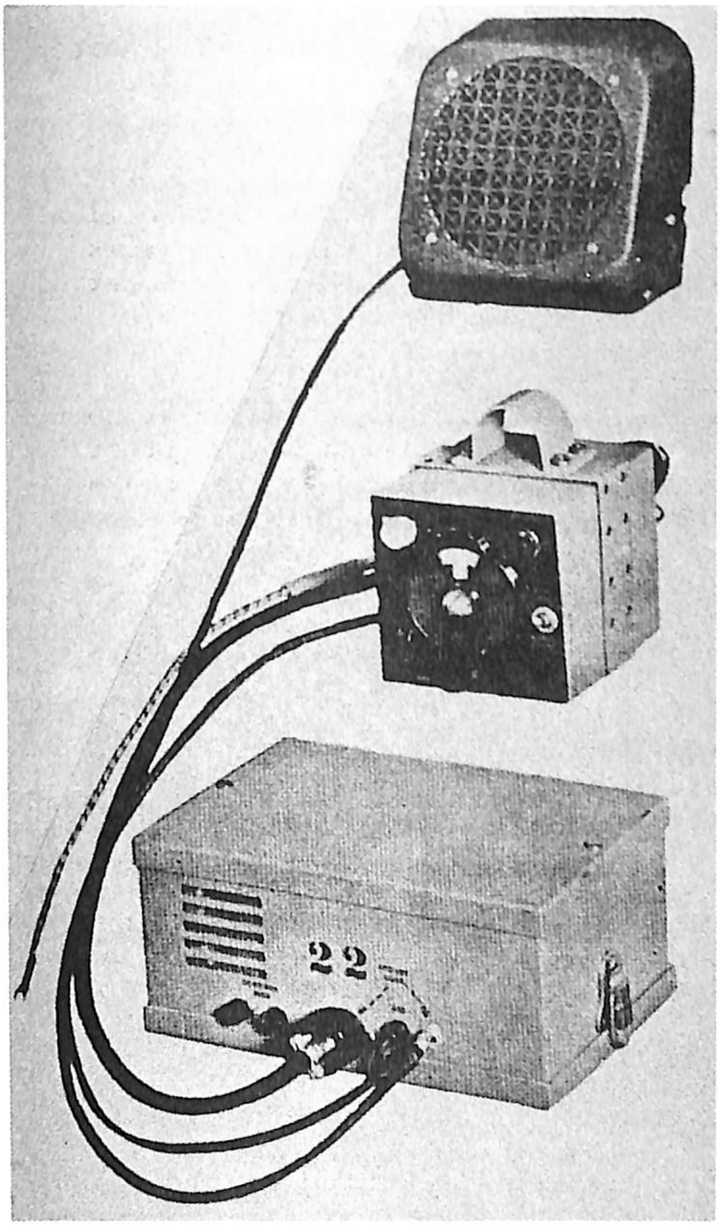


Figure 74. Type KU-R AM receiver, the Radio Laboratory's first fully successful mobile receiver. With its companion, the KU-T transmitter, it gave a high level of performance under adverse conditions. Receiver performance was assisted by a squelch control. The set competed favorably with new commercial FM sets of the time. See photo of combined unit in appendix I. (Forest Service photo, History Section)

Regional requests for an improved vhf portable/semiportable also led the Radio Laboratory to undertake a major modification of the type S/SV in 1940. The new type SX (Superregenerative Crystals)[23] used three crystal-controlled frequencies in the 10-meter band at 1/4-watt power each. These were selected either by a switch or push buttons. With the purchase of a separate attachment (SXA), the unit could replace either the S or SV. The popularity of the SX led the smokejumper's school in Missoula to request an ultralight version. The type SJ (Smokejumper) represented the ultimate in size reduction; at 6 pounds, the compact set could fit in a special leg pocket of the smokejumper's outfit.[24]

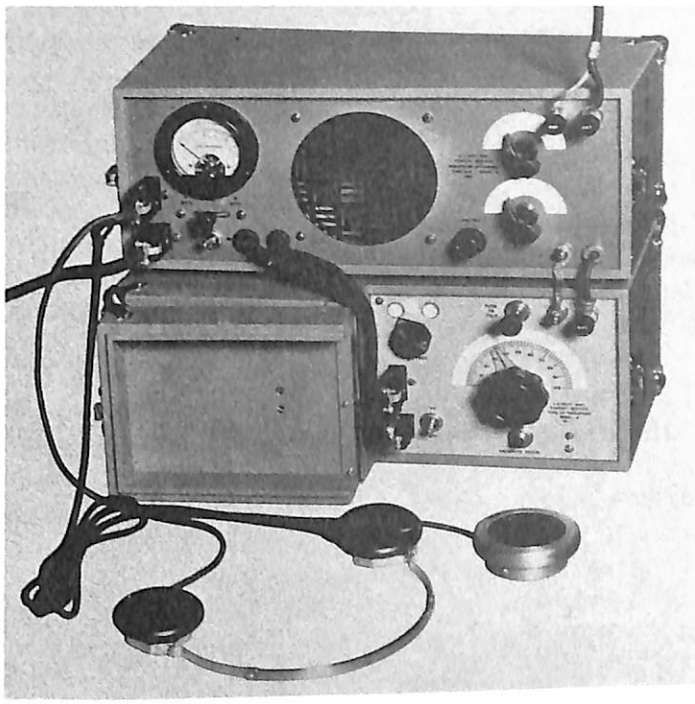


Figure 75. Type SX (superregenerative, crystal-controlled frequency) lower set, shown here interconnected for operation with the SXA, top. The SXA was an audio amplifier used as a standby speaker with the SX transceiver. The SX proved a very popular, light, portable set. It was a successor to the S and SV sets. See circuit diagram in appendix I. (NA:95G-407251)

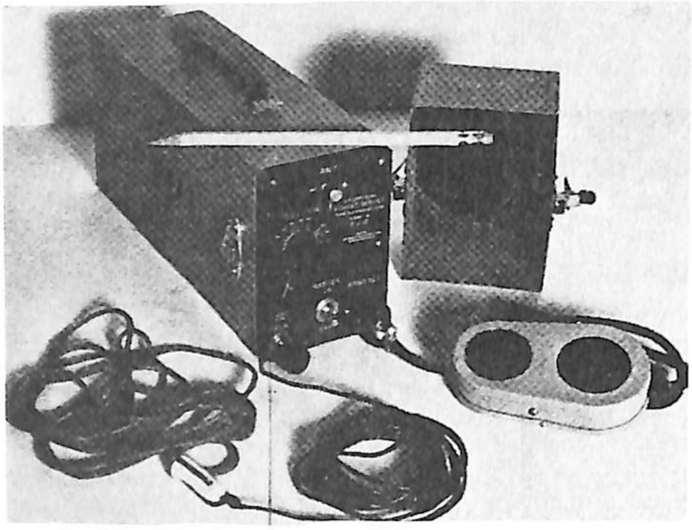


Figure 76. Type SJ set, developed as an ultralightweight model for smokejumpers, fitting into a special leg pocket and weighing only 6 pounds. Pencil gives an idea of its size. (Forest Service photo, History Section)

Figure 77. The RRS (Radio Relay Station) installation atop Mt. Diablo, Calif., first field setup of the Forest Service, July 1941. It allowed the nearby Regional headquarters in San Francisco to establish point-to-point communication with any outlying vhf radio within visible range of the repeater. Esthetics required the RRS to be placed in a plain building that minimized environmental impact. (Forest Service photo, History Section)

By early 1938, the staff at the Radio Laboratory was thinking of extending the effective operating range of the vhf semiportables.[25] In principle, vhf sets were limited to line-of-sight transmissions, but this could be extended if a third party relayed a message between two points not visible to each other. This concept might be thought of as a communication between a smokechaser and National Forest headquarters, with a lookout within sight of both parties retransmitting the smokechaser's message. The logical next step was to devise an "automatic relay."

First Radio Relay Station

In July 1941, a battery-operated radio relay design was completed at the Laboratory and readied for installation on Mt. Diablo, near Oakland, Calif.[26] The RRS was a composite of earlier vhf sets operating on standby until a carrier frequency turned on both the receiver and

Figure 78. Logan Belleville, standing, and Carl Davis, of the Radio Laboratory, at the RRS installation on Mt. Shasta, Calif. (Forest Service photo, History Section)

transmitter. Its introduction heralded a new era in Forest Service communication planning.

The selection of Mt. Diablo was significant. Located within communication range of Region 5 headquarters in San Francisco, the mountain gave the Regional office an opportunity to establish point-to-point communication with any outlying vhf radio within visible range of the repeater. If a system of strategically located repeaters could be placed throughout the State, it would eventually be possible for the Regional office to make contact with anyone in sight of a repeater. The Sequoia National Forest headquarters at Porterville, for example, might locate a repeater link on a point also visible to Mt. Diablo, bringing that office into direct contact with San Francisco. Similarly, if the Inyo National Forest could situate a repeater in line with the Porterville repeater, a 3-way link would be established between Bishop and the Regional office. The length of this daisy-chain communication system was limited only by an insufficient number of "intervisible" locations.

The RRS also had a significant impact on radio for the fireline aside from the inherent possibilities of vhf repeaters for administrative use. One criticism of vhf portable radio had been its inability to overcome the limits of intervisibility. A smokechaser who happened on a fire in a location where mountain ridges and the absence of a visible lookout tower hampered vhf communication was no better off than earlier smoke-chasers who had to rely on the telephone. To make contact, both had to leave the site. But with one or more vhf repeaters at strategic locations throughout a Forest, the smokechaser could now get his message out by sending his communication via the RRS link. This possibility was recognized by the Laboratory staff, who made plans to take full advantage of the technology.

Portable and semiportable sets were then designed with at least two transmitting channels. The first channel could be used on a Forest network when intervisible transmission was possible. The second channel would be the RRS link. Thus the anomalies of transmission would not keep fire crews, smokechasers, work crews, mobile units, or lookouts from establishing communications through one of the frequencies. This design virtually eliminated the last major objection to vhf use.

Two further advantages of the RRS are worthy of note. Its reliability made frequent maintenance inspections unnecessary; trips once or twice a year for adjustments and the replace-ment of batteries were usually the only attention required. This was in contrast to the annual chore of maintaining telephone lines and then repairing them after high wind, ice, and snow. The RRS also relieved overcrowding on the 100-meter channels for long-distance communication.

The way the Radio Laboratory staff coped with perceived objections provides insight into some of the guidelines they established for radio design. To be competitive with the telephone, the Radio Laboratory had to at least match the telephone's advantages, including ease of use, and relative simplicity. The simply constructed wooden box housing a Ranger's telephone was never shut off at the end of working hours; it always provided a silent communication hookup even if the many party line calls, which rang every bell on the party line, proved unnerving. Maintenance was inexpensive, and there was no battery drain during periods of standby.

On the a.c.-powered central station type U, the concept of standby, or 24-hour service, was touted as the "outstanding feature." The *Radio Equipment* bulletin pointed out that "when a call is received on the stand-by loudspeaker, it is only necessary to pick up the /telephone/ handset to answer."[27] This feature, matching one of the telephone's advantages, was improved in the battery-operated type T model D. The T/D, of course, incorporated a "silent stand-by calling system" that relieved the operator of the incessant background noise associated with the earlier receivers and "advised of incoming calls without the necessity of a loudspeaker in constant operation."[28] The relatively low battery drain of the T/D, like the telephone, made continuous 24-hour use possible.

Similarly, the duplex feature in Forest Service radio made it possible to interrupt conversations to ask questions. It also protected the communication system against inadvertent breakdowns. During the era of simplex operation, a radio operator under stress of an emergency, especially a fire fight, could neglect to throw the switch from "Transmit" to "Receive;" as a result, important incoming messages could be lost. By providing radio with duplex capability, the Radio Laboratory effectively silenced one more criticism.

A review of Laboratory literature also conveys an awareness of the need to provide a rundown of comparative costs by including an estimate of annual radio maintenance expenses in its catalog. A Supervisor could then easily calculate that if the initial cost of a semiportable set was listed as $100 and annual maintenance at approximately $20, the price of installing and maintaining a new 5-mile telephone line was much more.

Many Advantages Over Telephone

A number of other features extended the application of radio beyond that of the telephone; for example, the RRS repeater for long-distance transmissions; the Garco generator for extended, heavy-duty use in the interior; the quieter operation of vhf during electrical storms; and the mobile operation of KU-R/KU-T. Less apparent advantages over the telephone included comparatively private conversations as contrasted to multi-party lines made up of the Forest Service and numerous cooperators, elimination of the frequent delays caused by a backlog of calls at the local central, and freedom from the umbilical cord of the telephone. Thus radio was not only a supplement to the telephone, but also an electronic, primary communication device that eventually equaled and then surpassed the performance of its predecessor. The telephone spurred on the Laboratory staff to improve the radio.

Meanwhile, the administration of the Radio Laboratory continued along the lines established in 1932. Portland continued to determine the technical aspects of radio application, while the Washington Office "rubber-stamped" them into policy. As Regional interest in radio use grew, Earl Loveridge began to give serious consideration to the need for a separate radio section under the Division of Operation. Concerned that this would take time for approval, he once again turned to Jack Horton and the Radio Laboratory. "At present," he wrote in mid-1937, "the Section exists only in the formative stage, hence I have to depend on you and Simson for considerable assistance in the radio activities of this office."[29]

By the end of the 1940 fire season, nearly 4,000 radios had been ordered by the Regions. Some 90 percent were in the portable class (under 21 pounds), and 2,000, or one-half, were vhf sets with only 1 percent over 2-watt output.[30] These figures reflect the successful accomplishments of the Radio Laboratory in its effort to design lightweight portables for the fireline during the relatively short period, 1933 to 1940.

By this time, it was also apparent that the SPF was "probably the backbone of the high-frequency /100-meter/ communication system."[31] In 1947, for example, it continued to lead the popular 10-meter SX by some 400 sets--1,200 to 800, respectively.[32] The development of vhf, originally accompanied by almost immediate obsolescence, had found considerable favor on the National Forests and was promising to become more popular as technological improvements tended to level off. "Within the last year or two," Simson wrote the Regions, "this process has slowed up markedly and it is not anticipated that the obsolescence factor will again be nearly so severe as it has in the past."[33]

The lack of adequate frequencies continued to limit the extension of radio into the National Forests. Because of Simson's IRAC activities, the Forest Service had a relative abundance of frequencies, at least when compared to the U.S. Weather Bureau which had to borrow a frequency from the Forest Service to get on the air.[34] The Forest Service authorization to use 25 frequencies in the 2,000 to 3,000 kHz band (100 to 150 meters) and 75 frequencies in the 30,000 to 40,000 kHz band (roughly 10 meters, actually 7.5 to 10.0 meters)[35] was not a significant allocation--given the promixity of Regions to each other, the number of National Forests, and the score of tasks that might have to be handled on any given day.

All the accomplishments of the Radio Laboratory staff were conducted despite a lack of adequate manpower. Before World War II, the Laboratory never had more than eight employees. Allowing for Lawson's contract employment, and Belleville's rather late appointment in 1936, the accomplishments appear even more staggering.

Similarly, at no time did the budget for the Laboratory go over $30,000. In fact, considering the benefits returned to the Forest Service, the allotments for fiscal year 1939 reflect rather miserly expenditures, with Belleville's weekly salary of $31.15 less than that paid the stenographer and draftsman. A breakdown follows in table 1.

Figure 79. Radio Laboratory personnel, ca. 1939. Left to right, Earl Schoenfeld, Gael Simson, Harold Lawson, Logan Belleville, Ralph Kunselman, and Carl Davis. (Forest Service photo, History Section)

Table 1.--Allotment estimate, Radio Laboratory, FY 1939[36]

Item	Amount	Total
Salaries:		
A. G. Simson, Radio Engineer	$4,600	
H. K. Lawson, Associate Radio Engineer	3,200	
Earl Schoenfeld, Assistant Radio Engineer	2,600	
L. M. Belleville, Radio Electrician	1,620	
Ralph Kunselman, Radio Electrician	1,620	
Carl Davis, Radio Electrician	1,620	
P. W. Snapp, Draftsman	1,800	
A. Pedersen, Stenographer	1,800	$18,860
Travel:		
A. G. Simson	1,500	
Other radio personnel	1,000	2,500
Miscellaneous Expenses:		
Fuel, electricity, water, telephone and telegraph, freight, and express		1,030
Parts and equipment		4,300
Complete house on tower		400
Total, all items		$27,090

In retrospect, the radio design accomplishments in Portland deserve very high marks. Only one decade had elapsed between Beatty's SP-1930 and the Laboratory RRS. Perhaps only those who have struggled with developing a single idea can appreciate the scope of this endeavor. It is no mean accomplishment to master the fundamentals of a design, test the innumerable variations, struggle with the gremlins that work their way into the circuitry, and then overcome the common "wisdom" that says if the prototype works, the final product won't. Though rewarding, the process is a highly personal endeavor that takes its toll, but it was repeated at the Radio Laboratory perhaps 100 times in a 10-year period.

In addition, the Radio Laboratory had responsibility for implementing a smooth transfer of this technology. Special projects, cooperation with other Government agencies, a great deal of travel and the expected bureaucratic administrative chores all combined to place additional demands on an already limited staff.

Reference Notes

1. U.S. Department of Agriculture, Forest Service, "Review Your Radio," *Service Bulletin* (1939): 6, p. 6, Gaylord A. Knight Collection.

2. U.S. Department of Agriculture, Forest Service, "Forest Service Communications Conference," Portland, Ore., 20 February to 3 March 1935, mimeographed summary, Gaylord A. Knight Collection.

3. The attendees of record were the personnel from the Radio Laboratory, William Apgar (R-1), Francis Woods (R-4), Fred Funk (R-5), and Leonard Blodgett and W. Holtz (R-6). Forest Service, "Communications Conference."

4. The SP Special (or SSP) was a "beefed up" 5-watt SP.

5. Forest Service, "Communications Conference," p. 2.

6. Forest Service, "Communications Conference," p. 3.

7. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

8. Harold K. Lawson, interview with the author in King City, Ore., May 1978.

9. William Apgar, interview with the author in Sun City, Ariz., January 1978.

10. U.S. Department of Agriculture, Forest Service, Radio Laboratory, "Technical Notes accumulated January 4 to January 12, 1938, at the Forest Service Radio Laboratory InterRegional Radio Meeting," typed copy, Gaylord A. Knight Collection.

11. A Gael Simson, "U.S. Forest Service Radio Equipment," 2 January 1935, mimeographed memorandum, Gaylord A. Knight Collection.

12. A. G. Simson, "Radio as a National Forest Protection Tool," *Journal of Forestry* 36, no. 4 (April 1938): 367.

13. A. G. Simson, "U.S. Forest Service Radio Developments," 10 April 1938, historical paper, including expected design changes, Gaylord A. Knight Collection.

14. Harold Lawson, "Memorandum for Mr. Simson," 26 October 1938, Gaylord A. Knight Collection.

15. A. G. Simson, "The Role of Radio in National Forest Communication," 11 April 1936, mimeographed copy, Gaylord A. Knight Collection.

16. The designation "type K" for "Kar" is only an educated guess, based on the method used to select other radio types. Neither Lawson, Belleville, nor Claypool could recall specifically why this letter designation was selected. Kar was considered an appropriate designation even though there was a commercial mobile radio produced by the Kaar Company at about this time.

17. U.S. Department of Agriculture, Forest Service, Radio Laboratory, *Radio Equipment Bulletin* (1939): 10.

18. A. G. Simson, "Memorandum," 27 January 1939, Gaylord A. Knight Collection.

19. H. K. Lawson and L. M. Belleville, "Mobile 30-40 Receiver for the U.S. Forest Service," *Electronics*, January 1942, p. 23.

20. Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

21. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

22. Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, and April 1979.

23. In amateur radio parlance the word "crystal" is written "xtal," hence the SX designation.

24. S. R. Winters, "Radio Equipped Smoke Jumpers," *Radio News*, April 1942, p. 6.

25. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

26. Logan Belleville, "Field Diary, No. 4," July 1941 to December 1941, Gaylord A. Knight Collection, 7 July 1941.

27. U.S. Department of Agriculture, Forest Service, Radio Laboratory,

Radio Equipment Bulletin, October 1939. Looseleaf. Lifting the handset automatically turned on the transmitter.

28. Forest Service, Radio Laboratory, *Radio Equipment Bulletin*, October 1939.

29. Earl Loveridge to the Regional Forester, Portland, 29 April 1937, Gaylord A. Knight Collection.

30. Lawson and Belleville, "Mobile 30-40 Mc Receiver," p. 24.

31. Simson, "Memorandum," 27 January 1939, p. 3, Gaylord A. Knight Collection.

32. D. S. Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, p. 14, Gaylord A. Knight Collection.

33. A. G. Simson, "Memorandum," 27 January 1939, p. 3, Gaylord A. Knight Collection.

34. William P. Kramer, "Office Memorandum to Region 1," 29 July 1948, Gaylord A. Knight Collection.

35. Simson, "Memorandum," p. 5. In the 10-meter band the Forest Service actually used only the 28,200- to 32,500-KHz (28.5- to 32.5-MHz) range, or 9.23 to 10.53 meters.

36. Simson, "Memorandum," p. 5 (slightly edited).

Chapter VIII

Eat, Sleep, and Drink Radio:

Administration, Cooperation, and Special Tasks

> *(The radio operator) will guard his health and keep as physically fit as the job permits so that he will not fail in emergencies. By example, he will show that he can take it and come up smiling.*
>
> - Forest Service *Radio Handbook*[1]

Men like Simson, Lawson, Squibb, Claypool, and Belleville came to radio development with a natural inclination, talent, and respect for the subject matter. By teaching themselves the basics and keeping pace with technological developments, they grew up with the subject while increasing their own self-confidence. As time progressed, the subject and individual merged into one. Logan Belleville willingly "ate, drank, and slept radio."[2] The net result was that the Radio Laboratory achieved its mission relatively quickly. It was staffed by highly creative men dedicated to their profession because of enthusiasm and free choice. The Washington Office could ask for an inch, expect a foot, and receive a mile.

Gael Simson quietly set the example for total commitment to the radio development program. As the principal administrator, his Portland location often placed him several thousand miles from many of his duties. He served both the Chief of the Forest Service and the Regional Forester of Region 6. His tasks, culled below from a memorandum from Earl Loveridge, encompassed a wide range of administrative functions and made him a well-traveled man.[3]

One of Simson's most important duties was his assignment to the IRAC. This assignment became his through a series of delegations, from the Secretary of Agriculture to the Chief Forester to Assistant Forester Loveridge to the Regional Forester in Portland, who passed it onto him. Each agency of

Chief, Forest Service	Regional Forester, R-6
(Simson's responsibilities through the Washington Office)	(Simson's and Lawson's responsibilities through the Radio Laboratory)
1. Formulate national policy.	1. Technical advice and recommendations in policy; technical application and administration of radio policies.
2. All Washington, D.C. contacts.	2. All field contacts, including technical and procurement.
3. Frequency allocations.	3. Technical assistance in frequency assignments.
4. Cooperation with State and Federal Agencies.	4. Cooperation with Regions.
5. Normal administrative management.	5. Administrative supervision of Radio Laboratory unit.
6. Field inspections.	6. Field inspections.

the Federal government, including the Armed Forces, was assigned a seat in IRAC. Along with E. C. Wagner, an attorney, Simson was responsible for respresenting the entire U.S. Department of Agriculture.[4] Because IRAC met as often as once a month, Simson frequently had to leave the Laboratory to attend meetings.

Cooperation with other Federal agencies and State departments of forestry also kept Simson on the road. One such activity was a three-point program to obtain vhf and hf frequencies for the States; another was the modification of IRAC regulations as applied to non-Federal forestry.[5] When the application and use of radio had to be demonstrated to State or Federal agencies, or sets had to be inspected, at locations where radio could be effectively used, Simson would travel to appropriate Forest Service Regional headquarters, pick up the Regional communication officer, and then go to the site.

The Laboratory would also inspect sets before delivery. Sales were made to such diverse agencies as the Navy; the Indian Service, National Park Service, Reclamation Service, and Grazing Service, all in the U.S. Department of the Interior; the Biological Survey and Weather Bureau in the U.S. Department of Agriculture; and the Bureau of Lighthouses in the Department of Commerce. So Simson's time was often at a premium.[6]

The Weather Bureau used the Laboratory more than the others did. The Forest Service began in the 1930's to prepare daily fire-weather summaries as indicators of forest fire danger in each Region. For this purpose, it depended largely on the Weather Bureau to supply it with data at frequent intervals at many locations --on temperature, humidity, wind direction and velocity, lightning, rainfall, atmospheric pressure, etc. The Forest Service combined such data with its own local observations and its measurements of the fluctuating moisture content of forest litter and dead branches and tree trunks to estimate the fire hazard from day to day during the fire season in its major forest areas, and later to calculate numerical fire danger ratings. The Laboratory, therefore, provided radio frequencies for joint use, sold sets to the Weather Bureau, and helped the Bureau develop mobile radio vehicles.

The success of the Radio Laboratory and the proliferation of Forest Service radios brought a measure of national renown to the work. At least once a year, an article had to be prepared for publication in a leading magazine or journal. Visits from news people and dignitaries took up additional staff time. One time,

Figure 80. Gael Simson in Arkansas for State forestry demonstration. (Forest Service photo, History Section)

Figure 81. U.S. Weather Bureau mobile radio van, 1938. (NA:95G-364875)

the National Broadcasting Co. (NBC) developed a radio script closely following the sequence of a real forest fire control operation. NBC requested that actual sites and equipment be used rather than duplicated in the studio. Under normal circumstances, this request was no problem, but a timed script required a great deal of advance preparation. Up until a few moments before the program went on the air, the telephone company was still frantically attempting to remove 60-cycle noise from the telephone line. Taking part at their posts were a smokechaser, two lookouts, a fire camp dispatcher, and Logan Belleville riding around in a pickup equipped with mobile radio. To the relief of all, the broadcast came off without a hitch. In the closing moments, the announcer asked Gael Simson if fire emergency work was the only use made of the radio system. The answer, which might have been predicted by those aware of the Forest Service's agreements with A. T. & T., was "Yes." Then Simson carefully added, "We do not use it as a substitute for our telephone system, but merely as an emergency device,..."

President Roosevelt's Visit

The visit of President Franklin D. Roosevelt to the Pacific Northwest in 1939, concerning the expansion of Olympic National Park in Washington at the expense of Olympic National Forest, also required a temporary diversion from the usual Laboratory duties. At the request of John Bruckart, supervisor of the Olympic National Forest, Simson and Belleville motored up to Tacoma to install a public address system for the scheduled speeches. After the program, Simson and Belleville quickly disassembled the equipment, loaded the Chevrolet panel truck, and hurried back to beat the traffic. As they sped along, crowds waved flags at them and the highway patrol motorcycle officers pulled out in pairs to escort them. Believing the Presidential party was just behind him, Simson did his best to keep out in front. Several miles later, the two men stopped for lunch and learned that the President was indeed some distance behind, led by an identical vehicle, and that the Washington State police had been confused.[8]

Further examples of cooperation with State and Federal agencies ranged from the simple to the complex. One particularly unique request for assistance came from the Portland Civil Service Board. The Board asked for a written examination that would test the skills and knowledge of applicants for radio operator and radio technician jobs. Lawson and Belleville put together a comprehensive exam and were subsequently thanked by the Board for their efforts. "We found," wrote the chief examiner, "that the radio sections of the examination had a remarkably high degree of reliability..."[9]

Special requests for electronic equipment to suit unusual applications also found their way to Portland. In the fall of 1938 a violent hurricane hit the coast of New England, with loss of life, property, and shattering of immense stands of timber. In response to numerous requests, the Forest Service was authorized to organize and operate the emergency Northeastern Timber Salvage Administration (NETSA) to reduce hazard of fire, insects, and disease, as well as to recover as much as possible of the great potential value of the lumber.[10] But the numerous nails, bolts, and spikes in the logs were raising havoc with the saw blades. Having attended a radio short course at the Lab, Leonard Blodgett, a timber specialist who was transferred from Region 6 to become a District Supervisor of the NETSA project, knew exactly where to turn. He wrote to Gael Simson to request that the Laboratory try to develop a metal detector.[11]

The Laboratory was unenthusiastic. Horton informed NETSA that "from a technical standpoint the problem you present is extremely difficult."[12] Blodgett, however, was not put off. Following consultations with Simson, who happened to be in Boston at the time, and Foy Squibb in the Eastern Region (R-7, now part of R-9), he prevailed upon Lawson to look into the matter further. For some months until September 1939, Logan Belleville struggled with a prototype.[13] He eventually completed the type X (Experimental) metal detector after devising an electronic bridge arrangement that became unbalanced in the presence of metal and, thereby, changed the frequency of an audible 1,000-Hz tone. The device was sent to NETSA. Judging from the queries on other possible uses, which ranged from ore exploration to the detection of metal in a cow's stomach, it received much interest from the general public. However, it was cumbersome and proved impractical, and there was no time to refine it further.[14]

A similar project evolved shortly after the beginning of World War II. The Army's request for an acute listening device to detect the approach of enemy bombers led the Radio Laboratory to build the type TE (Tin Ear). When preliminary tests demonstrated that "detection time by unaided ear [was]...30 seconds ahead of the simple 'Tin Ear,'" the project was abandoned.[15]

Regional assistance and cooperation also consumed a significant portion

Figure 82. Ralph Kunselman demonstrates the experimental type X metal detector developed by the Radio Laboratory, while Harold Lawson looks on. The gadget was designed to warn sawyers of nails, bolts, spikes, wire, etc., in logs they were processing after the New England hurricane of 1938. The work came under the timber salvage program of the Forest Service and cooperating States. (Forest Service photo, History Section)

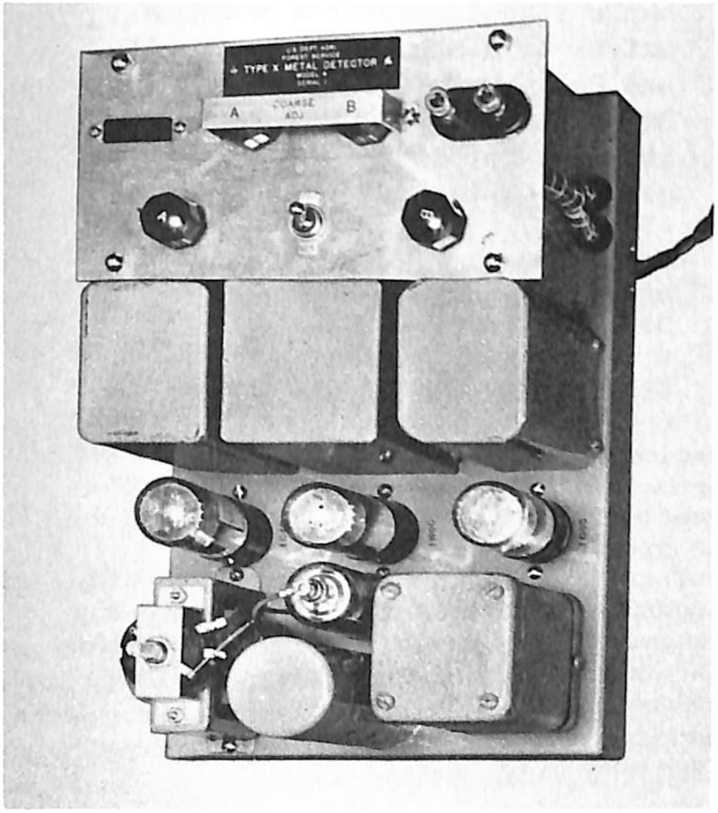


Figure 83. Interior layout of type X radio metal detector, an experimental prototype developed by the Radio Laboratory in 1939 to warn of metal in logs. (Forest Service photo, History Section)

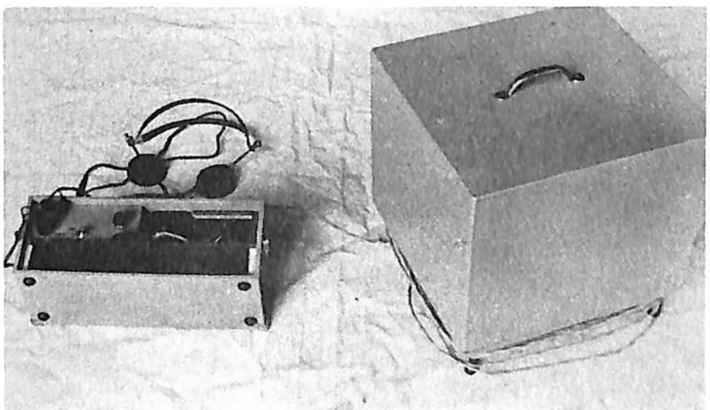


Figure 84. The "Tin Ear," type TE, a listening device created by the Radio Laboratory, at the request of the Army to detect approach of enemy bombers. (Forest Service photo, History Section)

of Laboratory time. Harold Lawson always had a backlog of Regional correspondence relating to technical problems, design improvements, and procurement, so Lawson and the staff spent a number of months accumulating materials and putting together an all-Service radio manual. Before then, a small pocket-size instruction book for the operators and working schematic drawings for the technicians had been inserted with each radio set shipped out. This practice had become a clerical problem for the Regions which struggled to keep pace with the paperwork for the many model changes and new products. When the *Radio Handbook* was published in 1938, it relieved the clerical situation greatly.

The *Radio Handbook*, bound in the traditional dark green of the Forest Service, dealt with all aspects of radio on the fireline. It gave the historical background of the program and went into the organization and policies of radio in the Service, use of radio in planning and application, and use of communication networks on large fires. It also outlined the proper Forest Service operating procedures and basic radio fundamentals. Several hundred pages of schematics, parts lists, circuit descriptions, and pictures were included to aid in servicing the sets. The 500 pages were removable and were frequently updated and circulated by the Laboratory.

The *Radio Handbook* was not only an organized compendium of Forest Service radio facts, but also an instructional device for technician training. It still left much to be desired, but now, theoretically, a person with previous experience in radio and assigned to a forest, could take the *Handbook* and one or two other recommended texts, and be successful in his job.

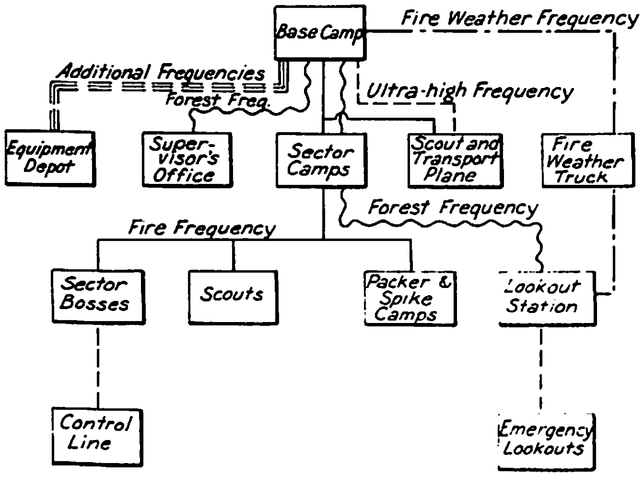


Figure 85. Suggested plan for radio network on "conflagration" fires, from the Forest Service Radio Handbook. (Forest Service photo, History Section)

Trips to Assist the Regions

From time to time, the Radio Laboratory staff had to travel to adjacent Regions to make technical inspections and installations. This experience often provided them with firsthand knowledge of Regional communication problems and allowed them to answer specific questions. The men went by automobile, boat, airplane, and horse, doing their best to smooth the transition of Forest Service personnel from telephone to radio. One entry in Foy Squibb's diary reflects the effort and time required. On a trip through Oregon, he spent Friday, July 21, 1933, traveling to and from an installation on Pearsol Peak. That night he recounted the day's work that had taken him 30 miles by car and 14 miles on horseback:

> Left 7:00 am with Blair for Pearsol Peak--arrived 10:30--changed directions of antenna to get feeder at right angle to it. Checked set and found oscillator condenser out of adjustment so set wasn't putting out a signal. Contacted Stove Gulch, Bald Mtn., Tennessee Mtn., and Bolan Mtn. for check on set. Results not so good at distance of 10 miles but fine for distances greater or less than 10 mi.
>
> Left Pearsol 1:00 pm--arrived Anderson Ranch 3:15 pm--Rode with Blair in govt. truck to Redwood R. S. /Ranger Station/--arrived at 6:00 pm[16]

Regional trips also gave the staff an opportunity to attend communication meetings and to discuss particular Laboratory design problems with authorities in the electronics field. Logan Belleville once logged a 12-day automobile round trip between Portland and Los Angeles. The diary entries, summarized below, reflect the value and the pace of such ventures away from the Radio Laboratory:

> Oct. 11, 1939
>
> Left Portland in company of H. K. Lawson in government car at 7:30 a.m. Arrived at Yreka, Calif., at 5 p.m. and contacted "Windy" Miller, forest radioman, and discussed general radio matters.
>
> Oct. 12, 1939
>
> Left Mt. Shasta in a.m., arrived in Vellejo, Calif., in p.m. After dinner went with Lawson and Squibb to A.I.E.E. /American Institute of Electronics Engineers/ meeting in San Francisco. F. E. Terman discussed directive antennas.
>
> Oct. 14, 1939
>
> Saturday. Visited Government Island. In p.m. visited ________ /undecipherable/ and returned to Vallejo where visited with Squibb.

Oct. 15, 1939

Sunday. Traveled from Vallejo to San Francisco.

Oct. 16, 1939

Met Fred Funke at Regional Office. Visited Bud Baine at Technical Radio. Visited Eimac tube plant. Visited Stanford University where saw F. E. Terman--discussed S set problems with him, saw Klystron working and met Morgan with whom discussed mobile antenna report of Dept. of Interior.

Oct. 17, 1939

Met Fred Funke in Oakland with whom started trip south. Went through Yosemite. Visited North Fork supervisor's headquarters on Sierra and discussed general radio problems. Continued on through Fresno and visited Bakersfield.

Oct. 18, 1939

Arrived at Pasedena USFS office. On to USFS radio shop in Arcadia where went over specific radio problems. Visited Monitor Piezo Products Co. to discuss several problems with crystal oscillators.

Oct. 19, 1939

Made transmission tests at Arcadia. Left about noon on way north. Stopped at Santa Barbara to look at antenna problem. Continued north to San Luis Obispo.

Oct. 20, 1939

Continued north looking over topography and making transmission tests. Arrived in Oakland.

Oct. 21, 1939

Saturday. Government Island. Talked with Hanney, Funke and Crabb. Left for Modoc National Forest.

Oct. 22, 1939

Drove through Lassen National Forest. Visited Ranger station at Fall River Mills. Drove on to Klammath /sic/ Falls, Oregon.

Oct. 23, 1939

Arrived back in Portland.[17]

During the years immediately preceding World War II, the Portland staff personally handled a number of requests from the Regions, including special one-of-a-kind projects dealing with unique communication applications. Because Region 6 was close to the Laboratory, its requests ranged from modifications of communication sets to the construction of a radio trailer.[18] In search of a package that would allow smokejumpers to parachute radios to the fireline, Region 1 asked the Laboratory to experiment with various shockproof devices, including loaves of bread.

Installation of Regional systems and the inspection of communication applications also took the staff away from Portland. Perhaps the most extended trip was made by Bill Claypool in 1936 to the Caribbean National Forest in Puerto Rico. Claypool first traveled by rail to New York City to board the ship. He detailed the New York experience for Harold and Bee Lawson in a lengthy letter from Rio Piedras. A short excerpt from his letter reflects the interests of the men associated with the Portland Radio Laboratory:

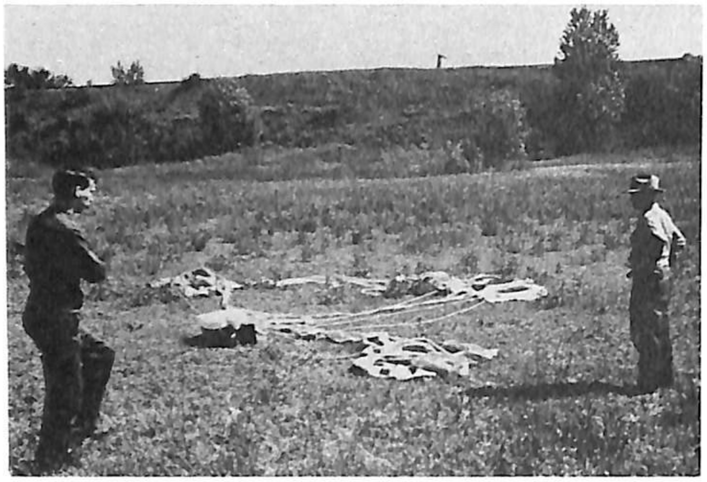


Figure 86. Parachute experiment with radio package. Note the loaves of bread on top of the package. One of a series of experiments conducted for Region 1 in the late 1930's to find a way of shock-proofing radios parachuted to smokejumpers on a fire. (Forest Service photo, History Section)

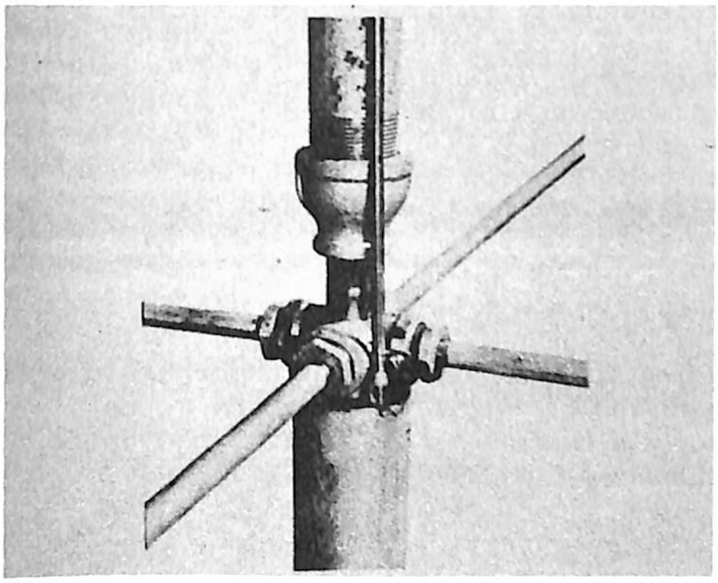
Figure 87. Radio trailer of Pacific Northwest Region (R-6) in 1939. (Forest Service photo, History Section)

> Radio City held so many attractions that I could not see the previous day that I returned the next morning early and spent several hours in the New York Museum of Science and Industry. And there, Harold, you would find things that would interest you so you would never want to leave. For example every sort of electrical principle such as capacitive, inductive, and resistive reactance and combinations are displayed in working form so simple that the layman can even understand the underlying facts. All sorts of electrical gadgets that perform unusual tricks with explanations of all. Every kind of scientific subject was displayed even to working models of wind tunnels that showed the effects of streamlining and aircraft construction and design. The Holland tunnel in miniature complete even to the automatic gas content analyzer...[19]

Designing a Testing Set

The Radio Laboratory staff always tried to keep radio costs to a minimum because the cost of a communications system was a financial burden for the Regions. They designed alternatives less costly than commercial test equipment. One of these, the type A test set, became a Laboratory catalog product. It served many functions: a grid-dip oscillator, a modulated oscillator, and a rectifier wavemeter. It was originally conceived by Logan Belleville for use in his Twin Falls radio shop. Along with the type D test set (for supplying a frequency-modulated test signal in visual alinement of wideband *if* amplifiers), it served as a functional, economical testing device in many Forest Service radio repair shops.[20]

Annual meetings furthered inter-regional cooperation. Radio Laboratory staff and the Regional communications personnel would discuss and analyze each set in detail and suggest improvements and modifications. Sometimes these recommendations involved entirely new projects. Because of



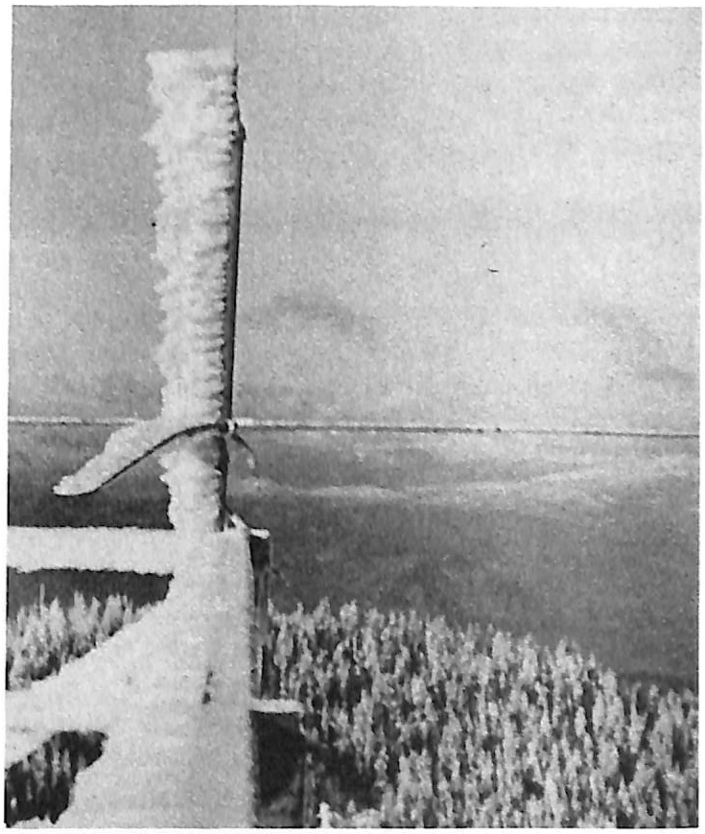


Figure 88. "Plumber's Delight" antenna, a creation of the Radio Laboratory. Photo at left shows details of the radial supports. Photo at right shows an installation on a Forest Service lookout station in Region 6, covered with rime ice. (Forest Service photos, History Section)

concerns voiced over the inability of the ground-return Forest Service telephone lines to handle additional traffic, the 1938 conference suggested that the Radio Laboratory look into carrier telephones, that is, telephone wires used for the transmitting medium; several test sets were constructed in Portland. In technical terms, the project was unsuccessful because of the inability to predict the transmission distance over any given line and the rather low-grade performance of a ground-return system.[21] Belleville, who looked back on it with a smile, thought the project was unofficially dropped because the staff had completely overlooked the fact that "...the unbalanced telephone line made a very effective antenna for lon-wave radio from as far as the East coast, and the interference was R9 /perfect/."[22]

Continual improvement and updating of antenna design was another Laboratory requirement. Antennae, which may determine the success or failure of any radio, were important factors in set-up time, reception, transmission, and maintenance. On interregional trips, the staff would often find time to stop at manufacturers' plants and universities to review recent developments in tubes and components, and to discuss the intricacies of particular configurations of antenna construction. Sometimes this brought them into disagreement with F. E. Terman, now commonly referred to as the "Father of Silicon /transistor/ Valley," and his staff at Stanford University.[23]

Antenna design, however, was not always so well-studied or esoteric. After RCA came out with a particularly effective vhf rod-type antenna at what Forest Service circles considered a very high price, Belleville suggested they "turn it inside out" for their production and use.[24] The result was a collection of pipes that could withstand the vagaries of wind, snow, and ice. Known as the type PD (Plumber's Delight), it served admirably at many remote Forest Service locations.

The most time taken from radio design was for the model-bid-construction practice. The Radio Laboratory had adopted the procedure because the staff lacked the test equipment to specify precisely the exact electrical performance of their designs. Potential bidders could determine production expenses by costing out the parts and labor necessary to duplicate the laboratory model. This practice was usually very successful, and awards went to manufacturers willing to work closely with the Laboratory.

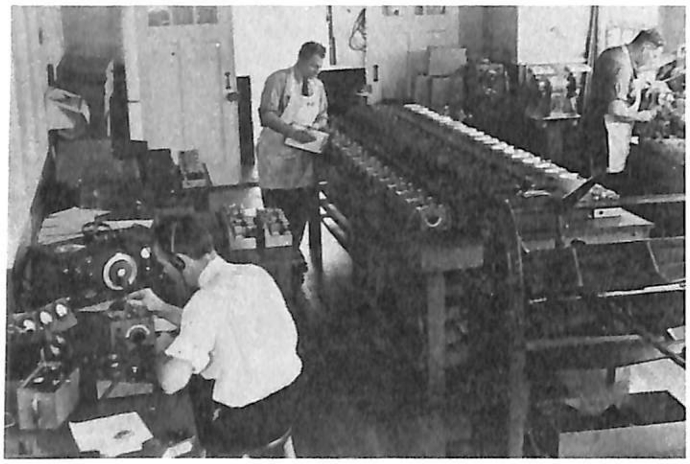


Figure 89. Inspecting incoming SV sets from the manufacturer at the Radio Laboratory, before reshipment to the Regions. Left to right, Charles McPherson, Carl Davis, and Ralph Kunselman. (Forest Service photo, History Section)

Actually, one staff member always seemed to be on temporary detail for preliminary acceptance tests of the sets at a manufacturer's plant, where any needed minor modifications were to be identified as sets came off the production line. This usually involved substitution of a resistor or capacitor--a practice that often left the Laboratory with an abundance of short-lead components[25] --and greatly facilitated the final inspection process in Portland before filling the Region orders.

Some Problems with Suppliers

Sometimes, however, this procedure did not work, especially when the Forest Service rushed to get additional units into the field in time for a fire season. Once, when contracts for some type T sets were awarded, the Laboratory hastily provided a model that lacked cabinet, antenna, instruction manual, and nameplates --exclusions covered either as exceptions or as special items that were to be identified after the contract award; the potential bidder could set a cost for the items based on previous experience, go ahead with the other tasks, and then call for the specifications at an appropriate point in the construction.

The Laboratory expected contractors to order parts as soon as verbal notification was received so that construction could start quickly after written notification. Western Wireless, Ltd. of San Francisco was awarded such a contract for 130 type T sets when it was already "strapped" for adequate personnel on a contract for Forest Service type M and S sets. Charles Watson received a telephone call in June 1936 that his company had won the bid, but he did not proceed to order parts in advance. A newcomer to this volume of business and lacking adequate labor or physical plant and financial resources, he later said, "...it was thoroughly inadvisable for us to borrow the necessary money on the strength of an order which, in fact, was not /yet/ an order.[26]

This hesitancy, though technically legal, placed additional pressure on Western Wireless. Because he could not move into production quickly, Watson used up any grace period that might have been extended to the company if legitimate problems arose during the 45-day contract schedule.

The problems of Western Wireless soon began to snowball. When the September 2 contract deadline passed, Watson asked Gael Simson for an extension based on a number of "unforeseen circumstances" due to not receiving Kellogg handsets, the inevitable (and from the Laboratory's point of view, predictable) failure of suppliers to deliver parts on schedule, as well as some "problems" created by the Radio Laboratory. These last alleged problems were as diverse as failure to specify nomenclature on nameplates and to authorize the substitution of a five-position rotary meter switch for a double pole-double throw switch, failure of the original sample to work properly, and need to rewire the receiver decks because of a change in the hook-up of the quench coil.[27]

Harold Lawson responded to Watson's complaints with an onsite inspection. He found Watson's complaints unjustified. Receiver and transmitter decks were not yet completed. Panels, brackets, and shield cases were not drilled, tapped, or mounted. Watson's contention that the lack of handsets and nameplates was holding up production was specious. Even if they were on hand, they could not be used until construction was complete. "It would appear that a large part of this delay is due to the use of insufficient labor and the employment of unskilled men, Lawson concluded.[28]

Lawson also dismissed the complaints that the Radio Laboratory had not supplied a draft of the instruction manual and antenna specifications. Western had previous contracts with the Forest Service requiring the company to supply these items. Irritated by what he viewed as intentional delays, Lawson charged that the "...failure on the part of Western Wireless to call for antenna specifications or instruction manual copy was merely a method of evasion or an attempt to obtain contract time extension from the Forest Service on the basis of failure to supply /a/ complete model."[29]

By this time, Watson realized that his relationship with the Radio Laboratory was suffering. He wrote Regional Forester C. J. Buck in Region 6 in expectation of sympathy for his campaign from higher echelons. He recounted his original complaints and charged that additional delays were warranted because the Radio Laboratory sample, on which his bid was based, "was far from complete."[30] But if Watson thought the Regional office was not aware of the unique bid status of the contract or would be swayed by a divide-and-conquer approach, he did not understand the Regional administrative structure or the relationship between the Radio Laboratory and a Regional office. Rather than a willing ear, Watson received a one-sentence reply from M. L. Merritt, Acting Regional Forester. He bluntly called Watson's attention to a memorandum from Lawson in October that he attached to his reply. It outlined Laboratory criticism after a preliminary inspection of set TL-100 sent to Portland by Western Wireless.[31]

In the normal chain of events, Forest Service contractors shipped a preliminary sample radio set to the Laboratory for approval before an inspector visited the contractor to certify compliance of the remaining sets. In this way, minor necessary modifications could be identified before the Laboratory spent money on an onsite inspection; the contractor, in turn, would be certain that modifications would have a minimal impact on final production costs. The financially pressed Watson had ignored the Laboratory evaluation.

The required modifications were minor, but time-consuming. New meter faces at 50-mA scale rather than 25-30 mA, and additional shunting of the meter grid current were necessary to keep from driving the meter off scale. Other modifications were less time-consuming, e.g., clarification of labels, switching of two leads, soldering, cabinet stenciling, and comments on the panel hinges.[32]

Perhaps of less concern to Watson, but more important, was that the T sets were no longer needed. Unintentionally, this made for further delays. No longer pressed to get the T sets on the fireline and involved with other assignments for the upcoming 1937 fire season, the Radio Laboratory was not about to drop everything in order to accommodate Mr. Watson. Believing Watson had brought the problem upon himself and constrained by limited staff and an ever-present scheduling problem, Simson and Lawson simply let the matter fit into whenever time was available.

Watson corresponded regularly with Simson and Buck during October. He made very plaintive and frequent pleas for payment, even partial payment, never wavering from his position that outside vendors and the Radio Laboratory were responsible for his plight.[33] The Region 6 office steadfastly supported the Laboratory and replied that it would "...arrange to have the type 'T' sets inspected when all are complete."[34] This, of course, included all antennae, handsets, and modifications to the original.

Watson then sent separate letters to Simson and Buck. By this time, he was walking the thin line between contract concellation for noncompliance and Western Wireless's need for some financial assistance to complete the modifications. Although still holding to his original argument, Watson did admit that modifications from the original sample were not yet complete, coming as close to demanding an inspection as possible.[35] Simson responded with the following radio message: "BELLEVILLE WILL ARRIVE IN SAN FRANCISCO NOVEMBER THIRD ONE FIFTY PM TO INSPECT T SETS."[36]

Watson met Logan Belleville at the San Francisco airport on the appointed date. By November 11, eight days later, Belleville had made little progress. While this was primarily due to a mixup by the express company in shipping test equipment, Belleville had also found several variations in the T sets. These included lack of adjustment in RF coils, a shortage of handsets, absence of switches, no cabinets, and incomplete testing.[37] He told Watson that the sets had to be completed for inspection.

Meanwhile, for lack of work and the frequent absence of Watson, Belleville took most of the next day to visit Fred Funke who supervised radio in Region 5. Returning to Western Wireless in late afternoon, he found "much activity towards getting /the/ sets ready.[38] The following day Belleville also noted the "place cleaned up and work progressing satisfactorily," but very few sets were being completed.[39] With this in mind, the possibility of having to wait 2 more weeks for all sets to be completed, plus a telegram from Simson suggesting, "IF INSPECTION BEING

DELAYED ACCOUNT SETS NOT READY SUGGEST RETURN PORTLAND YOUR JUDGEMENT /sic/ SATISFACTORY,[40] Belleville confronted Watson and "Gil" Gilbertson, the radio engineer for Western Wireless. Realizing that it might take a supreme effort to arrange another inspection, Watson secured telephone permission from Lawson to continue work through the following week.[41] Three days later, but still facing 100 incomplete sets, Belleville's frustration was reflected in his field diary. "Whoopee!" was his final comment for that day.[42]

Belleville continued to run into problems with adjustments and component substitutions that commonly occurred between Laboratory prototype and finished product. Such delays were usually worked out after consultation with Lawson over KBAA, telegram, or telephone. But these problems were complicated at Western Wireless by Watson's attempts to economize. Belleville had to reject units several times because tacks were substituted for screws, even the best cabinets were substandard, and not all components were available.[43] The most frustrating problem, however, was Western's inability to cut the antennae to the proper length. After Belleville discovered that the wires were considerably too long, Watson apologized and placed another man on the job. A few days later, Belleville learned to his dismay that the antennae were still too long. Checking further, he discovered that the measurements were made on a pattern maker's shrink rule, which was 3/16 inch longer per foot than standard.[44] After a third attempt, each wire was cut to the proper frequency.

On November 26, after putting in double time for several days, Belleville completed the inspection of the last T set and departed for Portland. He left behind a very relieved Charles Watson and the impression that the Radio Laboratory would expect strict contract compliance in future dealings.

Thus, throughout the 1930's the Radio Laboratory staff were involved in a number of activities that speak well for their work. But the success of the radio development program cannot be measured solely by their effort and output. Radios were intended for the fireline. Their acceptance in remote areas of the National Forests is the final measure of the Radio Laboratory's accomplishments.

Reference Notes

1. "Operators and Operating Practices," *Radio Handbook* (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation, ca. 1938), sect. B7.1, pp. 14-22.

2. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

3. Loveridge to Regional Forester (R-6), 29 April 1937, Gaylord A. Knight Collection.

4. Simson's brother was the representative for the Department of Commerce.

5. Simson, "Memorandum," 27 January 1939, Gaylord A. Knight Collection, p. 5.

6. Simson, "Memorandum," p. 3. The Weather Bureau was transferred to the Department of Commerce June 30, 1940.

7. National Broadcasting Company, "Script for Forest Service Radio Communication Demonstration," 10 May 1939, mimeographed, Gaylord A. Knight Collection; Harold K.

Lawson, interview with the author in King City, Ore., May 1978; and Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

8. Belleville, interview with author.

9. Roger W. Reynolds to Harold Lawson, 10 July 1939, Gaylord A. Knight Collection.

10. Walter Wesselius, "Experience from the New England Hurricane," *Electrical Engineering* 58, no. 3 (March 1939): 99-101. See also Earl E. Peirce, *Salvage Programs Following the 1939 Hurricane* (Berkeley: University of California, Bancroft Library, 1968).

11. L. D. Blodgett to A. G. Simpson /sic/, 25 March 1939, Gaylord A. Knight Collection.

12. F. V. Horton to Director, NETSA, 6 April 1939, Gaylord A. Knight Collection.

13. Belleville, interview with author.

14. Belleville, interview with author, and George Vitas, telephone conversation with Frank Harmon, History Section, Forest Service, 25 March 1981.

15. F. H. Brundage to Regional Forester (R-5) 23 April 1942, Gaylord A. Knight Collection.

16. W. F. Squibb, "Diary-June 23, to Sept. 29, 1933," Gaylord A. Knight Collection.

17. Belleville, "Diary #3," October 1939, Gaylord A. Knight Collection.

18. W. S. Claypool, "Memorandum for Mr. L. K. Mays," 28 September 1939, Gaylord A. Knight Collection. This memo describes the major Forest Service radio equipment included in the trailer.

19. Bill Claypool to Harold and Bee /Lawson/, 19 October 1936, Gaylord A. Knight Collection.

20. See Appendix I for details on the types A and D test sets.

21. H. K. Lawson, "Memorandum for Files," 15 November 1938, Gaylord A. Knight Collection.

22. Belleville, interview with author.

23. Belleville, interview with author, and "Field Diaries," *passim*, Gaylord A. Knight Collection. Other visits were frequently made to such manufacturers as Hewlett-Packard and Eimac (Eitel-McCullough).

24. Belleville, interview with author.

25. Logan Belleville to Harold Lawson, 13 June 1939, Gaylord A. Knight Collection.

26. Charles L. Watson to Gael Simpson /sic/, 12 August 1936, Gaylord A. Knight Collection.

27. Charles L. Watson to Gael Simpson /sic/, 4 September 1936, Gaylord A. Knight Collection.

28. "Memorandum for the Files," Harold K. Lawson, 14 September 1936, Gaylord A. Knight Collection.

29. Lawson, "Memorandum for the Files," 14 September 1936.

30. Charles L. Watson to Shirley Buck, 21 September 1936, Gaylord A. Knight Collection.

31. M. L. Merritt to Western Wireless, Ltd., 3 October 1936, Gaylord A. Knight Collection.

32. Harold K. Lawson, memorandum, per A. G. Simson to Mr. B.

Gilbertson, Western Wireless, [n.d.], Gaylord A. Knight Collection.

33. See Charles L. Watson to Gael Simson, 5 October 1936; M. L. Merritt to Charles L. Watson, 8 October 1936; A. G. Simson to Charles L. Watson, 10 October 1936; Charles L. Watson to C. J. Buck, 13 October 1936; Charles L. Watson to A. G. Simson, 23 October 1936; and F. H. Brundage to Western Wireless, Ltd., 26 October 1936--all Gaylord A. Knight Collection.

34. *Ibid.* and F. H. Brundage to Charles L. Watson, 26 October 1936, Gaylord A. Knight Collection.

35. Charles L. Watson to C. J. Buck, 27 October 1936, Gaylord A. Knight Collection, and Charles L. Watson to "Gael" [Simson], 27 October 1936, Gaylord A. Knight Collection.

36. A. G. Simson to Western Wireless, 2 November 1936, radiogram, Gaylord A. Knight Collection.

37. Logan Belleville, "Field Diary and Travel Record," 11 November 1936, Gaylord A. Knight Collection.

38. Belleville, "Diary," 12 November 1936.

39. Belleville, "Diary," 13 November 1936.

40. A. G. Simson to Logan Belleville, 13 November 1936, telegram, Gaylord A. Knight Collection.

41. Belleville, "Diary," 13 November 1936.

42. Belleville, "Diary," 16 November 1936.

43. Belleville later learned that the supposed shortage of Kellogg handsets was due to the express office's refusal to release them to Watson, as they were shipped C.O.D. It was also Belleville's understanding that Watson got these out of hock after a phone call to Herbert Hoover, Jr., his brother-in-law. Belleville, interview with author.

44. Belleville, "Diary," 19 November 1936.

Chapter IX
Radio in the Regions:
Reasons for Wide Variations in Use

> *While the Forest Service, as seen by the Chief or by the casual outside observer, assumes the form of a traditional administrative pyramid, it appears to the individual Ranger as an inverse pyramid with himself at the apex.*
>
> \- Herbert Kaufman[1]

The grouping of the National Forests into first 6 and later 10 Regions, together with the loosening of centralized control from Washington, was intended to and did benefit their administration.[2] It was expected by Gifford Pinchot that stationing Regional Foresters permanently in the field and making them responsible for all activities within their respective territories would result in more effective management. In general it has worked out that way. In 1982 there were 154 National Forests encompassing a net area of 292,700 square miles, managed by 123 forest supervisors and grouped into 9 Regions.

One problem has been that regional divisions cannot be made entirely along lines corresponding to forest type, geography, or climate. For practical reasons, a regional boundary generally follows rather closely the boundaries of its outer States; it may encompass forests of diverse climate, terrain, elevation, vegetation and, therefore, fire conditions. In Region 6, for example, Oregon and Washington, the Regional Forester deals with the dense rain forests of the Pacific Coast as well as the drier and more open forests east of the Cascade Range. In the Pacific Southwest Region (R-5), which coincides with California, great differences are apparent between the redwoods of the northern coast and the scrub pines and dry brush of the southern interior forests.

Demographic patterns are similarly diverse. The Region 8 Forester at Atlanta must deal with communities affected by decisions that apply to areas surrounding the Sam Houston National Forest near Houston, Texas, the Francis Marion National Forest along the coast of South Carolina, and the Cherokee National Forest in the southern Appalachian mountains of Tennessee. Even in Region 1, which since early 1909 has included Montana, northern Idaho, North Dakota, and a corner of South Dakota, the Forests are not all similar.

Rarely are a Ranger's duties the same throughout a Region. Often the most urgent needs of a particular forest as seen by the Forest Supervisor, are entirely different from those of a Supervisor in another corner of the same Region. This potential for conflict is reflected in the national policy determined by the Washington Office and the interpretations made in the Regions.

James B. Bruce, for example, a Montpelier District Ranger in Region 4's Caribou National Forest, Idaho, and Thomas V. Pearson, Assistant Operation Chief in Region 4, suggested to Washington in 1935 that a firefighting crew of paratroopers might prove invaluable as an immediate strike force against fires. Major Evan Kelley, Regional Forester in Region 1, did not like the idea. Writing to Earl Loveridge, he noted the high risk to the men, and said Region 1 would have little need for their services. More to the point, he questioned the wisdom of relying on men who would jump from airplanes. "I am willing to take a chance on most any kind of a proposition that promises better action on fires," he wrote to Loveridge, "but I hesitate very much to go into the kind of thing that Bruce proposes. In the first place, the best information I can get from experienced fliers is that all parachute jumpers are more or less crazy--just a little bit unbalanced, otherwise they wouldn't be engaged in such a hazardous undertaking; accordingly, I discount materially the practicability of Bruce's idea."[3]

Despite Kelley, the Forest Service smokejumper school and headquarters was established only a few years later, nearly in view of Kelley's Regional office in Missoula. Sane or not, smokejumping is a vital and colorful mainstay in the firefighting arsenal of the National Forest System.)

Accordingly, many factors may affect the advent and acceptance of a new idea and device in the National Forest System. The lumber industries and the dominant political, business, and social attitudes may have a significant impact at the community level. On the District Ranger and Forest Supervisor levels, the budget and relative needs for various improvements may be important considerations. At the Regional level, such considerations multiply in importance, become more complex in scope, and mix with considerations based on current professional opinions, technology, and management criteria. In Washington, special interest groups, Congressional leaders and committees, and Presidents may significantly influence or alter existing policy. Even so, the individual Forest Supervisor and his Rangers play a major role in when and how new developments are accepted, integrated, and ultimately utilized throughout the National Forest System.[4]

Electronic communication did not escape this maze of complex forces. Some Regions, for example, placed radio under the supervision of the Division of Operation, others put it under the Division of Fire Control, and some under the Division of Engineering. The varied geography, climate, population, and communication facilities compounded the lack of uniformity, making radio a "must" in some cases and not necessary in others.

The cost of installing and maintaining radios, for example, in the terrain of rugged mountains and intemperate climate lying between the Kaniksu National Forest in the tip of Idaho and the Regional office in Missoula would be less than for telephone, while in Region 8 a short telephone trunk line out of the Sam Houston National Forest in Texas could cost-effectively tie that area to Atlanta through some 750 miles of A. T. & T. telephone lines. In western Oregon National Forests, population was dense enough quite early to encourage commercial telephone line development. On the Big Horn National Forest in north-central Wyoming, however, telephone lines were installed by the Forest Service in its early years because of a scarcity of both population and commercial telephones.

Strong Geographic, Demographic Influences

The cost of installation and maintenance notwithstanding, predominant geographic and demographic conditions also strongly influenced the communication plans of each Region. Region 1, for example, would opt for low-frequency band, 3-MHz (100-meter) sets because it did not have the prominent high peaks visible from many lower points, as was typical in Region 6 and northern Region 5. And Region 1, a relatively rugged, unpopulated territory, would insist on more power to "force" its radio messages through. On the other hand, Region 8 would subsequently favor the 30- to 40-MHz vhf (10-meter) sets for use over the gentle terrain of the Southeast. Even though Regions 1 and 8 differed on the type of equipment they needed, they agreed on the use of intraregional radio networks. Region 6, however, had little use for this application because of its well-developed network of commercial telephone lines.

The issue of output power as it related to National Forest conditions further complicated the position of the Radio Laboratory. Region 1, of course, championed a high-power policy, and National Forests in other Regions found particular merit in this approach, with the Angeles National Forest in southern California a close second to Missoula. Fire crews on the Angeles were often stretched out over long distances because of the unique chapparal vegetation, as well as the high velocity and extreme heat and dryness of the infamous Santa Ana winds in the area. Because of the numerous population centers near the Angeles, the Forest Service radio operators also preferred increased power to overcome the QRM, or interference, from other private operators, the Army, the Navy, and commercial air flights.

Given these diverse communication needs, there was some value in the Washington Office's hesitancy to dictate radio use. The staff lacked the necessary technical background to prescribe programs that could incorporate all Regional needs. They also may have been hesitant to take action that went against established decentralized Forest Service policies. Radio was still in its infancy, and such issues as output power, battery life, unit size, comparative circuit, and adaptation of particular components did not lend themselves to Servicewide directives. The technology had yet to be improved, the tool better understood, and conditions of use determined through trial and error. Washington believed that until then, decisions affecting radio design were best left to the discretion of the Radio Laboratory and decisions regarding application left to the field. Consequently, no Servicewide policy on comprehensive radio development or procurement evolved during the early years of the program.

Until World War II, the Regions centered in Missoula, San Francisco, and Portland (R-1, R-5, and R-6) provided the main thrust for radio use. Denver, Albuquerque, Ogden, Washington, D.C. (later Philadelphia), Atlanta, Milwaukee, and Juneau (R-2, R-3, R-4, R-7, R-8, R-9 and R-10) did little innovation. Surprisingly, Region 2 with many of the forests and 14,000-foot peaks in central Colorado, believed it had little to gain from immediately adopting radio. Indeed, the Region, which some considered a "grazing outfit," was never visited by Harold Lawson in over 20 years of travels.[5] Radio was used in Colorado, but its acceptance was limited because communication needs were met by existing telephone systems. Radio also lacked financial support, was resisted by individuals with opposing views, and was superseded by other needs.

The Eastern Region

The Eastern Region (R-7), which originally encompassed Kentucky, West Virginia, and the eastern States from Virginia to Maine, also had no need for extensive new communication facilities. After the design of the type T set, Foy Squibb was temporarily assigned to the Region to provide radio instruction and install S and T sets on the Cumberland (now Daniel Boone) National Forest in central Kentucky. The lack of funds at the Radio Laboratory kept him in Region 7 for 4 years.

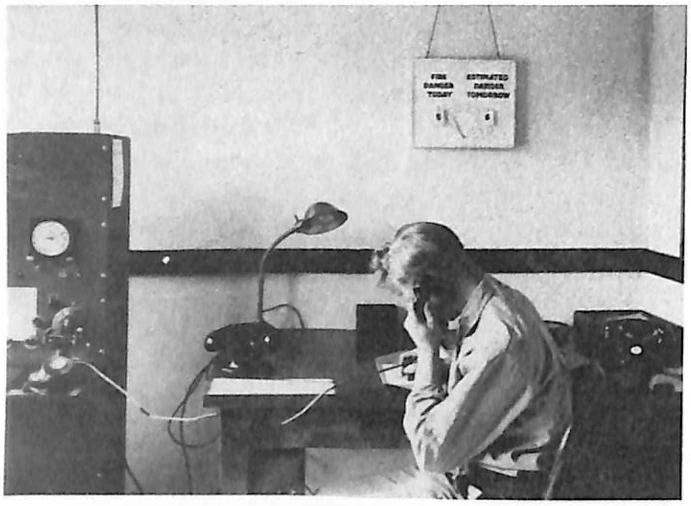


Figure 90. Operator Bradford talking over set U-9 at Baldwin Ranger Station, Manistee National Forest, Mich., 1937. (NA:95G-367687)

Squibb's initial duty in June 1935, "...was considered an experimental field installation for the testing and developing of equipment and methods for use by the Eastern National Forests." During the second year he was detailed to other forests "...to determine performance and applicability of radio communication on several National Forests and several installations each consisting of a few stations." By 1938, when Squibb was appointed Regional communication engineer, Region 7 had made little headway in radio development. By the time he resigned a year later, he had only completed studies of communication needs and the "installation on several National Forests of radio systems similar to but less elaborate than the system installed on the Cumberland Forest."[6]

This is not to say that Region 7 lacked communication facilities. The population density provided an adequate base for commercial telephone systems that could be tapped by feeder or trunk lines from lookouts to the nearest towns. In addition, with the limited elevations in the Northeast, vhf sets had a particular advantage over line-of-sight distances; the fewer obstructions meant that less 10-meter equipment was required for installation in 45- and 100-foot towers.

A great deal of Squibb's time in Region 7 was required to install these vhf sets. The isolation of the backwoods and its people was both an advantage and a disadvantage. On the positive side were the "cooperators" who, through a Forest Service telephone hookup, could serve as a valuable unpaid volunteer staff. In the remote backwoods areas of Kentucky, however, Squibb had to learn never to approach a cabin door at night without first announcing his presence at the gate. With "moonshiners and revenooers" in abundance, a load of unexpected buckshot was liable to greet a stranger.[7] Also on the negative side were a number of practices, including the burning of underbrush, that had gone on for generations before the Forest Service was established.

Rural Tennessee on the Cherokee National Forest had an unusually high incidence of small forest fires. When the alarm sounded, the entire town would show up and "work their butts off" to put out the fire. The Forest Service studied every possible cause for the rash of fires. In desperation, Region 8 sent in W. R. Murphy, a psychologist from Texas. After several months, he managed to get to know the townspeople and become friends with the local minister.

One Sunday, after blessing the town from the Forest Service lookout tower, the pastor revealed the source of the problem to Murphy. The Forest Service policy allowed residents to collect only "dead and down timber" for firewood, and the residents had taken it upon themselves to insure a continual supply of this necessary resource. After starting a small fire, they would turn out in numbers to chop down trees for a firebreak, and then return some weeks later to collect the burnt and cut timber. After the ruse was discovered, the Forest Service started identifying trees that could be harvested. "Like shutting off a switch, the fires stopped."[8]

Aside from his single-handed effort to bring radio to Region 7, Foy Squibb also made a concerted attempt to upgrade the performance of the vhf sets. In addition to improving the set itself, (his changes were not always agreeable to his former colleagues in Portland), he studied and experimented with various antenna configurations that would enhance vhf transmission and reception. He improved on a type J antenna then in amateur use by experimenting with quarter- and half-wave vertical, aluminum configurations. Utilizing galvanized iron water pipe for the mast, he also devised a supporting member to give the equipment structural integrity. Precariously perched on a plank protruding from the window of the 100-foot lookout towers, Squibb installed many of the units with C. Otis Jett, the Regional telephone engineer.[9]

Figure 91. Operator Howes with type S set on Jefferson National Forest, Va., 1937. (NA:95G-355028)

Radio also found limited application in the Southwestern Region (R-3) and the Southern Region (R-8). Their histories of mild, brief fires associated with certain species of pine limited the extension of radio. Gael Simson noted, "...fires are short-lived, and a first crew ordinarily is sufficient."[10] Region 3, therefore, was far behind the others in adapting radio for the fireline; Foresters there were just gathering to witness radio communication demonstrations in late 1937. But in Region 8, one of the many factors that could unexpectedly extend radio into the National Forests appeared in the person of Gaylord A. Knight.

The Southern Region

In August 1934, Harold Lawson made one of his many trips to install radio equipment. In Athens, Tenn., he set about hooking up an M set in the supervisor's office of the Cherokee National Forest. With the main installation complete, Lawson planned to run the antenna diagonally across the street to a church steeple. He approached a church elder for approval, and in conversation learned that the elder, who owned a hardware store, had a son who knew radio and might be able to help with the installation.[11]

Figure 92. District rangers at a meeting in Coronado National Forest, Ariz., waiting for test call from Tucson, March 1937. (NA:95G-344490)

The young man was Knight, a tall, good-natured individual whose humor and pleasing demeanor added a new dimension to the title of communications technician. He was an amateur radio buff (5AQR and 4AB) who had grown up with radio. After his father bought the second home radio in town, the younger Knight built the third set. This knowledge, experience, and interest led him to open a radio repair shop while still in grammar school, and later to take a 3-year college course in math, chemistry, and the physical sciences.[12]

When Lawson completed the installation on the Cherokee, he saw the need for someone to service and repair the system. He suggested Gaylord to the Forest Supervisor, and Knight was later employed as the technician for radio and telephone.

Gaylord Knight remained in Athens for 2 years. In 1936, he moved with the Forest Supervisor's office to Cleveland, Tenn., and took on additional, if unrecognized, communication duties as radio technician at-large for Region 8. By July 1941, the Regional Forester had come to recognize the importance of radio communication and offered Knight the official title of Regional Communications Officer. This entailed moving to Regional headquarters in Atlanta.[14] Although it meant a decrease in salary from $2,000 to $1,800 per year, he accepted the joint radio and telephone assignment with high expectations. He was disheartened, however, by spending 4 months in the new job behind a desk with no work to do. He finally demanded to be put to work, but by that time World War II abruptly halted his yet-undefined job.[15]

Figure 93. Gaylord Knight, right, Southern Region radio specialist, on assignment with personnel from Arkansas Department of Forestry. (Forest Service photo, History Section)

During his first 7 years, 1934 to 1941, in Region 8, Knight's personal convictions about radio's value significantly affected the coming of radio on the fireline. He had always felt that radio would replace the telephone. When he came to the Region, there were 7,000 miles of telephone line and 15 radios. When he retired nearly 40 years later, Region 8 had 4,000 radios and no telephone lines.[16]

Figure 94. Radio communication in Southern Region (R-8). Assistant Ranger R. M. Stratton, later a technician, receiving a message on the type S set, 1937. (NA:95G-367378)

In Region 10 (southeastern Alaska), the varied climate, geography, terrain, vegetation, and population made the need for radio communications and fire control considerably different from the needs of the lower nine Regions. Stretching along the ruggedly mountainous southeastern islands and coastline are its vast Chugach and Tongass National Forests where rainfall often exceeds 100 inches per year. Population between Ketchikan, Juneau, and Anchorage was sparse and roads and trails were few, and expanses of water vast--inlets, bays, fjords, and channels. The Rangers took to boats to patrol the endless miles of mountainous islands and coastline.

The telephone system was inadequate. Late in 1933, Gael Simson and Foy Squibb sailed to the Tongass to install type M sets in the Ranger stations and on the patrol boats. They proved unsatisfactory and led to the subsequent design and installation of the type B2 by Bill Claypool in 1934.[17] Region 10 had little other need for radio until the post-World War II period.

The Intermountain Region

The Intermountain Region (R-4), directed from Ogden, Utah, is a good example of how personal attitudes affected adoption of radio. Lack of adequate finances, a condition not unique to Region 4, meant that the opinions of the Rangers had considerable influence; very few could find a reason to replace the proven telephone lines with a new, unfamiliar device.

The task of administering the Region 4 telephone and radio communication program was assigned to Francis Woods. For 10 years since 1922, Woods had served on a Regional mapping crew. In that time, he developed the interest in radio and acquired the amateur radio license (W6NRN) that undoubtedly led to his appointment as communications officer. Until 1950, Woods would be the only radio technician for the National Forests in all Utah, Nevada, western Wyoming, and southern Idaho. "All you could do was get a piece of equipment going and run to another forest," Woods recalled.[18] Yet when Woods retired in 1958, conditions were not much improved. Even with four more technicians for five forests, he had 16 forests under his charge.

The popularity of over 5,000 miles of telephone line in Region 4 was the main reason for resistance to radio. With up to 12 lines serving some supervisors' offices, and a good rapport between the Region and the Mountain Bell Telephone System,[19] there was a solid nucleus for Regionwide telephone networks. It was folly for Woods to argue the advantages of a forest radio network based on a single frequency allocation. As Woods pointed out, "The supervisors had a legitimate gripe," and their insistence that radio parallel existing telephone lines was understandable.[20] Until radio proved it could outperform the telephone, many Rangers used the new tool only where the tried and proven alternative ran alongside it.

For Woods to build up a Regional radio inventory and demonstrate the application of radio, he needed freedom to pursue this goal single-handedly. He seldom had the time. One reason was his responsibility to improve the telephone. This included design of a 2-watt amplifier to boost transmissions over lines up to 100 miles long with 30 to 40 people "hanging" on the line, as well as an unsuccessful attempt to develop a mechanical device to break up speech so that several voices could be transmitted simultaneously over the same line. Even more time-consuming was a Regional campaign to lower all ground-return lines to a resistance of 40 ohms or less. It required considerably effort and much ingenuity to devise and locate ground rods where a value of resistance would provide the required impedance. In one instance when all else failed, Woods had the crew drive rods into the pit under an outhouse. He then rang the supervisor for a very successful test call. On hearing how the call was accomplished, the supervisor simply replied, "I've heard a lot of that on the line, but this is the first time I've talked to it."[21]

Another problem limiting the extension of radio in Region 4 was the inordinate amount of talk that became routine on the single-channel forest frequency. In an attempt to limit these conversations, Woods first went to the "Q" amateur designations, then devised a separate code when this did not solve the problem. But codes were not enough to stop those who had learned that talking into a microphone could command the time and attention of distant listeners. Resorting to a tape recorder, Woods monitored transmissions for playback as examples to violators of what not to do.[22]

Time went on, and a concerted effort was made to overcome the objections of Rangers to replace some high-maintenance telephone lines with radio. But opposition continued. Woods conceded that radio was never intended to replace telephone in Region 4, but Regional attitudes were not favorable to even a limited change. By the time commercial sets became available a few years after the end of World War II, the Intermountain Region had experimented with only two Laboratory-designed vhf-type T sets. When Woods retired in 1958, the Region was still using PF, SP, and SPF sets from 1935. Woods' observation that "in those days ...Region 4 didn't give very much money for communication,"[23] indicated that the Regional administrators didn't expect much from the radio development program. Their priorities on a limited budget were for programs with proven benefits.

Any gains for radio made in Region 4 during the first two decades of its existence were due to the patience of Francis Woods, as well as the time he sacrificed to teach a communications class at Utah State University. Many part-time summer employees and graduate foresters received a thorough introduction to the uses, operation, and advantages of radio on the fireline as part of their requirements for a forestry degree. As they returned to or went into the Forest Service, their familiarity with radio grew into support for the device. After World War II, when radio development entered its second phase, this attitude, along with the radio experience of many war veterans and a 1948 operating manual by Woods entitled *Radio Training Plan*,[24] would bring a decided shift in Region 4 attitudes towards the acceptance of radio. In the meantime, however, its communications continued to be based on the telephone.

The California Region

Region 5 took an early, positive view of radio. The San Francisco office authorized a number of higher powered commercial purchases for the high fire-risk Angeles National Forest. In late 1933, the Angeles established a 500-watt control station in Pasadena and several 100-watt portables and mobile stations elsewhere. This action, of course, worried Jack Horton in Portland, because he feared the practice would spread and create a demand for separate frequencies for every National Forest in the country. As he pointed out to Roy Headley, "There ain't that many frequencies available." [25] The Angeles continued the experiments, much to the consternation of Harold Lawson who picked up their transmissions during the 1932 St. Joe installation in Idaho.[26]

Figure 95. A 100-watt mobile set on the Angeles National Forest, Calif., August 1933. (NA:95G-282674)

The assignment of Region 5 radio supervision to the Fire Equipment Section tended to defuse the impact of the Angeles experiments. Fred Funke, head of the section, took steps to support the Radio Laboratory philosophy of low-power outputs. Although not technically versed in radio electronics fundamentals, Funke saw merit in this approach to fireline communication. He also attended all of the Portland communication conferences, where he often played the role of arbiter on the issue of output.[27]

As Lawson recalled, the Radio Laboratory had a "soft spot in its heart for Fred" because he would push to get orders through the San Francisco Regional office; he had reasoned that the Radio Laboratory with its limited facilities couldn't perfect hardware unless radios were purchased, thereby giving the Laboratory an opportunity to improve on its product. Lawson considered Fred Funke as "...our savior in R-5 because he would go down there and sell effectively a bill of goods sometimes."[28]

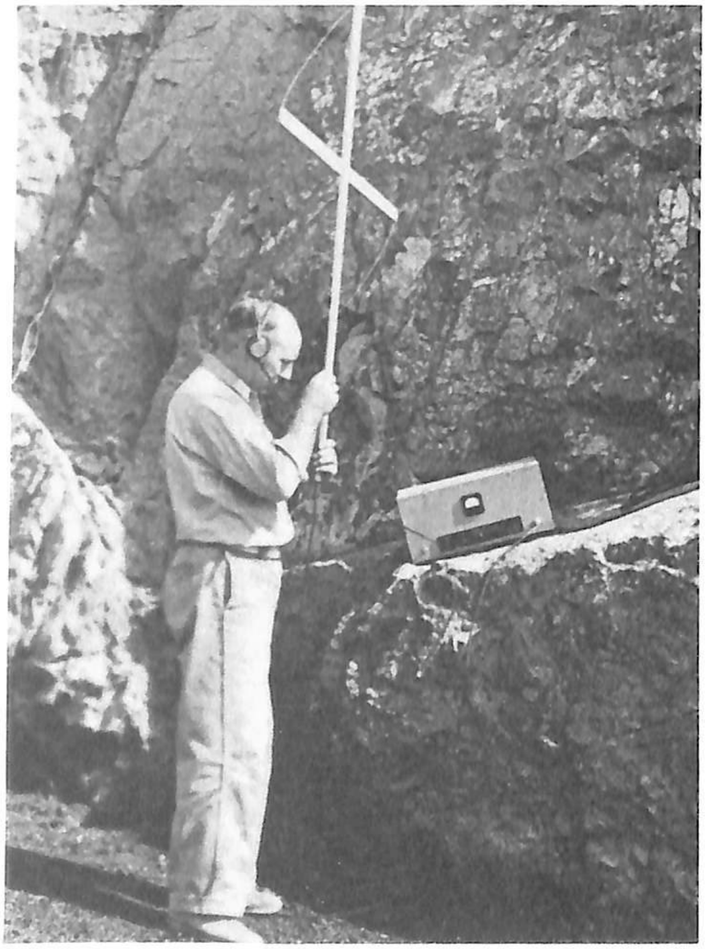


Figure 96. Making signal strength measurements in the field. Fred Funke, head of the fire equipment section in the California Region (R-5), (now the Pacific Southwest Region). (Forest Service photo, History Section)

Complete records of Regional radio purchases no longer exist.[29] However, Funke's support of the Laboratory was significant in 1936, when Fred Haynie, supply officer in Oakland, tabulated the spring purchases. Of the 272 sets scheduled for preliminary purchase, a very high proportion (110), 40 percent, were for Region 5.[30] If each Region had had a "savior," the total purchase would undoubtedly have been two or three times higher.

Funke also made a concerted effort to publicize the successful use of radio for the fireline. In a letter to the Regional Forester, he extolled the virtues of the radio network in the Plumas-Nelson Creek fire of August 17, 1934.

A combination of 10-meter and 100-meter sets had allowed Funke to try various installations and tests on the Plumas fire. The resulting fire network effectively demonstrated the manner in which all three classes of sets--portables, semiportables, and fixed-base--could be deployed. The final paragraph of Funke's memorandum is a classic example of the early use of radio as it evolved in most Regions under actual fireline conditions:

> Arriving at the Nelson Creek Fire early Monday morning with George James to assist in getting the outfits in use, we found that Mr. Curry had sent his crew in a few days earlier and that they had given the 'T' type sets an opportunity to demonstrate their usefulness to advantage. Arrangements [were] made to put in a net of PF and SP sets to connect the headquarters camp at Sloat with the various camps on the sectors, using an 'M' type set at Sloat. Coldwater, Jackson Place, Cottonwood Creek and Nelson Pt. were thus connected to Sloat and later

a PF set was placed on the line in Jamison Creek. As a supplement to this net a 'T' type set was placed on the slope of Jackson Pk. at a point where a large part of the fire area was visible, this type set, operating on about 9 1/2 meters requiring practical intervisibility between points being contacted, the frequency being used being on the order of an optical frequency. Using this 'T' set as an outlet for the fire line work to a 'T' set installed at Sloat headquarters camp, operators were sent out with the sector bosses with 'S' sets to instruct the men in charge of the sectors in the use of the equipment and to make necessary contacts with camp. Excellent results were secured in making rapid contacts with headquarters and report/ing/ conditions as well as receiv/ing/ instruction without the necessity of making long tedious trips to the nearest telephone. At one time seven 'S' type sets were in use on the line and I believe that Ranger Delaney can testify to the usefulness of the equipment, particularly on an inspection trip he made over the great part of the west line during which he was able to keep in touch with conditions on other parts of the fire throughout the greater part of the day. Breaks in the line were reported immediately and accurate locations given which expedited the work of control to a degree which has not been possible on past fires. 'T' sets were used at various lookout points on the fire area and changing conditions reported immediately.[31]

Earl Loveridge disseminated this example throughout the Forest Service because it "...presented the first extensive use of radio equipment on an R-5 /on-/ going fire and since radio made a real contribution to the control operation on this fire, it seems worth while to record some of the facts governing its use."[32]

The 110 sets purchased by Funke in 1936 were intended for crews that would be used as "first attack suppression crews."[33] This concept was approved by Roy Headley, and the authorization for purchase was made in June, some 2 months after Funke placed the order.[34] The sets greatly expanded California's nucleus of 11 SP sets, 10 PF sets, 27 S sets, and 60 T sets, indicating that Funke's support of radio went beyond personal considerations for the Radio Laboratory. Experience on the fireline had reinforced his favorable attitude.

In Regions 4, 7, and 8, only one technician or communications officer was initially hired to oversee each Regional radio and telephone program. In Region 5, however, Fred Funke started early to obtain technical personnel for communications planning and maintenance on each National Forest. Ray Richards on the Los Padres was the first, followed in 1936 by Guy V. Wood on the Sequoia.

Wood's appointment represented his return to his primary interest. Wood had gotten a ham license (W6ANS) a year before high school graduation and attended Pacific Radio School for 3 years. He then opened a radio manufacturing business in Porterville, where he manufactured broadcast and police radios until the Depression brought an end to the business. Wood was employed as a Porterville bank clerk when offered the Forest Service position.[35]

Guy Wood remembers that, in spite of Funke's efforts, Region 5 "had very little equipment in 1936." The equipment on the Sequoia consisted of some SP sets, a few S and TH-TL sets, and one type M. When Wood was appointed the first full-time Region 5 communications officer in 1945, his recollections indicate that the attitude towards radio was still negative. "We had to do a selling job," he recalled, and he met much the same resistance as Francis Woods in Region 4. With money short ("Boy it was hard to come by dollars"), and resistance high ("The oldtime Rangers were not too receptive"), much of Wood's time both in the field and Regional office was directed towards promoting radio. "Every job I went out on," he reported, "I had to demonstrate and convince."[36] Woods work was cut out for him.

Region 5 relations with the telephone company in California were good. Pacific Telephone and Telegraph Co. did not approve of the Region's use of the 100-meter band for point-to-point communication, but did not press the issue because the Region lacked clear channels in the 3-MHz range. In addition, the Navy shared frequencies in that spectrum, so interference was too much for 24-hour use. Then, too, the Region lacked enough sets for routine point-to-point communication. Networks were set up on an "as-needed basis," using a nucleus of sets installed at locations strategic to existing telephone lines.[37]

Much of the knowledge needed to effectively deploy radio communications on large fires in Region 5 had to be acquired through trial and error. Guy Wood had been on the Sequoia only a week when he was told to join a crew traveling to a fire. Expecting nothing unusual, he threw some radios in the back of the truck. At the fireline, he distributed radios to the fire bosses and rushed back to camp to install a base station. Much to his embarrassment, he learned that this was not the way to set up communications. Without establishment of an operating base station, there was no way to check out the field sets for proper operation or location. The fire bosses, preoccupied with the safety of their men and containment of the fire along their sections of the fireline, were loath to waste time making contacts with an unestablished base camp.

Wood had to make several trips between the base camp and the fast-moving fire bosses to insure that the network was operating properly. He learned that communications personnel should expect the very worst of conditions. Without anyone to forewarn him and expecting to be gone only a day or so, he had left Porterville without a thought to his own personal needs. He had not packed a change of clothing or his personal effects. Three weeks later he returned from the fireline a tired and disheveled but wiser man.[38]

Figure 97. Message center at night on the Barley Flats fire, Angeles National Forest, southern California, December 1936. Shown is the TH/TL set with separate circuits on the 10-meter band for reception and transmission, described in chapter 7. See figure 72. (NA:95G-341687)

Figure 98. One of several mobile radio units used for fire control in the Angeles National Forest, Calif., October 1938. (NA:95G-374663)

The Pacific Northwest Region

The North Pacific (now Pacific Northwest) Region had a noticeable advantage over the other Regions because of its decided radio interest, due primarily to Jack Horton, and its proximity to the Radio Laboratory. The Laboratory tested new designs and modifications on Region 6 forests, and staffers were readily available for consultation on the Region's specific communication problems. They could also be borrowed for special tasks and influenced in the choice of Laboratory projects. Nevertheless, the early use of radio in Region 6 was not spectacular. According to Bill Claypool, this was because Oregon and Washington "had a helluva lot of telephone lines."[39]

Since the settlement of the Willamette Valley in the mid-1800's, population had grown enough to justify private telephone service between many towns and cities. The Regional budget, as usual, was tight. Many Rangers favored the telephone. Thus, the telephone remained the mainstay of Region 6 communications into the 1950's.[40]

Almost immediately after the Radio Laboratory moved to Portland, Foy Squibb was detailed to install sets and instruct personnel in Region 6. During the summer of 1932, he traveled between the Radio Laboratory and the Chelan, Umpqua, and Siskiyou National Forests on training assignments that included the repair and maintenance of sets.[41] Between June 1933 and June 1935, he prepared communication plans and supervised the installation of Region 6 radio equipment on several National Forests, including the Olympic and Siskiyou.[42]

Early radio correspondence indicates that Region's acceptance of radio was accompanied with high expectations and considerable planning. "As money becomes available," R. H. Brundage wrote to the Chief in 1934, "radio will be extended, starting with those Forests having considerable areas of rough inaccessible country where the fire problem is acute."[43] Brundage believed this application was appropriate in view of both Squibb's success in training men in the proper use of radio and successful use of radio on the Tillamook burn of 1933. Squibb had made the installation there and supervised six or seven fire camps that helped the fire crews suppress the blaze. As a result, Brundage concluded, "...the general consensus in R-6 is that radio is paying its way."[44]

Bill Claypool was appointed communications officer in Region 6 after his trip to Puerto Rico and a brief stint with the Bonneville Power Administration. He took up where Squibb left off.[45] In the remaining few years before World War II, Claypool worked "very close" with the Radio Laboratory in an attempt to overcome technical problems, the opinions of Rangers who preferred telephone, and inadequate funding. "We did not have radio networks," Claypool remembered. "We used radio strictly for fire control with occasional use of uhf [vhf] for point-to-point communication."[46] It might also be worthwhile to note that this "occasional use" extended to other applications. As table 2 shows, R-6 had 375 radios in 1939, and hf sets outnumbered vhf sets in Region 6 by four to one.

Table 2.--Forest radio inventory, Region 6, September 23, 1939[47]

National Forest	Type: hf					Type: vhf			Totals	
	M	I	SPF	PF	SP	SV	T	S	hf	vhf
Chelan	2	1	20	12	15	-	-	-	50	-
Columbia	-	1	10	9	-	-	-	-	20	-
Colville	1	-	3	2	-	1	6	-	6	7
Deschutes	-	-	-	2	-	-	-	-	2	-
Fremont	-	-	4	1	-	-	-	-	5	-
Malheur	-	-	-	-	-	3	6	10	-	19
Mt. Hood	1	-	2	1	1	2	-	2	5	4
Mt. Baker	-	-	11	8	-	-	-	-	19	-
Ochoco	-	-	5	-	-	3	2	8	5	13
Olympic	2	-	-	35	4	-	-	-	41	-
Rogue River	-	-	1	2	1	2	-	-	4	2
Siuslaw	1	-	8	-	-	-	-	-	9	-
Siskiyou	3	-	14	23	1	3	1	9	41	13
Snoqualmie	2	-	7	-	5	2	4	-	14	6
Umpqua	1	1	15	9	2	-	-	2	28	2
Umatilla	-	1	5	11	1	-	1	-	18	1
Wallowa	-	-	3	3	-	3	-	-	6	3
Willamette	-	-	3	6	-	-	-	-	9	-
Whitman	-	-	2	-	-	2	1	1	2	4
Wenatchee	1	-	15	-	1	-	-	-	17	-
Totals	14	4	128	124	31	21	21	32	301	74

The table shows the impact of Forest Supervisors and Forest Rangers on radio use in their areas.

Figure 99. Sending weather report to base camp. Type SPF set in use on the Spud Hill fire, Columbia (now Gifford Pinchot) National Forest, Wash., August 1937. (NA:95G-350530)

In southwestern Oregon, the crews in the coastal mountains of the Siskiyou bordering on Region 5 had 54 radios. The Deschutes, in central Oregon on the eastern slope of the Cascade Range, had only 2.

In eastern Oregon, the Umatilla had 18 hf sets and 1 vhf set, while its neighbor, the Malheur had the opposite condition, no hf and 19 vhf.

The Colville in northeastern Washington had 7 fixed-base units compared to 3 semiportables and 3 portables. This suggests a forest administrative network similar to adjoining Region 1. Indeed, the Colville was part of Region 1 from 1943 to 1974. By contrast, the Mt. Baker in northwestern Washington had no fixed-base units, 11 semiportables, and 8 portables. This suggests a fire control network.

The diversity of National Forest radio systems in Region 6 may be partly attributable to how well other systems met communication needs; a well-developed telephone network out of Bend, Ore., for example, may explain why the Deschutes had only two radios. It could also be argued, although less convincingly, that Mt. Baker had no fixed-base units because of the telephone. The data, however, suggest other reasons for the variations. A total lack of hf radios (Malheur), virtually no fire network (Colville), an emphasis on hf (Umatilla) or vhf (Malheur), and the differences in inventory (Siskiyou, Deschutes)--all tend to support the thesis offered by the Laboratory that personal opinion, not technology, was responsible. This state of affairs was exacerbated by the decentralization policy of the

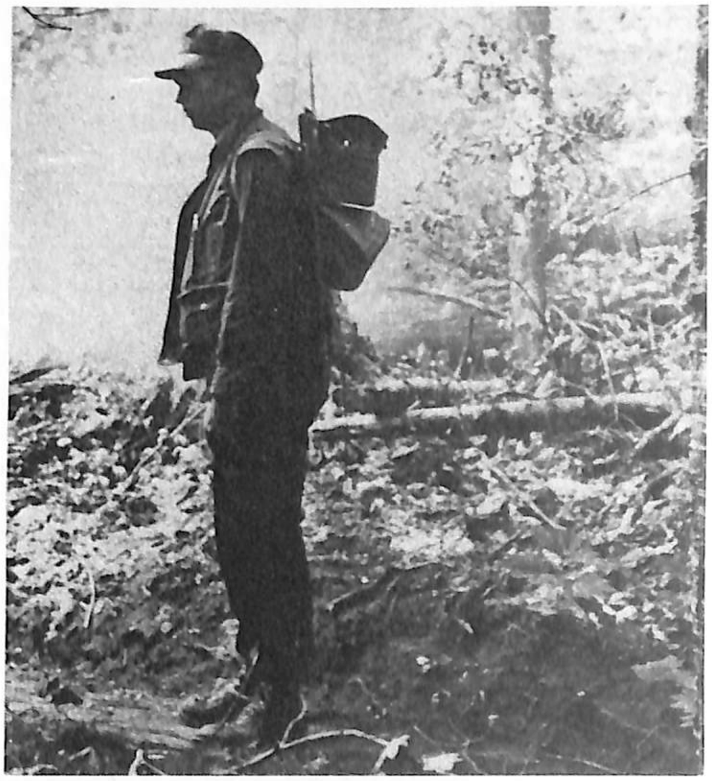


Figure 100. Fire scout George Clisby with portable radio on the Willard fire, Columbia (now Gifford Pinchot) National Forest, Wash., August 1939. (NA:95G-391287)

National Forest System. In the absence of a Servicewide policy from Washington, each Region allowed its Supervisors and Rangers to determine what, if any, use would be made of this new tool. The Radio Laboratory continually pressed the Washington Office for a Servicewide policy that would, at least, allow them to evaluate their own accomplishments and goals. Washington's hesitation continually frustrated the Laboratory.

Sent to inspect the Northern Region communication system in 1940, Harold Lawson pointed out the folly of an inspection based upon the absence of standards. Except for implied regulations and limitations, there was no authority for passing judgment on any system. After completing the inspection, and finding a number of radio communication practices in contradiction to the recommendations of the Laboratory and the experience of Region 6, the futility of the exercise, and a decade of frustration, made its way into Lawson's final report. "They can't all be right," he observed in disgust.[48] The decisions for the most part reflected the varied opinions of the men in the field and were based on everything from economics to personal prejudice. This decentralized approach carried the potential for conflict should the ideas and plans of an enterprising Region come into conflict with those of the Radio Laboratory, IRAC regulations, or the A. T. & T. lease agreement. In Region 1 out of Missoula, this possibility became a reality almost immediately.

Reference Notes

1. Herbert Kaufman, *The Forest Ranger: A Study in Administrative Behavior* (Baltimore: Johns Hopkins University Press, 1960), p. 67.

2. Region 7 has since (1966) been divided between Regions 8 and 9. Until 1930 Regions were called Districts, rather than Regions.

3. Evan W. Kelley to Earl W. Loveridge, 19 July 1935, Gaylord A. Knight Collection.

4. Kaufman, *Forest Ranger*, pp. 62-65.

5. Harold K. Lawson, interview with the author in King City, Ore., May 1978.

6. W. Foy Squibb, "Application for Federal Employment, Fort 8, Part 16(c)," *ca*. 1940, photocopy provided to author by W. F. Squibb, Gaylord A. Knight Collection.

7. W. Foy Squibb, interview with the author in Ramona, Calif., January 1978.

8. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, and April 1979.

9. W. F. Squibb, "Memorandum for Forest Supervisor--Antenna Test," 6 August 1935; W. F. Squibb, "Memorandum for Regional Forester--Design of a High Frequency Antenna for Permanent Installation on Lookout Towers," 3 September 1936, and Squibb, "Field Diary," 1935, all Gaylord A. Knight Collection; and Squibb, interview with author. C. Otis Jett of Region 7 Engineering completed the mechanical design for Squibb; see Squibb, interview with author.

10. A. G. Simson, "Role of Radio in National Forest Communication," 11 April 1936, typed, Gaylord A. Knight Collection.

11. Lawson, interview with author.

12. Knight, interview with author. Knight attempted without success to locate a university which offered radio engineering, note 29, chapter 5.

13. Lawson, interview with author.

14. P. M. Prater to Forest Supervisor, District Supervisor, Station Director and Division Chief, Region 8, 11 July 1941, Gaylord A. Knight Collection.

15. Knight, interview with author.

16. Knight, interview with author, and Donald Sanders, interview with the author in Beltsville, Md., April 1979.

17. Squibb, "Diary," 6 November 1933-4 December 1933 and Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

18. Francis Woods, interview with the author in Ogden, Utah, January 1978.

19. Region 4 telephone systems were based upon the transposition schemes of Western Union, rather than A. T. & T. Woods believed that the Regional Office often hired Mountain Bell employees to install particular systems and to wire up a number of Regionally designed telephone switchboards. Woods, interview with author.

20. Woods, interview with author.

21. Woods, interview with author.

22. Woods, interview with author.

23. Woods, interview with author.

24. Francis W. Woods, *Radio Training Plan: Installation and Operation* (Ogden, Utah: U.S. Department of Agriculture, Forest Service, Region 4, 1948). The pamphlet was written for the SPF model.

25. F. V. Horton to Roy Headley, 26 January 1934, Gaylord A. Knight Collection.

26. Lawson, interview with author.

27. Guy V. Wood, interview with the author in Porterville, Calif., January 1978.

28. Lawson, interview with author. Guy Wood also pointed out that Robert Deering of the Division of Operation in the Regional Office also took an active interest in the funding of radio. Wood, interview with author.

29. When the Laboratory was moved in 1952, many of the records were destroyed. The few which remained were either copies which had been distributed or a few significant ones rescued from destruction.

30. Frank Haynie to Regional Forester, Portland, 6 April 1936, Gaylord A. Knight Collection. The final count of 1936 purchases was tabulated at 466 units for a total of 1,123 units in the Regions. See C. J. Buck to Chief /Forester/, 15 September 1936, Gaylord A. Knight Collection.

31. E. W. Loveridge, "Memorandum for Regional Foresters--All Regions," 16 October 1934, p. 2, Gaylord A. Knight Collection.

32. Loveridge, "Memorandum."

33. C. B. Morse to the Chief /Forester/, 15 May 1936, Gaylord A. Knight Collection.

34. Morse to Chief. Approval was written in the margins and initialed. Headley's comment was "sound and important."

35. Wood, interview with author. Date of employment was May 18, 1936.

36. Wood, interview with author.

37. Wood, interview with author.

38. Wood, interview with author.

39. Wilbur Claypool, interview with author in San Antonio, Tex., July 1978.

40. Claypool, interview with author.

41. Squibb, "Application for Federal Employment," and Squibb, "Diary" 23 June to 29 September 1933, Gaylord A. Knight Collection. McCabe says the cost on the Chelan was $5,000 and that the Olympic planned to invest $8,000. See Francis R. McCabe, "The Use of Radio in Forestry," (Senior thesis, School of Forestry, Oregon State Agricultural College, 25 April 1934), p. 29.

42. Squibb, "Application for Federal Employment."

43. F. H. Brundage to the Forester, 26 January 1934, Gaylord A. Knight Collection.

44. Brundage to the Forester.

45. Civil Service appointments to electronics positions in the Forest Service were at a premium during the Depression. Claypool had gone to Bonneville as a means of getting Civil Service status. When this was accomplished he transferred back to the Forest Service. Claypool, interview with author.

46. Claypool, interview with author.

47. Condensed from W. S. Claypool, "Memorandum for Mr. Mays," 23 September 1939, Gaylord A. Knight Collection.

48. See chapter 11, citations 44 to 47, for further discussion on this inspection.

Chapter X

A Dissenting Opinion:

Communication Plans and Practices in Region I

In a brand new thing like that we were bound to have divergent opinions.

- William B. Apgar[1]

On July 2, 1932, Frank Jefferson, the Northern Region's (R-1) Forest Fire Control Chief, wrote William "Bill" Apgar at Savenac Nursery in Haugen, Mont., to confirm an earlier discussion. Jefferson outlined a plan whereby Apgar and a man of his choice would be made available by Assistant Regional Forester Elers Koch for up to 5 days of firefighting. With each carrying two of the first type P and SP sets, they were to serve as a communication strike force for any fire in the Region. "The experiment that I have in mind," Jefferson wrote, "is that of using radio for the sole means of communication on fires remote from telephone and the general plan which I have in mind is that on call, you, with an assistant, will immediately proceed to the designated fire, install one radio set at the nearest telephone communication point, take the second set into the fire and establish communication between the two sets."[2]

This early selection of Bill Apgar to head the experiment indicates that the Missoula office was giving serious thought to the application of radio. Apgar was a 14-year veteran of the Service serving as the Assistant Forester at Savenac. He had earned a master's degree from the Yale School of Forestry where he wrote his thesis on grazing, then became interested in radio, and got amateur license W7CRU. He had become aware of a need for more effective communications after an early experience in R-1 with the heliograph when he was a fire guard at the Castle Butte lookout station on the Lochsa Ranger District, Clearwater National Forest, northern Idaho.[3]

Described as a "nice guy" by his superiors and coworkers, Apgar had a penchant for perfection, and he pursued his new assignment with alacrity and force.[4] He was never one to shun responsibilities or yield to adversity. He adopted a demeanor that reflected this attitude as well as his belief that Region 1 was a tough place to work and it took tough men to meet the challenge. He always went into the field with a Colt revolver strapped to his hip, although he was never forced to use it. During his 20-year tenure as the Regional Communications Officer he said he never thought of himself as a "communication man," but as "a Ranger who used electronic communication to get a job done."[5]

Figure 101. Loading radio supplies aboard Ford trimotor airplane of Johnson Flying Service, longtime contractor for the Forest Service, at Missoula, Mont., in the 1930's. William Apgar, Region 1 radio chief, stands near plane. (Forest Service photo, History Section)

Apgar's efforts during the 1932 radio experiments were hampered because the semiportable SP sets were not yet completed by the manufacturer.

Jefferson suggested that Apgar "...try to contact Calder /Idaho/ with the portable sets and get what you can out of that phase of the experiment."[6] At Calder, Harold Lawson was completing installation on the St. Joe Forest when Apgar wrote asking him to maintain a daily radio schedule. "We will begin calling on the hour, calling for five minutes and listening for five minutes, for a period of half an hour," he wrote. Apgar then added, "We have also logged the /Calder/ portable sets with our portable sets so I see no reason why we cannot get through."[7]

After this limited experiment, Apgar began to prepare for the 1933 fire season with a flourish. He got authorization for the purchase of 47 additional sets, including 2 M sets, 2 SSP sets, 24 SP sets, and 18 PF sets. He did not get any additional P sets.[8] In a myriad of

Figure 102. Field demonstration of the Radio Laboratory's SP (semiportable) radio by Richard Ogg of Region 1 mobile radio unit (Station W7AOD), at a temporary lookout station, ca. 1933. Ogg is using alidade (fire locator) attached to tree. Note binoculars on equipment kitbox, which was used to carry the SP set, antenna, and heavy-duty batteries required for semipermanent locations. (Forest Service photo, History Section)

fire season experiments primarily conducted between planting camps and the nursery, Apgar was able to tally 6,792 separate communication contacts. After subjecting the call logs to careful scrutiny, he concluded that this number represented a successful completion rate of 96.5 percent.[9]

Not content to drop the experiment after the fire season, Apgar established a winter radio network, or point-to-point contact, among the Clearwater, St. Joe, Lolo, and Flathead National Forests, the Savenac Nursery, and the Priest River Experiment Station. "...It seems safe to say," he concluded after this latter phase of the experiment, "that the sets have more than paid for their use in the decrease of long distance telephone charges."[10] Venturing one step further, Apgar ruminated on the "future use" of radio in Region 1 and concluded that "the installation of appropriate sets for the Forest necessitates a Forest as well as a Regional radio development plan."[11] One year later, he took a major step in this direction with the installation of an M set in Missoula for the "administrative use of radio." "Daily schedules with sets all over the Region" were reported.[12]

Another interesting conclusion drawn by Apgar from his 1933 experiments was that the SP and PF sets were unsatisfactory for Region 1. "Services other than for lookouts," he informed the Laboratory, "frequently reach from 50 to 100 miles and it is here that we notice the lack of power to consistently enable two-way communications." Expanding on this thought, he stated that "our aim" over these distances is a 95 percent reliable transmission rate. The SP and PF could not achieve this performance. Because these sets were designed to operate out to distances of only "10 to 25 miles" Apgar rated their performance a "failure" at the longer distances.[13]

Conflict with Radio Laboratory Started Early

The significance of these experiments and findings should not be overlooked. By this early date, the evidence seems conclusive that Region 1 had seen a use for radio in serious conflict with a number of current situations, namely, the Laboratory's philosophy of low-power portability, Washington Office agreements with A. T. & T. and IRAC regulations. The Region's establishment of interforest networks for point-to-point contact, the emphasis on fixed-base stations, and the redefinition of semiportable radio all support this contention.

In retrospect, it is not clear whether Major Evan Kelley, the Regional Forester, and his staff influenced Apgar to take this stand, whether Apgar persuaded them, or whether impetus came from both directions. It is possible, for instance, to reflect on Jefferson's 1933 memorandum to Apgar and conclude that the Regional office planned to use radio only as a relay from the fireline to the nearest telephone line and then to the Regional office. If this were so, the administrative staff in Region 1 probably intended to use radio only for network hookups. It will also be recalled that, coincidentally, Harold Lawson was making the first field installation in the National Forest System over on the St. Joe National Forest in Region 1. Why then, it might be asked, didn't the Missoula administrative staff duplicate this system elsewhere in the Region?

In all fairness, it should be pointed out that some former Region 1 employees believe that population was too sparse and field personnel too widely dispersed in the northern Rockies in the 1930's for the Lab's system to be possible. Communication distances of 50 to 100 miles were indeed common. With wilderness and vast uninhabited spaces the rule rather than the exception, it was not realistic to expect a smokechaser to be within 15 to 20 miles of another radio set all or even most of the time. As long as production of the Radio Laboratory sets fell short of this need, Apgar would have to devise a scheme for men in the interior to get their messages out. Probably a system employing high-powered, fixed-base units at Ranger stations and high-powered, semiportable sets for men on horseback with pack string would have served this purpose. (See William Morton's comments in chapter 15.)

The proponents of low power, however, are quick to point out how hastily a Regional network was set up between the various forest headquarters in Region 1 and the Missoula office. Given the regulations dictated by IRAC and the A. T. & T. leases, the network concept transcended the bounds of prudence, if not legality. Furthermore, the low-power proponents contend, the entire Region was not wilderness. Forests such as the St. Joe could have been readily adapted to low power. Because this strategy was rejected out of hand by Apgar, the implication is that other motives were responsible for Region 1 opposition. Low power advocates also point out that this attitude led the Region to reject such valuable new technology as vhf. Once the Regions's 3-MHz network was established, the justification for retaining it would have to be that the lightweight portables could not fit into the network scheme, and that vhf had no use because it could not be used with the established hf network.[14]

There is evidence that Region 1 and the Radio Laboratory had undertaken a joint effort in early 1934 to design the most practical communication plans for the St. Joe National Forest. After Lawson's installations were complete, Frank Jefferson wrote the Laboratory on January 9 to ask about the possibility of adding vhf to St. Joe. Lawson replied with a two-page recommendation and a map outlining a proposed hf/vhf network.[15] The recommendations focused on vhf use between selected primary lookouts and the St. Joe headquarters in St. Maries. Supplementing this network would be a fire network of hf sets. Lawson envisioned type PF sets (100 meters) used for portable fire applications in conjunction with SSP sets (100 meters) in the lookout towers. Communications between St. Maries and the lookouts could then take place on the vhf frequency (10 meters) without interfering with the portable radio fire channel.

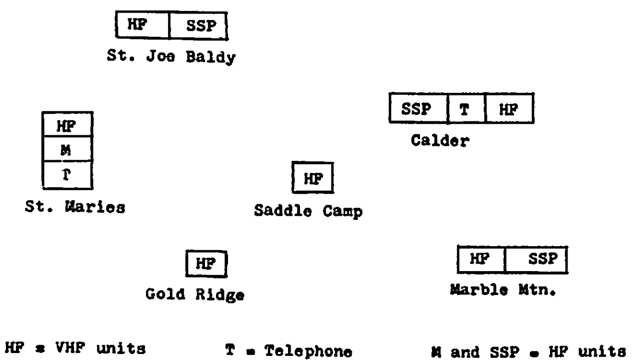


Figure 103. Harold Lawson's pioneering vhf/hf network plan for the St. Joe National Forest, Idaho, 1932. (Forest Service photo, History Section)

Bill Apgar did not implement Lawson's suggestions even though he thought that 10-meter vhf sets on some lookouts would "help in relieving traffic."[16] Two years later, while professing to believe there was still a "distinct use for ultra-high frequency (vhf)," he still was not prepared to say how important this use would be because vhf was "still in the experimental stage."[17] Seven years later, after the Laboratory development of the vhf types S, T, U, SV, T/D, SX, KU, and the introduction of the RRS automatic relays, it was evident that Apgar's motives were not founded on technical considerations. He thought vhf was of "no practical use" in Region 1, and he prevented its adoption.[18] All elements of the Regional network system had to conform to the 3-MHz frequencies for administrative, long-distance communication.

The significance or even recognition of the potential collision course between the Radio Laboratory and the Missoula office was some time in developing. At first, this was mainly due to total confusion over the apparent lack of acceptance of radio as a Servicewide tool and the low expectations of the Washington Office. In January 1934 Earl Loveridge wrote to Assistant Chief Roy Headley, "I wonder if we should not face the fact that our radio sets are not rated as having much value, outside of Region 6?"[19] He could not escape the conclusion that he might have been oversold on the idea, even though he had "...the greatest confidence in the ability in radio matters of Simson and Horton."

Loveridge reviewed the information he had received on Regions 1, 4, and 5--considered most likely to benefit from radio--and was discouraged by what he found. His respect for Simson's and Horton's opinions, "together with their bubbling enthusiasm and confidence, and their ability to describe or suggest glowingly the progress being made in forest radio development," he continued, "has kept me from realizing that the other Regions are not only non-enthusiastic but actually cold toward the idea of using the sets that have so far been developed."[20] The following were among the points he made:

> Region 1 (Missoula)--Radio was used only under the direct sponsorship of Simson or Lawson. If they were not present "...there is practically no use of radio ... or any appreciable talk about using it on project fires, etc." [This appears to be an inaccurate appraisal of R-1's actual use of radio.]
>
> Region 4 (Ogden)--According to Francis Woods the men had no success with the few sets they had. "This is not a typical attitude in Four to worthwhile innovations."
>
> Region 5 (San Francisco)--For the Region as a whole, including the attitude of the Regional Officers, little thought or consideration is evident as to the possible use of the Beatty-Simson sets."[21]

Loveridge recommended to Headley that an impartial board be established to look into the problem. To insure unbiased results, he suggested that the Board take the sets into the field, turn them over to the appropriate personnel, and then observe the results. "If, instead, Simson or Horton are allowed to manipulate the radios for the Board and Lorelei them with convincing talks and demonstrations, rather than tackling the problems exactly as the ordinary recipient of the sets has to tackle them, the investigation will be of little value."[22]

Roy Headley did not follow these suggestions to the letter. Instead he responded in line with the established decentralized policy that allowed each Region to determine its own radio applications. In a letter to all Regional Foresters on January 9, 1934, he made it clear that each Region had Washington Office approval to utilize radio as a communication device. But his major concern was undoubtedly based on his memory of his experience with Ring Bell Adams in the early 1920's, and he feared that money might be spent unwisely. Including an edited draft of Loveridge's memorandum with his letter, Headley posed the following questions to the Regional Foresters:

> What about the enclosed memorandum by Loveridge?
>
> We spent quite a lot of money on the gambling proposition that we could develop practicable radio equipment for our work. We succeeded far beyond our most sanguine expectations--or we thought we did. But the equipment is accepted and put to use practically only in the Region in which it originated.
>
> It is time to find out what is the matter. Have we been all wrong in thinking we have developed a valuable and practical new tool? Is it lack of money that stops it from being introduced? Are we merely up against another case of the "inertia of even informed minds?" Have we handled the research end of it well only to fall down some now in organizing the application of the results of the study? Or what is the matter?
>
> Do not misunderstand me. I am no longhair advocate of radio as a solution of all fire problems. I know it has distinct limitations. But if it is a real tool, I see no reason why we should not use it

> in its proper field more promptly than we seem to be.
>
> Whatever we do, let's don't drift and stall. Let's not again take 10 years to learn a new tool that should be learned in 3. And if the tool is no good let's find out and act accordingly.[23]

Nine days before the answer date, Lewis Stockdale, Assistant Regional Forester for Operation in Region 1, sent a four-page reply to Headley. The tenor of the response was decidedly defensive:

> It is somewhat of a jolt to learn of the low opinion in which Region One's volume of radio use is held in your office. We had thought (just among ourselves) that we were making nice progress in extending the use of this new tool. Perhaps we are wrong in this assumption, or perhaps we just have not made noise enough about the use that we are making of radio.[24]

Proceeding to make some "noise" on the subject, Stockdale outlined the 2-year history of radio in Region 1, pointing out that the Region now had 59 sets. During the previous season, the Region had relied on radio on the Coeur d'Alene National Forest in Idaho for practically all communications in one Ranger District and about half in another Ranger District. In addition, radio was used in tree planting camps; for regular service between Savenac, Priest River, and Missoula; between the Ranger stations on the Clearwater National Forest, also in Idaho, and for point-to-point communication.

Stockdale conceded that the Region could have accomplished more. However, he reported, the consensus of the Regional Office was to "make haste slowly" during the initial phase of radio development. In the opinion of those in charge, there were three "sound" reasons for this approach. First, because staff had to familiarize themselves with application possibilities, they had limited purchases to a "reasonable number of sets" for test purposes. Secondly, they recognized that they would have to "sell the idea" and thought it "unwise" to attempt to "high pressure" radio use. Finally, there was a "lack of assurance as to permanency of current radio development."

Elaborating on the last point, Stockdale thought they had acted in a "canny" manner by delaying further purchases until the "bugs" were out of radio and it had a chance to "shake itself down." After pointing out the obsolescence of the P set, the development of the M, and the "promise" of vhf, he also noted that "...it has not been possible to plan intelligently for radio distribution and use, /because/ the service deemed impossible today becomes a possibility tomorrow, and a certainty by the following morning." Stockdale assured Headley that the Missoula office was "...much better prepared now to proceed with such planning than we were two years ago, and you may be assured that in this planning radio will be given a fair chance to compete for the furnishings of communication service."[25]

Apgar Put in Charge of Radio

In support of this commitment, Stockdale notified Elers Koch that Apgar would be put in charge of radio and telephone work in the Region.[26] In a letter to Apgar one month later, Jefferson outlined the duties of the new position. Many of the points made in Stockdale's memorandum to Headley were repeated, but there are several significant contradictions between the memorandum sent to Washington and what the Region really had in mind.

"Your immediate job," Jefferson wrote to Apgar, "...is to get into effective use the radio sets which are now in the Region..."[27] Until that was accomplished, Apgar was to be very careful in proceeding further with investment in radio. Cautioned Jefferson, "We have a relatively large number of sets /59/ in the Region now and until we have placed these to the very best advantage we should refrain from further investment." But the most surprising comment was that "we do not consider radio (at present) as being a practicable tool for a fireman to carry with him into the woods;..."[28]

Even before his appointment to the new post, Apgar received a folder of correspondence from each Forest Supervisor. In apparent response to a Regional query, each had summarized his communication equipment and experiences. The response to radio in general was favorable overall, but a number indicated problems with low power, crowding on the single frequency, and the appearance of '...more *absolutely useless* and *time-consuming guff* on the radio than is ever heard on a party telephone line."[29] For every criticism against portable use, however, there was corresponding praise for PF operation.

After convincing the Regional Office that more sets were necessary for the 1934 fire season, Bill Apgar drew up new communication plans for seven National Forests. It is apparent from these plans, the records of 1933, and the 1935 purchases, that he carried out the Regional command to ignore portable radio "for firemen to carry into the woods." Table 3 shows the preponderance of fixed-base M sets and higher-wattage, semi-portable SSP sets that provided the majority of early communication in Region 1.

Gael Simson and Harold Lawson at the Radio Laboratory, Jack Horton in Region 6, Earl Loveridge as Chief of Operation, and Roy Headley as Assistant Chief Forester in the Washington Office would all eventually provide formidable opposition to the Region 1 emphasis upon higher power and point-to-point communication. They held that the telephone was to be used for matters relating to general administration; radio was to be reserved for the primary use of men in the field. Their concepts differed vastly from those in the Missoula office. One group planned from the bottom up, the other from the top down.

Table 3.--Active radio sets, Region 1, 1933-1935

	Class					
	Fixed Base	Semiportable		Portable		Experimental
Year	M-20W	SSP-5W	SP-1W	PF-3½W*	P-1¼W	vhf-2W
	(Number of Active Sets)					
1933[30]	3	2	29	18	7	-
1934[31]	21	39	23	17	-	2
1935[32]	42	118	23	17	-	10

* The existence of a 3 1/2-watt PF set is questionable. (See appendix I.) There was some discussion of increasing the power of the PF. However, no records indicate that this occurred to any measurable extent.

Major Points of Contention

There were four major points of contention: (1) the adequacy of low-cost lightweight, low-power sets vs. heavy, high-power sets; (2) the financial waste of duplicating existing telephone equipment and service with radio; (3) the hazard of and the potentially lasting penalties for violating both Federal frequency assignments and the agreement with A. T. & T. (Bell Telephone Co.); and (4) the high equipment cost of establishing high-power Regional radio networks for broad administrative functions.

Region 1's Apgar Radio Network Plan held that lightweight sets could not fulfill the unique needs of the Region; Bill Apgar would have preferred "portable" sets like the 5-watt SSP[33] even though this would represent almost a two-fold increase in weight that would definitely take these units out of the lightweight class.[34] He did not see this redefinition of portability as a problem; he thought of communications from the opposite end of the spectrum. With a central, high-powered station at Missoula, plus M sets of 20 watts, or higher,[35] on each National Forest and Ranger District, his definition of a "portable" unit would be whatever was necessary to reach the network. If this required enough power to reach 50 to 100 miles, or a 50-pound set, that was how Apgar would define portable.

Another reason Washington opposed converting to a sophisticated system was its high initial cost, due in part to the waste and expense of duplicating current telephone lines or replacing them with radio. In addition, even if questions of technical reliability were ignored, the process would have been time-consuming; it could require a decade of anguish and argument over budgets and earmarking of specific funds. In addition, many CCC camps were assigned to maintain and construct telephone lines throughout the National Forest System.[36] To ignore this windfall of a ready-made, all-expense-paid labor force, as Apgar was suggesting, bordered on fiscal irresponsibility.

The third and perhaps the greatest concern of the Washington Office and most Regions with point-to-point communication was the threat of violating both IRAC regulations and the substantial toll-line discount agreements with A. T. & T. Following several calls from a representative of the Bell Telephone Co., Roy Headley wrote the Regional Foresters in 1935: "Their concern has always been with stories that radio is to supplant regular pole line service between Regional offices and somewhat distant supervisors' headquarters," or "point-to-point" communications.[37] As a reminder, Headley noted that the IRAC legal authorization associated with the Forest Service frequency allocations did not allow this use. The seven IRAC rules specifically outlining the limits of Forest Service radio application read as follows:

(1) /For/ emergency calls from points which are not connected by regular telephone lines.

(2) For intermittent contacts with mobile crews.

(3) For connection with points which cannot, practicably, be connected by telephone lines because of topographic barriers.

(4) To connect with points which are occupied so infrequently, and of such short durations, that investment in wire communication is clearly unjustified. The bare comparison of costs of radio vs. telephone lines is not a proper basis for determining the type of equipment to be installed.

(5) /For/ very infrequent contacts between supervisor's offices or other more distant points not connected by satisfactory commercial lines, but only when such calls can be clearly justified as not being in violation of the spirit and intent of the authorization granted us.

(6) To communicate with CCC camps and other temporary camps for which no other means of contact are available when justified by local conditions.

(7) Radio should not be used for point to point contact for general administrative business in the frequency band 3000-3500 k.c., since these frequency allocations are required primarily for fire communication purposes.[38]

Figure 104. Checking in a Civilian Conservation Corps (CCC) crew after a fire. Olympic National Forest, Wash., 1939. (NA:95G-380066)

At the 1936 Spokane Fire Equipment Conference, the Apgar Plan was soundly opposed in a Radio Committee report. Reiterating the seven mandatory IRAC communication rules, the Committee emphasized its support for the telephone agreement. "In order to forestall needless alarm on the part of the A. T. & T. Co. that Forest Service radio is unnecessarily infringing on their utilities, the report stated, it is recommended that sufficient contact be maintained with local A. T. & T. Co. representatives to insure their full awareness of Forest Service radio activities insofar as these activities might be construed as affecting them."[39]

A fourth criticism from Washington was the lack of economy of Apgar's plan; they contrasted the low costs associated with simplicity of design with the high costs of higher-powered transmitters and more sensitive receivers. The Radio Laboratory's policy was to keep radio design simple, but the equipment requirements for long-distance network communication rose proportionately with the complexity of the technological design. The more refined and complex a circuit, the more labor and components required, and the higher the cost.

Whether Apgar could have the Region 1 funding to implement his plan in its entirety is theoretical; this possibility was not settled until much later. By championing the program, however, Apgar brought himself into direct conflict with the Radio Laboratory.

The Laboratory philosophy for radio design and development was simplicity, ruggedness, and dependability. To paraphrase Simson, a set should be built for operation by a mule. This did not suggest a lack of confidence in the mental capacity of firefighters.

Instead, it reflected the realization that they were not trained radio operators, and in addition were often under stress comparable to that of soldiers in combat. Pressed to get a message transmitted at a time when seconds were important, a nontechnical radio operator did not have time to go through the numerous tuning procedures required to operate complex equipment.

Region 1 Used Amateur Radio Men on Fireline

Bill Apgar was undaunted. He challenged the Radio Laboratory's concept of a radio operator on the fireline. By the second year of Region 1 radio use, he redefined the profile of the typical radio operator on the fireline. He canvassed the Region to come up with a list of 26 men who would make themselves available as paid volunteers at various times for fire radio operation. It held the names of 12 men from Spokane, 6 from Missoula, and 8 from other areas around the Region. All but one held an amateur radio license.[40]

Like other Regional communication officers, Apgar always considered one of his primary and most difficult jobs to be to "sell" radio to the men in the field. By planning to use men well-versed in radio operation, he could virtually circumvent the need for simplicity of design. Men who could take a radio apart and put it back together were not frustrated by complex tuning procedures.

The procedure Apgar planned to use for these ham radio operators was similar to that of a civilian defense program. When word of a major fire arrived, he would notify the first man on each of three lists; the men notified in turn would secure the number of required radio operators. In case of a bad fire season, a powerful base radio station would be established at Missoula as a communication center relaying telephone messages to the Regional fire desk.[41] With trained operators on the higher-powered radio sets at fire base camps, the Missoula fire boss could coordinate and direct fire crews by radio like a behind-the-lines commander.

Over the years, Bill Apgar continued to add to his list.[42] He acquired names for the "Mobile Radio Unit" by advertising for amateurs over a Spokane radio station, spreading the word through amateur radio channels, and sometimes knocking on doors when he heard a practiced "fist" sending a message. If a few happened to be natives of nearby Canada, they could "become" U.S. citizens for the fire's duration by selecting a temporary hometown of their choice from a map of Region 1.[43]

But even though Apgar eventually had the name of every available amateur in the Region, this plan did not become the recommended policy of the Radio Laboratory. The use of temporary, seasonal radio operators went against the grain of contemporary Forest Service philosophy and policy. Not only was employment of outsiders contrary to tradition,[44] but it also provided a higher level of technical competence than called for. Radio was being developed as a tool for men already a part of the Forest Service organization. To provide them with a radio that went beyond their skills and, more importantly, their needs, would have severely limited the use of radio. In the battle against fire, a strategic weapon that can be operated only by highly skilled personnel may fail totally if the operator is disabled or absent. The weapon must be designed for use by almost any soldier, otherwise spectacular successes will be overshadowed by colossal failures and a resulting lack of confidence in the device.

Bill Apgar had a great deal of respect and admiration for Regional Forester Kelley. He was a man, Apgar remembered, who "wasn't afraid to tell Washington what to do."[45] In turn, Major Kelley appeared to respect Apgar's position and supported his attempt to develop the network concept. In a 1936 letter to Chief Forester F. A. Silcox (who had preceded him in Missoula), Kelley questioned the limitations placed on Region 1 by the A. T. & T. leases and IRAC regulations. He described the Missoula station to Silcox and explained its responsibilities for maintaining communications on project fires, relying messages to and from the fire desk, coordinating airplane patrols, disseminating fire-weather warnings, monitoring frequencies to prevent interference, and providing other miscellaneous services.

Kelley believed radio was important to speed daily reports to Missoula, where tabulations were made and responses or orders returned. "If you want to consider it as such," he reported to Silcox, "it means a total of nine hundred messages distributed in thirty minutes," a fact, he added, that is "absolutely impossible to accomplish except by using radio." Uneasy about IRAC frequency regulations, Kelley said there would be no interegional interference and asked Silcox to reconsider the question. "I see no reason," he added for good measure, "why this network cannot continue to function, but since there is a difference of opinions we would like a decision on it."[46]

The response from the Washington Office is not available. It is significant to note, however, that a few months later, after Apgar conducted numerous propagation tests, Region 1 authorized Apgar to purchase a site for a Regional radio operation center in the Whitaker hills above Missoula on the eastern edge of town. The transaction was completed in 1936 "for $1 and other considerations."[47]

The KBCX Operation at Missoula

Much later, Bill Apgar remembered the Operations Center (KBCX) as a "beautiful" location for Regional communications. A CCC crew put

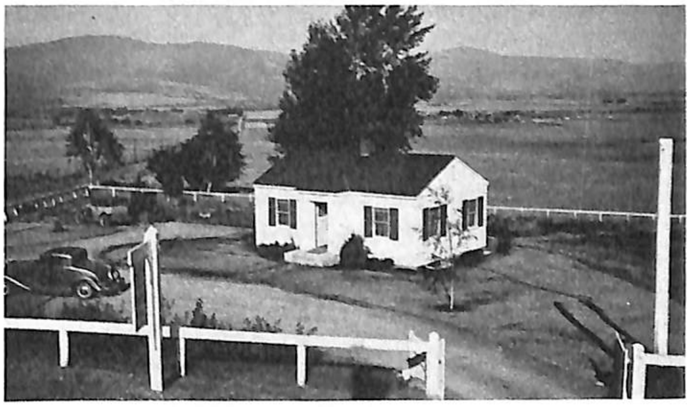
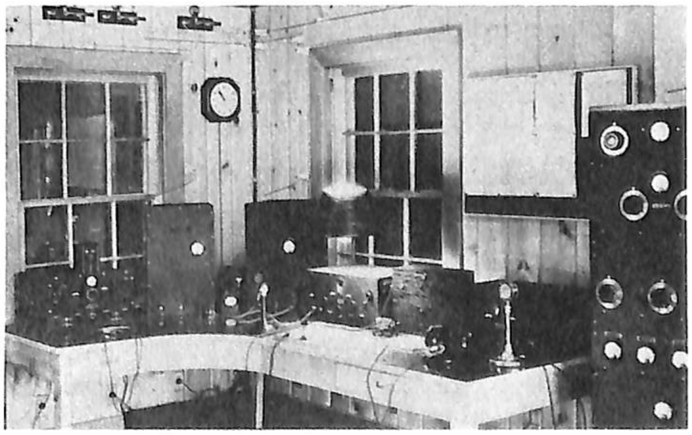


Figure 105. Exterior, above, and interior, below, Region 1 Radio Operations Center, Station KBCX, Missoula, Mont., 1937. (Forest Service photos, History Section; NA:95G-331156).



the building up. It was divided into two sections, with one room for communications, one for a service shop. Living accommodations were in the basement. A crew, hired by Apgar mostly from CCC trainees, occupied the center around-the-clock.[48] Transmissions from the National Forests around the Region were clear and suffered little interference.

To strengthen his position on high-powered communication, Apgar set out to acquire up-to-date equipment. He selected two of the popular Hammarlund Comet Pros and an improved Super Comet Pro for reception. For transmitters, he utilized two type M sets and a custom unit of his own design that he had used earlier for a base station at Ft. Missoula and the University of Montana. Rated at "something over 100 watts," Apgar's transmitter had sufficient power to maintain 100-meter communications with all of the National Forests in the Northern Region.[49]

Beginning in 1932, Bill Apgar had a considerable effect on radio application throughout Region 1. In the early communication plans, he employed M sets at Forest Supervisors' offices, 5-watt SSP sets for Ranger stations and a combination of SSP and SP sets for use primarily at Blister Rust Camps (BRC) in the interior.[50] He also passed on his attitudes toward high power to many Rangers through a program of radio indoctrination seminars on the individual National Forests he began in 1934.[51] Any sentiments for use of low-power portable radio by smokechasers could be overcome in these meetings by arguments on the importance of administrative radio. It is not surprising to find that when the Regional office called on each National Forest to draw up extensive radio and telephone communication plans, "the job of contacting Forest and building this plan has been assigned to William Apgar...," and "he will make it a point to visit each Forest as soon as possible, in order to get the plans organized and in effect so that the necessary work to complete the systems in accordance with the plan can be accomplished during the next fiscal year."[52]

The communication plans that Apgar made between 1935 and 1937 for each National Forest in the Northern Region were examples of efficient organization and purpose.[53] He also thoroughly evaluated existing and required telephone services. The plans, however, varied and were somewhat limited in scope, but they generally centered on the strategic location of a type M set and an SP, SSP, or SPF set on each Ranger District.[54] Each document was approved by the Forest Supervisor, Assistant Regional Forester Clarence Strong, and the Improvement Inspector, Clyde P. Fickes, carrying with it the implication of fixed Regional policy. This policy remained in effect until 1940-41 when Apgar undertook a general revision of these plans.

The degree to which Apgar centralized Regional communications through Missoula was also evident in his approach to radio service and maintenance. Once each year, usually in the spring, the Forest Supervisors were asked to gather up all radio units for annual inspection by a traveling KBCX Operations Center technician.[55] This particular policy irritated Forest Supervisor Ray R. Fitting on the St. Joe. He had found this type of maintenance unsatisfactory in the past, not only because it was inconvenient, but because the sets often came back in worse shape than when they left. In addition, the timing of this service was counter-productive. Fitting argued against their removal when they were most needed to communicate with work crews and CCC camps. As an example, he noted in a letter to F. E. Thieme, Assistant Regional Forester and Chief of Engineering, that "I have delayed calling in the radio equipment from CCC camps due to the fact that during the past ten days a great deal of trouble has been experienced in connection with keeping the /telephone/ communication system in working order on account of high water."[56] With the usual springtime snowmelt and runoff, the telephone lines, which ran up through the mountain valleys, were vulnerable to the vagaries of nature.

To keep the radios in working condition, Fitting had earlier hired Dave Brown, a St. Maries resident, as a radio technician. Brown was able to inspect the sets at their installation sites with a minimal amount of inconvenience and downtime. But this approach did not please the Regional Office. In a return letter to Fitting, Thieme pointed out that radio was still in its "infancy," and required many modifications best handled by the "Regional office specialists." Thieme suggested that "until the number of sets on the Forest reach the number where they will warrant the hiring of a man to look after them, a specialist from the Regional Office who will handle the work on a number of Forests appears to be the most economical and would cut down on general overhead expenses."[57]

The matter might have been settled had not Apgar chosen to defend his group against Fitting's complaints. In a disparaging memorandum to the Engineering Branch, Apgar insisted: "If these sets were inoperative when received in the field it was due entirely to careless handling from the time they left St. Maries until received in the field."

Before signing the correspondence with the unusual title, "In Charge of Radio," Apgar complicated matters by questioning Brown's qualifications as well as the administrative abilities of those in charge of the St. Joe. "Dave Brown is a very good man..." he wrote, "however, I would not consider him an experienced radio technician and what is more I do not believe Mr. Brown would so classify himself." He seemed compelled to continue: "For some reason, the St. Joe Forest has had more trouble with radio communication that all other Forests in this Region combined." And then, to top it all, Apgar tersely commented, "Mr. Fitting's letter is typical of the attitude on the St. Joe."[58]

Fitting told the Regional Forester he was not impressed with the status of anyone "In Charge of Radio." The St. Joe Forest Supervisor flatly declared "...that there is no need for the Regional Office to plan on sending a radio man in to overhaul the sets,"[59] he pointed out the specific "unsatisfactory conditions" of previous inspections, the satisfactory background, training, and qualifications of "Mr. Brown," and the value of having a man for on-site work. In a parting shot, Fitting left little to the imagination: "In my opinion, he /Brown/ is the most competent service man that we have had working on the sets, with the exception of Mr. /Harold/ Lawson..."[60] Exemplifying the influence that a supervisor could wield over his domain, Dave Brown was retained as the St. Joe Forest radio technician. As of

1979, he had completed 43 years of continuous service in that capacity, all on the St. Joe National Forest.[61]

The Region 1 relationship (in a rare similarity to other Regions) with Mountain States Telephone and Telegraph Co. (M. S. T. & T.) and numerous other private exchanges was very cordial and cooperative. Charged with joint radio and telephone responsibilities, Apgar received his training in telephone line construction from M. S. T. & T. and utilized their construction practices throughout the Northern Region.[62] Nevertheless he showed a decided preference for radio over telephone. A measure of this attitude is reflected in the figures for telephone lines in the Region. After reaching a high point of 12,650 miles, they dropped to only 1,164 miles of line by 1977,[63] and Dave Brown sent a Christmas note to the retired Bill Apgar indicating that not only were the differences of 1936 forgotten, but that their attitudes regarding telephone were similar. "Our dream has come true. The last Forest Service telephone line on the St. Joe had been replaced by radio."[64]

During the first few years of Forest Service radio, Region 1 was well on the way to developing the concept of network radio. With the high-powered station in Missoula and M sets in the offices of each Forest Supervisor, the principle of administrative communication had been established. By adding semiportable sets to Ranger stations, lookouts, and guard locations, and Regional Office in Missoula could achieve almost instant communication with all inhabited locations in the system.

Many problems--IRAC regulations, A. T. & T. leases, and the questions of interference and portable radio for the fireline--were yet to be overcome before the Missoula office could proceed with its plan. The technology required to produce portables that could be carried by an individual and reach 100 miles, and the ever-increasing interference as radio inventories doubled each year, also raised questions that went beyond IRAC and A. T. & T. regulations. The answers would not come easy for the Forest Service.

Reference Notes

1. William Burnett Apgar, interview with the author in Sun City, Ariz., January 1978.

2. Frank J. Jefferson, "Memorandum for Mr. Apgar," 2 July 1932, Gaylord A. Knight Collection.

3. Apgar, interview with author.

4. This description of Apgar was provided by George Duvendack. See George Duvendack, interview with the author in Bozeman, Mont., May 1979, Gaylord A. Knight Collection.

5. Apgar, interview with author.

6. Frank J. Jefferson, "Memorandum for William Apgar," 6 August 1932, Gaylord A. Knight Collection.

7. W. B. Apgar to Mr. Lawson, 9 August 1932, Gaylord A. Knight Collection.

8. W. B. Apgar, "Radio Report-1933," 27 February 1934, typed copy, Gaylord A. Knight Collection. These figures are approximate and were determined by deducting the portable sets which Lawson had on the St. Joe (1 M, 5 SP's, and 5 P's) and Apgar's two 1932 sets.

9. Apgar, "Radio Report-1933."

10. Apgar, "Radio Report-1933," p. 3.

11. Apgar, "Radio Report-1933," p. 7.

12. W. B. Apgar, "Radio Communication Report-1934," [n.d.] [*ca.* late 1934-early 1935], typed copy, p. 1, Gaylord A. Knight Collection.

13. Apgar, "Radio Report-1933," p. 4.

14. In the reading of the preliminary manuscript, two individuals questioned the emphasis placed on Apgar, or the attention to his actions. I have, therefore, taken this opportunity to emphasize that the issues were technical, not personal.

15. L. C. Stockdale to H. K. Lawson, 9 January 1934 and H. K. Lawson to Regional Forester (R-1), 13 January 1934; both Gaylord A. Knight Collection.

16. Apgar, "Radio Report-1933," p. 8.

17. Elers Koch to the Forester, 9 April 1935, Gaylord A. Knight Collection.

18. Apgar, interview with author.

19. E. W. Loveridge, "Memorandum for Mr. Headley," 6 January 1934, Gaylord A. Knight Collection.

20. Loveridge, "Memorandum for Mr. Headley."

21. Loveridge, "Memorandum for Mr. Headley."

22. Loveridge, "Memorandum for Mr. Headley."

23. Roy Headley to Regional Foresters, 9 January 1934, Gaylord A. Knight Collection.

24. L. C. Stockdale to the Forester, 20 January 1934, Gaylord A. Knight Collection.

25. Stockdale to the Forester, pp 2-4.

26. L. C. Stockdale, "Memorandum for Mr. Koch," 12 March 1934, Gaylord A. Knight Collection.

27. Frank J. Jefferson, "Memorandum for Mr. Apgar," 14 April 1934, Gaylord A. Knight Collection.

28. Jefferson, "Memorandum for Mr. Apgar," pp. 1, 2.

29. F. A. Williams, "Use of Radio at Planting Camps," 8 February 1934, Gaylord A. Knight Collection. Each of the letters was initialed "WBA" indicating Apgar's knowledge of same.

30. Apgar, "Radio Report-1933," p. 1.

31. Apgar, "Radio Communication Report-1934," p. 1.

32. Elers Koch to the Forester.

33. Apgar, "Radio Report-1933."

34. Apgar, interview with author.

35. Apgar, "Radio Report-1933."

36. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978; Apgar, interview with author; Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977; Guy V. Wood, interview with the author in Porterville, Calif., January 1978; and Harold K. Lawson, interview with the author in King City, Ore., May 1978.

37. Roy Headley to Regional Foresters, 25 April 1935, Gaylord A. Knight Collection.

38. Headley to Regional Foresters, p. 2.

39. A. G. Simson, "Report of Radio Committee-Spokane Fire Equipment Conference," 19 February 1936, Gaylord A. Knight Collection.

40. W. B. Apgar to Frank J. Jefferson, 3 May 1933, Gaylord A. Knight Collection. The leader was Paul Dickman (W7AQM) and the group included H. V. "Gravy" Graves (W7CEG) and Russell Richmond (W7CRH), a Northwest Airlines pilot.

41. W. B. Apgar, "Memorandum for Mr. Jefferson, 23 May 1934, Gaylord A. Knight Collection.

42. Apgar updated the list each year. By 1941 there were 32 amateurs between Spokane, Billings, and Kalispell. See "Mobile Radio Unit-1935;" "Mobile Radio Unit-1936;" "Emergency Radio Unit-1937;" "Emergency Radio Unit-1938;" "Emergency Radio-1939;" "Emergency Fire Radio Unit-1940;" and "Emergency Fire Radio Unit-1941," all Gaylord A. Knight Collection. By 1950 the group was known as the "Regional Office Radio Squad."

43. Apgar, interview with author.

44. Organizational acculturation may be considered synonymous with the more familiar characteristic of fraternalization. See Kaufman, "Developing the Will and Capacity to Conform," *The Forest Ranger*, pp. 161-200.

45. Apgar, interview with author.

46. Evan W. Kelley, "Memorandum for Chief, Forest Service," 11 March 1936, Gaylord A. Knight Collection, pp. 2-5.

47. Apgar, interview with author. The offer was made by an estate attorney who hoped the sale would spark real estate sales in the neighborhood. It is interesting to note that in 1978 housing surrounded the site and stretched across the valley. In 1971 the location was donated to the city of Missoula.

48. Apgar, interview with author.

49. Apgar, interview with author.

50. W. B. Apgar, "Memorandum for Files," 28 March 1938, Gaylord A. Knight Collection.

51. L. C. Stockdale to Forest Supervisors, 14 April 1934, Gaylord A. Knight Collection.

52. Clarence C. Strong to Forest Supervisors, 2 May 1935, Gaylord A. Knight Collection.

53. These plans are maintained in the Regional Office, Missoula, and were in the possession of the author at the time of writing this chapter. See Gaylord A. Knight Collection.

54. See, for example, W. B. Apgar, "Communication Plans-Lewis and Clark National Forest," 12 March 1937, Gaylord A. Knight Collection.

55. C. P. Fickes to Forest Supervisors, 10 April 1936, Gaylord A. Knight Collection. See page 306.

56. Ray R. Fitting to Regional Forester, 29 April 1936, Gaylord A. Knight Collection.

57. F. E. Thieme to Forest Supervisor, 18 April 1936, Gaylord A. Knight Collection.

58. Apgar to Thieme.

59. Fitting to Regional Forester, 14 April 1936.

60. Fitting to Regional Forester, 29 April 1936.

61. Dave Brown, interview with the author in St. Maries, Idaho, May 1979.

62. Apgar, interview with author.

63. J. H. "Bud" Coats, "Communications in the National Forests of Region One," *ca.* 1979, unpublished draft, Gaylord A. Knight Collection.

64. Apgar, interview with author, and Brown, interview with author.

Chapter XI
Good Fences:
Regional Networks, Portable Radios, and Interference

And the more clearly the laws are understood whereby "interference" can be prevented, the more clearly the laws will be understood whereby "prevention" [sic] can be prevented; that is, the better the laws of the game are understood, the better both sides will play it.

- Comdr. Bradley A. Fiske, U.S.N.[1]

Earl Loveridge asked Roy Headley in January 1934 to appoint an independent radio review board that Horton and Simson could not disregard. Headley passed the memo on to the Regions. Jack Horton was a bit miffed, although he agreed on the need for stronger direction. He suggested to Headley that the Washington Office may not have been correctly informed or was a little too far behind the times. "*We have had*," he emphasized on behalf of the Radio Laboratory in his lengthy reply, "*more business than we could attend to under this plan*." The design, purchase, inspection, and shipment of units was no small task for the limited staff, and was already placing demands on the Laboratory personnel that could not be met, Horton contended. He voiced numerous objections.

Apprehensive that Loveridge's requested review board might cause many more Rangers to demand radios, Horton asked for more manpower before matters got "out of hand." Horton warned: "We can't run a $100,000 business with a few temporary men and get desirable results. Of course we can toss out equipment if, and when, the Regions make requests and furnish the jack." But, he added, "*It may wreck the project*." Recommending that each Region hire a communication engineer, and that "someone or a committee" be appointed to decide the kind of equipment and frequencies to be used, Horton called Headley's attention to the trend in the field away from the original concept of the role of radio. He wrote:

> When we started this radio work I insisted that low power was essential. Also we contemplated only an extension of communication from our present system, mainly for fire control. Now we seem to be leaning to high power and to [the] replacement of telephone lines. This is wrong and is the result of not enough technical planning. We should stick to our plans.[2]

Headley and Loveridge ignored his alarm and continued to waver between feeling "overjoyed" and oversold. They issued occasional reminders of the IRAC regulations and the A. T. & T. lease agreements, but evaluated specific purchases or Regional applications only in terms of the annual budget. By adhering to the Forest Service philosophy of decentralized control, the Washington Office created an administrative vacuum with the potential for significant conflict even over relative trifles. It did not take long for the related issues of interference and output power to move into the breach.

High Power Caused Interference

At the various communication conferences held in Portland during the 1930's, the transmitter output power was often a major topic of debate. The 1935 conference spent considerable time discussing interference among the 700 forest radios and the effects of output power on the problem. These two inseparable issues were handled by a conference recommendation (though the conference was "practically divided on this point") that low power should govern. "With the limited frequency assignments at our disposal," the recommendation concluded, "and the increasing use of the air /line/ channels, the interference problem will become acute unless we limit power to that which is the minimum necessary to make satisfactory contact."[3]

It is not apparent that the resolution had any effect. Shortly after the meeting, the Angeles National Forest, which had originally installed a 500-watt base station and a number of 100-watt outlying transmitters, objected to "too much outside interference." In a letter he thought important enough to send to the Chief Forester, Alfred K. Crebbin, Assistant Supervisor, complained that fire control efforts were hampered by "unauthorized information arriving in fire camps through the medium of every Tom, Dick, and Harry..."[4]

In Region 5, which possibly exercised a significant amount of control and planning through Fred Funke's efforts, Belleville and Lawson learned that "one of the principal difficulties experienced on the Shasta in the use of 3000 kc /3 MHz/ exists with the Wenatchee and Siuslaw Forests in Region 6 and the Salmon Forest in Region 4."[5] Due to this interregional interference, Mt. Shasta had to limit radio use by arranging a schedule of operating periods for alternative air time with these two Regions--an action that could result in effective fire control communication.

An ironic turn of events also occurred in 1939 when the Ogden office complained to Portland of interference caused by the Radio Laboratory's high-powered station, KBAA, with its station, KBAS. Engaged in a fire fight, Ogden (R-4) was hampered and perturbed by interference from KBAA and smaller transmitters at Grant's Pass and Gold Beach, Ore., and Helena, Mont. "Unless some means of eliminating such interference is soon devised," complained Arnold R. Standing, R-4 assistant in Operations, "the effectiveness of radio communication is seriously handicapped since we are rapidly approaching the critical period in our fire hazard and /we/ need our radio communication."[6] Regional Forester Watts apologized, attributing the problem to an inexperienced technician from Region 6. He then informed Ogden that "steps are being taken to make it impossible for Station KBAA to turn on more power."[7]

Many solutions were offered. They ranged from reemphasis on telephone use to proper transmission procedures, support of vhf, cooperative operating schedules, increased frequency allotments, better communication planning, and, as expected, increased power.

To encourage brief transmissions and thereby limit some frequency congestion, Gael Simson suggested that messages on fire-weather reports, grub orders, scout reports, and tactical discussions be written down before being transmitted.[8] Francis Woods attempted to achieve this same effect by devising a code and using tape recordings to play back to the "long-winded" violators of proper transmission protocol.[9]

In Region 1, Bill Apgar designed a confidential code for the most frequent messages used on the fireline. He originally conceived it as a procedure to cut down the number of inaccurate reports by the news media. Following a conflict on his first fire (the Pete King in 1934), he had banned newsmen from the scene because they intercepted messages and, he believed, irresponsibly revealed several deaths; this had overloaded the fireline switchboard with calls from the worried parents, wives, relatives, and friends of some 3,000 firefighters. Although Apgar later admitted this banishment "cured the newsmen of sucking eggs" (that is, it was ineffective), he revised the code in an attempt to resolve the issue with the press and make brevity a necessity, while still retaining relatively confidential transmissions.[10] Through the facilities of the KBCX Operations Center in Missoula, he was then able to monitor the results, enforce compliance, and offer another reason in favor of hand-picked amateur radio operators.

Telephone Vs. Radio

In a statement reminiscent of his earlier doubts about radio acceptance, Loveridge said that telephone lines were as "cheap as radio in the long, long run." Horton questioned Loveridge's source of information, and Loveridge cited an earlier study on the Olympic National Forest showing "...no very great difference in cost ... when one considers the greater dependability of the former /telephone/."[11] Because vhf required a corresponding development period, Loveridge thought it would make economic sense to utilize the CCC and "other cheap labor." He concluded, "It seems to me we should encourage the use of regular telephone communications, rather than establishing a radio network which will have to depend on the limited number of frequencies we have available."[12]

Jack Horton disagreed with Loveridge's premise and pointed out the error of his logic. With regard to the "greater dependability" of telephone over radio, he reminded his superior that using the Olympic case was arguing from the specific to the general; the implication was that a single incidence in favor of radio could generate the opposite conclusion. But Horton's most telling criticism--one that would be borne out in the future--effectively resulted in the issue being ignored for several more years.

As for the value of the "cheap labor," Horton was worried that the CCC would eventually be disbanded, leaving the Forest Service with countless thousands of miles of new telephone line in need of continued maintenance and repair, but without the necessary manpower. "Very probably in the future," Horton perceptively noted, "we will roll up some of our telephone lines and install radio, because we will be able to demonstrate that from a maintenance and reconstruction standpoint radio should have been installed in the first place."[13]

The cash value of the A. T. & T. discounts notwithstanding, there was an inherent disadvantage to the agreement restricting the equitable division of telephone and radio applications. If there were no leases, a more realistic appraisal of the matter may have led to guidelines allowing the use of each communication tool in the most appropriate manner. Cost-benefits may have been calculated, particularly for point-to-point communication, and substituting one for the other economically justified.

This evaluation did not take place largely because of the knee-jerk reaction each time someone suggested radio for a unique application. When, for example, Oregon newspapers reported that Forest Service radios would be used in conjunction with the elk hunting and winter sports seasons, the Forest Supervisor on the Umatilla was forced to cancel the experiment. "...Whereby the charges for our use of their facilities /Pacific Telephone and Telegraph/ are discounted by 50 percent," Carl Ewing wrote his forest

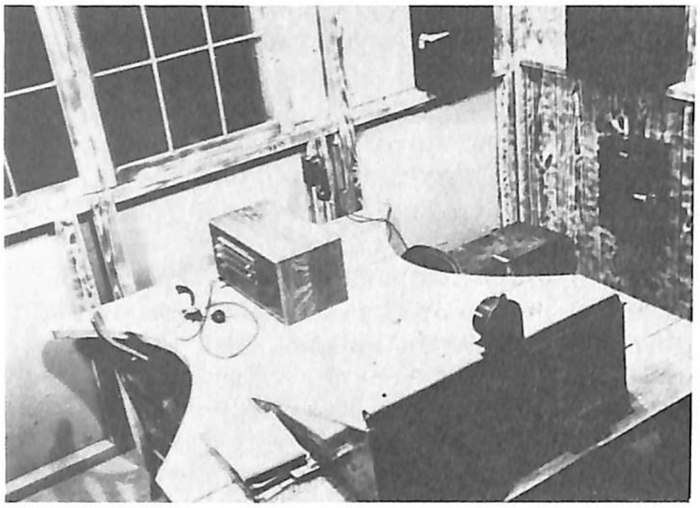


Figure 106. Forest Service desk-type telephone switchboard in a field location. (Forest Service photo, History Section)

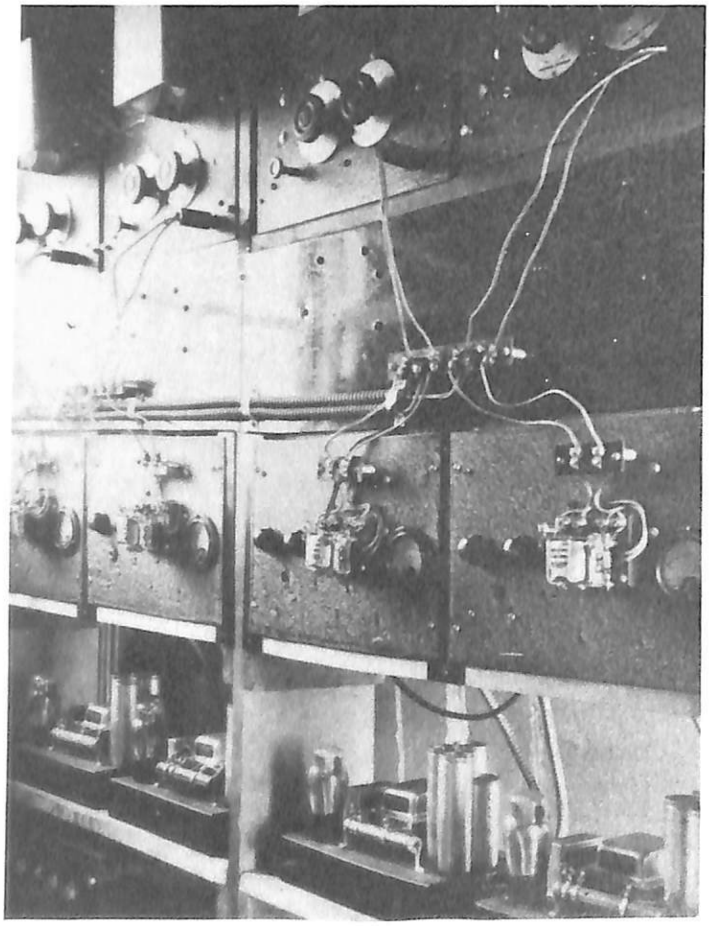


Figure 107. Forest Service electronic telephone switching circuits. (Forest Service photo, History Section)

officers, "/regulation/ prohibits our using, except in emergencies, Government-owned facilities which parallel or duplicate the commercial facilities already available."[14]

Considering that more effective radio plans were being hampered by A. T. & T. lease agreements, insufficient attention was given to telephone as one way to reduce radio interference, and vhf began to acquire a reputation for adequate intraforest communication. If networks were placed on the line-of-sight vhf, the administrative functions of a forest could be

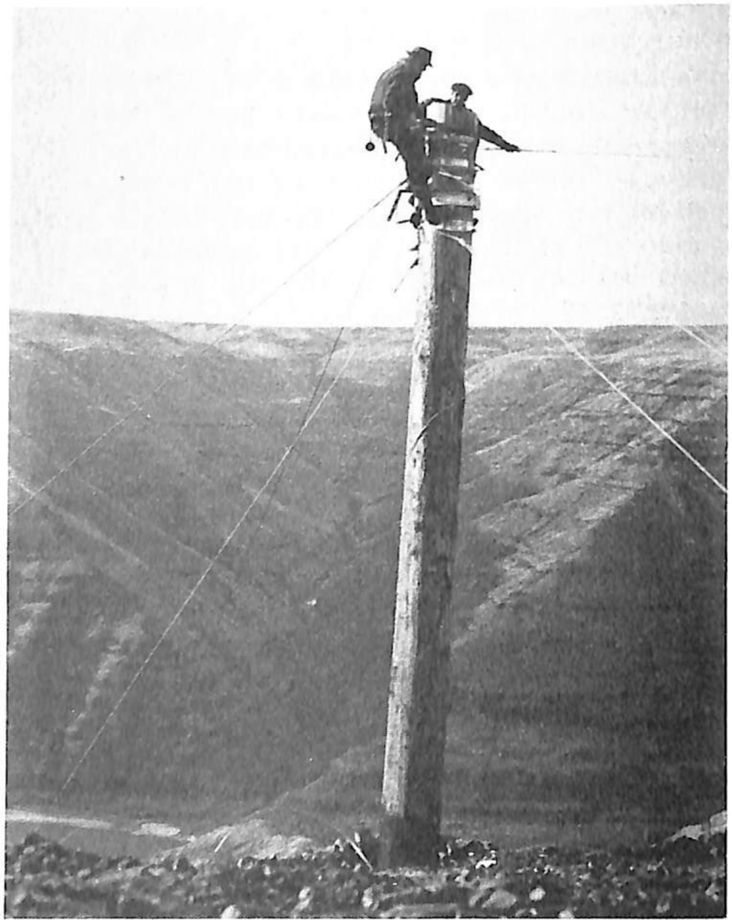


Figure 108. Men installing a Forest Service telephone line to a lookout point in the Southwest have a spectacular view. River at base of bluffs is possibly the Colorado or a tributary. (Forest Service photo, History Section)

accomplished without interference to the 3-MHz "fire channels."[15]

Previous experience with vhf, particularly with the semiportable set, had not been successful. Gael Simson was the first to recognize that "none of them have been satisfactory," and he admitted that the early vhf semiportables were intended only as "stop-gap makeshifts" until the radio industry provided better vhf components.[16]

Yet by the late 1930's, when technology had improved, advanced vhf design had been achieved at the Radio Laboratory. Vhf was used on the Klamath National Forest to the exclusion of hf, with such gratifying results that Region 5 proposed drawing up vhf plans to use some 30 type T sets, 60 type S sets, 6 type SV sets, and 30 vhf mobile receivers for each of its forests.[17] This proposal led Harold Lawson to conclude, no doubt for the benefit of Region 1, that "in view of the fact that the Klamath Forest embraces an extremely rugged area, the satisfactory use of ultra-high [vhf] only provides rather definite evidence that proper planning, personnel training, technical aid in maintenance, and an impartial attitude can produce a very workable communication system without the use of frequencies in the range of 3,000 kc [kHz]."[18]

Some radio men tried to sidestep the interference issue by suggesting that the problem could be eliminated by an increase in frequency allocations. This remedy had the least chance of success. The proponents of this solution saw the problem not as one of interference but of an insufficient number of frequency assignments. But the Forest Service was fortunate to have what were considered "generous allocations" in comparison to its occasional secondary-user classification by IRAC, subject to appropriation by primary users.[19] The military services were given highest priority in frequency assignments, but they had allowed the Forest Service to use some of their 3-MHz frequencies with the understanding that power output would be limited and that use would be surrendered when necessary. This surrender would occur if national priorities required their return to the primary assignee, or if a previous noninterfering joint frequency assignment over vastly separated points abruptly changed due to a relocation or reconsideration by the primary assignee (the military). For this reason, National Forest officers were reminded that the use of radio "...is dependent upon the willingness of the U.S. Navy to permit us to use the [3-MHz] channels allocated to them..."[20]

The closely spaced assignments between users of frequencies in the 3-MHz band

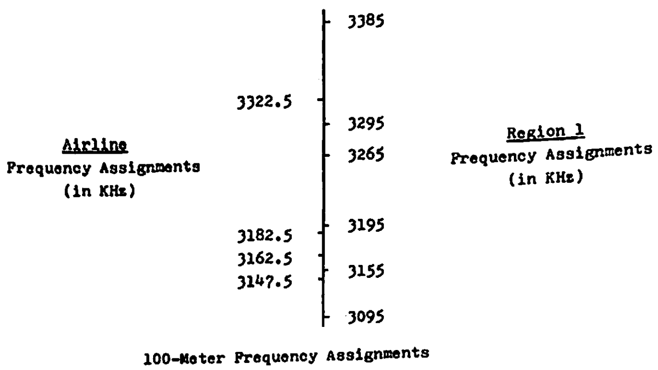


Figure 109. This diagram of frequency assignments in the 100-meter band in the early 1930's shows why radio transmissions to and from overhead commercial airplanes were interfering with the sending and receiving of messages during firefighting missions in the Northern Region of the Forest Service. The diagram is from William Apgar's 1934 "Radio Report to the District [Regional] Forester," (Gaylord A. Knight Collection)

also resulted in numerous cases of interference. A common complaint of Region 1 during fire fights was the reception of airline broadcasts from overhead commercial flights. Lacking receiving equipment that could bring about adequate separation, the Region requested the reassignment of airline channels to those either above or below theirs. The request ignored the cost of converting transmitters and receivers for the airlines, and also failed to recognize that IRAC had assigned these adjacent frequencies through necessity.

Two Regions Favor High Power

Support for "brute-force propagation" as another way to reduce the overcrowded conditions on the 100-meter band, came from Region 1. Francis Woods in Ogden also found merit in this approach, to a lesser extent. "I always thought that a good thing to shoot for was Region 1 radio communications," remembered Woods. He even borrowed a technique from Apgar and purchased a 100-watt Hallicrafter transmitter for the Wyoming (now Bridger) National Forest supervisor at Kemmerer, Wyo. It had 80 watts over the type M set but was within the recommended Forest Service power limit. This singular act gained little attention although Woods later admitted that he expected a reprimand from the Washington Office. He never received it.[21]

The justification for using higher levels of power was that overpowering the adjacent transmissions could eliminate interference. Depending on the conditions--including transmission distance, return from the ionosphere, the quality of both the transmitter and receiver, and the time of day--this might represent an output of no more than 20 watts. On other days, however, it might take 250 watts to force the message over the same path. This could work if the one being overpowered did not retaliate in kind, or the offended party did not have primary-user classification for that frequency and take offense at the lack of protocol displayed by the secondary user. The latter situation was more probable in the case of the Forest Service. With the Navy granted primary-user classification for most Forest Service 3-MHz frequencies, there was little danger that the low-powered, Laboratory-designed sets would interfere with ships at sea. It was more likely at 250 watts.

Region 1 records indicate that Missoula had experienced problems with interference as early as 1932. During the first Savenac experiments, Apgar was reporting significant conflicts between the Chelan National Forest in Washington and the St. Joe National Forest in Idaho while using the low-power SP sets. The ability of the SP's one watt to traverse great distances was noted by Apgar. "A case was reported where a fire call on the West Coast was seriously hindered by interference from an Idaho set."[22]

Authorized to use three 100-meter frequencies for the 1933 fire season, Apgar apportioned the 102 Regional radios among 7 National Forests. By the time of heaviest use, he found that even trained operators could not eliminate interference. "Interference from our own stations," he emphasized, "was one of the greatest difficulties encountered..."[23] It hampered effective communications significantly. As reported on the Flathead, "...the air seemed to be fully occupied by other stations and it was almost impossible for us to find any vacant period."[24] Apgar also learned that under ideal conditions "the SP sets will consistently lay down a signal at 400 miles...and it can readily be seen what interference will occur within this radius."[25]

The knowledge gained about interference effects, even at low power, was not lost on Bill Apgar. The proliferation of sets throughout the Forest Service increased network overcrowding, and severely threatened his plan. The fixed transmission schedules of a daily network depended upon each radio being on the air at a given time for roll call and exchange of information and orders; it could not be a hit-or-miss operation. If 900 messages, as Major Kelley reported to Chief Silcox, were to be distributed in 30 minutes,[26] each station had to be ready to take its turn and have sufficient output power to reach Missoula, whether transmitting from the Canadian border or the Custer National Forest in South Dakota. By definition, then, the output power required on any given day was the minimum wattage required on the Region 1 network.

Bill Apgar found technical justification for his philosophy on high-power in two examples. In Spokane, Wash., where Region 1 then kept a radio fire cache, the city police force had 60-watt mobile radios; Apgar had borrowed a few of these units several times for use on active fires. In addition to citing the state-of-the-art of mobile communications and the problems associated with hf transmissions even in a relatively small city, he would use this example as testimony of the untenability of the Laboratory's stand for low power. With a small group--the Spokane police--using 60 watts, he wondered how the Forest Service could expect him to communicate over thousands of square miles with 20 watts. This situation suggested to him that Portland was "playing around" with radio.

The second example was provided in the IRAC regulations allowing some Government agencies to use a maximum output power of 500 watts. Apgar viewed this an an indication of the actual value placed on high power by other knowledgeable sources, and took it as implied approval for his use of the higher values.[27]

In retrospect, it is obvious that Region 1 was aware of the interference problems that would occur if two or more Regions followed Apgar's lead. To overcome the accompanying interference, Apgar suggested communication schedules between National Forests and Regions on the order of one half-hour transmission followed by one half-hour of silence, when fire conditions required simultaneous frequency use. He supported this recommendation by citing the relatively good relations between Francis Woods and himself when KBCX in Missoula interfered with a fire fight in Region 4.[28]

Other officials did not agree. "Attempts to follow regular schedules are of no avail as emergencies arise that disrupt not only our schedules but others," complained one Forester.[29] More significantly, operating schedules could work only between National Forests or Regions with enough power to break their periods of silence when an unscheduled emergency arose. The fire boss on a California fire operating perhaps with only a 2 1/4-watt SPF had no way to overpower the stronger signals from the 100- or 250-watt Region 1 transmissions if he needed to request frequency clearance for emergency use.

Radio Laboratory Opposes Regional Networks

The staff at the Radio Laboratory found the various solutions to the interference problem inadequate. They couldn't get more frequencies, they had to uphold the A. T. & T. leases, they had a mission to produce portable radios for the fireline, and they opposed dividing the hour between conflicting users. The staff, however, had an even more compelling reason for resisting solutions that supported network communication. The Radio Laboratory had been established only because the private sector was not producing products required by the Forest Service. Dwight Beatty had continually emphasized this point, and the Washington Office later upheld it; the sacrosanct ground of the free-enterprise system was not to be abridged by a Government agency. Indeed, the Forest Service intended to withdraw from competition when the portable radios it needed became commercially available.

The concept of network communication did not fit into the framework of justifiable Forest Service radio development. High-powered sets were available through well-established manufacturers and could be acquired through regular Government procurement channels. There was no reason to continue the Radio Laboratory if the network concept, to the exclusion of fireline radio, was to be the goal. Design efforts at the Laboratory concentrated on development and perfection of lightweight, low-power, portable radios not available in the marketplace. Excursions into the areas of semiportability, mobiles, and fixed-base units took place only as necessary adjuncts, even if one eye was kept on economy.

Once the concept of portability was abandoned, there would be no justification for the Radio Laboratory. The issue of interference concerned the Radio Laboratory not because it affected network communications, but because it might affect the concept of portability and the ability to provide radio communications for the men in the field fighting fire.

Thus, the staff at the Radio Laboratory viewed the problem of interference from a technological standpoint. It was not a matter of increasing frequency allocations, devising operating schedules, moving other users off the band, or accomplishing communication through brute force. Rather, it was a matter of refining the system to overcome restrictions imposed by the other systems that came out of the revolution in communications. The Laboratory attempted to find the answers by improving the Forest Service sets and system to a point nearer technological perfection.

The extent to which differences of opinion could compound the problems of radio design came up during a review of the SPF set at the 1940 Portland Communications Conference. Francis Woods complained that the canvas bags for the SPF had a tendency to shrink. Bill Claypool then questioned the need for the bag, Apgar and Woods argued for its retention, Lawson pointed out that the Park Service no longer used the bag, the Park Service people said they did not use them because they were losing them, and Fred Funke said they were sometimes necessary. Interrupted briefly by a discussion over SPF antenna wire, Gael Simson returned to the problem, suggesting that the shrinking problem could be cured if a "surplus of one inch or so" was sewn into the bags. Somehow this led to a discussion of a shoulder strap and whether this modification should be included on the bag for $1.00 or left as a carrying handle on the SPF case. The responses were decidedly varied, as follows:

Funke (R-5)	No straps are necessary.
Apgar (R-1)	Leave as is.
Woods (R-4)	Add on shoulder straps.

Claypool (R-6)	Leave off, R-6 will attach.
Huckeby (R-2)	Leave as is.
Indian Service	Add on shoulder straps.
Oregon	Leave as is.
Washington	We don't use them.
Knight (R-8)	No response.[30]

If a minor modification could cause some dissension, it is easy to understand how major issues evolved into disagreements far removed from the immediate issues. Logan Belleville suggested reducing the output power of the SPF to reduce interference and achieve significant reductions in battery drain, and, thereby, reduce operating cost and weight. Responses reflected total support for the existing SPF without regard to the proposed technological changes. In his presentation, Belleville noted that improvements in the SPF receiver had been achieved with "newly developed low-drain tubes." To effect further gains, he proposed a reduction in transmitter output power from 2 1/4 watts to 1 3/5 watts. This change could either provide a worthwhile 50 percent reduction in battery weight, or a 100 percent increase in present battery life. The conference was not impressed when Belleville pointed out that the SPF was already operating at or below the suggested new output level when its batteries were not at full charge, and that this modification would result in only a minimal decrease of 1.5 decibels (dB).[31]

The SPF was understandably the most popular Forest Service set, and modifications would be resisted if only because no one could argue with success. But the many responses sidestepped the technological issues and, like discussion of the canvas bag straps, reflected distrust of change, questionable logic, and doubtful motives. In order of response, the arguments were as follows:

Apgar (R-1)	You are suggesting a reduction in power. We can't stand for that. If you are going to do anything, increase the power to give us more effective communications.
Woods (R-4)	In other words we would get poorer signals over a longer period of time.
Funke (R-5)	The SPF is a fine set and everyone likes it. Making changes would be a mistake.
Claypool (R-6)	We should maintain our present power for several reasons.
Knight (R-8)	The SPF should be left in its present form.
Huckeby (R-2)	We shouldn't reduce the power.
Indian Service	The SPF is highly satisfactory.
Oregon	The SPF should remain in its present form.
Washington	We don't use it.[32]

Conspicuously absent from these responses was a proposal for constructing several prototypes for Regional field tests. If these trial units did not measure up to previous performance, then the logic of the new design could have been properly criticized on its merits.

Overcoming Noise in Receiver

Many years later, Belleville would recall one irony of the power issue --the traditional overemphasis placed upon transmitter output power in the Forest Service. He was to point out that a better approach, especially in the 1930's, would have been to concentrate on alternatives such as "front-end," or receiver sensitivity. "You can improve the sensitivity of a receiver by a factor of two," he mused, "and everyone wonders what in the hell you've been wasting your time on. But improve the transmitter output by a factor of two and everyone applauds." Both achieve the same result, Belleville added, except that the receiver improvement has the great extra advantage of not causing a corresponding increase in the serious problems of transmitter interference with adjacent stations.[33]

The important issue, and the one which the staff at the Radio Laboratory pursued, was the need to improve the signal-to-noise ratio of the receiver. Improved reception could be achieved by adopting circuits that (1) increased the audibility of the transmitted signal over the ever-present background noise, (2) decreased the inherent noise of the receiver, and/or (3) provided adequate separation from adjacent signals. This is why the design philosophy of the Radio Laboratory was first to improve receiver sensitivity and selectivity, and then to reduce output power to a commensurate level and thereby reduce the potential interference on the already crowded frequencies.

It is interesting to note that this approach tied in with the Radio Laboratory emphasis on portability; Laboratory designs yielded sets weighing 25 pounds or less with a rated transmission capability of 15 to 25 miles for hf and 50 miles for the vhf portables over inter-visible ranges. An increased range would have resulted in heavier sets. As Gael Simson pointed out, "...reducing inter-Forest interference is a powerful reason for holding our equipment to low power."

"Moreover, our most portable sets must be low-powered in order to be portable," he reiterated.[34] To advocates of higher power, the Laboratory would argue that this consideration improved communications planning. In practical terms, it meant buying more low-power sets that could communicate over shorter distances, instead of fewer high-power sets. The latter, unit for unit, would cost more, create more interference, and still not be portable on the fireline.

An example of how this concept might be applied was presented by Fred Funke at the 1940 conference. Communication planning in Region 5 reflected a move to lightweight radio use following the earlier trials with high-power sets on the Angeles National Forest. By 1939, the San Francisco office had decided to eventually use some 5,800 radios consisting of 623 hf sets, 3,998 vhf units, and 1,288 separate radio receivers. Of this number, 3,430--the vast majority--were S, SV, and SPF lightweight sets, and only 100 were in the M and U class of fixed-base stations. Funke pointed out at the conference that the projected cost of $213,956 meant the total Regional radio investment would be less than the telephone investment for a single California National Forest. He expected to have this plan implemented in four or five National Forests by 1941, with a few more added each year.[35]

Region 1, of course, adopted the opposite approach. Although no exact figures are available, a fair estimate of the comparative costs of a network based on 20-watt M sets can be made and projected against the known, approximate costs of the portable S or SV used in Region 5. An example follows:

Type	Purchases	Unit Cost	Total
S, SV	4,000	$ 61	$216,000
M	720	300	216,000

Thus, for the same investment, Region 5 inventories could have included 3,280 more radios than Region 1 and even eliminated many telephone expenses. Continued maintenance of the telephone lines between lookouts and Ranger Stations would increase expenses considerably. To preserve its network concept, however, Missoula gave up the greater fire control capability of portable radios and created an inherently much more expensive system. It was apparent at the 1940 radio conference that the levels of communication planning in other Regions were in varied stages of refinement. Region 2 at Denver, which until now had had a limited use for radio because "the fire hazard is not extreme," sent a representative to Portland from its Division of Engineering. H. M. Huckeby arrived with a collection of communication maps for review by the Radio Laboratory that reflected a decided emphasis upon telephone use. The maps showed completed telephone plans for each National Forest in the Region, including wire hookups into Supervisors' offices and the Regional office. Radio was to be used "...only to get into the telephone line, rather than plan large hookups." When Simson asked about plans for future radio use in Region 2, Huckeby said that portable units capable of transmitting "20 miles would cover 90 percent of the cases." He declined further analysis. "We haven't used radio extensively, so I haven't much to report."[36]

Francis Woods said that the Ogden office in Region 4 was finding applications for vhf that suggested movement away from a heavy emphasis on telephone. "We have lookouts," he reported, "on the Challis, Salmon and Idaho Forests, that see from 20 to 70 other lookouts. Uhf (vhf) could fill that need and also give us about 85 percent coverage of the entire Forest." Woods thought that Region 4, unlike Region 8, would not "have much need for mobile units for fire control."[37]

Region 6 Emphasizes Telephone

Region 6, which administered both Bill Claypool's Regional communications office and the Radio Laboratory, continued to place heavy emphasis on the telephone. "Our principal use," Claypool said of radio, "is in the extension of our present telephone system and to supply certain lookouts that are manned for short periods, to which it would be unreasonable to build telephone lines." Claypool also reported that in applying this approach to radio, the Portland office expected that putting all communications on vhf would eventually be "technically possible." In response to the Region 1 criticism that obsolescence had previously made vhf investment economically impractical, Claypool responded in a manner indicating that the Portland office, while well aware of this factor, had not limited development because of it. "Limited funds for procurement, high costs of operation, and rather early obsolescence," Claypool countered, "had made necessary a very conservative Regional policy for radio utilization which normally prohibits extensive application for purposes other than fire control." In other words, because Region 6 was interested in vhf for purposes other than "large networks," it had found a significant niche for its use in fire control. In fact, Claypool stressed, "Most of our [radio] communication is uhf [vhf]."[38]

Gaylord Knight represented Region 8 at the conference. He had continued to function as the quasi-Regional communication engineer in Cleveland, Tenn. His attendance at the conference indicated that the Atlanta office was awakening to the possibilities of radio, even to the point of picking up the expense of his 2-week trip to Portland. The limited extent of Region 8 financial resources in the past was reflected in Knight's statement that "if we shifted to uhf [vhf], I believe we would almost have to stop radio at present because we haven't funds to purchase equipment." The few radios in the Region were hf, but the 30 to 40-MHz units probably could be useful because there were "intervisible lookouts where telephone was so expensive to maintain." Knight also believed that "our biggest need is for some better mobile equipment with a consistent 30-mile range..." The prevalent fire conditions in the Southern Region determined this need. He pointed out the importance of "twenty minute" speed in dispatching fire trucks to the scene. "If we didn't get to it in a hurry the fire could be out in the Atlantic ocean and half way back again," he later recalled with tongue in cheek.[39]

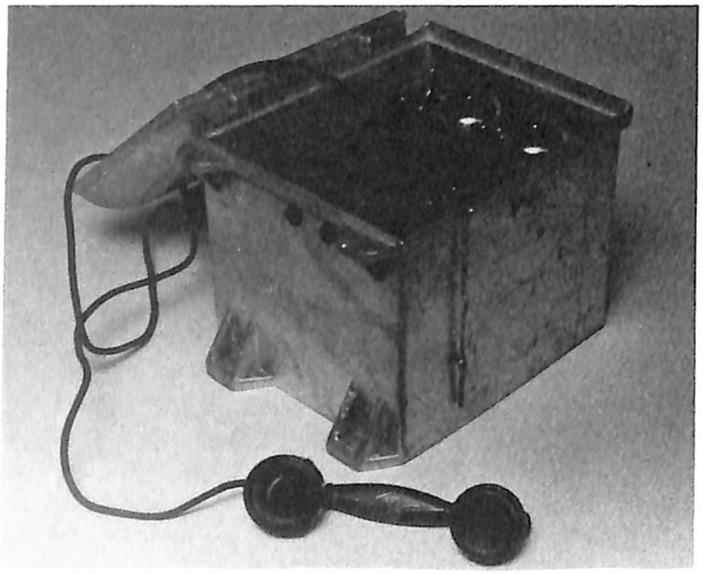


Figure 110. Lightweight aluminum field telephone case for a fixed location, a successor to the cast-iron model shown in figure 7. This was the A-1 model, dated 1932, made by the Kellogg Switchboard and Supply Company and used by the Forest Service. (Forest Service photo, History Section)

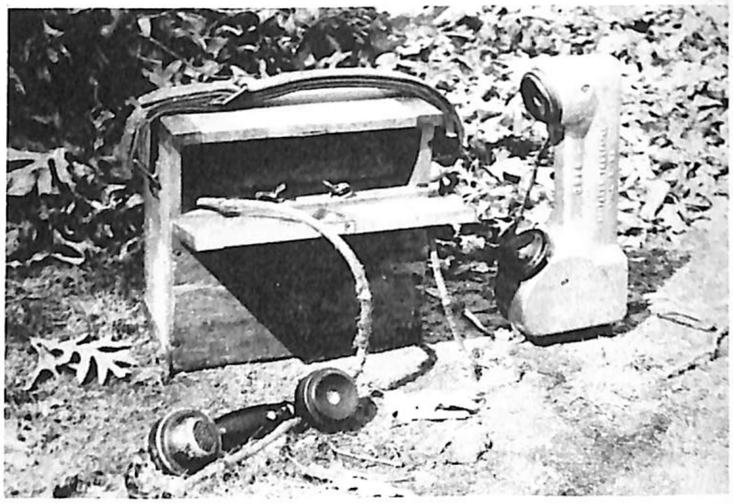


Figure 111. A strong emphasis on portability in communications began early on the National Forests. These Forest Service portable telephone handsets, made by Kellogg, were carried by Rangers and clamped to field telephone lines for use. Wooden box model (C-608) has a folding crank on the right side. The front is hinged to open down. This model, which dates from the late 1920's, was used through the 1930's. A more truly portable set in the modern sense, the aluminum model B-209 dates from the late 1930's and was used through the 1940's. It has an external contact for the telephone wire and two buttons to press--one to send a sound to alert the other party on the line, and one to press while talking. (Forest Service photo, History Section)

Figure 112. Portable S set being used by fire scout George Clisby on the Willard fire, Columbia (now Gifford Pinchot) National Forest, Wash., August 1939. (NA:95G-391295)

Both before the conference and again for several weeks after, the Laboratory staff worked through administrative channels to resolve the interference issue. The opportunity came when Region 1 brought out its plans for network improvement at the Ogden Fire Conference in mid-1940. During the discussion of communication systems, Region 1 outlined four substantial steps needed for complete implementation of the network concept:

1. Additional 3-MHz frequencies should be obtained.

2. New 6- to 8-MHz frequencies should also be obtained for daytime use, and the type M should be correspondingly redesigned for two-channel operation.

3. A 250-watt station should be approved for Missoula.

4. Region 1 should be authorized the use of permanent 50- and 100-watt stations in Supervisor's offices and Ranger stations.[40]

Gael Simson composed a lengthy memorandum for Earl Loveridge, and reviewed the Region 1 requests. On the first three points, there was little to discuss: additional 100-meter frequencies were "certainly needed, but there is little prospect of getting more frequencies." Action toward obtaining two 5.9-MHz telegraph frequencies was already awaiting IRAC approval. An unfavorable attitude by other Regions towards a 250-watt station on shared frequencies was well known.

On the fourth point, however, which represented the requirements for a Regional network, Simson said that this "engendered other implications" not directly related to technology. He questioned the economic benefits of radio over telephone by pointing out the large investment in equipment, salaries, and maintenance needed for a Regional radio network. Still another consideration was the IRAC-enforced Government policy that forbid use of radio where other satisfactory facilities were available. "Although I have no doubt there have been successful local departures from this policy by other agencies, the Forest Service has tried to maintain strict adherence," he wrote.

The A. T. & T. lease agreements posed another barrier. Abrogation of these leases would have been contrary to the wishes of "several of the Regions /which/ have placed a rather high cash value on this agreement..." Simson indicated that he would not be opposed to the Regional radio network concept if these policy issues could be resolved by the Washington Office. Meanwhile, he concluded, "There seems little point in going into the technical aspects until the policy phases have been evaluated."[41]

In spite of Simson's effort to force a policy decision from the Washington Office, Earl Loveridge sent a letter to Major Kelley, with a copy to Simson. The letter showed no evidence that Washington had more than a casual concern over the issue or intended to back off from its decentralized approach to Regional administration. "If a network is contemplated, it constitutes somewhat of a departure from our ordinary use of radio," Loveridge pointed out to Region 1.

Loveridge also included a copy of Simson's earlier memorandum for Kelley's review; it gave no evidence that Washington was remotely aware of the issues raised by Simson or Lawson. "The proposals for more powerful radio transmitters," Loveridge casually remarked to Region 1, "evidently raises questions of an administrative and policy nature." Then, in a gesture that threatened to set the issue back another year or more, Loveridge as Acting Chief, asked Region 1 to provide a host of network figures on transmitter locations, availability of telephone facilities, types of message traffic to be handled, importance of the network, and relative costs.[42]

Laboratory Personnel Study Region 1

Simson's response is not known. It would have been understandable had he thrown up his hands in despair over the words "somewhat of a departure" and "evidently raises questions." Instead, he sought to get his point across another way. He wrote to Headley and Loveridge on August 14, 1940 and volunteered, though the thought was not attractive, to go to Region 1 with Roy Headley. Loveridge declined the offer for both men, but expressed an elementary grasp of Simson's problem. "We appreciate at least some of the circumstances which made it distasteful for you to spend any more time in that Region looking into this matter, but also feel that regardless of how distasteful it might be to you a further exploratory trip would be made if you felt it would be worthwhile." Then, indicating for the first time that the Washington Office had misgivings over the Region 1 network concept, Loveridge noted, "We both feel that the Region should be required to get in line with established Service policy and the practice followed in other Regions..." This attitude was tempered with concern that Region 1 be offended by its loss of autonomy. "Denial of the radio network will make Region 1 feel we are not appreciative of their needs and are being obstructive," he cautioned Simson.[43]

Simson had already concluded that a definitive policy from the Washington Office would be some time in developing. In one last attempt to demonstrate the value and application of vhf to Apgar, he sent Lawson and Carl Davis to Region 1 to review Missoula's plans and needs. Lawson and Davis spent 2 days reviewing the topography on several Region 1 National Forests during the second week in July and the other 5 days observing KBCX operations, holding discussions with Apgar, and conducting vhf experiments.

Lawson presented his trip report in a lengthy, six-page memorandum. This report showed Lawson as decidedly impartial in his approach. He did not go to Missoula with preconceived notions. Neither did he attempt to defeat the proposal by defending either A. T. & T. agreements or IRAC policies. Instead, he considered Region 1 needs and plans entirely on merit. Simson would later point out, "It will be noted that Lawson's memorandum is purely technical and his conclusions and comments are purposely based entirely on technical considerations and without reference to policy."[44]

Lawson agreed with Apgar's observations on a number of points. If, for example, the network concept was approved, the power of KBCX should be increased to 500 watts on an exclusive 3-MHz channel, or provided a 50-meter (6-MHz) frequency with a 50-watt transmitter. Lawson noted that Region 1 had obtained "reasonably exceptional performance" with Radio Laboratory sets even though they were not designed for network distances. Lawson attributed this to "...a very excellent system of maintenance, personnel training, and an exceptionally fine operating procedure." Pointing out the ineffectiveness of mobile transmitters spread over distances of 250 miles between the widely scattered units in the Custer National Forest, Lawson also noted the technological problems associated with developing 3-MHz mobile equipment for those distances and instead recommended 50-meter mobile sets at 20 watts.[45]

Lawson also reviewed his analysis of vhf use in the Region. He knew from information obtained during topographic inspections of the Lolo, Helena, Deerlodge, and Bitterroot National Forests, as well as experience in the Coeur d'Alene, Clearwater, and Flathead National Forests, that there were few, if any, "outstanding topographic prominences, and that most peaks are about the same elevation." He pointed out this was not an obstacle to vhf use and that there were "...no unusual conditions or physical obstacles to prevent the intensive use of ultra-high frequency /vhf/ in the Region.

To support this conclusion and to illustrate "the possibilities of ultra-high frequency /vhf/ along the fire line and for scouting work," Lawson arranged a test along O'Brien Creek west of Missoula. The results indicated "...that non-intervisable /sic/ points can intercommunicate and that a small amount of technique, to be gained through experience with such equipment, can be applied to gain a very high degree of reliability." He also noted for the record that this experiment, "together with a topographic profile, was recorded by "Mr. Apgar," and said in summary:

> There are numerous places on all Forests in the Region where ultra-high frequency /vhf/ can be used to advantage in place of long-haul telephone circuits which serve only two or three isolated lookout points. The development of automatic relay equipment for ultra-high frequencies /vhf/ will open and enlarge such possibilities to a point where much of the present 300 kc (3 MHz) radio equipment may be retired from point-to-point service.[46]

Lawson offered one further suggestion to upgrade 3-MHz installations in places with power lines and other forms of local interference. He recommended remote receivers, a contribution made by Bill Claypool in Region 6 for these kinds of locales.[47]

If Lawson's approach to the issues dividing the Radio Laboratory and Region 1 may be characterized as fair, it is considerably more difficult to conclude that the Regional office in Missoula responded the same way. In fact, the Missoula arguments toyed with truth. Arguing that "the Regional policy has called for the discontinuance of radio on all lookout points as rapidly as satisfactory telephone service can be provided," and then contradicting this with the statement that the "network is desired to relieve an over-burdened telephone system," the Region told Lawson that vhf had no application because "the Region did not wish to consider a duplication of communication where telephones already exist."[48]

Given the past history of radio use in Region 1, it is difficult to give these claims much credence. Indeed the lengths to which Region 1 would resist the Laboratory philosophy of low-power portability for the fireline in the interest of its network concept are reflected in one cogent example. After insisting that portables have sufficient power to transmit consistently up to 100 miles, Apgar and the chief of fire control in Region 1, Otto Lindh, expressed a "...desire for an extremely compact smokechaser radio unit to weigh about 5 pounds..."[49] Since in 1940 halving the batteries also halved the weight, this design goal would have produced a unit with less than one-watt output. This was in stark contrast to Apgar's objections to reducing the output power of the 2 1/4-watt SPF to 1 3/5 watts, and the fact that this popular 3-MHz semiportable weighed about 20 pounds.

At the 1940 radio conference, Bill Apgar, attacking what he persisted in calling the "worthlessness" of current Laboratory-designed Forest Service radio equipment, argued against vhf use. By this time, Region 1 had a considerable investment in high-powered 3-MHz radio for its "17 Forest radio networks" and could not alter its course without significant economic loss, if not embarrassment.[50] The degree of difference between the advocates of radio for the fireline and the Region 1 network plan was also succinctly underscored in an exchange of dialogue at the conference. A question from Bill Claypool led Apgar and Funke to respond in diametrically opposite fashion, as follows:

Claypool: Do you take portable sets out on the fireline?

Apgar: Ordinarily a fire chief will not want to be hampered with it. If communication is necessary, we might send a set together with a high-powered generator. We have not tried uhf /vhf/.

Funke: In our Region no man wants to go out without an S set /vhf/ along with him.[51]

Apgar was also instituting a revision of his Regional communication plan at this time. It would have assured another 5 years of conflict over the power issue. With the Radio Laboratory professing "...that inter-Regional radio interference will be almost completely eliminated with the use of ultra-high frequencies /vhf/,"[52] and Region 1 arguing that "the 3000 kc band /hf/ is the mainstay of radio communication...,"[53] the two sides had reached an impasse. Only a third party could resolve the issue.

Region 1 Ordered to Reduce Power

It is not known why Earl Loveridge dropped his earlier concern over "obstructing" Missoula and decided to take a stand. He may have been motivated by a number of factors, including mounting A. T. & T. complaints over violation of the telephone lease agreement, threats from IRAC and the Navy if the Forest Service continued to exceed the regulated power limits, the knowledge that Region 1 was forcing the Forest Service toward a conflict with commercial manufacturers of fixed-base radios--or a combination of all three. More than likely, the major impetus for change accompanied the appointment in late December 1939 of Earle H. Clapp as Acting Chief Forester.

Clapp apparently had less fear of offending recalcitrant subordinates than did his predecessor, Silcox. He would "...chastise the field men for too often deciding for themselves whether or not they were going to follow orders..."[54] Loveridge subsequently complied with this new approach. He wrote to Major Kelley:

> It is my understanding that the Missoula station was built locally and that it has a power greatly in excess of that authorized to the Forest Service except on one frequency.

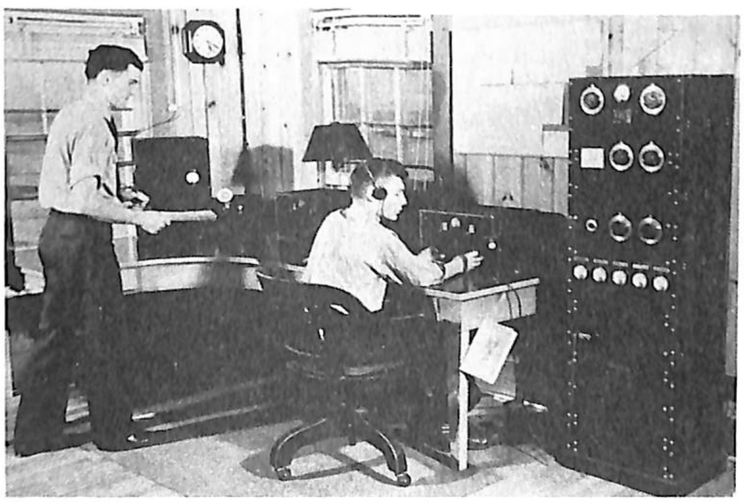


Figure 113. Allen Thompson and Jeffrey Geiser, right, operating KBCX, the Northern Region control station at Missoula, Mont., in 1937. William Apgar's powerful "home-brew" transmitter is the floor model unit at far right. The Region was ordered by the Washington Office to reduce its power in January 1941. (Forest Service photo, History Section)

> Your violation of the power limit authorized to the Forest Service is a source of considerable embarrassment to this office. Had you procured the transmitter in the prescribed manner...this would not have occurred.
>
> Henceforth, it will be appreciated if you will follow established policies in radio matters as I know you do in other activities.[55]

It was probably not a happy day in Missoula when Loveridge's communiqué arrived. Overlooking the technical issue of radio use for administrative management, Apgar had focused on the question of who was in charge of Regional matters. He had allowed his opinions to degenerate into personal attacks. He then became handicapped by his view that Portland's opposition to his ideas was "just pure and plain stubbornness" brought about "because they hadn't thought of it themselves." Region 1 would continue to ignore such technical improvements of vhf because of the network emphasis on

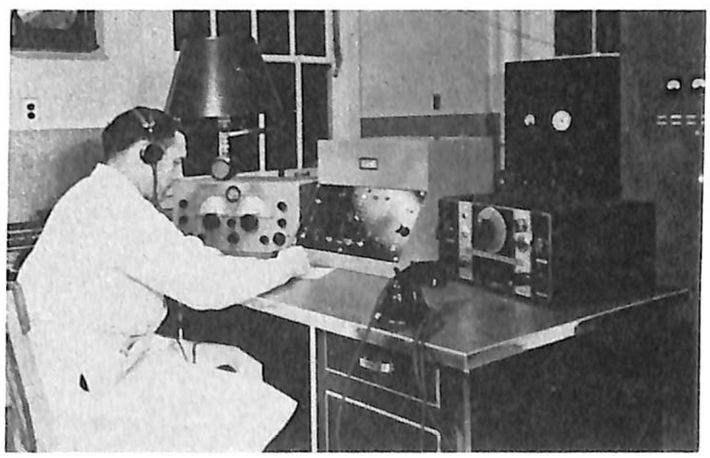


Figure 114. Carlton Brown at the console, designed by Logan Belleville, of Station KBAA, Radio Laboratory, Portland, Ore. This 250-watt transmitter was also ordered to a lower output. (Forest Service photo, History Section)

hf and Apgar's conviction that vhf was "kid's stuff" brought out by the Laboratory as "something new they hadn't fooled with." Frustrated by radio specialists who did not conform to his concept of Forest Service traditions, he lashed out at "Horton's Hobby Shop" because the men who worked at the Radio Laboratory "weren't Forest Service types."[56]

Francis Woods had also supported higher power. "We went out on a limb to prove it, and I think Apgar and I succeeded, he later reflected. But Woods would not politicize his opinion or overemphasize the importance of the issue. Neither did he let a difference of opinion distort his attitude towards the Radio Laboratory and its work. Instead, he would agree that the limitations on power allowed them "to get along pretty well" on their own. "I was in awe of Lawson," he later recalled, and did not press the issue.[57]

The tone of Loveridge's memorandum indicates that the Washington Office did not originate or encourage administrative radio in National Forest management. Until then, it was not clear whether the Washington staff members resisted giving direction to the development of network communication policy because of their attitude towards decentralization or because they actually wanted to encourage it. By ordering Missoula to cease and desist, they finally made it obvious that the network concept was entirely the brainchild of Region 1. Kelley, Stockdale, Thieme, Strong, Fickes, and Apgar represented the upper echelons of Regional management and first conceived of a use for radio that would extend their authority into the furthest reaches of the National Forests. The tasks normally delegated to Forest Supervisor, District Ranger, Fire Boss, or Forest Ranger could now be influenced from Missoula at will. Advice and direction would be provided, whether it was requested or not.

Radio mocked distance and isolation even more than did the automobile. Before its introduction, the Ranger was expected to be proficient in a wide range of forestry skills. His measure was the ability to perform the many duties associated with timber scaling, fire control, road construction, and timber planting. Even if the demands occasionally taxed a Ranger's abilities, the Forest Service system compensated by allowing for the exercise of personal opinion and some individuality. In a single stroke, however, administrative radio swept aside the freedoms associated with these responsibilities, obliterated the gap between line and staff personnel, and rudely ushered in the age of specialization. The Ranger was no longer expected to become proficient in all phases of forest management. Specialists with expertise in silviculture, engineering, firefighting techniques, or even landscape architecture, could now go into the woods, figuratively if not literally. If Rangers came up against situations beyond their ability, the advice of other experts could be solicited by reaching for the nearest microphone. The possibilities for standardization were endless.

A certain irony is associated with the Missoula office's discovery of the portent of administrative radio for the Forest Service. Perhaps no other Region clung so tenaciously to the right of self-determination. Indeed, Region 1 was ready to defend the principle of decentralized control against the Washington Office down to the last breath. But it refused to apply decentralization to its own Regional forest administration.

Ironically, too, Bill Apgar was one of the first casualties of the system he had so eagerly helped to create. The appearance of specialists, or men whom he believed "couldn't tell a cow from a goat," offended both his self-image and his perception of the Forest Service. Adhering to his belief in the value of rugged individualism, Apgar eventually chose early retirement rather than adjust to the change and compromise his principles.[58]

Before this happened, however, the necessity for a showdown between the advocates of radio for administration and those of portable radio for fire control reached the point where the Washington Office was forced to act to protect its longterm responsibilities. By 1941 all of the Regions were ready to become involved in the issue. But World War II made the issue moot, at least for the duration. By the time the war drew to a close 4 years later, technological developments changed the issue. It would be resolved only when the Washington Office decided to change completely the administrative structure of the radio development program.

Reference Notes

1. L. S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington, D.C.: Government Printing Office, 1963), p. 66.

2. F. V. Horton to Roy Headley, 26 January 1934, Gaylord A. Knight Collection.

3. U.S. Department of Agriculture, Forest Service, "Forest Service Communications Conference," Portland, Ore., 20 February to 2 March 1935, Gaylord A. Knight Collection. The 1935 conference discussed such subjects as new equipment, needed improvements in equipment, maintenance and servicing, adjustment of apparatus, special installations, noise suppression, and the training of personnel in the use of radio. See Roy Headley to Regional Forester, 5 February 1935, Gaylord A. Knight Collection.

4. Alfred S. Crebbin to the Chief, 16 April 1936, Gaylord A. Knight Collection.

5. H. K. Lawson, "Memorandum for Files, 2 November 1939, Gaylord A. Knight Collection.

6. A. R. Standing to Regional Forester 26 July 1939, Gaylord A. Knight Collection.

7. Lyle F. Watts to Regional Forester, 16 August 1939, Gaylord A. Knight Collection.

8. Simson, "Role of Radio in National Forest Communication," 11 April 1935, typed, Gaylord A. Knight Collection.

9. Francis Woods, interview with the author in Ogden, Utah, January 1978.

10. W. B. Apgar, interview with the author in Sun City, Ariz., January 1978. A confidential version of this was published for joint Forest Service/ Weather Bureau use in 1942. See *Interdepartment Fire Vocabulary Code, WB-11* (Washington, D.C.: Weather Bureau Office, 1942), mimeographed, Gaylord A. Knight Collection.

11. E. W. Loveridge, "Memorandum for Mr. Horton," 22 October 1935, Gaylord A. Knight Collection.

12. Loveridge, "Memorandum for Mr. Horton."

13. F. V. Horton, "Memorandum for Mr. E. W. Loveridge," 31 October 1935, Gaylord A. Knight Collection.

14. Carl Ewing to Forest Officers, 7 December 1938, Gaylord A. Knight Collection.

15. F. V. Horton ("dictated by HKL /Lawson/ over phone") to Regional Forester (R-5), 20 December 1939, Gaylord A. Knight Collection.

16. A. G. Simson, "Memorandum," 27 January 1939, p. 4, Gaylord A. Knight Collection.

17. R. L. Deering to Regional Forester (R-6), 12 December 1939, Gaylord A. Knight Collection.

18. Lawson, "Memo," 12 December 1939, p. 1, Gaylord A. Knight Collection.

19. D. S. Nordwall, "Memorandum for the Record-Radio Laboratory Inspection," 24 March 1947, p. 2, Gaylord A. Knight Collection.

20. Ewing to Forest officers.

21. Woods, interview with author. Woods reported that Apgar purchased several of the Hallicrafters for Region 1. Woods also purchased an English-made Phillips frequency meter. This action was in direct violation of the ban on foreign purchases. This, too, was overlooked.

22. Apgar, "Radio Report-1933," 27 February 1934, typed, p. 12, Gaylord A. Knight Collection.

23. W. B. Apgar, "Radio Communication Report-1934," /n.d./ p. 5, Gaylord A. Knight Collection.

24. K. Wolfe to Regional Forester (R-1), 23 January 1934, Gaylord A. Knight Collection.

25. Apgar, "Radio Report-1933," pp. 10-12.

26. Evan W. Kelley, "Memorandum for Chief, Forest Service," 11 March 1936, pp. 2-5, Gaylord A. Knight Collection.

27. Apgar, interview with author. 500 watts was authorized for the military and Weather Bureau.

28. Apgar, interview with author.

29. A. R. Standing to Regional Forester (R-6), 26 July 1939, Gaylord A. Knight Collection.

30. Forest Service, Radio Laboratory, "Inter-Regional Radio Communication Conference-Minutes of Meeting," Portland, Ore., 2 December to 7 December 1940, p. 88, Gaylord A. Knight Collection.

31. Forest Service, Radio Laboratory, "Conference," p. 88.

32. Forest Service, Radio Laboratory, "Conference," pp. 81-91.

33. Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

34. A. G. Simson, "The Role of Radio in National Forest Communication," 11 April 1936, typed copy, p. 2, Gaylord A. Knight Collection.

35. Fred Funke, "Communication Planning" (Paper presented at the Inter-Regional Radio Communication Conference, Portland, Ore., 2 December 1940. See Forest Service, Radio Laboratory, "Conference," p. 21.

36. Forest Service, Radio Laboratory, "Conference," pp. 3, 4.

37. Forest Service, Radio Laboratory, "Conference," pp. 2, 9.

38. Forest Service, Radio Laboratory, "Conference," pp. 6, 7, 11.

39. Forest Service, Radio Laboratory, "Conference," pp. 7, 8 and Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, April 1979.

40. Earl W. Loveridge to Regional Forester (R-1), 15 April 1940 and A. G. Simson, "Memorandum," 30 March 1940, both Gaylord A. Knight Collection. The Laboratory had constructed a prototype MX (Medium-power experimental) for experimental use on 5,902 kHz.

41. Simson, "Memorandum."

42. Loveridge to Regional Forester (R-1), 5 April 1940, Gaylord A. Knight Collection.

43. E. W. Loveridge, "Memorandum for Mr. Simson," 21 August 1940, Gaylord A. Knight Collection.

44. A. G. Simson, "Memorandum for Mr. Loveridge," 26 August 1940, Gaylord A. Knight Collection.

45. H. K. Lawson, "Memorandum for Files," 23 August 1940, p. 4, Gaylord A. Knight Collection.

46. Lawson, "Memorandum for Files," p. 5.

47. Lawson, "Memorandum for Files," p. 3.

48. Lawson, "Memorandum for Files," pp. 1, 2.

49. Lawson, "Memorandum for Files," p. 1.

50. Forest Service, Radio Laboratory, "Conference," pp. 1, 33.

51. W. B. Apgar, "Operating Procedure and Operator Training" (Paper presented at the Inter-Regional Radio Communication Conference, Portland, Ore., 2 December 1940.) See Forest Service, Radio Laboratory, "Conference," p. 40.

52. F. V. Horton to Regional Forester (R-5), 20 December 1939, Gaylord A. Knight Collection.

53. Evan W. Kelley to Mr. [Lyle] Watts (R-6), 5 November 1940, Gaylord A. Knight Collection.

54. Harold K. Steen, *The U.S. Forest Service: A History* (Seattle: University of Washington Press, 1976), p. 234.

55. E. W. Loveridge to Regional Forester (R-1), 2 January 1941, Gaylord A. Knight Collection.

56. Apgar, interview with author.

57. Woods, interview with author.

58. Apgar, interview with author.

Chapter XII

Communication Bridges:

World War II and the Aircraft Warning System

And now let me say, again, that I am happy to be back in the Forest Service. I believe in it, and in the fellows who are in it, so much so that I'd be perfectly willing to take this gang to South Africa, or Rhodesia, and build a railroad, or anything else.

- Chief Forester Silcox[1]

The most obvious wartime changes in the Forest Service came from the call to arms. Shortly after the declaration of war, Gael Simson accepted an appointment as colonel and administered frequency allocations for the Army. Logan Belleville joined the radar receiver research group at the Massachusetts Institute of Technology (MIT), and Earl Schoenfeld went to RCA. The loss of Harold Lawson was averted only after Associate Regional Forester F. H. Brundage warned the Washington Office that it was "...impossible to replace Lawson unless you wish to discontinue Radio Laboratory and all its work except service and repair of equipment..."[2]

Effects were widespread. Throughout the Forest Service, abrupt orders suddenly removed key figures and thrust new men into their places. Major Kelley, for example, left Region 1 to head a Forest Service southwestern Guayule (rubber production) project. Bill Apgar accepted a commission as a lieutenant commander in the Navy.

The most significant change wrought by the war resulted from plans to protect the Nation from attack. One afternoon in Atlanta, before Gaylord Knight even had a chance to reflect on the course of world events, his supervisors entered the communications office to tell him that Region 8 was assigned the task of providing telephone communications for an Aircraft Warning System (AWS) along the Atlantic and Gulf coasts between South Carolina and the Texas-Mexico border. Reflecting on the condition of many Forest Service telephone lines that had been neglected for 2 years, Knight shook his head. "They got very agitated," he was to remember with a smile, "and thought for a moment that the best thing they could do was to throw me out to start with." Three hours later they all left on an evaluation trip that confirmed Knight's earlier opinion and kept him on the road for the duration of the war.[3]

Earlier Trials on Pacific Coast

The assignment of the AWS project to the Forest Service was no less logical than growing guayule for rubber. In both cases, the "gang" was being asked to build what Chief Silcox had earlier referred to as "anything else" during his 1934 remarks at Ogden.[4]

One difference between the two projects was that the Forest Service had been introduced to the AWS in mid-1937. At that time, the Army successfully used Region 5 telephone network and lookout stations for practice warnings of aircraft approaching the coastline. The national defense capabilities of the National Forest fire-control facilities were demonstrated, and this exercise was repeated along the entire Pacific Coast during 1939 and 1939.[5] Thus, the Forest Service had an idea of what would be required of them in a national emergency. In fact, the Forest Service had provided the Army complete maps of lookout locations and communications facilities in a continuing preparation for use of the system at a later date.

Following the declaration of war, the Secretary of War wrote to the Secretary of Agriculture outlining the expected operation. The interceptor commands would first review the proposed Forest Service locations and then notify the Regional Foresters of the lookouts to be made habitable for year-round use; this included winterizing where necessary. Maintenance funds, necessary improvements, and personnel would be provided by the War Department after it received estimates from the Forest Service.[6]

This transition from fire detection to aircraft detection appeared to be fairly straightforward; in actuality, there were many problems. Although William P. Kramer had replaced Roy Headley as head of the Office of Operation in Washington, the complexities of radio science continued to be misunderstood. One example illustrates this point. The Radio Laboratory and Regions, 5, 6, and 8 had been informed of their AWS assignments. The lack of suitable communications in the arid, underpopulated Southwest had led the Army and Region 5 to conclude that a number of spotters equipped with Forest Service vhf radios and strategically situated relay repeaters would serve as an adequate network for communications with Army filter centers. To set up this system, Region 5 asked the Radio Laboratory to send several staffers to Government Island to train technicians on installation and maintenance procedures. Reviewing its schedule, the Radio Laboratory meanwhile requested Washington Office approval for a number of changes in emphasis more in line with AWS requirements. One request was in support of Region 5's plan to hold an electronics school at Government Island.[7]

Training Program Proposed

William Kramer responded to the proposal in a return letter to Region 6. He doubted the feasibility of sending Laboratory staff to Government Island to run an electronics school. He stated bluntly: "I think it is the function of the Laboratory to train trainers rather than impair its own program by conducting field training school." Harold Lawson telegraphed San Francisco, through the Regional Forester, of both the disapproval and Kramer's suggested alternative that Region 5 send one man to Portland. "This should be satisfactory if you have one man with fundamental radio knowledge and some experience. Otherwise we will request Washington Office to reconsider."[9] Region 5 resubmitted its request to have men trained at Government Island because it lacked the "one man" qualified "both as to technical experience and teaching ability."[10]

Before the San Francisco letter reached Washington, F. H. Brundage of Region 6 composed a lengthy re-review of the work schedule changes suggested by the Radio Laboratory. He pointed out to Kramer that none of the proposed trainees had a background in radio technique or theory. Training would have to begin with the fundamentals. "This is an unfortunate situation," he pointed out, "for top grade service men cannot be made from such material in two weeks or even in two months." Confident that the Washington Office would appreciate the special qualities required to teach the complexities of electronics, he suggested that Region 5 be authorized to hire someone with radio experience for the special training in Portland. "To attempt to train an inexperienced man and expect him to pass on what he can remember," Brundage emphasized for Kramer's benefit, "would seem to be an extremely poor way of training the larger group."[11] Kramer telegraphed his reply to San Francisco two days later:

> UNDESIREABLE STRIP LABORATORY OF THREE PRINCIPLE /SIC/ TECHNICIANS FOR INSTRUCTION PROGRAM YOUR REGION. SUGGEST ALTERNATIVE YOUR SENDING TWO OR THREE MEN TO RADIO LABORATORY FOR SHORT INTENSIVE COURSE THERE WHO IN TURN MAY TRAIN YOUR FIELD TECHNICIANS.[12]

Region 5 agreed and informed the Radio Laboratory that it would send Fred Funke, William "Bill" Williams, and Guy Wood, subject to Portland's approval. Anxious to get the program underway, the San Francisco office set a tentative starting date for 5 days later and suggested that "...it will probably take two weeks for this group to secure even a reasonable grasp of the program." Region 5 also proposed that the Radio Laboratory staff prepare a thorough introduction to radio fundamentals and repair procedures for their telephone engineer, Bill Williams, as he "has little knowledge of radio, and whatever program is designed by the Laboratory group should be based on this information since we would like to give him an opportunity to secure as much training as possible along these lines."[13]

Harold Lawson responded. Irked at the cavalier attitude displayed by the Washington Office towards the Laboratory's plight as well as the complexities of radio science, he expressed his concern over training inexperienced men to train other inexperienced men. The following handwritten note to Jack Horton reveals Lawson's 10 years of frustration over the administration of the Laboratory program:

> This business of long distance control of the WO /Washington Office/ of details on which they are not prepared to render a decision is irksome. Maybe I'm just getting my teeth cut--perhaps it's an old story.
>
> Sending men to the Lab certainly does not save an appreciable amount of our time. We will still tie up two men for instruction. The third man proposed for the trip to Govt. Island was not on Lab staff (Claypool).
>
> The real joker in this whole setup is the fact that at least two of the R5 men, Funke and Williams (don't know about Wood) are not even remotely prepared to assimilate technical instruction on the details of radio servicing.
>
> If these fellows remember 50% of what we try to put across they will be doing exceptionally well. By the time that is reduced in passing it along to another unprepared man the net result will be a 100% mess.
>
> All of the above may seem to be rather extreme exaggeration--a reflection on the teaching program or the mentality of the student. Radio service men just aren't made in one easy lesson, not even mediocre ones.
>
> In view of the above and with the authority vested in R6 for administration of the radio project (see Loveridge's policy letter O, Special, Radio, R6, of April 29, 1937) I recommend that the Laboratory conduct the school at Government Island or decline any part in the program.[14]

Harold Lawson need not have been concerned over the subsequent veto of his recommendation,[15] for the needs and demands of the AWS completely restructured the program of the Laboratory in a way that could not have been foreseen during the early weeks of the war.

Telephone Lines Improved in the South

Gaylord Knight found the telephone construction project in the Southern Region less fraught with administrative complications. His task was to oversee the improvement of telephone lines to selected lookouts, construction of feeder lines from strategic coastal locations to the nearest existing commercial line, and tie-in of the system to filter centers at several major inland locations. He was in charge of a number of active and retired telephone employees and personally supervised much of the construction undertaken by the States, planning and reviewing the completion of some 3,000 miles of line in 6 months. The line stretched from Norfolk, Va., down the coast to the tip of Florida, and around the Gulf to the southern tip of Texas. When wartime shortages threatened completion at several points, a telephone call or a conversation with the right person always seemed to result in the appearance of a carload of wire at the proper railroad siding. The States received Federal funding for maintenance of the system when it was completed, but Knight spent the rest of the war years inspecting the lines under the authority given the Forest Service by the Secretary of War.[16]

Operation of the telephone segment of the AWS was straightforward. To relay a message, the observer cranked the phone, picked up the receiver, and said, "Flash." In that brief moment, the operator would "push two buttons" and the observer's words would be immediately routed to the filter center. The goal was 15 seconds between sighting and reporting, so the center had to be brief. A "Thank you" was the only indication that the observer's message had been received.[17]

Bill Claypool in Region 6 was able to rely on the existing network of telephone lines, selected vhf radio-equipped lookouts and special repeater stations for the northwestern portion of the AWS. The Claypool residence took an active part in the operation after Claypool terminated the system in his home and connected the link to the filter system with a telephone line.[18]

Operating fire lookouts in the winter was a new experience for Region 6. Ice and high wind plagued observers at elevations over 5,000 feet. "If we were lucky," wrote H. J. Andrews, "we simultaneously had one crew going in, one crew manning the tower, and one crew coming out." Not only did men resign under these conditions, but the Region also learned that aircraft observers could not hear or see airplanes during inclement weather. These stations were closed in favor of more temperate locations after the second season.[19]

The California AWS north of Los Angeles was similar to that in Region 6, while the less-populated areas of the desert Southwest were eventually covered with vhf observer stations and repeaters. Guy Wood was assigned the task of locating these remote sites and placed on permanent assignment from the Sequoia National Forest. He crisscrossed the desert to verify the transmitting and receiving potential of over 100 sites proposed by the Army, returning to supervise the installations.[20]

"It is going to be a tough job but /I/ think we can do it," he wrote to Lawson.[21]

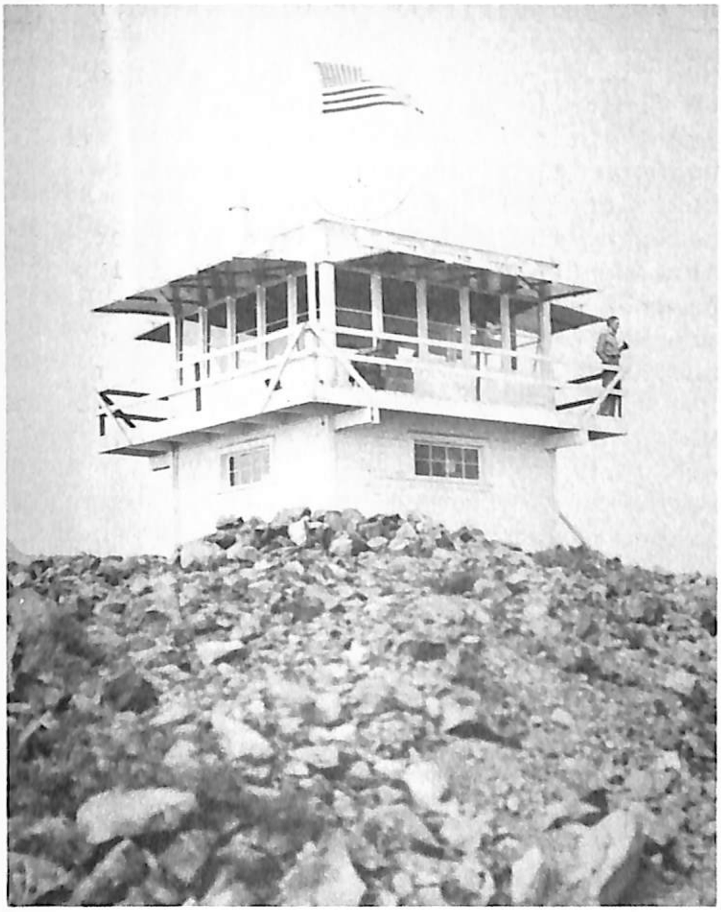


Figure 115. The Forest Service's networks of lookouts throughout the country, developed and perfected over the years for efficient fire detection and control, provided an excellent working system for another emergency during World War II--the Army's Aircraft Warning System (AWS), later called a Service. The lookouts were ideal observation points from which to spot enemy planes. Having telephone and radio links with Ranger Districts, and National Forest and Regional headquarters, they provided the rapid communication needed by the Army to perform this essential function. Shown here is Burney Mountain Lookout, Lassen National Forest, in northern California. Photo was taken in 1936. (NA:95G-342262)

The time required for site selection, preparation, and installation delayed Wood's completion of this portion of the AWS. Simson wrote to ask if the Forest Service would be interested in putting the network on 41-49 MHz. The technical aspects of his question were not as difficult to answer as was his suggestion that the Radio Laboratory respond "quickly and confidently." The process of making frequency tests at the locations was time-consuming and when told of the time limitation, Fred Funke complained of Simson's lack of consideration for his former workmates. He asked of Lawson:

> What the heck does he think we do, just fly around from peak to peak and say 'here she is?' There is one world of work attached to such a job. Must examine sites--plot detection coverage, estimate road or trail job, moving of equipment to do job--housing of work crew --source of water supply--local source of building materials-- estimate cost of materials and labor for shelter, etc.,--then if all that seems O.K.--figure out about 4 stations to the net.

Funke then added as an afterthought, "This is just a little beef--pay no attention to it."[22]

The Southern Region operated the telephone AWS until the end of the war in Europe. The southwestern AWS radio network, however, was disbanded shortly after completion in 1944. The success of radar research and development, including the work at MIT to which Logan Belleville was assigned, made the post-reporting method obsolete on the West Coast.[23]

Modified T/D, RRS Sets Used

The Army decided on modified versions of the Forest Service T/D and RRS units for the AWS. The Radio Laboratory immediately began work on the revised editions and had models near completion by late March 1942.[24] The relay unit was housed in a 37-inch cabinet sufficient for dual transmitters and receivers and designed to include automatic radio control, remote telephone control, and carrier-controlled automatic switching.[25] The T/D, renamed the type T model E (T/E), was modified to incorporate a timed switching device that permitted simultaneous standby on two channels; it could lock on to a detected signal on either channel.[26] The use of AWS units on the Forest Service 30- to 40-MHz frequencies was expected to create further interference for fire control. As Funke explained when he wrote to Lawson: The "soup" was "thick down here" from the police, the Navy, "the Clumsy Callen Clue [CCC] til the cows come home," the walkie-talkies on the artillery range, and the military mobile units.[27] But suggestions to move to 224 MHz in order to pass over this interference were not approved.[28]

The Army Air Corps was originally expected to require at least 60 fixed-base stations and repeaters for the system. But the Radio Laboratory was warned that complications would arise covering every technical problem in the book. "Indeed," cautioned Region 5, "many of them were not found in the book."[29] In addition to the Army's under-estimate of the number of units needed, Guy Wood had no more than completed a detailed parts list for the radio repeater when he learned that only a unit description was needed for Army procurement. The authority to purchase parts had to go through time-consuming Army Air Corps channels because the Forest Service had a lower priority number for acquiring critical wartime components.[30]

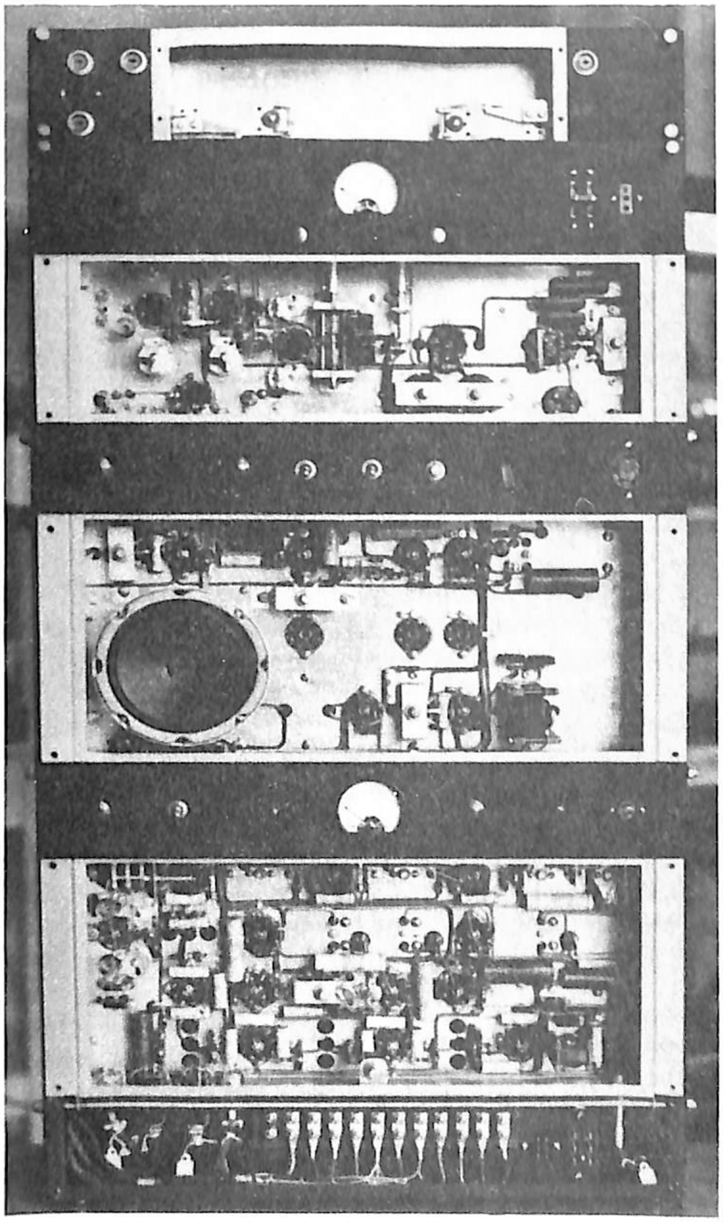
The most significant problem was finding a means to produce the units when "...it would appear that getting the equipment built by contract is almost out."[31] Harold Lawson suggested that the sets could be constructed at the Laboratory. Following the usual exchange of correspondence with Washington, it was then agreed that radio technicians from Region 5 would be sent to the Laboratory.[32]

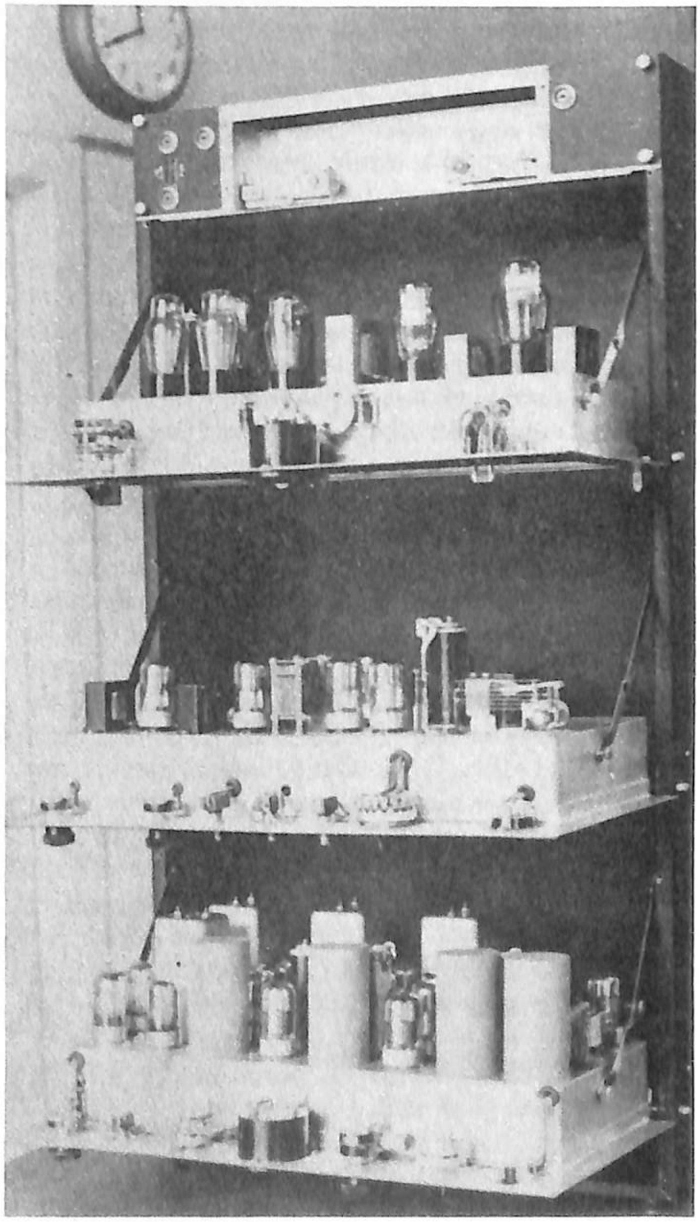
Fred Biggerstaff, the first California technician to arrive, found the depleted staff at the Laboratory already engaged in production. Within the next few months, in early 1943, he was joined by four or five other Region 5 technicians. "All of the fellows felt as I did. It was an opportunity we would probably not get again," he remembered. Shortly thereafter, eight local women were hired and the Laboratory was turned into a "miniature factory."[33] The special crew was discharged on January 4, 1944, after constructing, testing, crating, and shipping some 877 units. The breakdown was as follows:

Quantity	Type	Description
118	T/E	Dual channel transmitter-receiver combination.
32	U[-2]	Dual channel a.c. fixed station.
76	RC	Double relay transmitter-receiver combination.
107	RDR	Relay receiver.
101	RD-2T	Dual channel relay transmitter.
219	VPR	Receiver vibrator power supply.
224	VPT	Transmitter vibrator power supply.[34]

The type TE (Tin Ear) enemy bomber listening device was an unsuccessful Laboratory project, but the design of a radio packset for the Coast Guard shore patrols was successful. Unable to locate a suitable commercial or military set for their application, Lawson "within less than 30 days, had produced an original circuit design and supervised production of a working model..." The radio packset, operating between 2 and 3 MHz and weighing slightly more than 20 pounds, was reproduced for the Coast Guard by a commercial manufacturer.[35]

Figure. 116. Radio relay repeater sets for remote station locations, designed for use in the Army's Aircraft Warning Service during World War II. Photos on both right and left are from the production line at the Forest Service's Radio Laboratory, Portland, Ore. Forest Service technicians built nearly 900 of these units for the Army Air Corps during 1943. The sets operated in the 30- to 40-MHz range. (Forest Service photos, History Section)





SPF Set Used by Army, Navy in World War II

The Forest Service type SPF found favor in the military forces. The Navy ordered and presumably used the popular set between ships and gun fire control shore parties in the landings at Sicily.[36] The Army also used the SPF for a number of communication applications. Simson contacted the Radio Laboratory at least once for spare units after he learned the Army was having trouble with its radio units.[37]

Regions 5 and 8 also turned over a number of SPF sets to the Army during the war. In 1944 Region 5 took part in a unique vacation for "an old intimate friend" of many West Coast Forest Service personnel from the early aerial fire patrol days. Guy Wood was asked to provide radio communications for Henry H. "Hap" Arnold, Commanding General of the Army Air Forces, and General George C. Marshall, Army Chief of Staff. The two sought "a little mental relaxation" on a Sierra mountain fishing trip, just after the U.S. invasion of southern France. Wood kept them in contact with Army communication channels during the period August 28 to September 6. A few days later, Hap expressed his appreciation in a letter to Guy: "You did a grand job and I want to thank you for the communication that you furnished us with the outside world."[38]

Several communication lessons learned during World War II tended to support a later move toward 10-meter radio use in the Forest Service. The favored frequency status of the military on the 100-meter bank had emphasized the tenuous position of the Forest Service in devising communication plans on these frequencies. Shortly after the outbreak of hostilities, the Washington Office reminded the Regions of restrictions on use of 100 meters, pointing out, "The military may at any time require all three thousand kc /kHz/ frequencies for their exclusive use. Also, the military may at any time impose complete radio silence on all non-military stations below 30,000 kc /30 MHz/."[39] The Regions were again reminded of this priority 6 months later after the Army and the Navy filed a number of interference complaints. Region 5 wrote its officers the following reprimand:

> We wish to again remind you that:
>
> 1. The armed forces control the 3000 kc /kHz/ channels.
>
> 2. They can order us off the air or prevent our using M, SPF and similar radios for the duration.[40]

The prior claim of the military to this frequency range naturally evolved into a Forest Service policy to "use ultra-high frequency /vhf/ radios and telephone lines whenever possible."[41] It also resulted in the first breakthrough in the prohibitive lease agreements with A. T. & T. for use of administrative radio. The Forest Service had been limited, of course, by the policy that "radio will not be used to parallel existing commercial wire facilities except where those facilities are inadequate, unsatisfactory or undependable..."[42] Now it concluded that wartime priorities made the telephone, like the 3-MHz frequencies, "inadequate, unsatisfactory and undependable."

Region 5 was quick to perceive this, "Certainly, there is ample proof that commercial /telephone/ circuits, especially in critical defense areas are inadequate and the service unsatisfactory."[43]

With limitations on both telephone and 100-meter radio use, it was now possible to justify network communication. Within 38 days after the declaration of war, the San Francisco Regional office instituted plans for a 10-meter Regional network "...for emergency communication between National Forests and with the Regional office when commercial facilities become clogged due to National Defense activities."[44]

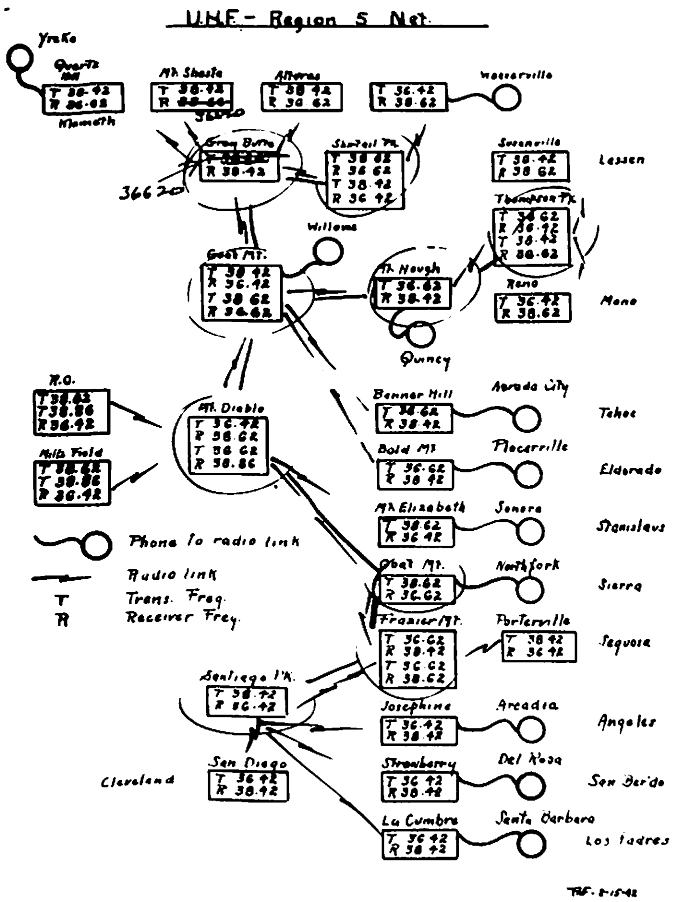


Figure 117. Working plan for 10-meter radio network in Region 5 (California, now Pacific Southwest, Region), February 1942. (Gaylord A. Knight Collection)

The status of Forest communication and radio maintenance was a frequent cause for anxiety during the war. The Radio Laboratory and the Regions were engaged in the AWS project, the Regional communication staffs were depleted, the CCC was disbanded, and wartime funds were seriously low. It was becoming increasingly apparent that much momentum had been lost since 1941. Even at the Radio Laboratory, the annual budget had progressively decreased from a high of $29,640 in 1937 to a low of $16,500 in 1945.[45] Regional purchases were low and even the Laboratory building "was sorely in need of a coat of fresh paint."[46] The Washington Office was worried about further deterioration in the telephone as well as radio communications setup. They decided in mid-1944 to review the situation. The Regional Forester in Portland was asked to appoint two inspectors.

Telephone, Radio Deteriorate in Field

Region 6 selected Raymond Conarro, head of administrative management in the Southern Region, and Harold Lawson of the Radio Laboratory to conduct the inspection. Conarro and Lawson selected 13 National Forests in Regions 1, 4, 5, and 6 for study, and contacted the Regional office staff, Forest Supervisors, District Rangers, and others who had direct contact with the communications systems. Their 14-page report was completed in August and found the systems in generally poor shape. Lawson and Conarro deplored the lack of a progressive Servicewide communications program; they found it encouraged "local attitudes" of Regional officers and Forest Supervisors to determine policies and practices that were "...most inefficient and unbusinesslike ...," considering the $8 million investment in telephone systems alone.[47]

In one Region, telephone lines were built to commercial standards; in another, construction and maintenance were based on piecemeal "patch and splice" using nonstandard operational procedures and a half-dozen homemade switchboards. Some systems were of excellent quality, but others were just a collection of wires and switches thrown together in a desk drawer. They found "hodge-podge, hit-and-miss" stores of line wire, pole hardware, insulators, drop wire, lightning protectors, underground cables, and other accessories. The wartime lack of funds had worsened the situation. Regions had to abandon or maintain lines strictly according to urgent need or budget. Maintenance, service, and reliability declined, and the time incurred in trouble-shooting increased proportionately. The inspectors noted that allowances for maintenance of ground-return tree lines needed to be increased by more than half, and more than seven times for metallic pole lines.[48]

Radio in the four Regions had fared no better than the telephone in the judgment of Lawson and Conarro. They believed as many as half the wartime technicians were incompetent. Much of the maintenance seemed to be of the experimenting and tinkering variety, where "in every case the equipment involved had been lessened in efficiency or the work was not pertinent and was primarily a matter of personal amusement." Limited by a lack of technical training and numerous equipment failures, field radio operators made improper use of equipment. The inspectors came across an SX set in a lookout station, while the appropriate T sets were aging in a warehouse. They did not say so, but perhaps this was because they found officers in charge of radio to be "definitely prejudiced" against radio use. "Throughout this Region," they concluded, "...radio is largely a plaything."[49]

Lawson and Conarro frequently found radio networks paralleling telephone

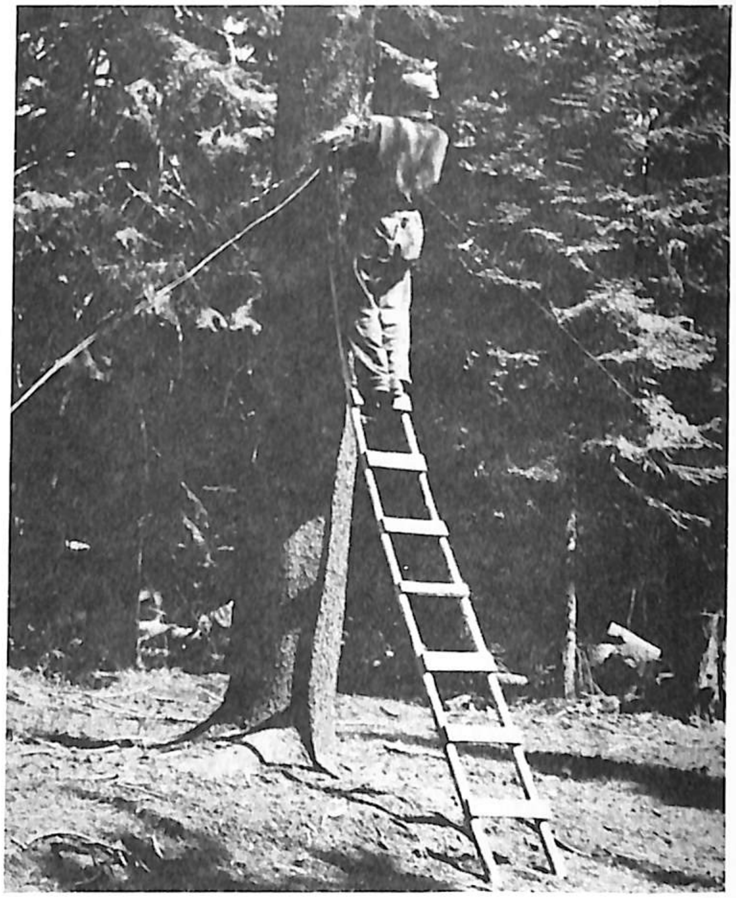


Figure 118. Civilian Conservation Corps (CCC) enrollee installing a single-wire, ground-return telephone tree line on the Columbia (now Gifford Pinchot) National Forest, Wash., in 1939. (NA:95G-380399)

lines and "long-haul telephone lines constructed where radio would have been more economical." Supervisors and divisional heads authorized Regional communications plans that should have guarded against unnecessary expense and duplication but failed to do so because they gave little thought to their attendant responsibilities. The oversight came from a lack of interest, ignorance of technical requirements, or because they automatically concurred in recommendations. As a result, communication plans often overlooked the basis for communication planning and were unbalanced, reflecting the particular opinions and prejudices of their authors. In this sense, Lawson and Conarro concluded, the plans would remain "worthless" until Servicewide conformity was required. Without such requirements, the Forest Service could expect not only inconsistent application, but--as in the four inspected Regions where two of the Regional communication engineers were assigned to Operation and two to Engineering--divided loyalties.[50]

The end of the war marked an end to nearly 4 years of quiescence in the Forest Service communication program. Nowhere was this more evident than in the radio design effort. The Radio Laboratory had been totally occupied in producing radios for AWS since January 1, 1943. Previous development and design programs had stopped, and Regional purchases had been limited by unavailable parts and other project priorities. Only 286 pieces of standard Forest Service radio equipment were procured and inspected by the Laboratory during World War II.[51] Before the war, this would have been the approximate total yearly purchases of Region 5 alone.

In all Regions, communication personnel returned from active duty and non-military assignments to find the communication program in total disarray. Radio units purchased before 1942 were in bad shape. "Many were non-operative and had been placed in storage," Gaylord Knight noted on returning to Region 8.[52] Others had been repaired by anyone around, and operated accordingly. All units were at least 5 years old, showed wear, and reflected obsolescence. Of the 2,937 radios in inventories, 688, or nearly one-fourth, were rated as "not effective."[53]

The 62,938 miles of telephone line[54] also posed a monstrous problem. The *Telephone Handbook* was obsolete, lines had not been maintained and many had been constructed or repaired by an overburdened staff.[55] They had deteriorated before their time and, without the CCC, threatened to remain that way unless they could be abandoned or sold.

The solution to the telephone problem would evolve slowly. But as Harold K. Steen remarked in his history of the Forest Service, "The war was the last hurrah for many forestry pioneers and brought a change of direction for American forestry."[56] The Forest Service telephone line was one of those pioneers.

The inevitable question--cost--was brought up at a meeting in the Atlanta Regional office. How much would it cost to rebuild Forest Service lines to commercial standards? Gaylord Knight, with 3 years' experience behind him, was asked to select a moderately difficult area, build a line to commercial standards, and report back on the associated costs. He selected a district on the Ocala National Forest and rebuilt some 250 miles in 3 to 4 months using Forest Service personnel and some "inexpensive conscientious objectors." The cost of that line has since been forgotten, but Knight recalled it was two to three times his estimate. The Regional administration agreed that costs of that nature were prohibitive. Someone suggested radio as a suitable long-term alternative. Knight was caught by surprise. Until now there had not been enough money for any long-range radio planning. From now on in Region 8, "...long-range was three days."[57]

Conditions at the Radio Laboratory were little better than those in the Regions.

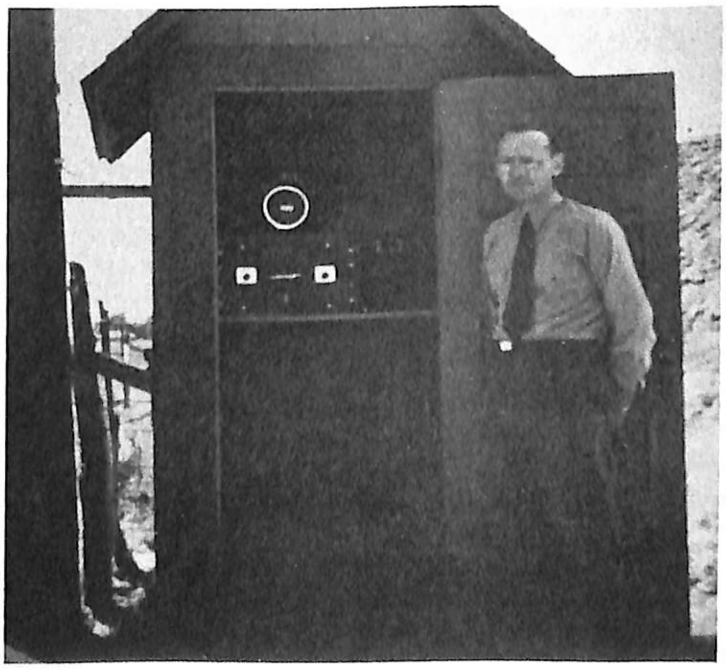
Jack Horton deplored the fact that "aside from one item of laboratory equipment purchased during the war period there has been no new or replacement instruments added for approximately six years." Observing that radio science had "long passed the rule of thumb design procedure stage" and higher frequencies "have simply obsoleted it," he recommended the immediate purchase of $1,500 for equipment and an allotment of another $3,800 for later purchases.[58]

Radio Laboratory Resumes Work

Fortunately, the Radio Laboratory lost only Gael Simson and Earl Schoenfeld after the war. Both remained in their new positions. Simson's former administrative role was assumed by Raymond M. Conarro, who remained attached to Region 8 but traveled with Harold Lawson on inspection trips when necessary. Logan Belleville returned to Portland after flirting with an offer to join Schoenfeld at the RCA laboratory.[59] With Lawson, Carl Davis, and Ralph Kunselman remaining, Belleville returning, and Fred Biggerstaff retained from the Region 5 AWS crew, the staff of five geared itself for the postwar era.

Biggerstaff's talents proved invaluable as technology brought further changes. A Marion County, Ohio, high school graduate, he had joined the CCC in 1933, serving as a leader of enrollees in the primary fire crew of the Lassen National Forest in California. The next year, his abilities were noted by

Figure 119. Unmanned Forest Service radio relay repeater stations at remote sites, housed incongruously but adequately in Navy surplus bulkhead, left, and in a former outhouse, right. These improvisations saved construction costs of shelters and reflected continuing shortages of funds in the immediate postwar period. (Forest Service photos, History Section).



the Forest Supervisor and he became a seasonal fire guard at the Yellow Jacket Lookout on Mill Creek Rim. This led to his appointment 2 years later as the fire dispatcher and radio technician on the Mineral Ranger District of the Lassen National Forest. After a brief stint as fulltime radio technician first for the Lassen at Susanville and then for the Tahoe National Forest at Nevada City, he came to the AWS project.

Fred Biggerstaff considered his seasonal Forest Service employment to be ideal. At the end of the fire season, he would return to the warmer climate of Monterey, Calif., where he worked as a "machinisto" on the sardine boats or as a laborer on Cannery Row. Utilizing this off-season time to best advantage, he also acquired a first-class FCC radio license at Western College of Radio, and then studied electrical engineering at Ohio State University for several semesters. He acquired an amateur radio license (W7OJB and W3YRV) after the AWS appointment.[60] Biggerstaff eventually became the principal electronics engineer of the Forest Service and enhanced its reputation for technical excellence in the land/mobile radio field.[61]

In addition to the wartime setback in the radio development program, several other developments promised to affect Forest Service communication planning. The most significant was the rapid change in radio technology precipitated by the wartime efforts of the armed services to get a communication advantage over the enemy. Research grants and large production contracts had encouraged commercial manufacturers, as well as such research groups as the one at MIT, to promote numerous technological advances. Wartime developments in radar, sonar, communication, and other electronic devices provided information that was transferable to civilian programs. They also contributed to improvement in frequency use above 30 MHz, FM radio, mobile radio, and portable radio.

Perhaps more important, the war years demonstrated radio's advantages in tactical situations. Many military men returned to civilian jobs knowing the value of communication, as well as with communication skills. This created a new market and a labor pool for manufacturers. Perhaps for the first time since Dwight Beatty demonstrated his "contraption" near Missoula, the Forest Service would have a commercial source for radio as well as experienced personnel. As Gaylord Knight remarked on this changed attitude towards radio, the men coming back from the military "now wanted a truckload."[62]

Electronic communication changes were in the making. Whether the Forest Service would take advantage of these changes, accepting some and rejecting others, or continue with its own development program was yet to be determined. Then, too, the prewar communication issues were still alive. Networks, interference, vhf use, point-to-point communication, and administrative radio had been ignored for the duration, but they were not forgotten.

Reference Notes

1. Ferdinand A. Silcox, "Opening Remarks at the Ogden [Utah] Grazing Conference," 2 November 1934, Gaylord A. Knight Collection.

2. F. H. Brundage, radio telegram to the Chief via Mackey Radio, 2 April 1942, Gaylord A. Knight Collection.

3. Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, April 1979.

4. Silcox, "Opening Remarks," p. 1.

5. Major Frederick Lofquist, 3rd Coast Artillery, H. Q. Harbor Defenses of the Columbia, Ft. Stevens, Ore., to James Frankland (R-6), 11 July 1938; M. L. Merritt (R-6) to Forest Supervisors (R-6), 10 July 1939, mimeographed summary of AWS operations; and series of cerrespondence between Region 6 and Ft. Stevens, including maps on locations, all stored in National Archives and Record Service, Seattle, Wash., Box 66742.

6. Henry L. Stimson to the Secretary of Agriculture, 1 January 1942, National Archives and Record Service, Seattle, Wash., Box 66742.

7. O. F. Ericson (R-6) to Chief, Forest Service, 30 December 1941, Gaylord A. Knight Collection.

8. William P. Kramer to Regional Forester (R-6), 3 January 1942, Gaylord A. Knight Collection.

9. Lyle F. Watts [Regional Forester] to Forest Service (R-6), 9 January 1942, telegram, Gaylord A. Knight Collection.

10. C. B. Morse (R-5) to Chief, Forest Service, 10 January 1942, Gaylord A. Knight Collection.

11. F. H. Brundage to Chief, Forest Service, 12 January 1942, Gaylord A. Knight Collection.

12. Telegram copy included in F. P. Cronemiller (R-6) to Regional Forester (R-5), 14 January 1942, Gaylord A. Knight Collection.

13. Telegram copy in Cronemiller to Regional Forester.

14. HKL [Lawson] to Jack [Horton], 15 January 1942, Gaylord A. Knight Collection.

15. F. H. Brundage to Forest Service (R-5), 15 January 1942, telegram, Gaylord A. Knight Collection.

16. Knight, interview with author.

17. Knight, interview with author.

18. Wilbur Claypool, interview with the author in San Antonio, Tex., July 1978.

19. Supervisor, Mt. Baker National Forest, to Regional Forester (R-6), 9 March 1950, National Archives and Records Service, Seattle, Wash., Box 66742.

20. These plans were not approved by the 4th Fighter Command until September 1942. See Guy [Wood], "Memorandum for Harold Lawson," 8 October 1942, handwritten, Gaylord A. Knight Collection.

21. Guy [Wood], "Memorandum for H. K. Lawson," 16 October 1942, handwritten, Gaylord A. Knight Collection.

22. Fred [Funke] to Harold [Lawson], 15 September 1942, handwritten, Gaylord A. Knight Collection.

23. Guy V. Wood, interview with the author in Porterville, Calif., January 1978.

24. H. K. Lawson to Francis W. Woods, 13 March 1942, Gaylord A. Knight Collection.

25. John C. Kuhns (R-6) to S. B. Show (R-5), 12 April 1942, Gaylord A. Knight Collection and Lawson to Woods.

26. [Region 6], "O, Personnel, Lawson, H. K.," 13 August 1943, Gaylord A. Knight Collection.

27. [Funke] to [Lawson].

28. C. B. Morris (R-5) to Regional Forester (R-6), 30 July 1942, Gaylord A. Knight Collection.

29. Morris to Regional Forester.

30. [Wood], "Memorandum for H. K. Lawson."

31. Guy [Wood] to Harold [Lawson], 9 November 1942, handwritten, Gaylord A. Knight Collection.

32. [Wood] to [Lawson]; Harold K. Lawson, interview with the author in King City, Ore., May 1978; and W. Frederick Biggerstaff, interview with the author in Beltsville, Md., April 1979.

33. Biggerstaff, interview with author.

34. F. V. Horton, "Inspection Memorandum," 9 May 1946, National Archives and Records Service, Seattle, Wash., Box B4266.

35. [Region 6], "O, Personnel, Lawson, H. K." The contractor produced 155 packsets.

36. *Spokane Daily Chronicle*, 2 December 1953, p. 3. These were manufactured under contract to the Navy by Spokane Radio Company.

37. Biggerstaff, interview with author, and Knight, interview with author.

38. H. H. Arnold to Guy Wood, 8 September 1944, letter in the possession of Guy Wood. Wood used an SPF set and an I set.

39. F. P. Cronemiller (R-6) to Forest Officers (R-5), 14 January 1942, Gaylord A. Knight Collection.

40. C. B. Morse (R-5) to Forest officers, (R-5), 29 July 1942, Gaylord A. Knight Collection.

41. Morse to Forest officers.

42. U.S. Department of Agriculture, Forest Service, *Forest Service Manual*, 1944, "Forest Service Policy-G.A.-17," p. 3.

43. Cronemiller to Forest officers, p. 2.

44. Cronemiller to Forest officers, p. 1.

45. D. S. Nordwall, "Memorandum for the Record-Radio Laboratory Inspection," 24 March 1947, p. 6, Gaylord A. Knight Collection.

46. Horton, "Inspection Memorandum."

47. R. M. Conarro and H. K. Lawson, "Report on Communication Study," August 1944, typed, pp. 2, 10, Gaylord A. Knight Collection. The forests were: R-1: Kaniksu, Coeur d'Alene, and Lolo; R-4: Boise and Payette; R-5: Los Padres, Angeles, Sequoia, Tahoe, Eldorado, and Klamath; and R-6: Siuslaw, Wenatchee, and the Radio Laboratory.

48. Conarro and Lawson, "Report," p. 10.

49. Conarro and Lawson, "Report," p. 5.

50. Conarro and Lawson, "Report," pp. 4, 5.

51. Horton, "Inspection Memorandum."

52. Knight, interview with author.

53. G. H. D. [Duvendack], "Communication Inventory-F. S.," 18 November 1947, mimeographed, Gaylord A. Knight Collection. These figures were plotted for 1947.

54. Lyle F. Watts [Chief] to Regional Foresters and Directors, 16 November 1950, Gaylord A. Knight Collection.

55. Conarro and Lawson, "Report," p. 10.

56. Harold K. Steen, *The U.S. Forest Service: A History* (Seattle: University of Washington Press, 1976), p. 234.

57. Knight, interview with author.

58. Horton, "Inspection Memorandum."

59. Logan [Belleville] to Harold [Lawson], 29 August 1945, Gaylord A. Knight Collection.

60. Biggerstaff, interview with author.

61. William B. Morton to Dennis Roth, Forest Service History Section, 18 April 1980, History Section files.

62. Knight, interview with author.

Chapter XIII

Putting the Pieces Back Together:

Postwar Adjustments and FM Radio

> *With the transition of FM and the adoption of miriad /sic/ improvements developed during the war, the Forest Service has reached a most important crossroads in its communications development program. It is important, therefore, that all interested factions understand and agree upon the various aspects of the developmental work and its application in the field.*
>
> – David S. Nordwall[1]

By the end of World War II, Harold Lawson had invested 14 years in the development of Forest Service communication systems. The temporary concentration of Radio Laboratory efforts on the AWS had not diverted him from the original goal of the design program as he watched wartime technological advances broaden the chasm between the prewar accomplishments and postwar requirements. The rapid advance of technology reemphasized the need to be prepared for peacetime conditions. Many new techniques and new discoveries would have to be assimilated into the design goals of the Laboratory.

Lawson frequently updated the projected Laboratory work plans while supervising AWS production and testing. Through Regional inspections, special studies, and concept papers on probable applications, he could compare the present status of Forest Service communication with the probable future requirements of the Laboratory. The 1944 working plans emphasized his perception of the Laboratory mission if the war ended before too long. He looked at the prior restraints on network use vis-a-vis a "policy for use of radio for point-to-point communication in view of new agreement/s/ with A. T. & T."

Lawson also gave thought to investigating "new developments in the radio field," "the perfection of the automatic relay," and the preparation of sample "Forest Radio Communication Plans." The emphasis upon "continued development /of/ light weight portable radio in cooperation with Fire Control ..." also received attention. In fact, he went one up on the previous definition of portability by devising the following new yardstick for simple, rugged, and reliable portable radio equipment:

The Yardstick for Portable Radio Equipment

1. Light. Is it light enough to be readily carried or moved about?

2. Small. Is it small enough to be readily carried or moved about?

3. Simple. Is it simple enough to be operated by regular personnel without a long course of instructions?

4. Rugged. Is it rugged enough to withstand the shocks normally encountered by fire equipment?

5. Dependable. Does it always work when you need it?

Lawson was anxious to continue the application phase of radio after the war. The ultimate objective of the Laboratory effort had been full acceptance of radio. But the issues of interference, point-to-point use, administrative radio, and portable radio for the fireline had evolved into major areas of disagreement before the war, limiting certain applications. He did not wish to see this pattern repeated. Each issue could be handled if kept in proper perspective.

The Laboratory had been opposed to point-to-point contact only when the process violated A. T. & T. lease agreements. If the agreements were cancelled, this means of communication would now become part of the Laboratory plans. Administrative communication, per se, did not threaten Laboratory philosophy unless portable radio became a casualty of the budget process. Ever since Squibb and he had brought the first vhf sets into the light of day, Lawson had always believed that a combination of 100-meter, low-power hf radios for fire control and 10-meter, low-power vhf radios was the best possible mix of communication systems for administration. The activity of one would not interfere with or overpower the other; they were complementary. Establishment of highly effective Regional networks at reasonable cost and without use of excessive power had become feasible with the design of the Laboratory repeater. He also supported this project. Otherwise there would have been no reason to include the RRS in the Forest Service radio repertory. Extended vhf communication had no purpose unless distant contact was intended.

Figure 120. A fire scout with his lightweight SPF set. Note pulaski (grubhoe-axe firefighting tool), shovel, canteen, and bedroll in foreground. (Forest Service photo, History Section)

Radio No Longer a "Stepchild"

These considerations were with Lawson when he set out in 1944 to inspect the western National Forests with Ray Conarro. Lack of a policy tying together all possible radio applications had been an unnecessary source of difficulty for the Laboratory. Lawson used the 1944 Forest inspection report as a forum for his views. He recalled the advantages of decreased fading and static, virtual 24-hour use, and relatively short antennas on the 10-meter vhf bands. He reevaluated the Laboratory 10-meter work plan. He called for an intensive design effort to remove the prewar obstacles of weight and form in the portables and an improvement in the physical and electrical reliability of the semi-portables and fixed-base units. For the first time, he stated in print that radio should no longer be the "supplemental" stepchild of telephone. In its sphere of application, Lawson hypothesized, vhf was an effective and efficient tool in the firefighter's arsenal. It could fill the void created by the 3-MHz primary-user status of the military.

To gain support, he canvassed National Forest personnel. He posed a situation where lookouts and Ranger District offices were provided with enough vhf radios to achieve 75 to 90 percent reliable fire-control coverage over the average District. In such a case, he pointed out, the telephone lines previously serving the lookouts would be eliminated; the telephone system would be retained only from the Ranger District level up to the Regional office. Lawson noted that this plan was "enthusiastically received" by those who had a chance to review vhf use in this manner. "It is believed," he further reported, "that the Radio Laboratory now has sufficient background of accumulated experience to produce the desired equipment." The only obstacles were the lack of funds and a decision by the Washington Office to commit this plan to policy.[3]

Conarro and Lawson proposed 22 remedies to the Chief of the Forest Service. They began with the establishment of Regional communication positions and ended with a plea for taking radio out of "the Jim Crack, the toy, the play thing class" in Forest Service communications systems. They asked the Chief to accomplish this through effective leadership; a positive, progressive, Servicewide program, and sufficient funding.[4]

Conarro and Lawson also submitted a separate, unofficial report to the Missoula Regional office. The two inspectors reviewed Missoula's justification for the Regional radio network maintained by Clarence Westcott in Apgar's absence.[5] Neither inspector would support the Region 1 claim that telephone use was inherently more expensive than networks for administrative communication or that busy telephone lines created inordinate delays. At their request, the Regional office submitted a separate accounting of its claims, indicating an annual cost of $2,080 on toll calls between the Regional office and its National Forests in 1943.[6] But there was no way the Region could determine toll savings on messages handled by the administrative network. Lawson and Conarro expressed doubts that a comparable reduction in toll charges would offset the estimated $3,000 to $5,000 annual operating costs for station KBCX.

The study also disagreed with the Region's contention that placing long-distance telephone calls was time-consuming. Checking with the Regional office switchboard operator and inspecting toll-call record sheets, the inspectors learned that "the preponderance of calls are completed in from one to three minutes and in those entries involving delays of one or two hours ..., in every known case, the called party was not immediately available to the telephone.[7] Region 1 would have to find grounds other than time or money if it intended to justify the existence of the radio network.

It was no secret in Forest Service communication circles that Region 1 had implemented its Regional network at the cost of portable radio for the fireline. Piqued by what he considered the Region's long practice of withholding or presenting information so that Rangers might develop a prejudice toward the concept of portability, Lawson used the 1944 inspection to try some reverse psychology. When asked, "What is the most important service radio can provide on your district?", the near-unanimous answer was "inter-district communication." But when the Rangers were asked if they were interested in "on the job" communication, the answer was universally, "Yes, it would be /the/ first priority if simple portable equipment was available." Given the existence of this equipment for 10 years, and the promise of better equipment in the future, Conarro and Lawson fore-warned Missoula that its "limited fire use of radio, together with the 'lukewarm' attitude of many field men towards radio, is undoubtedly the result of the intensive Regional network attitude, while local applications have failed to receive adequate assistance, or the initiating introduction needed from the Regional communications man."[8]

Chief Watts Strengthens Radio Policy

The Washington Office indicated late in 1945 that a change in the Radio Laboratory mission would take place. Lyle F. Watts was in the Chief's position, having moved there in January 1943 from his post as Regional Forester in Portland. William P. Kramer, formerly in charge of Lands in Region 8, had been in charge of the Washington Office Division of Operations since 1938. Watts was well aware of the Laboratory's problems and decided to establish a stronger radio policy. In an official statement, he left administration of the program with the Region 6 Regional Forester, but "under specific guidelines" from Washington. The major change was a 3-year, advance planning program. Each triennial, the Laboratory was to submit its recommendations to the Washington Office, which would then incorporate suggestions from the Regions and reissue the document under the Chief's signature. Any later Regional problems or special equipment requests were to be submitted to the Laboratory for its analysis and approval. Radio Laboratory training sessions for regional radio technicians were expected to "...provide the means to obtain uniform acceptance and application of approved policies and procedures."[9]

Figure 121. An early means of achieving vhf mobile radio operation. (Forest Service photo, History Section)

Figure 122. Establishing a fire base radio communications center, ca. 1940. (Forest Service photo, History Section).

Regional communications after World War II varied among Regions in a manner reminiscent of the prewar era. Region 6 perhaps gained the most because of the continued presence of the AWS. The conversion to peacetime operations for Bill Claypool meant maintaining and updating the AWS acquired facilities.[10] Gaylord Knight had already been informed of the new role of radio in the Southern Region,[11] and a similar role at a lower level was planned for Francis Woods in the Intermountain Region.[12]

It would take several years before finances caught up with expectations in either Regions 4 or 8. Efforts in the Southwestern and Eastern Regions (R-3 and R-7) continued to be limited, and it would take time for these Regions to approach the communications levels practiced elsewhere in the Forest Service. After Guy Wood's assignment to the AWS project was terminated, he was appointed the communications officer for the California Region (R-5). Shortly after, he pooled all of the 10-meter Forest units, including the AWS sets and some additional KU-R/KU-T2 mobiles, and redistributed them in accordance with Regional plans to establish a vhf network on each Region 5 National Forest. "This was the start," wrote Wood, "of a concerted effort in R-5 to prove to the Forests, and others, that 30- to 40-MHz radio communications systems could be a most valuable tool in forest administration."[13]

When Bill Apgar returned to the Northern Region from military duty, he was reassigned to his earlier Regional communication position in Missoula. The Conarro-Lawson 1944 inspection report was one of the first documents requiring his review. He noted his approval or disapproval of several paragraphs with initialed comments. Across the bottom of the first page, he wrote: "This so-called study is rather pathetic. Twelve days in a Region (6 in the field) is hardly sufficient time to even begin to know anything."[14]

Apgar had not changed his opinion on the value of Regional networks during his military absence, but times had changed. Chief Watts' memo meant he no longer was free to proceed without Portland's approval. Watts and Kramer had closed the loophole that had for so long allowed each Region to go its own way in communications, regardless of consequences. Pressed for justification after Conarro's and Lawson's report weakened his time and money argument, Apgar reviewed Lawson's earlier 1940 inspection report. Here he found, "based entirely on technical considerations and without reference to policy," Lawson's agreement to increase the power of KBCX if the network concept were approved by Washington. Lawson's position was adamant, and he had demonstrated convincingly to Apgar the value of portable 10-meter radio for Region 1 fire control.[15] The conclusion was obvious. If Region 1 intended to pursue the network concept, it would have to concede to portable radio for the fireline.

Apgar drew up new Region 1 network plans after a telephone call to Portland in which Lawson reaffirmed his earlier recommendations. Washington was asked to approve a Regional network between Forest Supervisors' offices west of Missoula and the Regional office. Radio (vhf) would be used to connect the Supervisors' offices with all the National Forests, including mobile equipment. A mix of hf Regional communication and vhf National Forest communication would take place for the first time in Region 1. Furthermore, Apgar conceded in his IRAC application that "vhf /is/ to be used on fire suppression and /for/ smoke jumpers."[16]

The IRAC "Application for Frequency Assignment" from Region 1 requested a power increase to 500 watts on 3,250 kHz, and 250 watts on 5,902.5 kHz at

Missoula and 13 Regional locations. The primary justification was lack of satisfactory wire (telephone) facilities between the proposed stations and sparsely settled areas. But Region 1 also replaced its weak argument for savings of time and money. The argument now was threefold: The Region had come to rely on the Missoula smokejumpers as a first-strike force in fire control. Communications with airplanes precluded telephone communication lines. A network radio facility required "...the intense use of aircraft for putting men and supplies into remote areas of fire fighting work."[17]

Region 1 Granted Power Increase

Kramer notified Region 1 of the IRAC concurrence on February 19, 1946. "Full cooperation" of the Region was expected in return. To effect the plan, Missoula would give up all but two of its 3-MHz frequencies, aside from two for exclusive use, in order to replace the loss to surrounding Forest Service Regions by interference caused by the Region 1 power increase. Full use of the 500-watt authorization was restricted by limiting some existing fixed-base stations to their present power. "Also," Kramer reminded the Region, "we must ask that you make every effort to use vhf wherever possible."[18]

Apgar set out to implement his Regional network by purchasing an autotune, 10-channel, 300-watt Collins 16F-9 transmitter and a few Wilcox fixed-frequency receivers. This news proved disconcerting in Portland. The Collins set was 10 times the cost of the Forest Service type M set. By ignoring the new consultation procedure with the Radio Laboratory, Region 1 apparently overlooked less costly options and short-circuited Laboratory oversight and concurrence.

Many surplus military radios were made available for transfer to civilian Government agencies after World War II. They had a wide range of applications and eventually provided the Forest Service with some very useful communication devices, especially since they were available for only the cost of transportation, repair, and modification. The military type TDF, for example, was a fixed-base unit of about 200 watts that had been tested and accepted by the Radio Laboratory. Its relative cost and performance brought up the hard question of why it was necessary to spend $4,000 on a Collins set when the inexpensive surplus set would serve just as well.[19] Apgar, quite expectedly, maintained that the higher power of the 300-watt Collins was needed in Region 1.

Lawson assigned Fred Biggerstaff to make an onsite comparison of the two sets. The test ground was to be between Orofino, Idaho, and Missoula, a distance of some 110 miles. When Biggerstaff arrived at Orofino, he uncrated the TDF, put the sets side by side, rigged a switching device, tuned the finials, and put in a test call to Portland about 400 miles away. He obtained the following results at noon while operating on both 50 and 100 meters:

TDF/Collins 16F-9 Transmitting Comparisons[20]

	3250 kHz		5902.5 kHz	
	Collins	TDF	Collins	TDF
I_{out} /watts/	300	200	295	210
S_{meter} /Portland/	7	6 3/4	8 1/4	7 3/4

Biggerstaff was confident that the 3 to 2 power differential favoring the

Collins would be insignificant when tested from Missoula, and a major disagreement with Region 1 would be settled. The results of the test were cogently recorded in the following entry from his field diary:

> Friday, 12-6-46
>
> Met with Crocker and Space shortly after 8 AM until 10:30 AM. Discussed communications problems and secured a disinterested listener Mr. Noel to judge the performance of the tests to be conducted at 2:00 PM. Went to Apgar's office and asked to have a buzzer and batteries supplied and explained there would be a test at 2:00. He promised to assist all possible and then tried to delay any progress. I finally ordered him flatly to get buzzer and batteries and to have them there and tested by 2 o'clock. He muttered something to the effect that I wanted a lot of things but he started getting the staff together and agreed to take me to the station at 1:00. I talked to Portland and then hooked up the buzzer and ran a few tests. At shortly after 2 Mr. Noel came in and the tests were run first without noise and then with noise in increasing amounts. The TDF outperformed the Collins in every respect. Bill /Apgar/ produced a set of elaborate graphs of S meter readings taken over two days showing approximately 1/2 S-meter division separation and made the statement that at certain critical periods that would mean getting a message through or not getting through. I told him he was wrong and he could not deny it. Returned to Crocker's office and spent the rest of the afternoon with him, Space, and Fred Waite who also witnessed the tests. The results of the tests preceeded me /sic/ to the office for Crocker was in definitely a different frame of mind and open to any suggestions.[21]

The Region ended up keeping the Collins transmitter anyway, but it did purchase Army TDF transmitters for many of its western Forests' headquarters.[22]

With the advent of frequency modulation (FM) radio and Chief Watts' postwar order for a 3-year work plan, the Radio Laboratory was faced with a decision unlike that of the mid-1930's. When 10-meter operation was proposed, not enough 100-meter equipment was available in the field to make a major change. Then, too, vhf fulfilled a need that did not conflict with the hf operation. But in 1946, the need to plan ahead complicated the issue and the incompatibility of AM and FM sets made the decision more difficult.

FM radio had not been used extensively until Fred Link Radio Company produced an FM system for the Connecticut State Police in 1940.[23] It also found application during World War II in the military services, and in some circles it gained a reputation as being preferable to AM broadcasts. Yet early FM had one major weakness that some engineers believed offset its advantage to produce a high signal-to-noise ratio from moderate strength signals. It required a wide band width for the transmitted signal and was considered a "spectrum waster" by those such as the Forest Service where frequency abuse was not treated lightly.[24]

The Radio Laboratory considered the alternatives. Because many Regional radios were now obsolete, it was an opportune time to make the transition before reinvesting in AM. The decentralized pattern of administration also favored FM. With the emphasis on National Forest use, as opposed to Regional networks, replacement could take place gradually without a large capital outlay. By moving all AM equipment from one Ranger District into adjoining Districts and equipping the first District with FM, satisfactory communication could continue. The remaining AM Ranger Districts could be similarly converted as funds became available.

Another factor was increasing Regional emphasis on FM mobile and airplane communication. Clarence Westcott had already completed preliminary aircraft installations in Region 1[25] and Gaylord Knight had acquired Lawson's permission to purchase and test several Link mobile FM sets.[26] Both men reported favorable results.

The drawback to this plan was the tendency of FM to be a "spectrum waster." Biggerstaff also believed that some early FM claims were not valid,[27] and Belleville "died slow" on AM. "I was a little stubborn about seeing its advantage for awhile," Belleville admitted.[28]

Figure 123. A Region 5 Forest Service airplane equipped with two-way radio for use in fire control. (Forest Service photo, History Section)

With the design of the mobile KU-T/KU-R, he had demonstrated the effective use of AM noise-silencing techniques comparable to the FM squelch control. He would argue against the transition until convinced otherwise.

Laboratory Switches to FM

A Radio Laboratory consensus on the merits of FM took several months to achieve. Finally the Laboratory staff concluded that FM was the way to go. They reached agreement by May 1946, and recommended to Jack Horton that the Forest Service communication systems by converted because of "...the more reliable squelch, better noise rejection, absence of heterodynes with interfering signals, and the capture effect inherent in FM discriminator circuits."[29]

After an inspection trip to Portland where the matter was discussed at length, Jack Horton agreed. He advised Kramer that "the procurement situation is still pretty bad but the Laboratory has arrived at the point where the Washington Office must make a decision as to whether we go to FM or stay with AM." Uneasy lest Washington again delay a decision and further compound the problem, Horton cautioned that "the question is entirely a matter of time, not equipment." He stressed the urgency of the matter and warned that "if we put off doing this now we will set back the use of FM at least five years."[30] The Washington Office accepted these recommendations and quickly approved the change. The Radio Laboratory officially made the transition in July 1946.

The Radio Laboratory FM work plans were similar to those of the earlier AM development program. Simplicity, ruggedness, and reliability continued to be the goal, with the emphasis on radios that could be used in fire control. Conspicuously absent were fixed-base, high-powered units. Priorities for FM prototype design were scheduled with handie-talkie first, followed in order by mobile unit, look-out set, packset, aircraft unit, and portable repeater.[31]

The type designations for the FM units were changed from the AM practice of selecting letter designations to describe the sets. By this time, the types S, T, and K units had become synonymous with the classification for portable, semiportable, and mobile, respectively. The corresponding units were thus dubbed SF, TF, and KF, with the F representing FM. Circuitry, according to Biggerstaff, was "...similar to standard commercial practice."[32] The sets reflected composite ideas from published articles in professional and amateur radio publications that had been modified for Forest Service use; a unique design feature was two-channel transmitting capability.[33] This extended the effective range of the sets when the second transmitting channel was set to the frequency of a nearby repeater. The single receiving channel of the unit, set to the network and the corresponding repeater frequency, provided full coverage of messages from local or distant sources. With this capability, portable sets could communicate on intervisible transmissions or switch to the repeater frequency for communications beyond their normal range.[34]

The mobile type KF (model A-T2-R) was designed by Biggerstaff. The main circuitry was housed in a 1/2-cubic-foot cabinet, while the operator's controls were contained in a separate small enclosure that could be conveniently located in reach of the driver. The superheterodyne receiver was crystal-controlled, which eliminated the critical and often difficult tuning procedures of previous units.[35] At an advertised output of 25 watts, the type IF was scheduled for availability in July 1947, but production was limited.[36] "It was so soon superseded by commercial models," recalled Biggerstaff, "that I thought the effort wasn't of any great value to the Forest Service. It was too short-lived."[37]

Type SF Has Most Efficient Layout

The primary design responsibility for the type SF (model A-T2-R), or FM handie-talkie, was delegated to Logan Belleville.[38] Field tests were scheduled for August 1947 and bid solicitations for the following March. The SF looked like the military SCR-536 walkie-talkie.[39] It operated in the 30- to 40-MHz range at 200 milliwatts (1/5 watt) and was also provided with dual transmitting and single receiving channels. At a weight of 9 pounds, including a 7-foot collapsible antenna, it continued the tradition of portability.[40] The handie-talkie, with the advantage of subminiature tubes, represented the most efficient physical layout of any Radio Laboratory design.

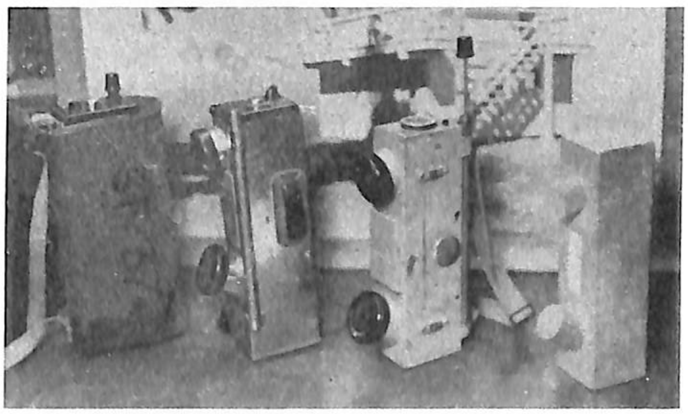


Figure 124. Forest Service handie-talkies. Right to left: wood mockup for type SF design; type SF, model A-T2-R; type SF, model B2; and type SF, model C in canvas bag. (Forest Service photo, History Section)

Development of the type TF (model A-T2-R), or FM lookout set, was a composite effort of the Laboratory staff. As outlined in the *Radio Handbook*, "It was designed to provide communications for lookouts or towers, act as an automatic repeater when required, and be used at stations where battery power is necessary."[41] The automatic repeating capability of the TF was considered "...of extreme value in radio networks employing handie-talkie type equipment."[42] If the handie-talkie operator had to address the network, the towerman would be requested on the first SF channel to flip a switch on the TF to the repeater position. By similarly switching to the network frequency on the second SF channel, the handie-talkie operator could access the network. But the importance of the 2-watt TF for lookout operation was not overlooked. On behalf of the tower operator it was emphasized that "no function has been compromised to secure each service."[43]

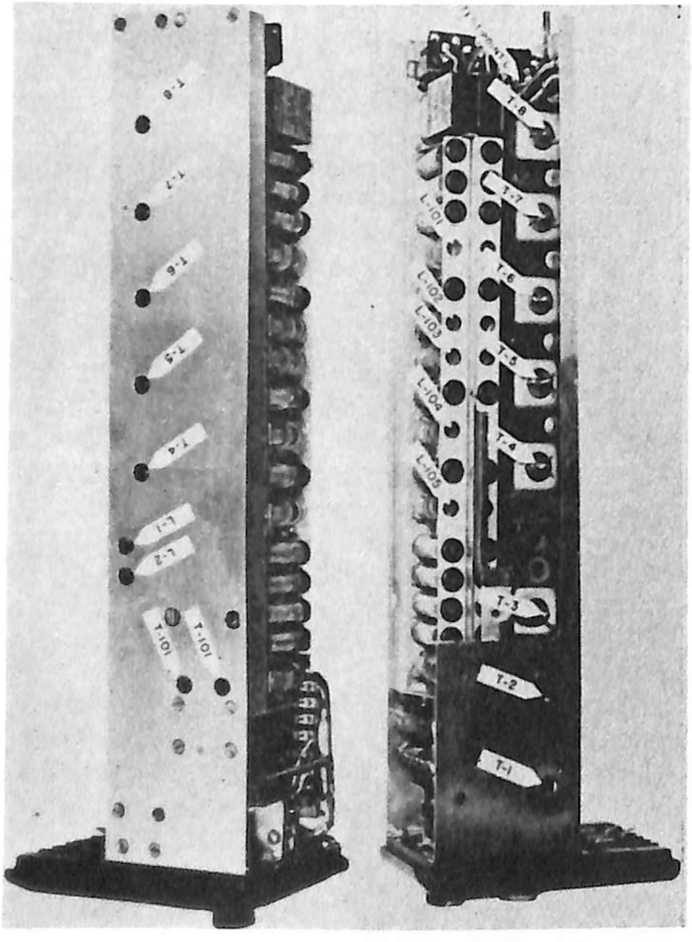


Figure 125. Two interior views of the component layout for the efficient type SF handie-talkie. (Forest Service photo, History Section)

The TF differed somewhat from the earlier semiportable configurations. Not the controls but the radio equipment was housed in a weatherproof cast magnesium case that could be located up to 200 feet from the operator's position. This provided separation for the dual antennas. An additional bonus was conserving space in the lookout tower rooms, especially those only 7 by 7 feet. A second control unit could be installed if separate living quarters were provided for the operator.

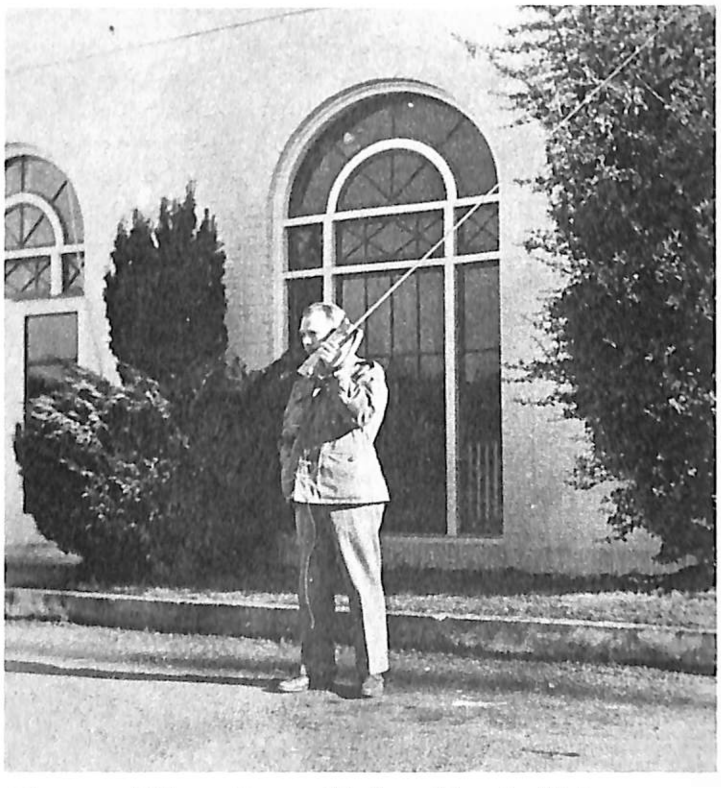


Figure 126. Type SF handie-talkie being demonstrated at the Radio Laboratory by Logan Belleville. (Forest Service photo, History Section)

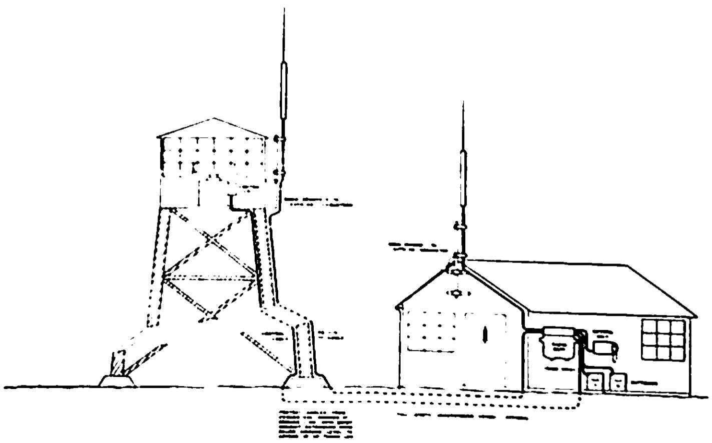


Figure 127. Simulated placement of model TF set for dual use as fire-lookout radio and automatic relay repeater unit. (Forest Service photo, History Section)

Lightning Arrester, Other Projects

A number of other projects were developed at the Radio Laboratory during the immediate postwar years. One of the most highly regarded was the cylindrical spark-gap lightning arrestor designed by Lawson. It won high praise from the National Bureau of Standards for improvement over previous designs.[44] In the absence of suitable commercial models, the Laboratory staff also completed designs for a battery-operated type SGA signal generator, a battery-operated type DM deviation meter, a type VMA vacuum tube voltmeter, and a type RWA RF wattmeter.[45] Investigation of frequencies in the 150-MHz range, improved antenna designs, battery types, and remote controls, also went on during the early stages of FM development. Bill Claypool's assignment in 1948 to the Bureau of Animal Industry, U.S. Department of Agriculture, increased the workload of the other men at the Laboratory. Claypool later left to provide radio engineering and supervisory assistance to the Mexican Government in an emergency program to stamp out hoof-and-mouth disease during a 3-year assignment.[46]

Region 6 sought a replacement who could serve halftime as the Regional communication officer and halftime at the Laboratory. Thomas H. Burgess, Assistant Regional Forester for State and Private Forestry, expressed his doubt to the Chief that someone could be found with both the required competence in "theory and design" for the Laboratory and the "practicable trend of mind" required for the Regional communications position. "The requirements are quite completely opposed," he noted. "The theoretical engineer would be quite apt to turn into a tinkerer in the field and the so-called 'practical' type of radio man is usually without the basic fundamentals and actual engineering ability we would like to have at the Laboratory."[47] Lest it be struck with a "prima donna," Region 6 put off the decision for a year and a half, until C. V. "Bud" Fontain accepted the position in late 1949.[48]

Well on its way to duplicating previous accomplishments in AM radio design, the Radio Laboratory was reaching a point where commercial FM developments were becoming competitive. From the beginning, the Laboratory's existence had been justified by the unavailability of suitable commercial radio products, and the 1945 "policy statement" from the Chief's office again pointed out that the primary function of the Radio Laboratory continued to be "...the development of radio and associated equipment for which a demonstrated need exists and which cannot be supplied from commercial sources."[49] But with more and more commercial products coming on the market in the postwar years, the Radio Laboratory's development program would inevitably be questioned. Even Lawson observed, "In my own mind I was convinced that the Radio Lab, as it had been constituted in the past, had served its day."[50] With the proliferation of FM commercial products, particularly from Motorola, "There was little justification for the Forest service to 'invent' things any longer."[51]

This transition, although obviously necessary, did not take place without a delayed reaction from Washington. Long under pressure to accept more responsibility in the administration of a Servicewide communication program, the Washington Office took this occasion to also effect a simultaneous change in its policy on communication leadership.

Jack Horton had been conducting a one-man campaign for a consistent Servicewide communication program since 1932. In 1934, of course, he had asked Roy Headley to appoint "a court of last resort" as a means of deterring each Region from devising and determining its own communication products and program. By 1945, the Washington Office had made an effort to achieve this through a revised statement of the Radio Laboratory's role.[52] But this effort did not have the one element Horton considered essential to unification; it lacked a "dictator."

Frustrated by Washington's failure to grasp this point, he waited a year to see how effective the 1945 order would be. He then reevaluated the state of Regional communications nationwide for the Washington Office. "It is apparent to me that each Region wants a special set up as far as radio is concerned, and each Region thinks its conditions are different," he observed. He illustrated this point by calling attention to the opposing opinions held in Regions 1 and 6 on vhf use, special Region 8 requirements for 25- to 50-watt mobiles and radio-equipped, tractor-drawn plows, and a Region 5 request for a handie-talkie that was a "full man backpack load."

"I cannot believe," he concluded from these numerous examples, "that there is a need for as many different types of equipment as is indicated by the Regions' demands." Instead, Horton believed, the communication men in the Regions were "selling their own ideas," and this led to "as many ideas as there are radio technicians. Where they have no radio technicians, they have no ideas," he wryly observed.[53]

For the twelfth time in as many years, Horton urged the Washington Office to reconsider the appointment of a dictator. Nearly at the pleading stage and not wishing to see a repetition of the AM problems during FM development, he concluded his report with the firm resolve that "paramount to all the above, is the selection of a man in the Washington Office to correlate the needs in all the Regions and give leadership to the /FM/ development."[54]

The Washington Office ordered an inspection of the Radio Laboratory before concurring with Horton. In all corners of the Laboratory and among the various aspects of the communication program reviewed by David S. Nordwall, Kramer's alternate in the Washington Office's Division of Operation, the question of leadership took precedence. After a talk with Horton, Nordwall agreed that a significant administrative problem existed in the Regional application of radio. He recommended "...the need for more positive direction and leadership from the Chief's office."[55]

The argument for leadership now caught the attention of Bill Kramer and Earl Loveridge. Their concern was not with technological issues but with administration. The gulf between the state-of-the-art in radio and the ability of nonradio men to understand significant technological issues was growing, and the Washington Office began to feel uneasy. While they were willing to take a secondary role in preliminary communication decisions, questions of fiscal and administrative responsibility were another matter.

By 1947, Kramer and Loveridge were primarily concerned with whether "they were getting their money's worth out of the Lab" and whether the Regions were usurping Washington's authority. In the vernacular, Kramer thought Lawson might be "leading him by the nose," and that allowing independence to such men as Apgar constituted a case of "tail wagging the dog."[56] Intent upon finding a solution, Kramer reached down to the Kaniksu National Forest in Region 1 to select a man with a reputation for being "a little bit hard-nosed" and who had also had several years of Army service. It did not surprise those who knew George Dunvendack that, within a few weeks after his appointment as Chief of Communications, the Forest Service communications program acquired a new look and new force.

Reference Notes

1. D. S. Nordwall, Assistant Chief, Division of Operation, Forest Service, Washington, D.C., "Memorandum," 15 August 1946, Gaylord A. Knight Collection.

2. Forest Service Radio Laboratory, "Annual Plan of Work-CY 1944," 8 May 1944, Gaylord A. Knight Collection.

3. R. M. Conarro and H. K. Lawson, "Report on Communication Study," August 1944, typed, pp. 6-9, Gaylord A. Knight Collection.

4. Conarro and Lawson, "Report," pp. 9-14.

5. Clarence Westcott, interview with the author in Missoula, Mont., May 1978.

6. Harry Coughlin (Engineer, R-1), "Memorandum," 8 August 1944, Gaylord A. Knight Collection.

7. R. M. Conarro and H. K. Lawson, "Communication Study-Preliminary Report for Information of Region 1 Only," 11 August 1944, pp. 2-4, Gaylord A. Knight Collection.

8. Conarro and Lawson, "Communication Study," p. 4.

9. "Radio Communications in the Forest Service," 14 November 1945, typed copy, included in D. S. Nordwall, "Memorandum for the Record-Radio Laboratory Inspection," 24 March 1947, Gaylord A. Knight Collection.

10. Wilbur S. Claypool, interview with the author in San Antonio, Tex., July 1978.

11. Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, April 1979.

12. Francis Woods, interview with the author in Ogden, Utah, January 1978.

13. Guy V. Wood to Dennis Roth, 1 April 1980, Gaylord A. Knight Collection.

14. Conarro and Lawson, "Report," p. 1, copy with Apgar's notes included, Gaylord A. Knight Collection.

15. H. K. Lawson, "Memorandum for Files," 23 August 1940, p. 4, Gaylord A. Knight Collection.

16. P. D. Hanson (R-1) to William P. Kramer, 26 February 1946, Gaylord A. Knight Collection.

17. E. W. Loveridge, "Application for Frequency Assignment," 6 February 1946, Gaylord A. Knight Collection.

18. Wm. P. Kramer to Region 1, 19 February 1946, Gaylord A. Knight Collection.

19. Harold K. Lawson, interview with the author in King City, Ore., May 1978, and W. Frederick Biggerstaff, interview with the author in Beltsville, Md., April 1979.

20. Fred Biggerstaff, "Diary," entry of 4 December 1946, Gaylord A. Knight Collection.

21. Biggerstaff, "Diary," 6 December 1946.

22. William B. Morton to Dennis Roth, Forest Service History Section, 30 April 1981, History Section files.

23. Dan Noble, "The History of Land-Mobile Radio Communications," *Proceedings of the IRE* 50, no. 5 (May 1962): 1408.

24. Biggerstaff, interview with author.

25. Westcott, interview with author.

26. Knight, interview with author. These were the Link types 35-UFM and 11-UF.

27. Biggerstaff, interview with author.

28. Logan Belleville, interview with the author in Saratoga, Calif., January 1978.

29. Fred Biggerstaff, "Design and Use of Forest Service Equipment," 1946, working paper, typed, p. 7, Gaylord A. Knight Collection.

30. F. V. Horton, "Inspection Memorandum," 9 May 1946, National Archives and Record Service, Seattle, Wash., Box B4266.

31. Fred Biggerstaff, first draft of paper presented to the American Institute of Electrical Engineers, ca. 1955, Gaylord A. Knight Collection, and Biggerstaff, interview with author.

32. Biggerstaff, paper, p. 9.

33. Fred Biggerstaff, telephone conversation with the author, November 1979.

34. W. F. Biggerstaff, "FM Radio Equipment for Forestry Applications," [n.d.], typed copy, pp. 3, 40, Gaylord A. Knight Collection.

35. Biggerstaff, "FM Radio," p. 16.

36. Nordwall, "Radio Laboratory Inspection," app., p. 1. (See note 9.)

37. Biggerstaff, telephone conversation.

38. There was a prototype forerunner of the SF known as the type SY "pack unit." Eight of these were placed in the field during 1945 for testing. The outcome led to a layout similar in design to the military walkie-talkie. Records on this set are unavailable, but the SY was undoubtedly AM even though it appears to have served as a handie-talkie model. See F. V. Horton, "Memorandum," 9 May 1946, National Archives and Records Service, Seattle, Wash., Box B4266.

39. Later designs included a hand-carried unit with telephone type handset included as part of the handle and a unit with special headset and close talking microphone for aircraft applications. See Biggerstaff, "FM Radio," pp. 1, 2.

40. Nordwall, "Radio Laboratory Inspection," app., p. 2.

41. U.S. Department of Agriculture, Forest Service, *Radio Handbook* (Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Operation ca. 1938), sect. C14,1. p. 1.

42. Biggerstaff, "FM Radio," p. 2.

43. Biggerstaff, "FM Radio," p. 2.

44. National Bureau of Standards, "Report on Tests of Forest Service Lightning Arrestor Devices," Reply FMD:1K, File I-3, 29 March 1946, Gaylord A. Knight Collection.

45. Forest Service, *Radio Laboratory Newsletter*, no. 2, 26 September 1949; no. 4, 1 May 1950; and no. 6, May 1951.

46. Forest Service, *Electronics Center Newsletter*, no. 19, December 1963 and Claypool, interview with author.

47. Thomas H. Burgess (R-6) to the Chief, 2 March 1949, National Archives and Records Service, Seattle, Wash., Box 53982.

48. P. L. Paine (R-6) to Alaska Communication Systems, Seattle, Wash., 16 September 1949, National Archives and Records Services, Seattle, Wash., Box 53982.

49. Forest Service, "Radio Communication in the Forest Service," 11 November 1945, typed copy included in Nordwall, "Radio Laboratory Inspection."

50. Lawson, interview with author.

51. Lawson, interview with author.

52. Nordwall, "Radio Laboratory Inspection."

53. Horton, "Inspection Memorandum."

54. Horton, "Inspection Memorandum."

55. Nordwall, "Radio Laboratory Inspection," p. 4.

56. George H. Duvendack, interview with the author in Missoula, Mont., May 1978.

Chapter XIV

Communication Leadership:

Toward Consensus and Standardization

> *...I believe we should have clearly in mind that communication facilities, whatever they may be, are simply the means by which we get our main job done. We are not running the National Forests just to have a place where we can operate communication gadgets. I remember once a telephone engineer told me that I must not ever forget that the reason the National Forests were created was so he would have trees to hang telephone wire on.*
>
> - F. V. "Jack" Horton[1]

George H. Duvendack was Supervisor of the Kaniksu National Forest in 1947. Thirty-one years later, he recalled his reaction when the order from Bill Kramer reached him. On the one hand, he "hated the idea" of going back to Washington; on the other, he agreed with the policy that "When asked, you went." But more than that, his selection caught him off guard. "Jesus," he remarked, "I was dumbfounded. I knew nothing about the insides of a radio. All I knew was when I picked up a radio I wanted it to work."

Not confident in his ability to manage the program, he approached Colonel Gael Simson, past administrative head of the Radio Laboratory and Chief of Radio Communications in the Washington Office until 1943, while in Washington, D.C. Duvendack told him he knew little about radio and insisted he had "no damn interest in it" except as a means of communication. Simson advised him to take the job nonetheless. Administrative ability was needed, not technical expertise, Simson pointed out.

Figure 128. George H. Duvendack at Dugger (radio) Tower, Ala., ca. 1948, soon after his appointment as director of the Forest Service's communications program. (Forest Service photo, History Section)

Duvendack, however, was not a novice to radio.[2] He had more background on the subject of electronic technology than it would at first appear. While working his way up through the Region 1 ranks to the level of Forest Supervisor, he had observed the application of this technology on the "doer level." He understood the promise of radio, its limitation as a tool, and, like Dwight Beatty, many firefights and actual communication experiences crowded his memory.

Duvendack set about organizing his priorities in Washington even though he was convinced that Kramer "...didn't appreciate what the hell I was up against." There I was on IRAC," he recalled, "with Admirals and Generals who knew what they were doing," and conversing with technical types even though "I was a fish out of the water." He found in Erwin Wagner, head of Administrative Services, an ideal means to channel his ideas to the IRAC members. In Harold Lawson he found "a damn nice fellow and competent man" who would act as his spokesman on technical matters before manufacturers' representatives.[3]

It did not take Duvendack long to run into some of the same problems faced by Jack Horton when dealing with the Washington Office. Two encounters with Assistant Forest Service Chief Earl Loveridge left him shaking his head. Loveridge called Duvendack one afternoon and requested a type SF set for a high-level meeting that same afternoon. Duvendack explained that the only SF in Washington was in the next office, disassembled down to the last tube and screw. Loveridge, totally unaware of the mechanics of the SF, was "not pleased" that the set could not be reassembled within a few minutes. Another time, Duvendack had just left his office to attend a meeting in one of the far corners of the huge South Building at the Department of Agriculture. As he walked down the hall, Loveridge fell in step beside him. Nearing the end of the corrider and a parting of the ways, Loveridge, known to agency personnel as "Our Work Finder and Efficiency Expert," asked Duvendack, "How many tubes in the SF?"

"Something like 16," George replied.

"Take four out," was Loveridge's terse command. He was dead serious.[4]

Duvendack had settled on a four-point plan of operation by the end of his first year in Washington. Highest priority was the manufacture of new Forest Service radios by private enterprise and the replacement of the Forest Service telephone lines with a combination of commercial lines and radio. He was concerned that the Forest Service was competing with industry in these two fields, so he thought it best to purchase the needed telephone service and to investigate the possibility that radio manufacturers might be induced to design ready-made units to Forest Service standards.

This latter venture was a matter of some standing, even at the Radio Laboratory. As early as January 1939, Gael Simson had outlined the "Objectives of (the) Radio Development Unit" and stressed that "...with a view to increasing the amount of commercial radio and materials and equipment suitable for forestry communication users...," the Laboratory would keep the radio industry informed of forestry's needs. Since then, many promising commercial developments had taken place.[5] "Present plans," it was also emphasized in an early 1947 report, "contemplate replacement of the Service-sponsored development program by commercial facilities to the fullest practicable extent and as soon as industry is able to supply the types and quality of equipment that the Forest Service must have."[6]

Duvendack had come to view the Laboratory staff as a "closed corporation," not necessarily from the viewpoint of vendors but in terms of exchange of ideas. It seemed to the new communications chief that when they dealt only with the smaller manufacturers near Portland they were losing by not utilizing the brains of engineers in the larger corporations. "My mission," he concluded, "was to stop our manufacturing, except under competition, in Portland, and get these sets manufactured by the larger manufacturers..."[7]

As a preliminary step, he scheduled an extensive trip for Lawson and himself to some 25 manufacturers "in the eastern part of the United

States." They also planned to look into the application of the nickel-cadmium battery, the transistor, and any "new developments in the radio art."[8]

Major Firms Show Great Interest

Between October 4 and 31, 1948, Lawson and Duvendack traveled to Chicago, Boston, New York City, Washington, D.C., and several other cities. They met with chief engineers, sales managers, and, in most cases, also the company presidents or vice-presidents. An SF set and pictures of the TF were passed around for review at each stop. The response was overwhelming. "We had innovations that none of the companies had," remembered Duvendack.[9]

"Time after time, they heard that the engineering in the handie-talkie would have cost over $100,000 if the work had been done in the laboratories of the large manufacturers."[10]

Intent on obtaining competitive bids to reproduce the sets, Lawson and Duvendack extolled its possible applications and markets in Federal agencies, as well as State divisions of forestry, the logging industry, railroads, and utility companies. They emphasized that the Army FM version of the handie-talkie would not be complete for another 18 months. "Sold on the field that exists," observed Duvendack, "RCA, General Electric, Belmont [Radio] and Federal Telephone and Radio were particularly enthusiastic and showed by their statements that they desire to submit bids sufficiently low to insure that they could use the engineering in our equipment and add another item or two to their line of radio equipment."[11]

The major obstacle with the plan to purchase commercial models was the absence of specifications covering Forest Service requirements. The Laboratory had lacked the instrumentation to measure required performance parameters and, therefore, had provided type samples for the manufacturers. Lawson and Duvendack agreed after their trip that a program to determine specifications should be instituted immediately.[12] Lawson assigned this task to Biggerstaff, and a new era in radio for the fireline was inaugurated.[13]

The long-standing issue of nonstandard communication systems was one of the first problems that Duvendack had to resolve. For the last dozen years, various Regions had questioned radio development and instituted communication planning just about whenever and however they saw fit. It would require considerable diplomacy to overcome this independent tradition and thereby achieve the essential level of uniform performance and standardization.

Standard performance may be obtained either by fiat or by a more democratic process that achieves the same results without backlash. Through the process of majority rule, opposing sides can be brought together under one roof, the issues discussed in a common forum, policy statements developed, and majority vote allowed to determine policy while allowing some latitude for local conditions and needs. The only caution required of the leadership is that their opinions and conclusions be amply represented among the voting members.

The 1948 Communications Conference

Using the logical guise of the long absence of a much-needed communications conference, Duvendack made plans to hold the first meeting in the eight years since 1940. He enlisted the support of Forest Service Chief Lyle Watts and Assistant Chief William Kramer.

They agreed that numerous developments had "created new problems in our field of communication," and that "there is a need for a meeting of minds and a united approach on many of our problems and procedures, not only among our communication technicians but more importantly among responsible administrative personnel to be included in the invitation."[14]

A few days later, the Division of Operation presented an agenda to the Regions for the January 19-23 conference. The 11 topics ranged from the general "Management's Job and Responsibilities" to the more specific "A Study of Frequency and Power Allocations." Each topic was assigned to a committee picked by the Washington Office. The emphasis was upon "committee work sessions" as opposed to "minimum time to adequately present a topic" and severe restriction on "floor discussion time." It was expected that "the committee reports and recommendations, coupled with their acceptance by the conference or the registration of specific objections, will be used here in setting policy, establishing standards and guidelines in planning, organizing, and managing the Forest Service enterprise."[15] In other words, the committees preselected by Washington would meet to reach a consensus and draw up a position paper. This paper would be presented to the conference as a whole, amended as needed, voted upon by the members-at-large, and submitted for "Washington Office action."

Several topics were presented each day of the conference. The tone of what was to come was set by Horton's presentation on management. "It is not until Management has indicated needs in communication," he firmly addressed the communication men, "that we require the advice and assistance of communication technicians." Stressing the differences between line and staff authority, Horton made no pretense about the expected role of communications personnel in the hierarchy of Forest Service administration. He partly blamed management leaders for shirking their responsibilities and partly blamed the technicians for devising systems "which did not express the needs of field men."

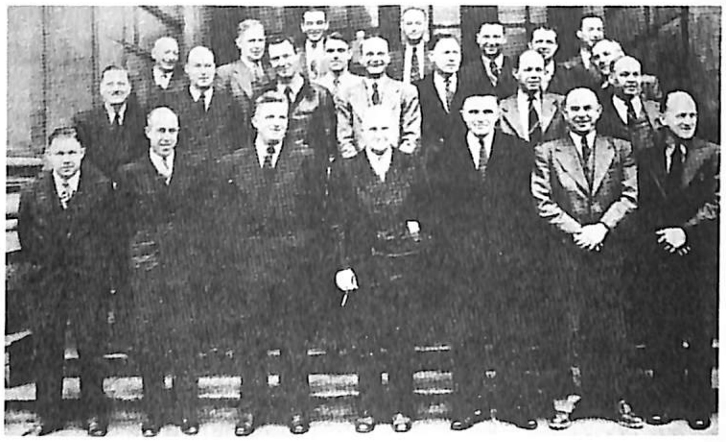


Figure 129. Postwar problems were discussed at the January 1948 Servicewide communications conference in Portland, Ore. Front row, left to right: W. Fred Biggerstaff (R-6), David S. Nordwall (Washington Office), George Duvendack (Washington Office), F. V. "Jack" Horton (R-6), Harold K. Lawson (R-6), Mayhew H. Davis (R-9), and Lawrence K. Mays (R-6). Second row: Norman F. Johnstone (R-9), Herbert T. Holmquist (Washington Office), Arthur L. Turner (R-2), Richard H. Lewis (R-3), Bernard A. Anderson (R-4), Guy V. Wood (R-5), and Thomas H. Burgess (R-6). Third row: William S. Williams (R-5), Raymond M. Conarro (R-8), E. Allan Loew (R-6), Francis W. Woods (R-4), Gaylord A. Knight (R-8), and Ernest M. Karger (R-7). Back row: James C. Iler (R-1), William B. Apgar (R-1), and Harvey O. Robe (R-2). (Forest Service photo, History Section)

"The first big job," Horton then concluded, "is to get some communications planning done on a Servicewide basis," and it should reflect the views of the Forest Ranger, not the communication technician.[16]

Vital Place of Radio on the Fireline

This first committee report reestablished the responsibilities of the communication technician. The second committee report reestablished the importance of communications on the fireline. "We may have Cadillac appetites, but Fords will get you there as well," this group concluded. Concerned that the administrative use of radio deprived "the man on the ground" of the limited communication funds, the committee stressed "it is far more important that the grass-roots organization, the doer level, be provided with the very best of communication than it is that the upper-bracket supervisors be provided with fingertip information."[17]

With two major issues down and one to go, Duvendack chaired the third group. It was made up of Lawson, Apgar, and Guy Wood, and a wiser choice for discussing "A Study of Frequency and Power Allocations" could not have been made. On the one hand, Apgar would undoubtedly be outvoted even if the new Washington Office chief of communications abstained. On the other hand, any minority report would probably never reach the conference floor. Especially after Washington's stamp of approval, recommendations passed through the majority-rule process would be difficult to ignore in Region 1.

"I like to compare the radio spectrum to a life boat," Duvendack later addressed the conference. "Both have limited capacities. If the lifeboat is overloaded, it swamps and sinks and thereby does not fulfill the job it was intended to do." Continuing in the allegorical vein, he pointed out that frequency spectrum management began on a worldwide basis. What would happen, he asked, if the United States did a "bang-up" job of regulation and control, but Mexico "ran wild?" The boat would sink, by implication. Only through "cooperation and a spirit of give and take on the part of all countries" did the boat stay afloat. This analogy, Duvendack concluded, was applicable within the Forest Service.[18]

Before completing his remarks, Duvendack also emphasized that the Forest Service was "sitting in clover" by comparison to many other Government agencies. "We have at this time an adequate number of frequencies," and "we enjoy group assignments."

At that time, the Forest Service had 29 frequencies (12 clear) in the 3- to 4-MHz band and 71 (23 clear) between 30 and 40 MHz, and could shift stations at will. Other agencies not only had fewer frequencies, but they had to secure authorization from IRAC for any variation in their approved assignments. "We enjoy this position," Duvendack reminded them, "because of limiting ourselves to 25 watts of power," getting in on the "ground floor," conforming to the policies handed down by the International Telephonic /Telecommunications/ Union and IRAC, and "the good judgement and foresight in securing our frequencies,"[19] or what he would later refer to as the "pack rat" tendencies of Gael Simson toward accumulating frequencies.[20]

As one last argument against the higher levels of output power and the use of 3-MHz Regional networks, Duvendack made this prediction: "The picture as I see it doesn't look very rosy for the retention and use of the frequencies we have from 2952 kc to 5905 kc (kHz)." Due to the higher classification of other users in this spectrum, the implication was clear. Continued expansion of investment in this region of the spectrum might be for naught.[21]

The remainder of the week was taken up with issues of safety; a demonstration of the SF, TF, and KF; maintenance; the practice of hiring technicians; cooperative relationships with state divisions of forestry; and financing. Participants also reaffirmed communications policy as stated in the *Manual* under "National Forest Protection and Management."[22]

At first glance, it may appear that the communication conference was composed of only antinetwork personnel. Certainly, the gathering had proposed regulations in line with prior Radio Laboratory philosophies. But the consensus favoring a new job definition for the communication technician and for providing communication on the "doer level," as well as the threat that 3-MHz frequencies might become useless, suggests that the administrative levels of Forest Service management were more concerned with costs than communication principles. To a man--from Bill Apgar to Harold Lawson--conferees accurately reflected the fiscal concern of the Washington Office. "We were certainly a shoestring budget outfit," Lawson recalled. He would be echoed many times over.[23]

Economic considerations, therefore, were significant determinants of Washington Office attitudes at the 1948 Portland conference. The loss of the 3-MHz frequencies was viewed, not as a technical issue, but as a financial problem. It would be difficult and embarrassing for Washington to explain later to taxpayers why, say, $500,000 worth of 3-MHz radios were no longer useful.

The Place of the Technical Specialist

The effort of National Forest administrators to come to grips with the phenomenon of "specialists" was the final issue at the Portland conference. During the next years, these selectively educated individuals would proliferate in all areas of administration--game management, grazing, forest pests, soil and water, public relations, recreation, fiscal management, and landscape architecture. In 1948, however, many were not yet certain of either their proper role or the authority they should wield. Even Bill Apgar, who harbored decided prejudices against the incursion of specialists into what he perceived as the domain of the Ranger, could not recognize that he was himself a specialist, indeed, one of the first communication specialists in the Forest Service.

The Portland gathering included administrators who were beginning to grasp the significance and implications of the issue. Jack Horton had had 20 years to reflect on this point when he addressed the conference. "At the risk of being misunderstood," he steadfastly maintained, "I believe it is fundamental that technicians should only act in an advisory capacity."[24]

But Duvendack has other motives for redefining the responsibilities of the communications technician. "My fourth priority," he explained, before accepting the job in Washington, "was to find a replacement for myself and return to my part of the woods."[25] When he returned to the woods he did not want "the tail wagging the dog."

There were high expectations over the ability of the Portland conference to limit the instances of increased transmitter power. This optimism was soon to be dampened, at least momentarily. Region 1 had been developing a Regional aircraft network for several months. Separate application had been made to IRAC to include the National Park Service at Yellowstone and Glacier National Parks in the network. In consideration of Region 1 agreements with the Park Service, which funded 12 smokejumpers, the application was "somewhat reluctantly" approved. Maximum power, however, was to be limited to 125 watts, Glacier was to communicate only with the Forest Service, and then only "in an emergency jeopardizing life, public safety or important property under conditions calling for immediate communication where other means of communication do not exist or are temporarily disrupted or inadequate."[26]

Encouraged by this initial success, Region 1 went one step further and asked the Washington Office to request the inclusion of the Weather Bureau in the network. Regional Forester Percy D. Hanson, noting the importance of fire-weather forecasts, spelled out the need for a 500-watt station in Boise and 100-watt sets in Weather Bureau mobile units. Hanson also pointed out that the Region was not using one of its assigned 3-MHz frequencies and would be willing to relinquish this channel for the Weather Bureau.

The response to Bill Kramer was less than enthusiastic. In fact, the Washington Office Chief of Operation was upset. "We have no intention of relinquishing" any frequencies, he wrote in a scolding three-page reply. He reminded Region 1 that other Regions had been doing without a 3-MHz network since the aircraft network was approved. Indeed, Kramer had no intention of submitting the application even without the frequency recommendation because "...the Forest Service will be asked by IRAC to share some of its frequencies for Weather Bureau use," a precedent he wished to avoid. If this were not enough, he reminded Hanson, "IRAC will not allocate frequencies for use between fixed points (Boise and Missoula) which can be served by wire."

Kramer also told Hanson he did not approve of this attempt to "drive wedges" in "fixed policies." Citing the "power limitations" of 25 watts on 3 MHz, which were "reaffirmed at the Portland Communications Conference," he accused Missoula of proposing and attempting to circumvent this "fixed policy."

More importantly, Kramer was most upset with the intent behind the Region 1 request. Communications between Boise and Missoula was point-to-point communication, not plane-to-ground communication. It had nothing to do with the aircraft network. Region 1, as a result, had put the Division of Operation on the spot and Kramer was not going to let them off easy. "The installation and resultant performance of your high power net has three adverse results." He noted:

1. It has delayed your development of a vhf net, wherein you would have much better radio communications than you now have in areas that can be served only by radio or messengers.

2. It has deprived other regions of the use of a frequency that they were using.

3. A few others would like to follow suit.

Kramer took a parting shot at Apgar for not "discussing" this application after the Portland conference when "asked" by Duvendack to refrain from further 3-MHz development in light of the possible restrictions on Forest Service use on these frequencies. For the benefit of Missoula, he reiterated the point that "adherence to our stated policies" would be expected. "Communication Officer Duvendack will be in Region 1 during the latter part of August and he will discuss the problem involved in more detail," Kramer forewarned the Region.[27]

The results of Duvendack's visit to Missoula are no longer on the record. But it is interesting to note that the communication plans for each of the Region's National Forests had begun to place important emphasis on vhf radio use. Apgar drew up very detailed plans, and now, in contradiction to his earlier opinions on the "worthlessness" of 10-meter communications, warned that "vhf radio, is not restricted to line-of-sight..."[28]

Frequency Allotments Reallocated

Most of the National Forests in Region 1 were well-equipped with vhf by 1956,[29] even though Missoula was allowed to retain its "existing regional net."[30] As predicted, the Regions were notified of the loss of 3-MHz frequencies following the 1952 International Radio Conference (IRAC) in Geneva. Nearly half of the Forest Service hf allocations were classified "out of band" at that time.[31]

Additional IRAC frequency authorizations were acquired in the higher frequencies during Duvendack's tenure in Washington. By 1948, the Department of Agriculture had two frequencies between 144 and 146 MHz, 26 from 146 to 172 MHz, 8 in the 216- to 219-MHz band, and 8 between 411 and 415 MHz. Most of these were allocated to the Forest Service.[32] Unlike previously, use of these frequencies awaited the availability of suitable commercial products.

Duvendack also took a sympathetic approach to other users of radio, giving up a number of Forest Service frequencies. He recognized that scarcity of frequencies made it vitally important that such organizations as State forestry departments have more than one joint frequency assignment, and he lent his support to this effort. He defended this action by pointing out that the Forest Service "could do nearly everything on telephone."[33] Meanwhile, Lawson got Horton's permission to use his own time to work on relieving State forestry departments of some frequencies in the interest of the logging industry. Although this "raised a lot of hell" with State forestry, Lawson defended his work with the same rationale used by Duvendack.[34]

Two factors aided Duvendack's quest to convert Forest Service telephone lines to commercial telephone circuits: The increasing incidence of inductive interference created by nearby high-power electric transmission lines and the advent of dial telephones.

Inductive interference was not new to the Forest Service telephone engineers, but the construction of distant hydroelectric plants, long stretches of high-powered lines, and the expansion of Rural Electrification Administration (REA) services following World War II reached a point where monetary damage agreements favoring the Forest Service were increasingly being settled. Between 1947 and 1949, the public utility companies in California, Washington, Oregon, Idaho, and Montana had to expend some $250,000 to correct interference on Forest Service lines caused by new powerline construction.[35] Radio was substituted in some cases,[36] but, in others, the previous single-wire, ground-return lines were replaced with higher quality double-wire, metallic lines.[37]

The conversion to dial exchanges in the Bell Telephone System created additional telephone problems for the Forest Service. Wherever National Forest lines ran through or to a local exchange, an operator would no longer be there to make the proper connection. Electronic switching systems would now relay the call in conjunction with the commands transmitted by the dial. It was convert, or else, for the Forest Service.

Much Forest Telephone Line Sold

These two matters provided more reasons for not maintaining Forest Service lines. Duvendack's favorable attitude, combined with these circumstances, led to increased sales of telephone line. The process usually involved putting a particular section of line up for bid in local newspapers, through mailings to interested parties, and by posting sale notices in the area Post Offices. A listing, for example, might describe the line as "one metallic telephone line consisting of two #9 wires attached to trees and occasional poles starting at the Sunset highway and extending approximately 4 miles to Kachess Guard Station, Wenatchee National Forest." The line might then be sold to Pacific Telephone and Telegraph for $100.[38] Or the ad might be for a combination of single wires on telephone company poles, and the setup purchased by lodges, ranchers, resorts, or residents who served as Forest Service cooperators. Between 1946 and 1949, decreases in holdings resulting from these sales and abandoned lines amounted to some 12,500 miles. Chief Watts expected that the extension of REA lines to many out-of-the-way locations would soon bring a further reduction in Forest Service holdings.[39]

The radio bid specifications requested of Biggerstaff had no precedent. The Radio Laboratory had tried at the close of World War II to interest RCA in the production an an "a-m Packtype Radiophone" based on very general specifications for size, weight, and power, and on specific suggestions for crystal control of the transmitter and a super-regenerative receiver. It was only an anticipatory request, however, in response to some indication of interest from RCA.[40] Nothing had come of the matter.

Bids were advertised on specific commercial products that the staff agreed were promising. The problem with this approach was that the bid was addressed to a certain make and model, "or equal." "This created ill feeling with other manufacturers...," Biggerstaff learned, because the "implication was obvious" that the Forest Service wanted only the stated make and model.[41] He was pressed to find a means to define specifications allowing other manufacturers' products to be included. He was stumped by the Radio Laboratory's lack of appropriate electronic test and measurement equipment.

Fortunately, Guy Wood was also sensing a real need to accurately measure the performance of Forest Service sets. He knew that trouble-shooting was more successful when technicians were provided with a repair manual that gave the precise expected performance criteria for each section in a radio. To obtain the nominal values for properly operating sets, he imposed upon his friends at the Hewlett-Packard Co., Palo Alto, Calif., to lend him the necessary equipment for recording performance.[42] He completed these measurements by early 1949 and forwarded them to the Laboratory.

First Use of Radio Specifications

The arrival of these specifications could not have been timed better. Biggerstaff needed bid procedures that could be used to test manufacturers' compliance with contracts. He rewrote the specifications to eliminate such nonessential items as color, and stated exactly how to measure the required performances. A dispute on performance "raged for a time" over such particulars as dynamotor versus vibrator power supplies. By eliminating restrictions on circuit types and stressing performance, he was able to increase the possibility of competition. The Forest Service thus would not be limited to one manufacturer and the associated high prices. "I believe it was this philosophy," he recalled later, "that gained much of the early recognition for the Forest Service specifications."[43]

Figure 130. An early Link lightweight FM radiophone packset (model 695-B). It was purchased in the early 1950's by the Forest Service under competitive bid on the basis of specifications developed by the Radio Laboratory. (Forest Service photo, History Section)

Fred Biggerstaff also placed heavy reliance upon the published standards of the Electronic Industries Association (EIA) for his specification parameters. A communication conference in Portland between December 5 and 8, 1949, provided an opportunity for the Regional communication officers and five State forestry departments to have a hand in composing the specifications. "Exceptional close agreement was reached...in the matter of technical standards," reported the *Radio Laboratory Newsletter*.[44]

Once the standards were agreed upon, Biggerstaff initiated the practice of continually updating and improving the data so that no one manufacturer obtained a monopoly. He strove to achieve specifications applicable to no less than two available commercial sets, and preferably, three or more. He also set about measuring the performance characteristics of a number of available commercial models, relying on test equipment that included dry ice for cold tests, light bulbs for heat, a Laboratory-designed "shake table" to measure such qualities as ruggedness, and whatever other equipment served his purpose.[45]

The bid specifications also proved valuable for "in-factory inspections" and Laboratory tests to insure compliance by successful bidders. It was originally expected that manufacturers would produce models of the SF, TF, and KF; however, the start-up costs proved prohibitive. So the manufacturers submitted their own designs as satisfactory substitutes in accordance with Laboratory specifications.

Problems did arise, however, with attempts to have the SF reproduced. The Harvey-Wells Co. of Southbridge, Mass., agreed to manufacture the type SF model C and was awarded a contract over other bidders who proposed their versions of the handie-talkie. The Radio Laboratory purchased 145 units in spring 1950 and distributed them to the field. Technical problems with the sets became evident almost immediately. In a case reminiscent of the problem with Western Wireless, the type SF suffered from unsoldered joints, faulty tubes, inoperative press-to-talk switches, and off-frequency transmitter and receiver circuits.[46] Mr. Harvey argued that "the failure must have happened in transit."[47]

The evidence of poor workmanship was overwhelming. Bill Kramer informed the company that the sets were being returned to the factory and that Biggerstaff would act as an inspector during the rework.[48] From this inauspicious and accidental beginning, the "in-factory inspection" became a regular specification compliance test carried out by Biggerstaff on all Forest Service bids.

Initial awards to manufacturers of non-Forest Service type sets also produced some early compliance problems. Radio Specialty Manufacturing Co. (RSMC) of Portland, one of the first manufacturers to bid for the early Radio Laboratory sets, attempted to move into the competitive market with the production of its own FM semiportables, lookout, mobile, and pack-type sets. Guy Wood discovered that several units in the RSMC type 1144 Packset picked up spurious signals transmitted by stations 10 MHz from the receiver setting. "It is obvious," he wrote the Radio Laboratory, "that the units do not meet the spurious response standards established in the USFS radio specifications" and were therefore considered "unusable" in the Region 5 network.[49] This led Gordon J. Gray of the Scientific Management Branch, Washington Office, to caution RSMC to correct the engineering problem in future deliveries.[50] Several months later, it was learned that RSMC was handicapped by a lack of working capital, a situation stemming from numerous contract extensions and delivery delays of up to 14 months.[51] "Although RSMC makes some types of radio that would be difficult to obtain elsewhere," forewarned Kramer's office, "we cannot continue to do business with them under their present delivery policies."[52]

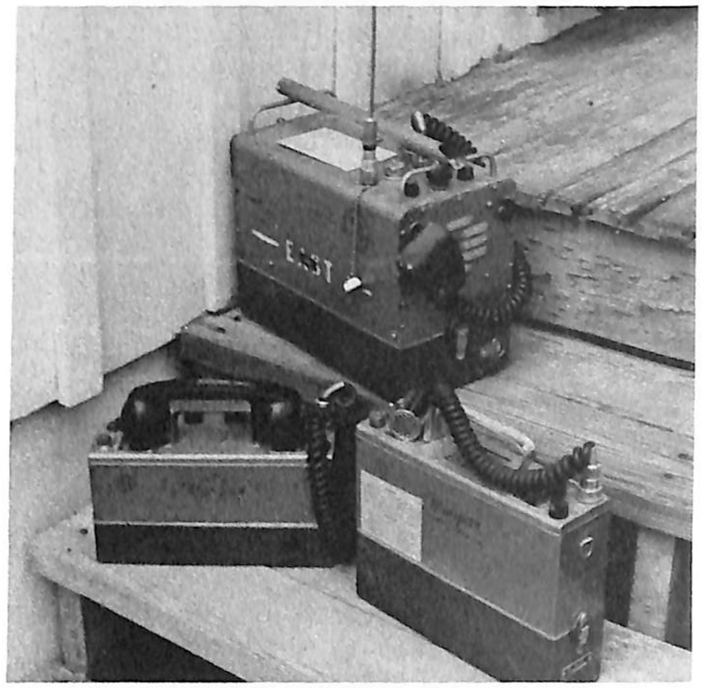


Figure 131. FM radiophone sets purchased by the Forest Service in the early 1950's under competitive bid. At top, model 1144-57-1; lower left, model 1160-37-1; lower right, 1160-15-1. The manufacturer (Radio Specialty Manufacturing Co.) had provided some of the earliest Forest Service radios. (Forest Service photo, History Section).

Corporations with more financial clout also received their share of negative compliance reports. Motorola, Inc. and GE, to name two, submitted some early equipment that had minor technical problems. Region 1 complained that because Motorola's SP-30049 universal remote control system did not perform satisfactorily, and Lawson had to have considerably preliminary work done on these units. "From the experience we've had so far with the various types of equipment," Bill Apgar informed the Laboratory, "the Region is certainly not satisfied with Motorola products."[53]

The problem with GE radio equipment was more specific. In one of the early GE sets, the fixed bias of the grid-drive circuit was erratic due to the use of the type 807 tube. When Bill Claypool, who had returned from Mexico to the Radio Laboratory, traveled to the GE plant to confront them with the problem, he detected an attitude implying that the GE engineers felt somewhat superior to the technical staff of the Forest Service. In response to the confrontation, Claypool amusingly informed Bud Fontaine, GE argued that the cost of the 807 tube was so low that the "infrequent" loss due to the failure of the grid drive "was of no great importance."[54]

The Radio Laboratory also discovered that some larger corporations could not be enticed to bid on the less lucrative contracts in the earlier phase of the specification program. When bid requests had been let in an attempt to obtain a fixed-base FM set for St. Anthony, Idaho, GE and RCA responded, but Motorola did not. The Radio Laboratory concluded "that Motorola is just not hungry enough for business this time and did not choose to sharpen its pencils for such a small order."[55]

This situation would be corrected in time as Forest Service annual radio purchases approached significant figures. Biggerstaff, Claypool, and Lawson remembered that Motorola, in particular, became very cooperative towards the Laboratory, perhaps more so than certain other manufacturers who exhibited an early attitude of "take what we have, or do without." Other manufacturers also developed a cooperative attitude. The degree of interest, of course, varied over time with all firms, including Motorola, often depending on who the technical contact person was.[56]

Certification Program Is Begun

An important factor in the success of the Forest Service bid-specification procedures was the coincidental development of a "certification" program. With knowledge gained through specification and in-factory inspections, Biggerstaff was able to measure the performance of any available commercial set. In substance, the certification of a set was merely a pre-bid statement by the Radio Laboratory that a particular model was in compliance with existing specifications. Knowing the unit had already passed inspection gave manufacturers more incentive to submit bids and encouraged them to consider the needs of the Forest Service in the early stages of design. Manufacturers could then confidentially approach the Laboratory staff to ascertain the value of particular techniques or modifications before incurring further developmental costs. Agreement was not always achieved, but this process gave the Forest Service an avenue to affect the configuration and performance of purchased sets. This advantage had been lost with the cancellation of the Laboratory design program.

In addition, the certification program allowed Biggerstaff to keep the specifications up to date. New concepts could be immediately incorporated into the data, and the Forest Service assured of obtaining the latest equipment.

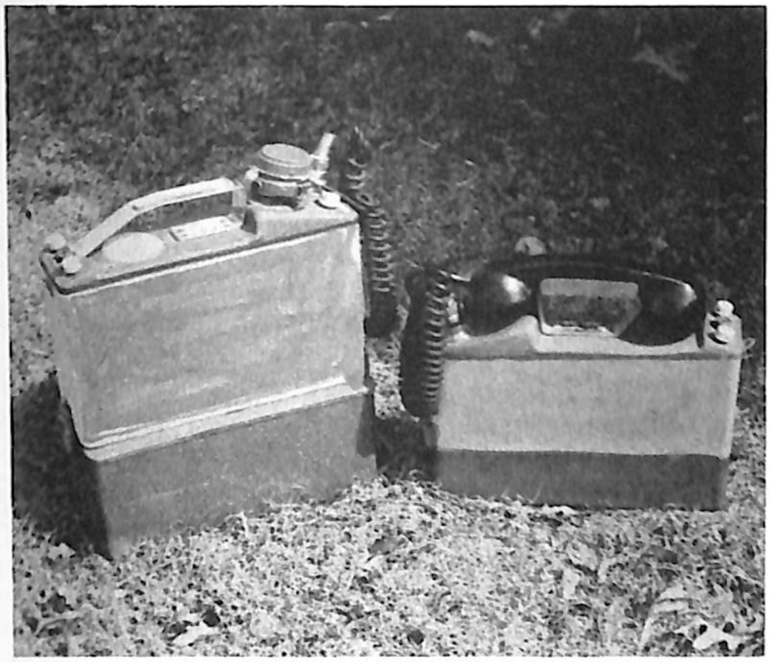


Figure 132. Handie-talkies, made by the Motorola Corporation, were purchased by the Forest Service under competitive bid in the early 1950's after precise specifications for the sets were completed by the Radio Laboratory. At left, model P31BAC-1061AM. At right, model H-21-3. (Forest Service photo, History Section)

Records of the certification program were faithfully maintained by Biggerstaff. Early tests indicate that the first compliance inspections began in mid-1949 and covered everything from central stations to mobile units and handie-talkies. Belmont Radio Corp. (Raytheon Corp.), Philco Corp., RSMC, Motorola, RCA, Link Radio Corp., Harvey-Wells Co., and GE all made the list. A notation beside each entry records "Rejected," "Accepted," or "Accepted Conditionally." By the end of 1951, only 8 out of 27 commercial models inspected had been given favorable ratings.[57]

The Regions began the process of converting to FM during Duvendack's tenure. One of the sets used in significant numbers for a few years was the military surplus SCR-610. It provided an economical alternative for mobile, fixed-base, and lookout-tower use on the Chelan National Forest, Wash.[58] When it came time for the Siskiyou and part of the Rogue River National Forests in Oregon to convert, the Regional office recommended purchase of this set. Even though the 640's provided by surplus warehouses were in only "good to poor" condition, the initial costs of reconditioning averaged less than $100 apiece, including transportation and the expense of sending someone to select the better ones.[59]

The 1951 cost estimates of Region 6 continued to reflect the advantages of the SCR-610 during the conversion from AM to FM. Although recommending 44 handie-talkies, 14 packsets, and 20 mobile sets--all commercial models--at a total cost of $37,432, the Region included 26 SCR conversion kits, indicating the set was still considered relatively important.[60] By this time, the total Region 6 radio inventory was approaching 1,500 units, with 1,053 sets already on FM and only 362 still on AM.[61]

Despite its usefulness, however, the SCR-610 had serious faults. "...It was difficult to maintain, its a.f.c. often failed to keep it on frequency, and the special bias batteries were soon impossible to obtain. They /the sets/ were therefore not used long, and their annual life cost, including maintenance and failures, was probably as high /as/ or higher than the equivalent commercial radios."[62]

Having significantly converted the Forest Service to commercial radio and telephone service and established a visible semblance of order in Regional approaches to communication planning, George Duvendack began to act on his third goal. It was time to move the Radio Laboratory closer to the Washington Office.[63]

Arguments in favor of moving the Laboratory were about as old as the Radio Laboratory itself. Occasional voices had been heard on the subject since the beginning of the design program in Portland. The 1935 Portland conference discussed the location of the Laboratory and drafted a resolution in favor of relocating the personnel where they would "...have opportunity to contact other individuals doing work of a like nature."[64] But it was not until 1947 that anyone gave much credence to the possibility.

At that time, David S. Nordwall of the Washington Office Operation staff, concluded his inspection of the Portland facility and recommended that "in view of the probable curtailment of /the/ scope of /design/ activities, consideration should be given to the desirability of locating the Laboratory and its staff at some point near Washington--such as Beltsville."[65]

Radio Laboratory Is Moved to Beltsville, Md.

Beltsville, Maryland, was a logical selection. On the edge of the town were the sprawling research facilities and farmland of the Experiment Station of the U.S. Department of Agriculture, no more than a half-hour drive to the Forest Service headquarters in the South Building near the Washington Monument, Washington, D.C., and a similar trip to the major airports near Washington or Baltimore. The facility had sufficient open space available for any experiments. Electrical interference was minimal, and short flights could take the staff to the headquarters of manufacturers. In addition, the staff could easily participate in Washington Office meetings and IRAC conferences. All these impressive advantages made the location an appealing choice to Duvendack, and he set out to convince Kramer that the cost was worth the move. First, however, he took steps to reach his last goal, a replacement for himself. George was ready to return to his part of the woods.

Duvendack kept an eye out for a suitable replacement on his trips through the Regions. Some months before, he had settled on E. Allan Loew of the Region 6 Engineering Division.[66] When the time was right, he approached Kramer about moving the Laboratory to Beltsville and promoting Loew to the job of Chief of Communications. Duvendack returned to St. Maries, Idaho, as supervisor of the St. Joe National Forest, the place where Harold Lawson had installed the first Forest Service radios on a National Forest.

Al Loew was better prepared for the communications assignment than his predecessor. He was a native of Washington State and had earned a degree in electrical engineering (power transmission) from the University of Washington, where his father was on the faculty of the School of Engineering. Loew had accepted a job with the Regional office in Portland in November 1936. Here he had been put to work surveying, controlling stream erosion, and installing small hydroelectric plants and gas generators at Ranger stations. He was then assigned responsibility when the administration and control of the Regional telephone systems were moved over to the Division of Engineering.[67] In this capacity, he had been involved in communication issues affecting both radio and telephone, attended the 1940 and 1948 communications conferences,[68] and had come to know Jack Horton well. "I got more support sometimes," Loew related about Horton's control of Regional budgets and financing, "than I did from my own boss."[69]

Arrangements to move the Laboratory were made by Loew in September and October and completed in November 1951.[70] Most of the active projects made the transition, with the exception of an experiment for potting subcircuit assemblies in a polystyrene compound. Only Biggerstaff and Claypool, however, remained with the Laboratory. Logan Belleville left the Forest Service for Tektronix Co. in Beaverton, Ore., when the shift to commercial purchase of radios became certain. He became significantly involved in the company's oscilloscope development program.

Deciding whether or not to move to Beltsville was an agonizing experience for Harold Lawson. He had been an integral part of the program since Dwight Beatty had hired him 20 years before, but he realized that the old days were over. Many rewarding experiences crowded his memory as he contemplated a decision. He had designed and constructed the first voice-transmission, semiportable SP set with no more than a hand drill, tin snips, and a few other tools. He had seen the Laboratory grow from a ramshackle house in Tacoma to quarters in Portland indicative of its stature in lightweight, low-power radio design and development. He had spent countless hours struggling at the workbench to extract the maximum efficiency from a collection of tubes, resistors, and capacitors. And he had been as pleased with a coworker's success as with his own.

A champion of vhf radio from the outset, Lawson would argue the merits and defend the faults of 10-meter radio in the interest of providing the best possible communication systems for the men on the fireline. Years later he sat in his living room and gently held a Forest Service handie-talkie as he recounted the Laboratory decision to go to FM. The SF unit, found in a surplus store junk box and given to him by a friend, represented far more than an inanimate object from the past. As Lawson talked, his eyes followed the outline of the shiny chrome enclosure. His hand went gently around the smooth contours of the case. His thumb depressed the press-to-talk switch as naturally as if the set invited operation. His conversations were technical and his demeanor authoritative as he reflected on history. The voice did not mask the pride. "We were not a research group; we were an applications group," he emphasized. The contradiction between his words and the object in his hand never occurred to him.

On May 15, 1951 Harold Lawson received a "Superior Service Award" from the Federal Government. It cited his "zeal, initiative, and success in developing greatly improved radio equipment to meet the communication requirements of land management agencies resulting in marked savings to the Government and usefulness for certain military search and rescue communication purposes."

For a while, Duvendack thought he had talked Lawson into making the move to Beltsville. But Harold and Bea Lawson had lived all their lives in the Pacific Northwest, and they chose to stay there. Lawson resigned from the Forest Service as the Radio Laboratory was being emptied of its contents. Thus ended a significant chapter in the history of electronics communications.[71]

Reference Notes

1. F. V. Horton, "Management's Job and Responsibilities" (Paper presented at the Forest Service All-Regions Communication Conference, Portland, Ore., 19 January 1948, pp. 1, 2, Gaylord A. Knight Collection.

2. George H. Duvendack, interview with the author in Missoula, Mont., May 1978. Duvendack, as indicated, expressed total ignorance of the theory and principles of electronics and set design, and claimed a lack of skills in set construction, maintenance and repair. He implied a minimal knowledge of or experience in radio communication. Bill Morton expressed surprise to the History Section at this response. As a technician in Region 1 (see chapter 15) and later assigned to Station KCBX in Missoula, Morton heard Duvendack sending messages in international Morse code at 20 words per minute from his station, KBBN, Sandpoint, Idaho, late in the evenings in an attempt to catch the KBCX technicians off guard. Also, Morton recalled Duvendack as a radio amateur who had had military communications assignments. See William B. Morton to Dennis Roth, Forest Service History Section, 18 April 1980, History Section files, p. 6.

3. Duvendack, interview with author.

4. Duvendack, interview with author.

5. A. G. Simson, "Memorandum," 27 January 1939, Gaylord A. Knight Collection and Harold K. Lawson, interview with the author in King City, Ore., May 1978.

6. D. S. Nordwall, "Memorandum for the Record-Radio Laboratory Inspection," 24 March 1947, p. 15, Gaylord A. Knight Collection.

7. Duvendack, interview with author.

8. [George Duvendack], "Memorandum for the Record," 16 November 1948, p. 1, Gaylord A. Knight Collection.

9. Duvendack, interview with author.

10. Duvendack, "Memorandum for the Record," p. 2.

11. Duvendack, "Memorandum for the Record," p. 2.

12. Lawson, interview with author, and Duvendack, interview with author.

13. W. Frederick Biggerstaff, interview with the author in Saratoga, Calif., January 1978.

14. R. E. Marsh to Regional Foresters, 6 November 1947, Gaylord A. Knight Collection.

15. D. S. Nordwall to Regional Forester, 12 December 1947, Gaylord A. Knight Collection.

16. Horton, "Management's Job," pp. 15, 17.

17. B. A. Anderson, "Communication Planning" (Paper presented at the Forest Service All-Regions Communication Conference, Portland, Ore., 19 January 1948, p. 21, Gaylord A. Knight Collection.

18. G. H. Duvendack, "A Study of Frequency and Power Allocations" (Paper presented at the Forest Service All-Regions Communication Conference, Portland, Ore., 19 January 1948, p. 27, Gaylord A. Knight Collection.

19. Duvendack, "Study," p. 30.

20. Duvendack, interview with author.

21. Duvendack, "Study," p. 31.

22. Duvendack, "Study," app., pp. 1-12.

23. Lawson, interview with author; Wilbur S. Claypool, interview with the author in San Antonio, Tex., July 1978; Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, April 1979; Francis S. Woods, interview with the author in Ogden, Utah, January 1978; W. B. Apgar, interview with the author in San City, Ariz., January 1978; and Biggerstaff, interview with author.

24. Horton, "Management's Job," p. 17.

25. Duvendack, interview with author.

26. Wm. P. Kramer to Region 1, 7 July 1947, Gaylord A. Knight Collection.

27. Wm. P. Kramer to Region 1, 29 July 1948, Gaylord A. Knight Collection.

28. W. B. Apgar, "Communication Plan-St. Joe National Forest," 16 July 1948, typed copy. Copies of the 1948-49 plans for all Region 1 forests were in my possession at the time of this writing. I expected to put them in the Gaylord A. Knight Collection.

29. J. H. "Bud" Coats, "Communications in the National Forests of Region One," ca. 1979, unpublished draft, p. 11, Gaylord A. Knight Collection.

30. R. Max Peterson (Engineer, Region 1) to Forest Service Radio Laboratory, 2 February 1960, Gaylord A. Knight Collection. Peterson became Chief of the Forest Service on June 27, 1979.

31. Howard Hopkins (Washington Office) to Regional Foresters, 12 April 1952, Gaylord A. Knight Collection.

32. Howard Hopkins (Washington Office) to Regional Forester, 22 April 1948, Gaylord A. Knight Collection. Gael Simson had been responsible for a large number of these between 140 and 160 MHz. See Knight, interview with author.

33. Duvendack, interview with author.

34. Lawson, interview with author.

35. G. H. Duvendack, "Rough Draft," intended for part of a report by "Mr. Muenster" on REA inductive interference, 1 February 1949, Gaylord A. Knight Collection.

36. Lyle F. Watts to Regional Foresters and Directors, 15 March 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

37. Watts to Regional Foresters and Directors. See also, Leo M. Moore, REA, St. Louis, to Regional Forester (Regions 1, 6, and 8), 23 April 1942; Wm. P. Kramer to Regional Foresters, 23 April 1942; "GHD" [Duvendack], "Memorandum to the Record," 9 February 1949; and G. H. Duvendack to Mr. [Gordon] Fox, 26 January 1951, all Gaylord A. Knight Collection.

38. U.S. Department of Agriculture, Forest Service, Region 6, "Invitation, Bid, and Acceptance," 3 November 1948, National Archives and Records Service, Seattle, Wash., Box 19034.

39. Lyle F. Watts to Regional Foresters and Directors, 16 November 1950, National Archives and Records Service, Seattle, Wash., Box 19034.

40. Wm. P. Kramer (dictated by Lawson) to Radio Corporation of America, 20 April 1945, Gaylord A. Knight Collection.

41. Fred Biggerstaff, "Forest Service FM Radiophone Bid Specifications,"

draft prepared for later use, ca. 1966, p. 1, Gaylord A. Knight Collection.

42. Woods, interview with author.

43. Biggerstaff, "Bid Specifications," p. 2. See also, Region 5, "Invitation Bid and Acceptance-Short Form Contract," 1949, National Archives and Records Service, Seattle, Wash., Box 53982. The sale of these two systems required 30 pages of description.

44. Forest Service, *Radio Laboratory Newsletter*, no. 3, January 1950, p. 1.

45. Biggerstaff, interview with author.

46. Kermit W. Lindstedt (R-6) to the Chief, 19 May 1950; L. K. Mays to Chief, 26 May 1950; W. B. Apgar to Harold Lawson, 6 May 1950, all National Archives and Records Service, Seattle, Wash., Box 53982; and Al Loew to Regional Forester (R-6), 4 August 1950, National Archives and Records Service, Seattle, Wash., Box B4266.

47. Linstedt to Chief.

48. Wm. P. Kramer to Harvey-Wells Co., 6 June 1950, and Wm. P. Kramer to Regional Forester (Regions 1, 2, 4, 5 and 6), 15 September 1950, both National Archives and Records Service, Seattle, Wash., Box 53982.

49. Guy V. Wood, "Memorandum to the Files," 10 December 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

50. Gordon J. Gray (Washington Office) to Radio Specialty Manufacturing Co., 14 December 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

51. Gordon D. Fox (Washington Office) to Region 6, 9 May 1952 and W. L. MacDonald (R-6) to Wm. P. Kramer, 10 June 1952, National Archives and Records Service, Seattle, Wash., Box 53982.

52. Fox to R-6.

53. Region 1 to Region 6, January 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

54. W. S. Claypool to C. V. Fontaine (R-6), 17 December 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

55. E. Allan Loew to All-Region Communication Officers, 15 May 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

56. Biggerstaff, interview with author; Claypool, interview with author; and Lawson, interview with author. Also see William B. Morton to Dennis Roth, Forest Service History Section, 18 April 1980, History Section files.

57. Forest Service Radio Laboratory, "Certification Tests," Log book of entries, typed and handwritten, Gaylord A. Knight Collection.

58. Paul K. Taylor (Chelan National Forest) to Regional Forester (R-6), 25 April 1950, National Archives and Records Service, Seattle, Wash., Box 53982.

59. L. L. Colville (R-6), "Memorandum," 12 July 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

60. C. V. Fontaine (R-6) to Fire Control (R-6), 12 March 1951, National Archives and Records Service, Seattle, Wash., Box 53981.

61. James Frankland (R-6) to Operations (R-6), 11 May 1951,

National Archives and Records Service, Seattle, Wash., Box 53981.

62. Morton to Roth, 18 April 1980, p. 7.

63. Duvendack, interview with author.

64. U.S. Department of Agriculture, Forest Service, "Forest Service Communications Conference," Portland, Ore., 20 February to 2 March 1935, typed copy, p. 4, Gaylord A. Knight Collection.

65. Nordwall, "Radio Laboratory Inspection," p. 15.

66. Duvendack, interview with author.

67. E. Allan Loew, interview with the author in Beltsville, Md., November 1978.

68. Forest Service, "Inter-Regional Radio Communication Conference-Minutes of Meeting," Portland, Ore., 2 December to 7 December 1940, pp. 1, 2; and "1948 Communications Conference," pp. 1-5, both Gaylord A. Knight Collection.

69. Loew, interview with author.

70. Howard Hopkins (Washington Office) to all Regional Foresters and Directors, 26 September 1951 and Edward C. Crafts (Washington Office) to all Regional Foresters and Directors, [n.d.], both Gaylord A. Knight Collection.

71. Harold K. Lawson to the author, tape-recorded comments on review of preliminary manuscript, [n.d.], Gaylord A. Knight Collection.

Chapter XV
The Electronics Center: Communication Programs After 1951

Now the times have changed to a point whereby a Ranger has access to radio, microwave, and walkie-talkies for communications. Telephone lines are almost a thing of the past so I guess after all is said and done I was born too soon.

- Leon L. Lake[1]

The name of the Radio Laboratory was finally changed to the Electronics Center at the end of 1963. This was done to reflect "a general electronics development" program as compared to the "previous emphasis on radio communications." The change actually could have been made 12 years earlier.

No radio design projects were initiated or completed after the Radio Laboratory moved to Beltsville late in 1951. All efforts were directed towards assisting the Regions in radio procurement and developing specialized equipment for Servicewide communication needs. Staff duties were limited to handle specifications and certification, "noncommunications electronics development," and IRAC meetings.[2] Biggerstaff was in charge of the Radio and Test Section, Claypool headed the Electronic Development Section, and Loew and Erwin Wagner handled IRAC matters and Washington Office duties.

Figure 133. The Forest Service Electronics Center, near Beltsville, Md., in 1979. It is located in the large outdoor Agricultural Research Center of the U.S. Department of Agriculture, outside Washington, D.C. (Forest Service photo, History Section)

The Region 1 radio network was one of the first matters taken under consideration in Beltsville. "I didn't agree with it," Loew reported, and he initiated steps to bring an end to its use. The response from Region 1 was reluctant and it became a matter of some contention with the Division of Fire Control in Missoula who, Loew said, "didn't think I was doing right by Region 1 by forcing the system out." Loew found the arguments for its continuation financially unjustifiable. Fire control was basically seasonal; the network required year-round funding. When it was necessary to compete with other programs for money "it didn't make much sense" to argue for the network when the telephone was more than satisfactory most of the year.[3]

Loew's next priority was a change in job classifications for the "fellows" who worked in communications. He was sensitive to Claypool's being passed over for the Regional communications position because he lacked a professional degree. Loew wanted to avoid this kind of situation in the future. He worked for a reclassification of job titles in line with the required engineering duties. Loew believed these men "...knew more about radio than most graduate engineers."

"I would hate to think," he confided, "what Fred Biggerstaff could have done with education." He pointed out that Claypool and Wood had technical libraries that would "swamp" most college professors. These men had "grown up" with radio; "...it had been their whole life."[4] Loew's confidence in the technical abilities of his staff of two carried over to his respect for their administrative abilities. He did not interfere in the day-to-day operation of the Beltsville facility, preferring instead to maintain his office in downtown Washington, D.C.

At Loew's suggestion, Biggerstaff began consolidating the specifications common to all types of radio in the Forest Service, and separated them from the unique features of each set in order to make the bid process less complicated. His early experience as a fire guard and radio operator was helpful, and he established the goal of obtaining "...the best possible equipment, for the best possible price." Yet he recognized that, by definition, all specifications require "compromise" decisions.[5] He sought input from the field so the specifications would not become biased, and he initiated a system of unsatisfactory equipment reports (UR) on equipment at the suggestion of Francis Woods to double check against equipment problems that had not been detected during certification and compliance but showed up during use in the field.[6] Biggerstaff also valued factory inspections, meetings with manufacturers' representatives, and participation in professional engineering meetings as other ways to maintain his objectivity in making evaluations.[7]

This approach to procurement was unique in the Federal Government. By side stepping the lists of products approved by the Government Services Administration (GSA) he enabled the Forest Service to buy communication equipment at a discount averaging 30 to 50 percent.[8] This practice also permitted him to maintain an up-to-date, certified products list representing the state-of-the-art in available communication products.

Applied Research at Beltsville

Biggerstaff also crossed over into applied research. Always seeking a better way to determine radio performance, he developed measurement systems for the fault analysis of vhf-uhf antenna systems. This technique was adopted by International Bell Telephone Co.[9] Another accomplishment was the derivation of a system to measure close-spaced antennas in radio relays.[10] Perhaps a better measure of Biggerstaff's expertise was related by Gaylord Knight when he discussed an Institute of Radio Engineers (IRE) convention in Tampa, Fla. Knight had been amazed to find during the social functions and informal

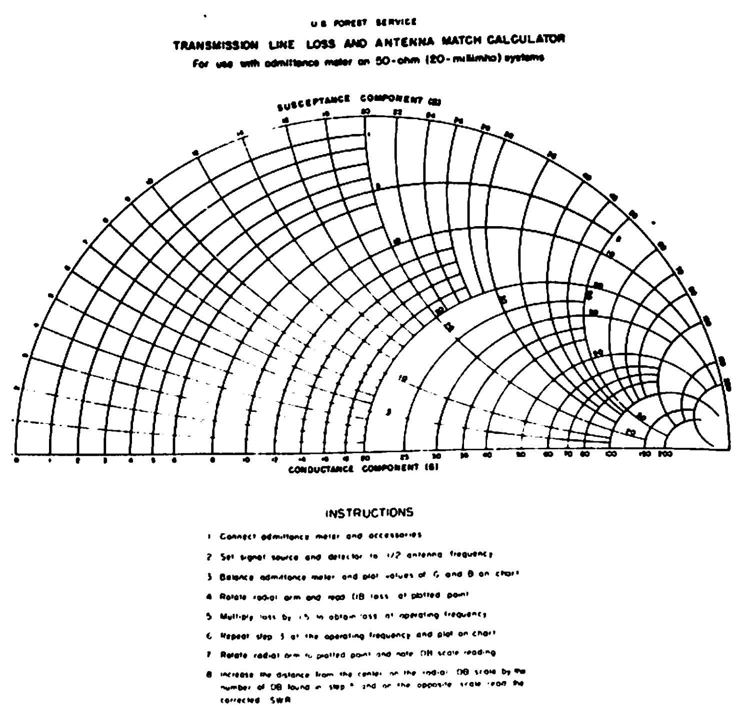


Figure 134. Transmission Line Loss and Antenna Match Calculator developed by W. F. Biggerstaff of the Forest Service Electronics Center. (Forest Service photo, History Section)

conversation that people who learned he was with the Forest Service invariably asked for an introduction to Fred Biggerstaff.[11] He also said, "I can recall time and time again sitting in with engineers from Motorola, RCA, and GE, who had Ph.D.'s, arguing with him over one of his findings, but none of them could back Fred into a hole; he was sound."[12] In 1960, Fred Biggerstaff was awarded a Federal Government "Superior Service Award" citing his "...exceptionally high and continued competency and performance in the field of mobile radio equipment testing and system's maintenance."[13] It was a long way from the CCC and his days as a machinist.

Figure 135. A signal generator designed by Wilbur Claypool and milled by him from aluminum stock at the Forest Service Electronics Center. (Forest Service photo, History Section)

Bill Claypool's Beltsville assignments were primarily of a unique applications nature. With occasional support from Biggerstaff and, after 1967, help from a new member of the radio staff, Howard Webb, he investigated such instrumentation as fire-weather telemetering, a high-speed electronic intervalometer, thermoelectric power generation, and infrared fire mapping.[14]

In each instance, a Laboratory model was constructed and tested; in most cases, models went into commercial production and were bought for Regional use. Other projects ranged from transistorized test equipment to a talking beaver to a Region 3 display.[15] But Claypool got the most satisfaction from combining his mechanical and electrical skills on projects. Not infrequently, he would begin a project with solid aluminum stock and mill it out for a chassis, similarly construct rectangular and circular containers for shielding, and then incorporate the electrical components of his design. Claypool's electromechanical talents, observed a co-worker, bordered on genius.[16]

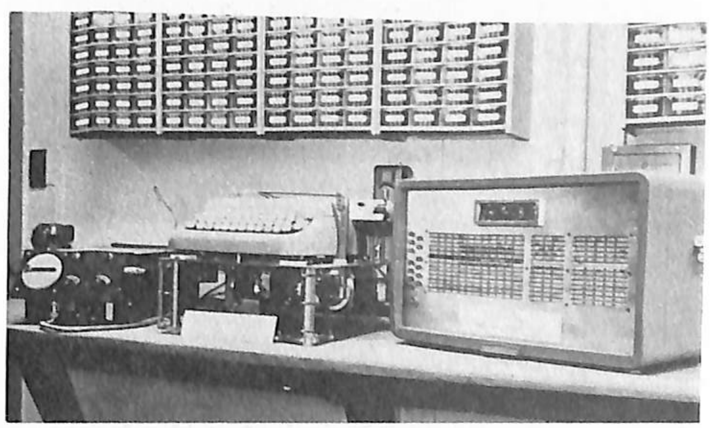


Figure 136. The recording components of the fire-weather telemetering system developed by Wilbur Claypool of the Forest Service Electronics Center. (Forest Service photo, History Section)

The Regions were given more developmental responsibility during Loew's administration. In one case, Carroll F. (Bud) Fontaine, Region 6 Communications Officer then on the engineering staff, worked with Minnesota Mining and Manufacturing Co. (3M) to complete field tests on the Laboratory-designed thermoelectric power source.

This additional responsibility also carried over into the areas of design and modification. Fontaine learned that his involvement in this aspect of engineering led to familiar problems with nonradio people. On one occasion, William L. (Bill) MacDonald of the engineering staff, inspected the Regional "radio shop" for his supervisor. In his final report to the Regional Forester, he questioned the need for "a so well-equipped" facility. Fontaine was taken aback, even a little annoyed. "This was somewhat of a surprise to me," he wrote. He then proceeded to review the radio shop projects and the resulting large savings for the Service:

Project	Savings Over Commercial Models
Conversion of 500 SCR sets	$220,000
Design of RF wattmeter	$45 to $95 each
18 Conelrad alarms	$1,048
Construct Lowell-Fall Creek telephone	$8,000
Design of deviation meter	$376
Design of battery-operated VTVM	$59 each
Many miscellaneous improvements	Value Unknown

"We can understand," Fontaine concluded for the benefit of Assistant Regional Forester Raymond F. Grefe, the Regional Engineer, "where if a person loses sight of the magnitude of the communications' operation, they may not realize that we are accomplishing our work with a minimum of personnel and equipment."[17]

The level of effort prescribed by Kramer's office for Region 1 was having its effect. Most of the Northern Region forests were well-equipped with low-band FM radios in the 30- to 40-MHz range by 1957.[18] Construction of the Region 1 FM aircraft network under the supervision of Clarence B. Westcott was also in progress.[19]

High-Band Vhf and Uhf

The investigation of high-band vhf (152-174 MHz) and uhf (411-416 MHz) had been underway before the move to Beltsville. Once again, as in Gael Simson's administration, the Forest Service had the advantage of obtaining these frequencies when technology proved their importance. "Although we see no such possibility," Gordon Fox, Alternate Director, Division of Operations, informed the Regional Foresters in mid-1953, "It nevertheless is wise to be prepared and to develop an allocation plan which will permit today's limited use of these frequencies to be made in a manner that will mesh with any expanded use in the future."[21] Motivated further by a disruptive solar sunspot cycle that year,[22] Claypool undertook construction of an experimental dual low-band/high-band vhf test unit in anticipation of moving to the higher frequency.[23]

Developmental work and technical research projects were also requested of Guy Wood in Region 5. One of the first efforts was to investigate FM close-radio-frequency separations (200 kHz on 30- to 40-MHz and 500/700 kHz on 160- to 170-MHz systems). "This network design," he reported on his 1947 experiment, "facilitated establishing Forest and Regional FM radio systems using then available commercial FM radio equipment."[24] Preparing for higher frequencies, he equipped a lookout tower with three transmitters (30- to 40-; 162- to 174-, and 411- to 416-MHz) for test communications with mobile receivers. His data over several months suggested the value of high-band vhf, particularly in reducing skip interference. The Radio Laboratory subsequently recommended "...that a real effort be made to engineer all new networks on the high-band frequencies between 162 and 174 Mc (MHz)."[25]

Another contribution from Wood was Project SNUTS (Something New Under the Sun). The question of using solar cells as a power source for remote radio repeaters led him to undertake field tests at an early date. His efforts, reported in 1958, established the technical feasibility of the concept long before solar cells were economically justified.[26]

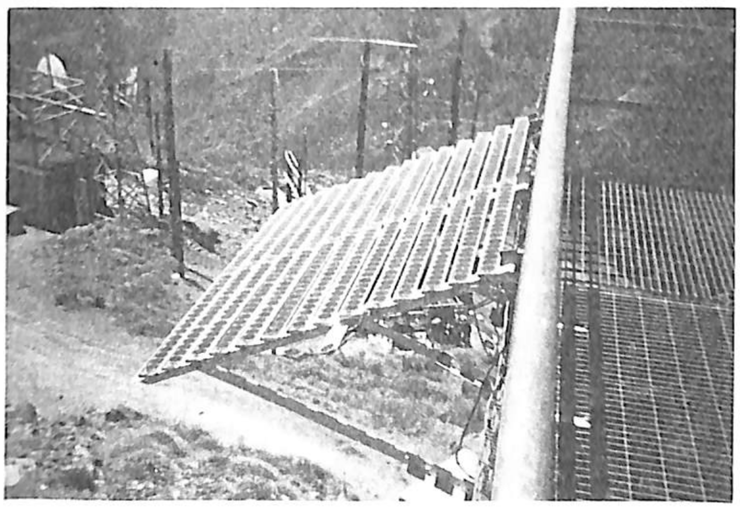


Figure 137. A 1958 project dubbed "SNUTS" (Something New Under the Sun) demonstrated the feasibility of using solar cells as a power source for remote Forest Service radio relay repeater stations. The pioneer unit was developed by Guy V. Wood, communications chief for Region 5 (California, now Pacific Southwest, Region). This photo shows a close-up of solar convertor unit at the test site. (Forest Service photo, History Section)

Contemplating retirement, Al Loew set about selecting his replacement. Meanwhile, Claypool took disability retirement. Several years before, in July 1961, Loew had promoted William B. (Bill) Morton from Region 3 to be his assistant in Washington IRAC matters. Morton accepted the Chief of Communications position. Biggerstaff retired the day after Loew, completing another major turnover in veteran personnel.[27]

Morton's Forest Service experience overlapped many of the significant communication issues of the previous 2 decades. Region 1 versus the Laboratory, telephone versus radio, the shift from AM to FM, and the trend towards centralized control were all familiar to him. After graduating from high school in 1940, he wanted to take aviation training in technical school, but switched to electronics when he learned the aviation

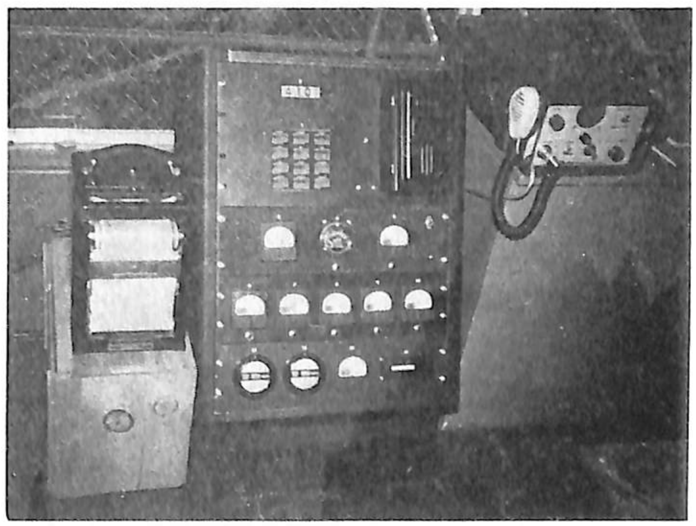


Figure 138. Instruments of the remote Forest Service radio relay repeater station powered by solar energy cells at a test installation in California. Developed by Guy Wood, shown left to right are strip chart recorder, special instrumentation, and the Motorola repeater unit. (Forest Service photo, History Section)

classes were filled. Before transferring to an Oregon college, he passed his amateur radio license exam (W7IOX, K3TGF, D4ABK).

Morton returned to Missoula 2 years later and became a member of Apgar's amateur operator call list for major conflagrations. This led to 6 weeks employment as a live-in station operator at KBCX before being drafted to serve in World War II. During the war, he decoded German messages for the Army Signal Corps at Eisenhower's European headquarters.

After his discharge, Morton enrolled at the University of Montana in Missoula and worked part-time at Apgar's KBCX while earning a degree in physics. He helped install the Collins transmitter that became an issue with the Radio Laboratory, and he was at Orofino for Biggerstaff's TDF/Collins test. "Personally, I think the Lab was wrong, technically, at that time," he commented much later on that exercise. Pointing out the difference between the 3 dB required for perceptible audio detection, as contrasted with only 1 dB necessary for a measurable change in RF power, he would side with the proponents of high power, at least on technical grounds:

> The matter should have been decided on policy issues. If a high-powered hf network was to be according to Forest Service policy, the extra power could often establish a margin of readability in marginal propagation and noise/signal conditions...The strong effect decentralization attitudes of the Forest Service had on communications policy /must be kept in mind/... The question, then, of high-power versus low-power is an issue only as it related to the requirements of centralization or decentralization and the use of the appropriate bands to meet these requirements.

After graduating from the university in 1948, Morton was assigned to the western half of Region 1 (northern Idaho) as the lone communication technician. Four years later, he was placed on temporary duty in Region 3 where he provided communication assistance for fire control. (While he was there, the first real Smokey the Bear was discovered on the Lincoln National Forest.) Years later, he remembered pondering the state of communications in Region 3 after returning to Missoula. He recalled expressing the opinion that he would not care to be a part of the Southwestern Region's communication problems. Yet, a few months later, in September 1952, Morton accepted the communication position in Region 3.[28]

The communication system that Morton confronted was backward, at best. Telephone lines served most of the Southwest. The lines, built by the Signal Corps on metal poles to keep the Apache Indians from burning them down, were turned over to the Forest Service by the Army after the Indians were subdued. Not surprisingly, the state of radio was not much more advanced. He had a limited amount of 3-MHz equipment and two technicians --one each for New Mexico and Arizona. Morton's first priority was the elimination of "psychological barriers." Wind and sand-precipitation static on the hf frequencies had fostered negative attitudes towards radio. When he left 9 years later to accept the Washington appointment, Region 3 had an FM network, employed technicians for each of the 12 National Forests, and "had a lot less telephone line."[29]

Regional Responsibilities Increased

The responsibilities of the Regional communication officers increased as Loew, Claypool, and Biggerstaff left. Morton supported and encouraged a more decentralized approach towards Regional communications, although he did not put the emphasis into written policy. His philosophy was: "Do your job, and we'll help you all we can."

Morton viewed the Electronics Center as a service agency for the Regions. Questions on number and type of equipment were to be left to the discretion of Regional authorities. If the Regions needed to know the capacity of a given number of sets to handle traffic, required special permits, had problems with frequency assignments, or wanted to know what commercial equipment was available, the Center would be quick to respond.

Techniques or problems too complex in scope or too costly for the Regions also remained the Center's responsibility. "The revision of the Forest Service *Manual* to establish communications policy; the defense of Forest Service procurement policies against bureaucratic and money-wasting GSA policies; promoting development of the 9,600-channel FM aircraft radio as a necessary base for nationwide fire aircraft operations;..." and satellite communications, first used in 1975, were examples.[30]

Morton believed these functions gave his group a unique quality--a quality that had accrued during the history of Forest Service two-way, land-mobile communication, certification, and specification. This reputation generated requests for assistance from other Government agencies, ranging from Laboratory design assistance to Claypool's assignment to the Mexican hoof-and-mouth program, and took Morton to New Zealand and Saudi Arabia as an advisor. "When Fred Biggerstaff first started he had to argue with the manufacturers about a test. Now we are quoted by others verbatim, as a result of the reputation he established."[31]

Administration of the communication program came full circle after Morton's appointment. It had begun with a decentralized approach, followed by more control during the Duvendack-Loew years. Morton was able to loosen the administrative ties because most points of contention had been removed between 1947 and 1967. After 1967, the Federal Telecommunications System (FTS) provided a less restrictive alternate communication source, Regional fire radio systems were well established, and a recognizable body of expertise existed in the communication profession and industry.

Two further developments removed much of the guesswork associated with earlier communication systems, reducing the need for Washington control. They were a Servicewide attempt to define systems communication planning and the establishment of an interagency fire cache.

Centralization of fire equipment inventories evolved early because the costs of purchasing and maintaining maximum levels of equipment for each National Forest were prohibitive and resulted in unnecessary duplication. During major fires, the equipment could be flown or shipped as needed to particular hot spots. In Region 1, for example, this expanded into such systems as a remount depot for supplying pack horses, a fire equipment center in Spokane, and a separate cache for the smokejumper's headquarters in Missoula.

The concept was also applied to radio inventories and resulted in establishment of a broad Federal Government fire equipment warehouse at the Boise Interagency Fire Center (BIFC). It was made up of the National Oceanic and Atmospheric Administration, the Department of Commerce; Bureau of Land Management, Department of the Interior; and the Forest Service. Large-fire communication systems were made available on an as-needed basis to these three agencies. BFIC retained control of maintenance and procurement; replacement of existing inventories was in accordance with the guidelines of the National Telecommunications Study.[32]

Thus, a part of the communication responsibilities in the various Regions devolved on BIFC, and Regional communication inventories decreased correspondingly. The Forest Service continued to make purchases in accordance with its needs, but the cache relieved part of that responsibility, allowing the Regions to coordinate purchases for their own use in harmony with the systems available through BIFC.

The first generation of Forest Service communication officers knew systems planning; each one had to give attention to the capability of their communication systems to perform certain prescribed fire-control tasks. These efforts at first ranged from the detailed maps and charts of Bill Apgar to the Region 3 inventory system of "this is what I have, this is what I want."[33] As time went on, new communication elements were added and the planning phase became more complex. Fire camps, fire bases, lookouts, slurry bombers, smokejumpers, observation planes, repeaters, Ranger stations, National Forest headquarters, and air bases might all be in need of radio communication on one fire. Communication officers realized their limitations in planning the proper number of radios, the exact assignment of frequencies, and the traffic-carrying capability of a network.

Al Loew recognized the seriousness of inadequate capability of a fire network to provide service consistently to all users. He assigned a committee chaired by Bill Apgar to review the problem at the 1953 communications conference. The other committee members were the Communication Chiefs for Regions 2 and 3, Roy L. Weeman and Bill Morton, respectively, and the Assistant Fire Control Chief in the Washington Office, Boyd L. Rasmussen. Its systematic approach bore Apgar's imprint.

It was suggested that a mock "battle condition" be duplicated. "Through the use of (1) sealed envelopes, (2) containing action instructions, (3) to be executed in accordance with carefully worked-out times, and (4) in a completely manned Forest with all clocks synchronized just about any kind of a fire condition that can be envisioned could be duplicated and the necessary communications messages fed into the network."[34] While the approach had some merit, it lacked administrative support and was not implemented. However, it did anticipate the complex fire simulator developed later.

Fire Communication Needs in the 1960's

The problem of determining the communication needs for the many elements involved in a fire fight continued to be a problem into the 1960's. Region 6 reviewed these issues after the 1960 fire season and suggested a number of recommendations to correct deficiencies. A shortage of radios, lack of communications with other agencies, need for temporary relays, and assignment of fire-radio frequencies into an integrated network all suggest that the logistics of communication were becoming more complex.[35] Hoping that an estimate of network capacity could determine the optimum number of radios, the Pacific Southwest Forest and Range Experiment Station (PSW) in Berkeley, Calif., contracted with Paul Rech at the University of California, to seek a solution using mathematical theory.

In 1964, Rech selected a mathematical model based upon machine repair problems. He utilized queueing theory, probability, and statistics to come up with equations for estimating "...the maximum number of radio sets which can be in operation in a given Forest net and/or the number of channels needed to insure adequate communication."[36] It did not take into account such factors as repeater links, radio interference, commercial communication sources, and topography, so the study provided only the foundation for a more precise followup.

Four years later, after additional work by Gideon Schwarzbart of the PSW Management Sciences staff,[37] a Communications Study Task Force was appointed from staff of the various divisions of the Forest Service. This group met in Washington during mid-1968 to consider objectives, scope, and a suggested approach. The Task Force noted the numerous problems in the system that cost $21 million and $3 million annually for replacement and maintenance.[38] At the Task Force request, Schwarzbart and Ernst S. Valfer of the Management Sciences Staff at PSW completed both a system-design criteria study and, with Prem S. Puri of Purdue University, an applications study on network operating characteristics.[39] The Task Force recommended a Servicewide telecommunications study to "...evaluate the management of the radio systems needed to satisfy the communications requirements of present and future Forest Service programs."[40] On July 1, 1970, the Forest Service approved the guidelines as a method "...for setting up requirements, financing procedures, and organizational structures for Communication Management."[41]

During the 18 months of the telecommunications study, a concerted effort was made to gather fire-radio network data, get a composite picture of Servicewide communications, and project the uses of communication systems in areas other than fire control. An all-Region conference was planned and study team members were assigned specific topics for evaluation.[42]

The complexion of Forest Service communications had changed considerably by this time. FTS, automatic data processing, leased lines, telegrams, and the mails--all combined to replace A. T. & T. for administrative use. Networks, the mere mention of which would have brought paroxysms of anguish 20 years earlier, were evident in Forest radio nets, zone-fire radio nets, fire-cache radio nets, and air-radio nets.[43] More significant, radio had long since outdistanced the telephone in Forest Service inventories. Between 1947 and 1959, radio inventories had increased almost fourfold, and Forest Service-owned telephone lines had decreased to one-eighth of their earlier postwar total. By December 1969, there were 22,123 radios and only 7,482 miles of Service-owned telephone lines.[44]

Communications technology was affecting the Forest Service administration. Policies in force for years now came in for criticism by the general public. Tommy R. Hensley, in a draft of "New Technology and Its Possible Applications" for the Telecommunications Study, gave thought to what he called the Communication Revolution and its effect upon Forest Service programs, public lands, and resource management practices. He noted the public's mounting criticism of these policies and the inability of the Forest Service to respond properly because of a "lack of good monitoring" of the effects of management on all resources under its control. Hensley called for an extension of new technology to "improve our field communications." Recognizing that "knowledge power" had shifted over the years from the exclusive domain of the "special interest" to the "general public," he expected "...that the public will become more and more knowledgeable and more and more effective in voicing their conclusions about resource management."[45]

The Telecommunications Study Group findings were thorough, all-encompassing, and voluminous. The work was published in four volumes in November 1972, with an additional two volumes of appendixes.[46] Much of the study was directed to historical issues.

It noted that one frequent criticism of both the Radio Laboratory and the overall communication policies of the Forest Service was the long assignment of the Radio Laboratory to Region 6. This situation created problems in its relations with other Regions, leading them to treat the Radio Laboratory as an organizational equal, not a superior. Lacking a defined place in the national organization, the Radio Laboratory had "developed somewhat like an orphan child." Without a specifically assigned Service-wide responsibility for management of the radio development program, the Laboratory could provide no more than technical support. "It has not been planned," pointed out the Telecommunications Study Group, "but /it/ has evolved because of the accumulation of piecemeal actions." The group concluded, "In short, there has been no specific organization entity at the WO /Washington Office/ level to develop and handle a management system that would allow fully justified field telecommunication needs to be consolidated at the Washington level."[47]

Study Stresses Value of Leadership

In a tone that would have pleased Jack Horton, the study reiterated the benefits of direction and coordination that accrued from effective management leadership. "This leadership must start at the Washington Office level and pervade the entire field /of/ telecommunications organizations."[48]

The study pointed out that the lack of financial support for the radio development program had created cumulative costs of obsolescence estimated at $6,300,000 by 1971. Blaming this on a 33-year-old budgeting system, the group found fault with the delegation of planning authority to the line officers--from District Rangers through the Regional Forester. Even though they did not have the funds, these administrators were planning and approving a level of field communications that could not be achieved. "Consequently, the Regional electronic organizations are receiving criticism from line management for not providing the level of communications planned and approved." From the standpoint of the communications officer, it was "a bleak looking situation."[49]

For the first time in the history of Forest Service radio, it was possible to critically compare radio systems with telephone systems. The radio provided consistent year-round operation and also ushered in other developments such as airborne operations and better area coverage. "Radios do all of this now at equal or less cost per month than a leased commercial telephone."[50] If the Forest Service had still maintained 63,125 miles of telephone tree line at a per-mile cost of $25, the study reported, the estimated annual maintenance costs would have been $1,578,125, with no more field coverage than in 1940.

In an attempt to give credit where credit was due, the Telecommunications Study Group complimented those directly involved in the history of Forest Service communications. By separating the problems of policy from the accomplishments of action it was found, in spite of the handicaps, that:

> A meager force of engineers has worked with the technicians within financial constraints which preclude consideration of really viable alternatives and have had demands made on their time for assistance in a multitude of areas other than field communications. Historically the Forest Service mobile radio systems have been examples for others to follow. This has been accomplished, in a large part, because of the dedication and tenure of the engineers and technicians.[51]

In some respects, it is not possible to find fault with the administrative levels of the Forest Service for not recognizing this point a generation earlier. But if hindsight has its advantages, leadership also has its responsibilities.

Many factors kept the Washington Office from recognizing the benefits of unrestricted application of radio; indeed, the applications could have been formulated as early as Beatty's demonstration. The A. T. & T. lease agreements posed the most apparent barrier. But a more insidious factor was the ever-present, pervasive concern that the Forest Service might cross the fine line between private enterprise and Government involvement and perhaps even approach socialism. Constant reminders of the secondary role of Forest Service radio vis-a-vis A. T. & T. leases, protests over the failure of commercial entities to supply commercial radio equipment, and the resistance towards policies reflecting able management occurred time and again.

This reaction was perhaps not out of the ordinary, given the time and the circumstances. It could not have been expected that the concept of lightweight, low-power, portable radio would have such limited application for so long, or that the Government would need to involve itself in set production. Even the best informed opinions, undoubtedly, gave the Radio Laboratory no more than a 5-year existence. It appeared certain that private enterprise would have suitable equivalents on the market long before the Laboratory could become a permanent part of the Forest Service. When 5 years passed with no change in the situation, the inevitable only moved 5 years closer, and there was even less reason to invest further in the Forest Service radio development program.

The Forest Products Laboratory (FPL), for example, established by the Forest Service in Madison, Wis., in 1910 to test and develop new forest products, was considered supportive of, not antagonistic to, big business. The initial investment of FPL included a staff of 20, a payroll of $28,000, complete test equipment, and abundant test materials.[52] In 1946, during the 14th year of its radio development program, the Radio Laboratory had only seven employees, a budget under $28,000, and not enough laboratory equipment to adequately measure the performance of a single Forest Service radio set.[53]

In this context, the Radio Laboratory was placed in the organizational hierarchy where it would have a low profile. It was no accident that this situation persisted and that the Washington Office scorned pleas for more effective leadership. Once it was certain that private industry could supply radios to meet Forest Service standards, George Duvendack was appointed to the long-needed position of communications czar. But the Radio Laboratory could not claim the legitimacy it had been denied for 15 years. Unfortunately, the changed commercial scene eliminated the reason to continue its existence as a producer of radio sets.

Broad Accomplishments of Radio Laboratory

For 20 years, the staff at Portland was handicapped by lack of resources and leadership. Yet, ever after a virtual shutdown during World War II, it still took private enterprise 20 years to catch up with the Laboratory. The Laboratory staff never went above eight employees, yet they designed, modeled, tested, produced, inspected, and shipped an array of hf and vhf portables, semiportables, and fixed-base units second to none. As the Telecommunications Study Group correctly observed, "They have constructed and maintained literally hundreds of systems--systems which warrant no apology."[54]

The accomplishments of the Radio Laboratory went far beyond the bounds of the Government agency for which it was intended. Both the military and private industry benefitted in ways that transcended technical application. The responses of Motorola, GE and RCA during the Duvendack-Lawson 1947 exploratory trip to eastern manufacturers indicate a considerable technological spin-off from the design efforts of the Radio Laboratory.

Fred Link, the unofficial dean of FM radio design, reviewed this contribution from his vantage point some years later. He recalled the Forest Service reputation for simplifying circuit designs and producing sets that withstood bad weather and abusive treatment. Link remembered investigating Forest Service sets at his laboratory in New York City and a number of visits with the Radio Laboratory staff. He agreed it was fair to conclude that Forest Service radios contributed to lightweight, low-power technology. "I would never say, Link emphasized, "that industry led the way in this regard." In any event, he concluded, "The Forest Service certainly had an impact on Fred Link Radio."[55]

The impact of Forest Service radio upon the frequency, duration, or intensity of forest fires cannot be documented. Coincident with the development of radio were such other advances as fire-weather forecasts, additional access roads, better machinery, new firefighting techniques, increased manpower, and public education. Each affected the other; the historical record reflects only the aggregate.

There were many instances of radio influencing potentially catastropic situations, saving lives, and averting the destruction of property. Few Forest Service fireline personnel are at a loss when asked to recount such experiences. Some anecdotes have even become legend.

An influence more difficult to measure is Bristow Adams' speculation in 1906 about the psychological benefits of electronic communication in the Forest Service. Yet here is the ultimate measure of the Radio Laboratory accomplishment.

The level of judgment and the degree of confidence, emotion, and physical durability that an individual takes to the fireline are directly related to the effectiveness and reliability of the tools at hand. The complexity of these tools may at times be a handicap. A chain saw without gasoline is not equal to the axe.

This latter point was emphasized during a visit by this author to the Missoula Aerial Fire Depot in 1978. After a tour and briefing, the conversation came around to a discussion of the soon-to-be-installed, 9,600-channel communications system. Several staff members were uneasy about the new technology, but most felt that the system would provide a higher level of fireline control.

Milton "Cookie" Calloway then asked a question that brought silence. As a veteran pilot for countless air drops of equipment and smokejumpers, he had lost track of the number of times he had decided whether to place himself and his cargo in jeopardy. He was used to billowing clouds of dense smoke, narrow canyons with vicious downdrafts, and low-level flights over the tree tops. Yet, he wanted to know if the Fire Depot Operations Center would be able to continue its practice of placing a check call to pilots every 30 minutes. He wanted reassurance that if he failed to answer this call and a subsequent call, a search and rescue mission would be launched immediately. This function of the radio was the most important to Calloway.[56]

Dwight Beatty and those who followed him at the Radio Laboratory recognized that radio was more than an electrical box permitting two-way communication; it was a tool that allowed men to extend their abilities in the face of adversity.

Simple, rugged, and reliable were more than adjectives; they were design commands. In today's language, human engineering was the first watchword at the Radio Laboratory. It captures the essence of the Laboratory's contribution to radio science and the men on the fireline.[57]

Reference Notes

1. Leon L. Lake, "Hot Telephone Jobs," *Early Days in the Forest Service* (Missoula, Mont.: U.S. Department of Agriculture, Forest Service, Region 1, 1976) 3:149.

2. U.S. Department of Agriculture, Forest Service, *Electronics Center Newsletter*, no. 19, December 1963, p. 1.

3. E. Allan Loew, interview with the author in Beltsville, Md., November 1978.

4. Loew, interview with author.

5. W. Frederick Biggerstaff, interview with the author in Saratoga, Calif., January 1978.

6. U.S. Department of Agriculture, Forest Service, *Radio Laboratory Newsletter*, no. 11, ca. 1957, p. 1.

7. Biggerstaff, interview with author.

8. Loew, interview with author, and William "Bill" Morton, interview with the author in Beltsville, Md., November 1978.

9. International Bell Telephone, "UHF, VHF Point-to-Point and Mobile Telephone Service Antenna Systems Fault Analysis," *Bell System Practice*, Preliminary draft of Section R49, XX5, pp. 1-18; and Forest Service, "Instructions: Forest Service Radiation System Evaluation Kit," with W. F. Biggerstaff to Regional Communications Officers (R-1 to R-9), 12 January 1961, Gaylord A. Knight Collection.

10. W. F. Biggerstaff, "Operation of Close-Spaced Antennas in Radio Relay Systems" (Paper presented before the Washington Chapter of the IRE Group on Vehicular Communications, 1958), reprinted in *Radio Laboratory Newsletter*, no. 12, 3 April 1959, pp. 1-11.

11. Gaylord A. Knight, interview with the author in Atlanta, Ga., November 1977, February 1978, April 1979.

12. Loew, interview with author.

13. U.S. Department of Agriculture, Forest Service, "Nomination for Superior Service Award," 1960, mimeographed, copy in files of Electronics Center, Beltsville, Md.

14. See respectively: U.S. Department of Agriculture, Forest Service, "Progress Report, ED & T Project Number 825-Fire Weather Telemetering System," 25 January 1963; A. W. Greeley to Regional Foresters and Directors, 17 April 1961; Robert C. Heller and Wilbur S. Claypool, "A High-Speed Electronic Intervalometer" paper presented by Forest Service, July 1957; Loew, interview with author; and Forest Service, "Infrared Fire Mapping Unit-A New Tool," 6 September 1966, a fact sheet by Division of Fire Control, Washington Office, all Gaylord A. Knight Collection.

15. U.S. Department of Agriculture, Forest Service, *Radio Laboratory Newsletter*, no. 9, 1 June 1953; no. 13, 14 October 1961; and no. 16, 28 May 1962.

16. Morton, interview with author.

17. C. V. Fontaine to Assistant Regional Forester Raymond F. Grefe (R-6), 27 April 1955, Gaylord A. Knight Collection.

18. J. H. "Bud" Coats, "Communications in the National Forests of Region One," ca. 1979, unpublished draft, p. 11, Gaylord A. Knight Collection and J. H. Coats, interview with the author in Missoula, Mont., May 1978.

19. Forest Service, Region 1, *Northern Region News*, no. 23, 21 June 1957, and Clarence Westcott, interview with the author in Missoula, Mont., May 1978.

20. Gaylord Knight reported that "time and time again" Gael Simson recounted how he obtained these frequencies because no one else was interested. High-band vhf and uhf, however, were not acquired until the post-World War II period. See U.S. Department of Agriculture to IRAC, 21 November 1958, Doc. 4288/1-2.10.2, Gaylord A. Knight Collection.

21. Gordon D. Fox (Washington Office) to Regional Foresters, 13 August 1953, Gaylord A. Knight Collection.

22. *Electronics Center Newsletter*, no. 19, December 1963.

23. This prototype is in the Forest Service radio and telephone collection (located at the Electronics Center,

Beltsville, Md., as of date of publication of this history). It was machined from aluminum stock, Claypool's trademark.

24. Guy V. Wood to Dennis M. Roth, Head, History Section, Forest Service, 1 April 1980, History Section files.

25. W. S. Swingler /Assistant Chief, Forest Service/ to Regional Foresters, 9 August 1954, Gaylord A. Knight Collection.

26. Guy V. Wood, "Solar Powered Radiophone Operation," typed report, Gaylord A. Knight Collection.

27. Loew, interview with author, and Morton, interview with author.

28. Morton, interview with author; W. B. Morton to Dennis Roth, 18 April 1980, p. 2, and Bill /W. B./ Morton, "Editorial Notes on 'A History of the Telecommunications in the U.S. Forest Service,'" 18 April 1980, p. 8, History Section files.

29. Morton, interview with author; Morton to Roth; and Morton, "Editorial Notes."

30. Morton to Roth; and William B. Morton, conversations with the author in Beltsville, Md., October 1980.

31. Morton, interview with author, and William B. Morton to Dennis Roth, 30 April 1981, handwritten comments, History Section files.

32. Boise Interagency Fire Center, *Large Fire Communications Instructions* (Boise, 1978), p. 5.

33. Morton, interview with author.

34. E. Allan Loew to Wm. Apgar, 21 January 1953, Gaylord A. Knight Collection. Committee recommendations are attached.

35. Forest Service, Region 6, "Problems of Communications on the Fire," 23-27 January 1961, Gaylord A. Knight Collection.

36. Paul Rech, *Some Aspects of a Radio Communication Net* (Berkeley, Calif.: Operations Research Center, 9 September 1964), Report ORC 64-22.

37. Prem S. Puri and Gideon Schwarzbart, "Reneging and Retrials in Queueing Theory: Results and Applications," /n.d./, mimeographed, Gaylord A. Knight Collection.

38. Chester A. Shields to Russell T. Cloninger, Donald W. Smith, Lennart E. Lundberg, William B. Morton, 10 July 1968; W. B. Morton, "Statements of Objectives of Communications Study Task Force," 18 July 1968, typed rough draft; and W. B. Morton to Members of Communications Study Task Force, 22 July 1968, included with typed draft of "U.S. Forest Service Communications Study," 22 July 1968, all Gaylord A. Knight Collection.

39. Gideon Schwarzbart and Ernst S. Valfer, "Forest Radio Net Operating Characteristics," Part I: "System Design Criteria," 1969, mimeographed; and Gideon Schwarzbart, Ernst S. Valfer, and Prem. S. Puri, "Forest Radio Net Operating Characteristics," Part II: "Applications," 1969, mimeographed, both Gaylord A. Knight Collection.

40. U.S. Department of Agriculture, Forest Service, "Service-wide Telecommunications Study--Study Plan," /n.d./, mimeographed, p. 1, Gaylord A. Knight Collection.

41. U.S. Department of Agriculture, Forest Service, *Information Digest*, no. 14, 1 July 1970, p. 1. Members of the team were Schwarzbart (Study

Leader), Valfer, William P. Kennedy, and Miles R. Hall, all of PSW; Jack F. Carter, R-5; Karl W. Spelman, R-4; Bill Morton and Tommy R. Hensley of the Electronics Center; Chester A. Shields, Director, and Lewis E. Hawkes, Administrative Management, Washington Office, and Merle S. Lowden, Director, Fire Control, Washington Office. Hawkes had come in from R-3. Others were added as the study progressed.

42. Edward W. Schultz /Deputy Chief, Forest Service, for Administration/ to Regional Foresters, 5 Ausust 1970, Gaylord A. Knight Collection. Memo includes roster and agenda.

43. L. E. Hawkes, "Financing a Forest Service Telecommunications System," 20 May 1971, typed rough draft for Telecommunications Study, Gaylord A. Knight Collection.

44. Hawkes, "Financing," p. 2.

45. T. R. Hensley, "New Technology and Its Possible Applications," /n.d./, typed draft for Telecommunications Study, p. 2, Gaylord A. Knight Collection.

46. U.S. Department of Agriculture, Forest Service, *A Study of Forest Service Telecommunications*, 4 vols. (Washington, D.C.: Government Printing Office, 1972).

47. Forest Service, *Telecommunications*, vo. 3, pp. 5, 6.

48. Forest Service, *Telecommunications*, vol. 3, p. 7.

49. Forest Service, *Telecommunications*, vol. 3, pp. 67, 68.

50. Forest Service, *Telecommunications*, vol. 3, pp. 5, 6.

51. Forest Service, *Telecommunications*, vol. 3, p. 5.

52. Harold K. Steen, *The U.S. Forest Service: A History* (Seattle: University of Washington Press, 1976), p. 133.

53. /D. S./ Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, app., Gaylord A. Knight Collection; F. V. Horton, "Memorandum," 19 May 1946, National Archives and Records Service, Seattle, Wash., Box B4266; Harold K. Lawson, interview with the author in King City, Ore., May 1978; and W. Frederick Biggerstaff, interview with the author in Saratoga, Calif., January 1978.

54. Forest Service, *Telecommunications*, vol. 3, p. 45. The Study Group was equally complimentary to the entire communications organization of the Forest Service.

55. Fred Link, telephone interview with the author in Denver, Colo., 26 January 1979.

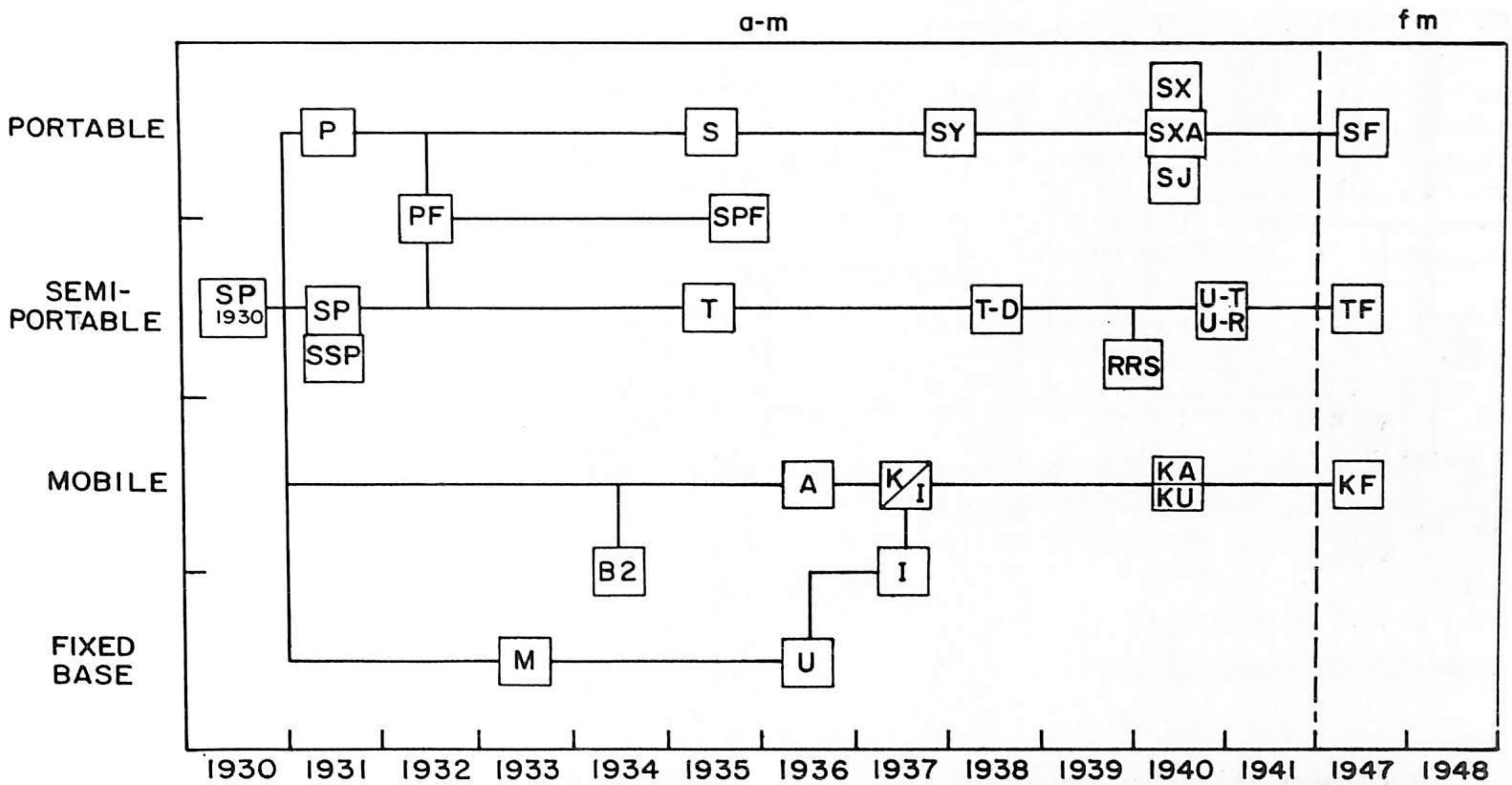
56. Milton Calloway, John Robertson, Charles Kern, and John Hertz, group discussion with the author at the Aerial Fire Depot, Missoula, Mont., May 1978.

57. The radio function was realined in the Washington Office in 1980-81 under the Computer Technology and Telecommunications Staff--at first renamed Radio Management, then changed back to Communications and Electronics, and finally Radio and Electronics--with some shift in responsibilities. There is a basis for some concern over the potential for misjudgment. *Radio for the Fireline* recounts many of the problems associated with past administrative decisions of a like nature. It is hoped that this history will provide a more thorough understanding of the relationship of telecommunications planning to other Forest Service programs, as well as point out a priceless legacy, and a future, which "warrants no apology."

Appendix I

Forest Service Radio Models — Photos, Diagrams, and Data

Chronological Development of Forest Service Radio Sets, by Type and Function



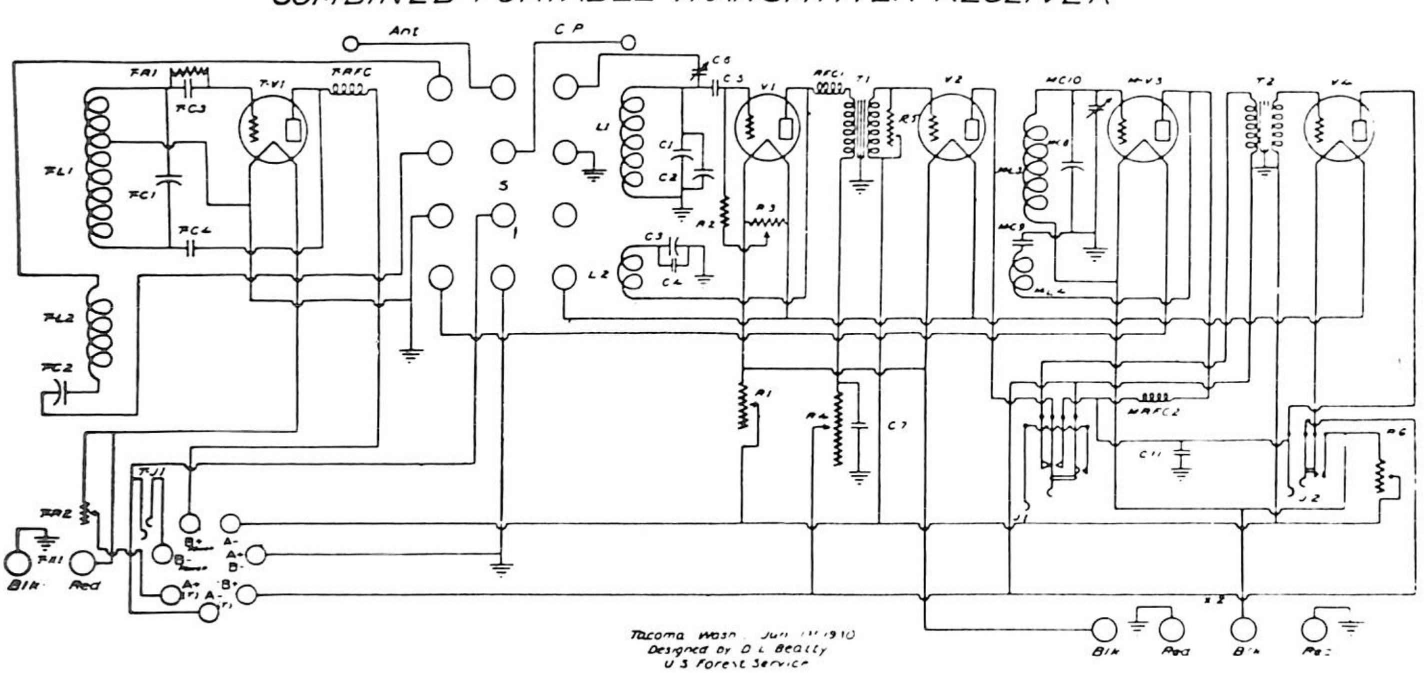
Hf Types

100 meters (2.9 – 3.5 MHz)

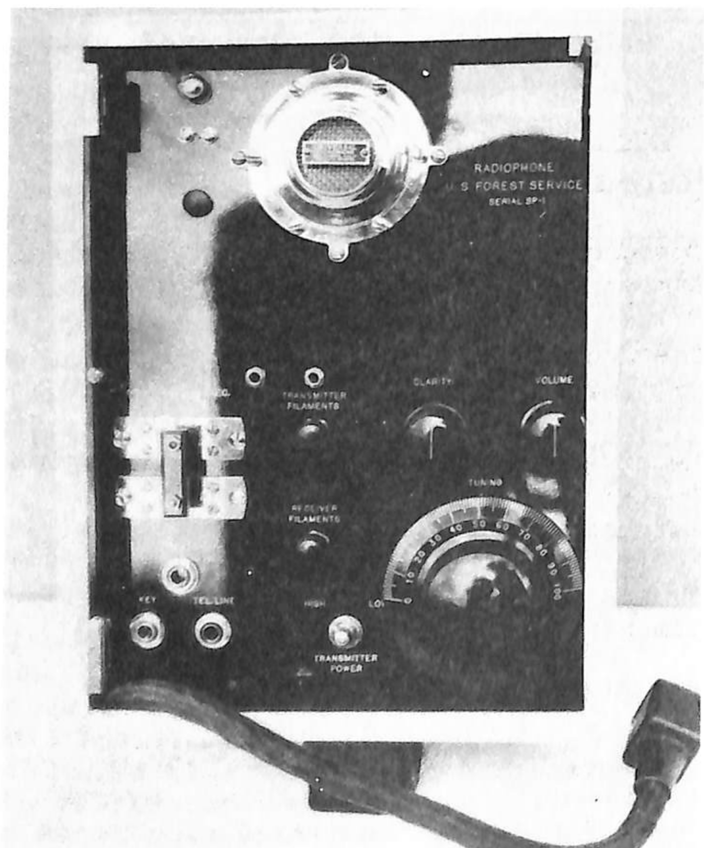
(NA:95G-249757)

SP - 1930

Designed by:	Dwight L. Beatty, 1930
Number produced:	9
Price:	$140
Models:	Original only
Frequency:	3 MHz
Transmitter:	1 watt, c.w., AM
Receiver:	Regenerative
Antenna:	Long wire with counterpoise
Dimensions:	6 x 14 x 8"(radio only)
Weight:	17# 14 oz. (79# 5 oz. complete)*
Principal use:	Test purposes
*Comments:	Radio: 17# 14 oz. Equip. case: 11# 11 oz. Antenna equip.: 5# 12 oz. Battery with case: 44#

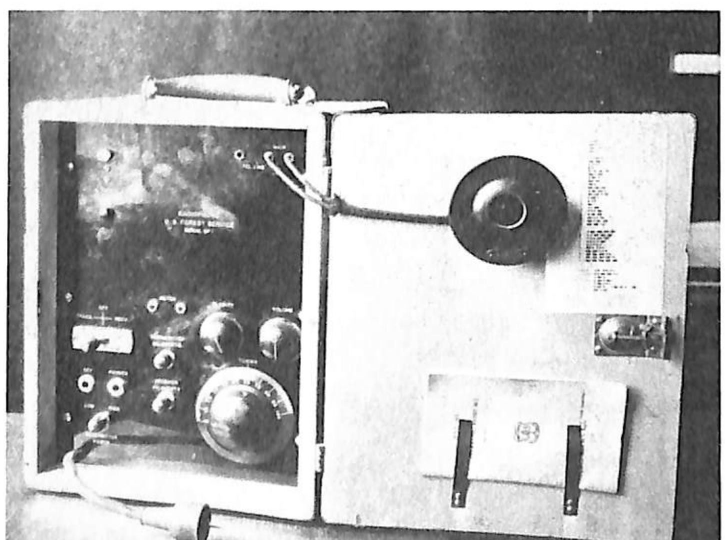


Schematic Diagram, SP-1930



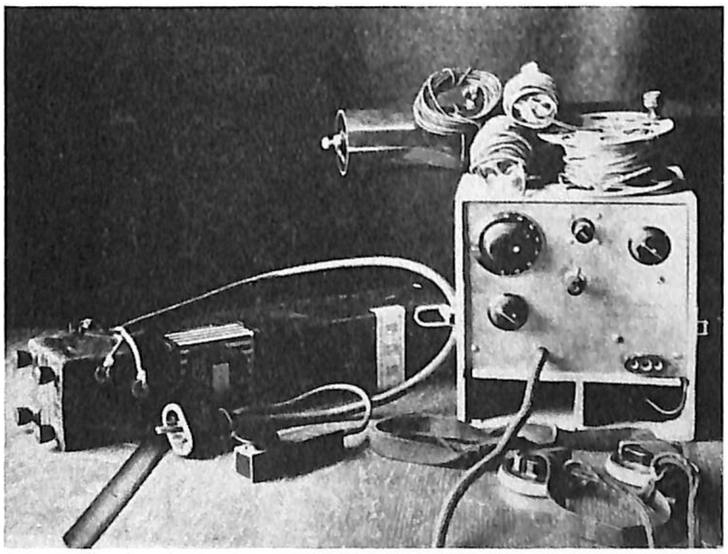
(National Archives:
Record Group 95G-262848)

(NA:95G-274968)



Type SP

	'Semiportable' SP*	SSP*
Designed by:	Harold K. Lawson, 1931	HKL, 1932
Number produced:	500	See SP
Price	$146	
Frequency	3 MHz	
Transmitter:	1 watt, voice-c.w., AM, VFO	4 1/2 watts
Receiver:	Regenerative, simplex	
Power:	Dry batteries	
Antenna:	135'/75' Center loaded (see text)	
Weight:	20# net, 55# w/batteries	
Dimensions:	9 x 10 x 13"	
Principal use:	Lookouts and other temporary locations	
*Comments:	Both sets used modified circuit of SP-1930 (see diagram) Type SSP had higher first cost, but lower operating cost	



(NA:95G-274971)

Type P*

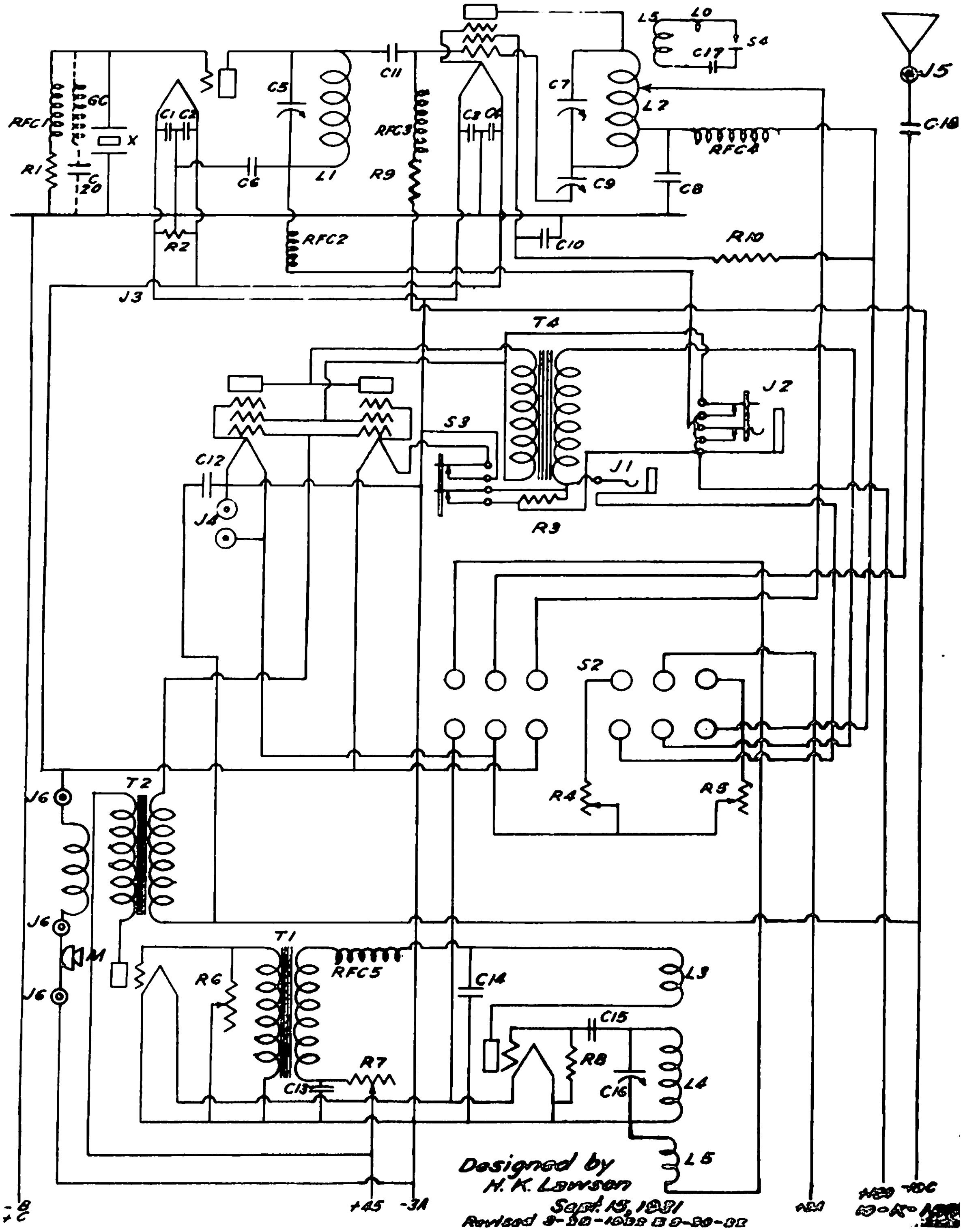
'Portable'

Designed by:	W. Foy Squibb, 1931
Number produced:	104
Price:	$50
Frequency	3 MHz
Transmitter:	1 1/4 watts, c.w., AM, VFO (set and lock)
Receiver:	Regenerative, simplex
Power:	Dry batteries
Antenna:	75' Center loaded (see text)
Weight:	5# 9 oz. - 12# complete
Dimensions:	6 x 7 x 7"
Principal use:	Smokechasers, fire scouts, and trail crews
*Comments:	It used a slightly modified circuit of SP-1930 (see diagram)

R-6
FC Radio
SP Spec

SCHEMATIC DIAGRAM

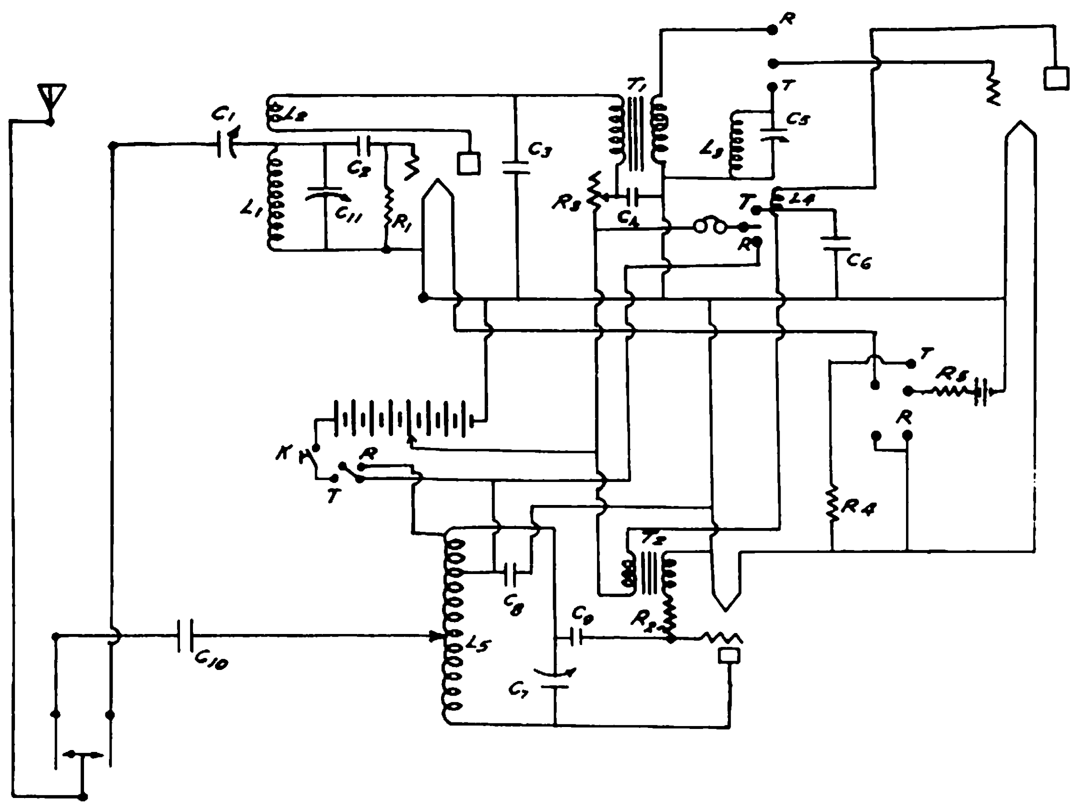
U.S.F.S. SP RADIOPHONE



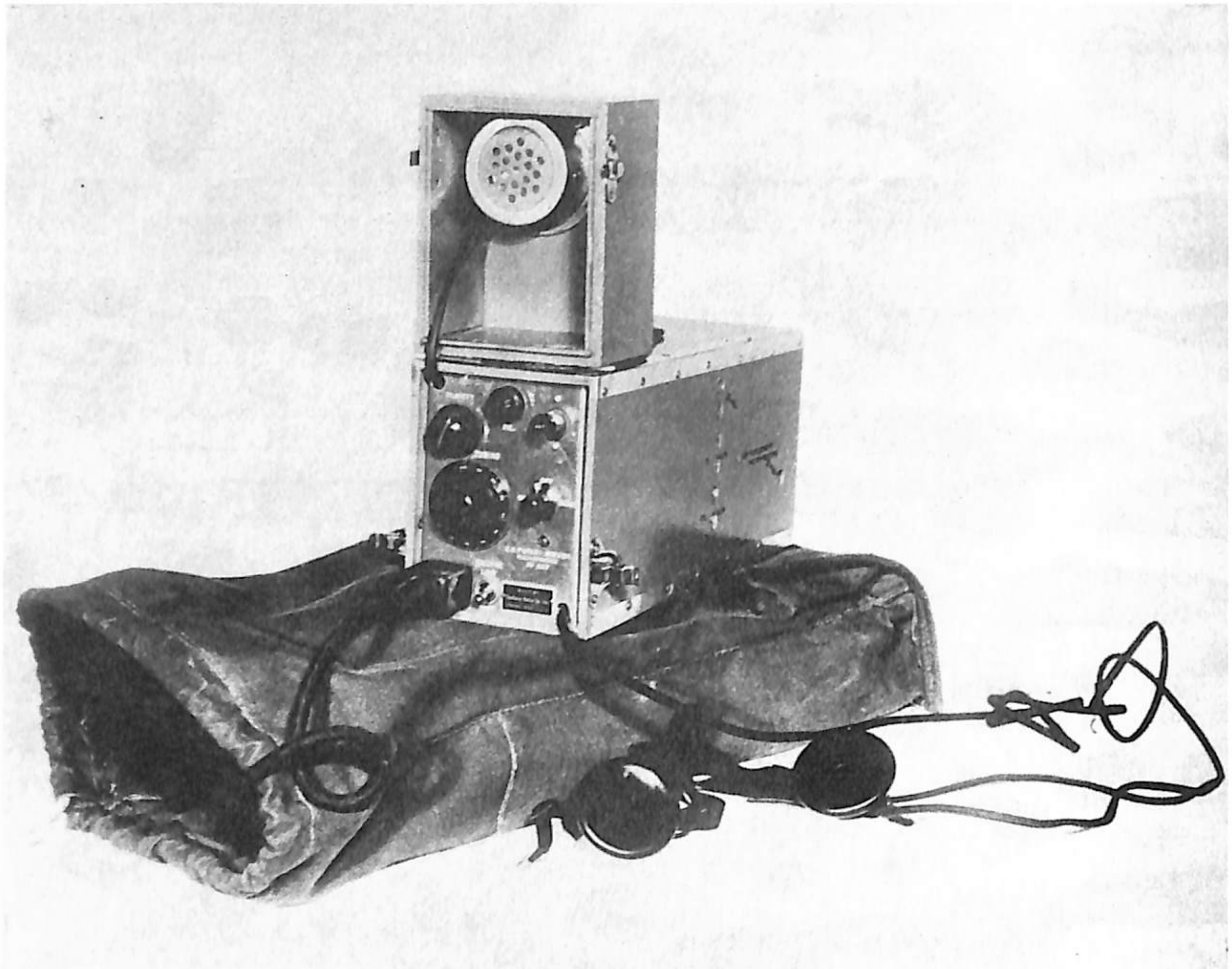
F.C. Radio
Portable

SCHEMATIC DIAGRAM

U.S.F.S. PORTABLE RADIO



Designed by
W. F. Squibb
Dec. 1931 Revised 9-27-32
10-K-159 KSB

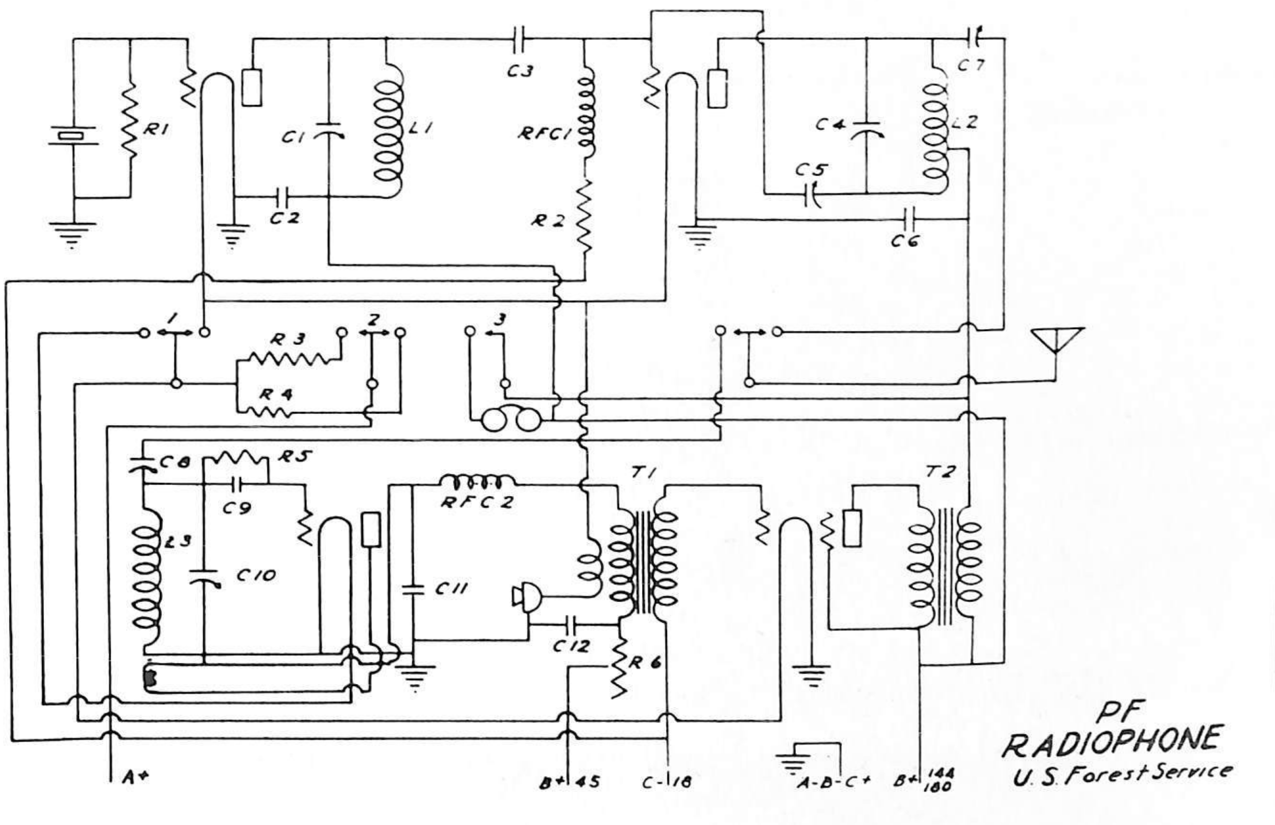


(Forest Service photo, History Section)

<u>Type PF</u>

'Portable Fone'*

Designed by:	Harold K. Lawson/W. Foy Squibb, 1933
Number produced:	450
Price:	$60-$75
Frequency:	3 MHz
Transmitter:	2 1/4 watts, voice-c.w., AM, xtals
Receiver:	Regenerative, simplex
Power:	Dry batteries
Antenna:	Center loaded, half wave (see text)
Weight:	14-15#
Dimensions:	4 x 5 x 16"
Principal use:	Smokechasers and work crews
*Comments	Sometimes advertised as "Portable Fireman" PF Kitbox included heavy-duty batteries

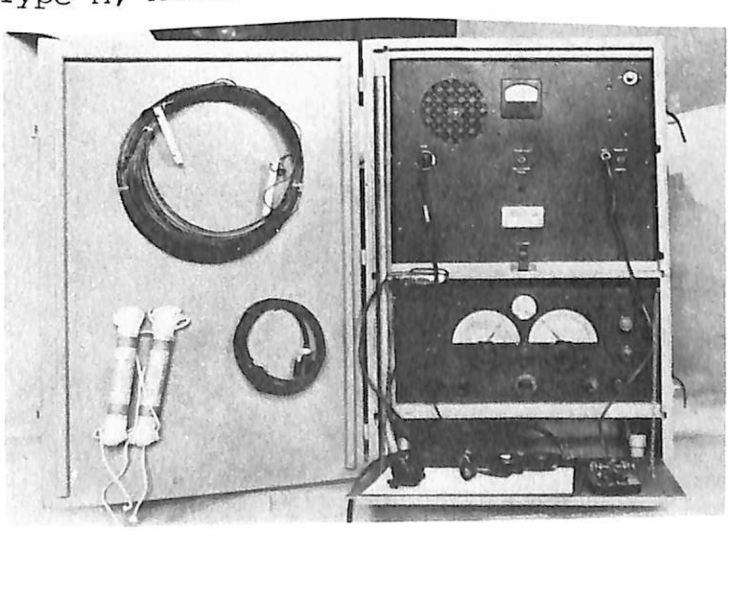


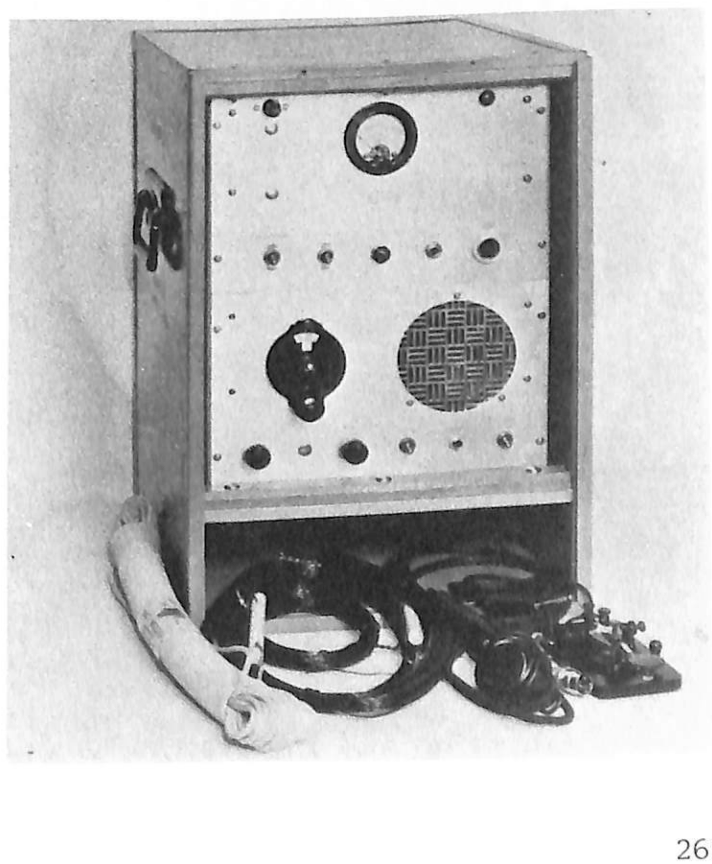
Schematic Diagram, Type PF

Type M, Model D

(Forest Service photos, History Section)

Type M, Model C



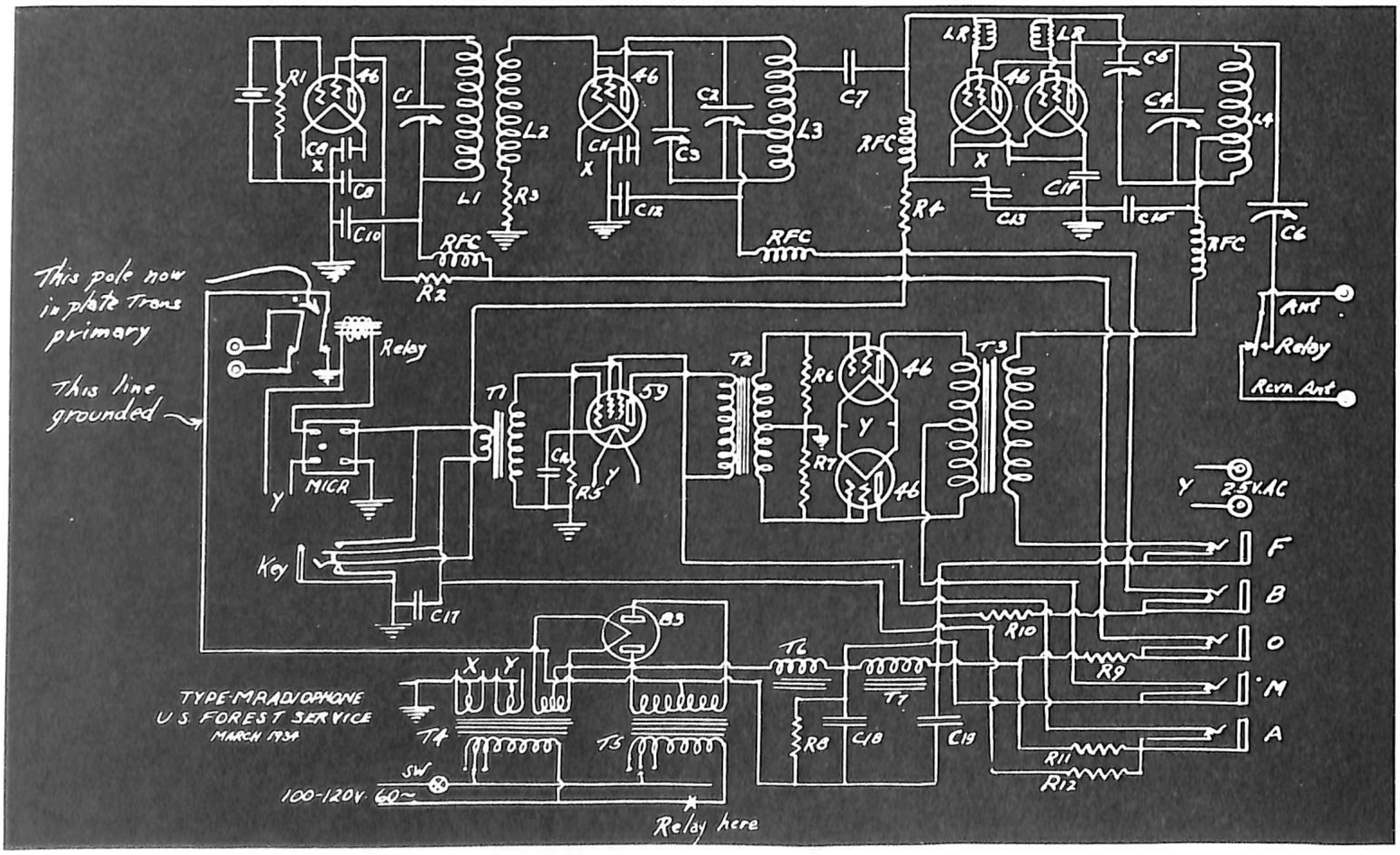


Type M*

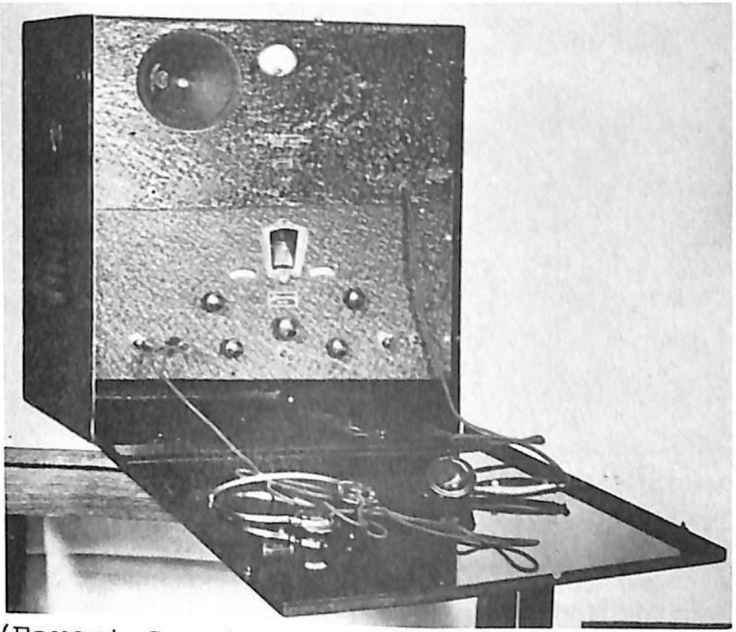
'Medium power'

Designed by:	Harold K. Lawson, 1933
Number produced:	210
Price:	$290
Models:	A, B, C. (Belleville), D (Claypool)
Frequency:	3 MHz
Transmitter:	20 watts nominal, voice-c.w., AM, push-to-talk, xtal
Receiver:	Hammurland Comet Pro and other commercial types; later models Forest Service superheterodyne
Power	110 volts (a.c.) or gas engine generator
Antenna:	Half-wave, single wire feeder
Weight	75-200# depending on model
Dimensions:	10 x 14 x 22" (transmitter only)
Principal use:	Central station for fire crews and supervisor's headquarters
*Comments	Model A (2 units) Serial Numbers 1-96 Model B (1 unit) Serial Numbers 97-152 Model C (1 unit) Serial Numbers 154-180 Model D (1 unit) Serial Numbers 181-210

Schematic Diagram, Type M-Model A



Type M-Model B



(Forest Service photo, History Section)

Schematic Diagram, Type M-Model B

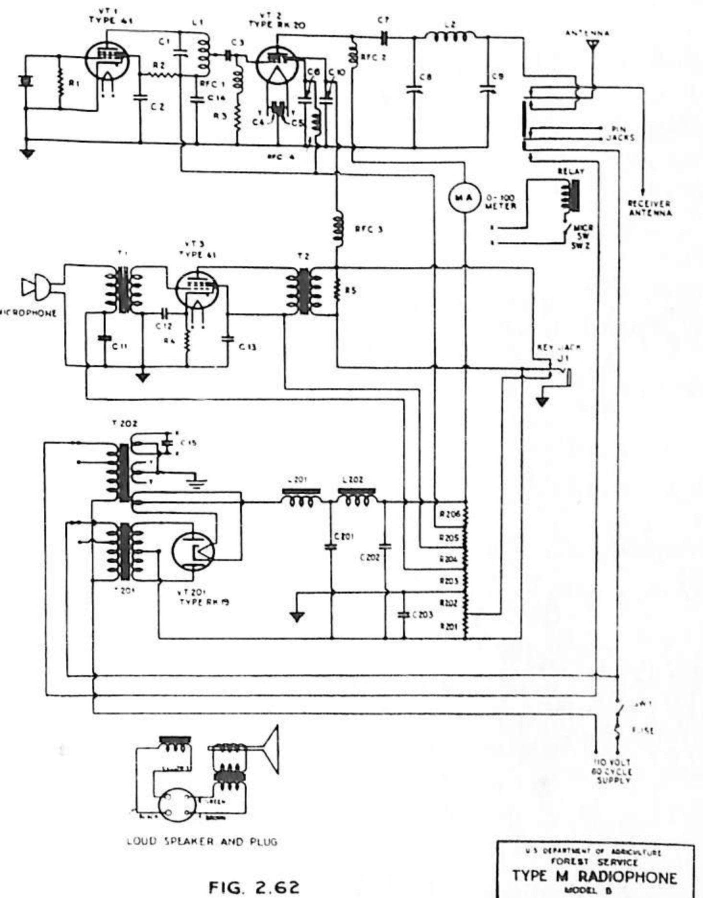
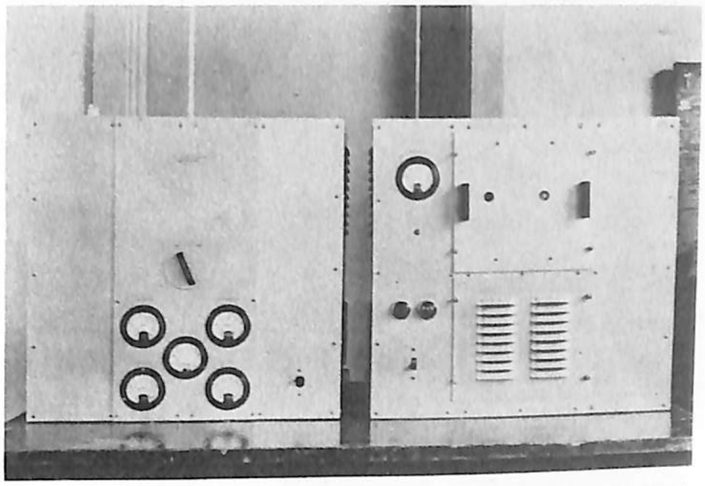


FIG. 2.62

Type B

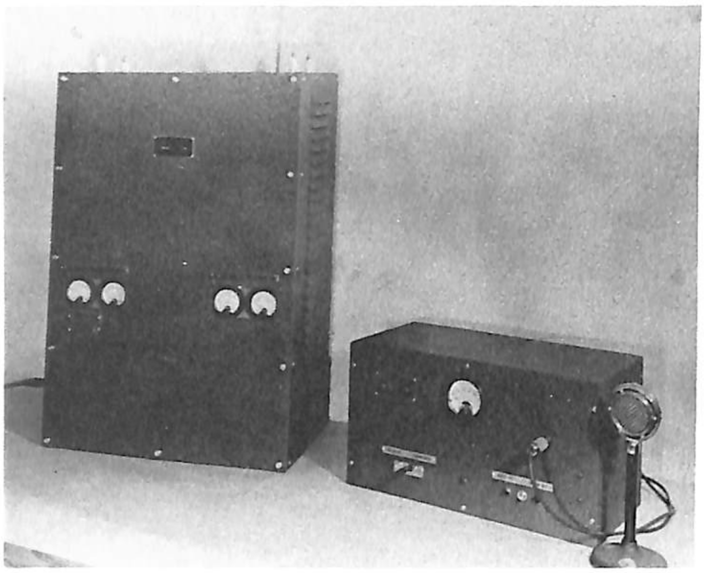


(NA:95G 305779)

<u>Type B*</u>

'Boat'

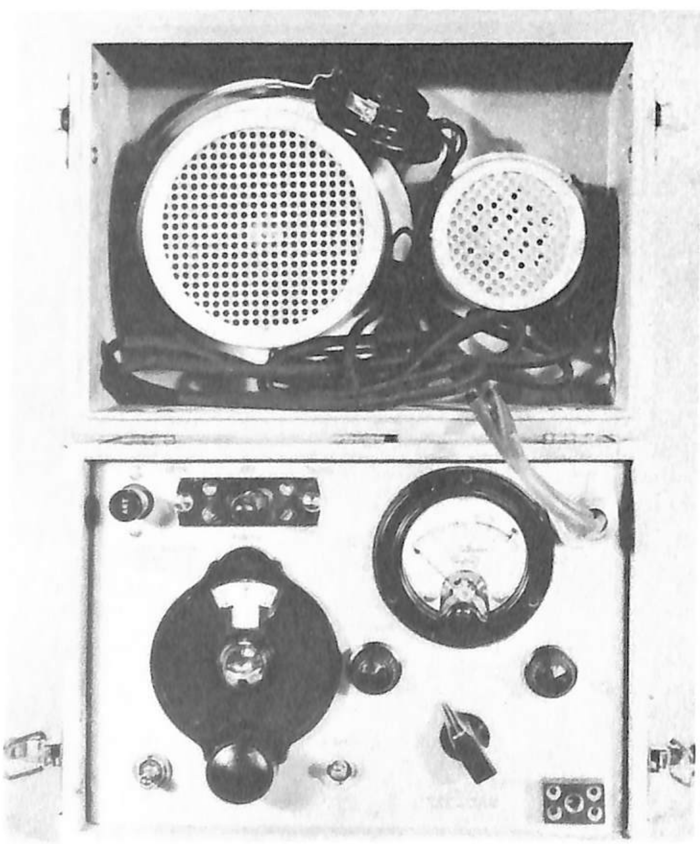
Designed by:	W. S. Claypool, 1934
Number produced:	8
Models:	B and B2 (Radio Laboratory staff)
Frequency:	2300 kHz and 4600 kHz
Transmitter:	200 watts, 2 channel xtal, voice, AM, simplex
Receiver:	Hammurlund Comet Pro
Power:	Gas Engine alternator
Antenna:	Marine Marconi
Weight:	Unknown
Dimensions:	24 x 24 x 12" each
Principal use:	Ship to shore
*Comments	For use on Forest Service patrol boats in Region 10 only No schematic diagram available

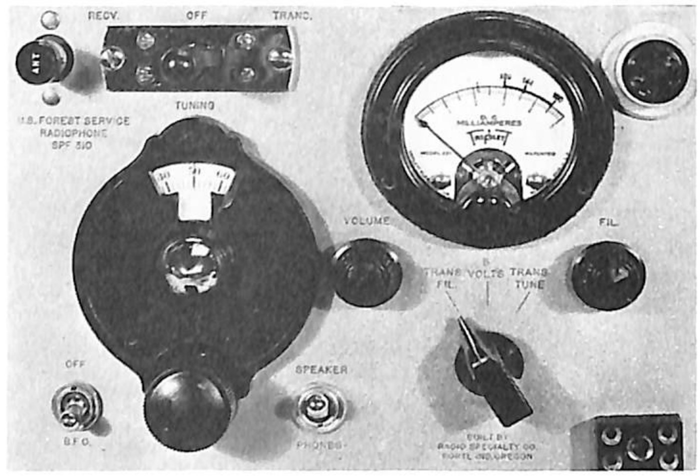


Type B2

(Forest Service photos, History Section)

Type SPF radio installed in carrying box; speaker, mike, and headset in hinged section on top.





Forest Service SPF radio, Model AA (Serial No. 310), front panel

<u>Type SPF*</u>	'Semiportable Fone'
Designed by:	W. S. Claypool and Laboratory staff, 1935-36
Number produced:	1200
Price:	$140
Models:	A,AA,AB(or BA),AD,AE,AF
Frequency:	3MHz
Transmitter:	2 1/4 watts, voice-c.w., AM, xtal
Receiver:	Superheterodyne, simplex
Power:	Dry batteries
Antenna:	Half-wave--off-center or end-fed
Weight:	21# w/lt. wt. battery, 60# w/Kitbox
Dimensions:	6 1/2 x 9 x 14 1/2"
Principal use:	Fire crews and emergency lookouts
*Comments:	PF modified with superheterodyne receiver

Model A Serial Numbers 1-264
Model AA Serial Numbers 265-480
Model AB Serial Numbers 481-743
Model AD Serial Numbers 744-903
Model AE Serial Numbers 904-966
Model AF Serial Numbers 967-1200
A number of additional SPF sets were produced by industry for the military during World War II (see text)

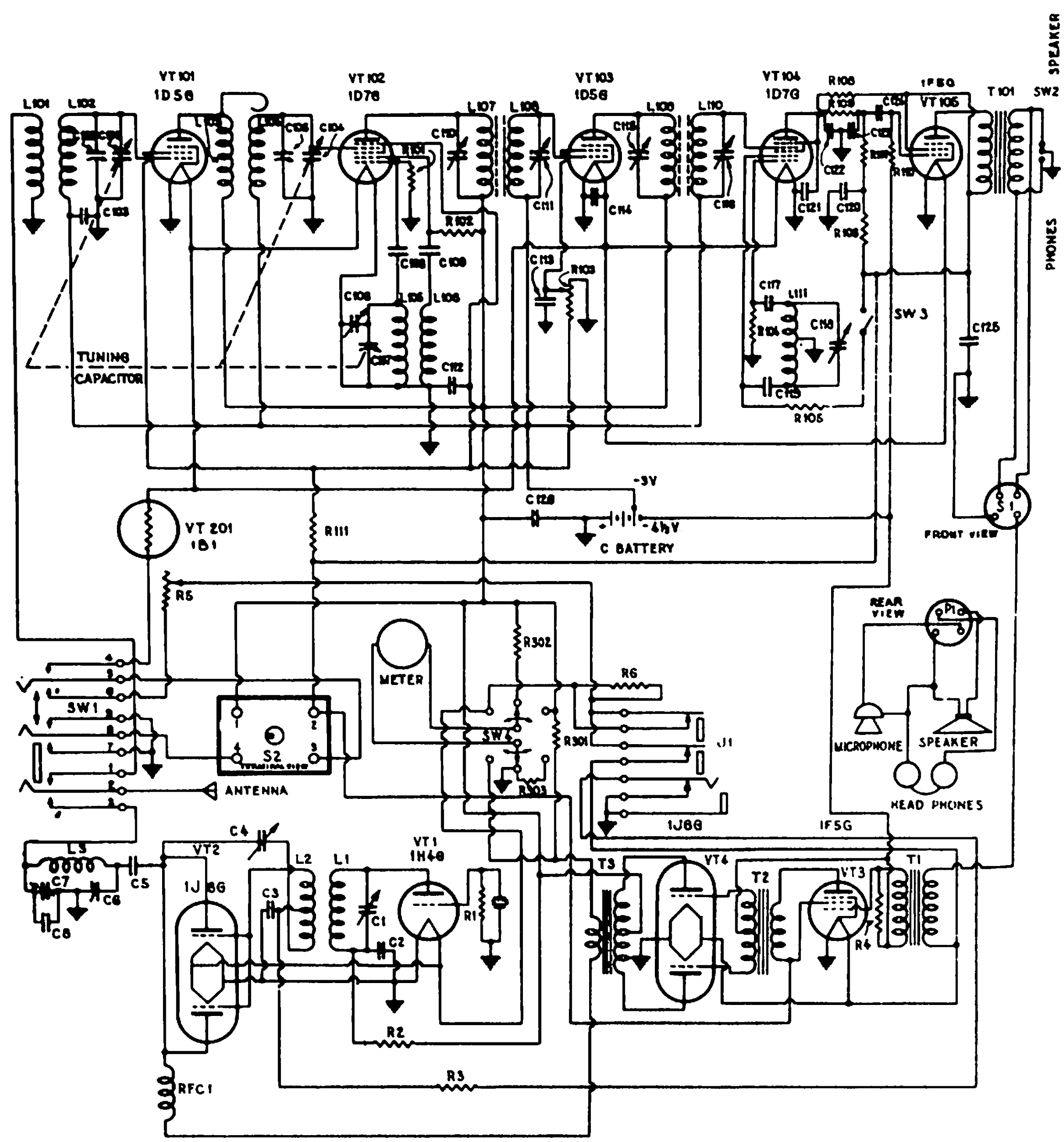
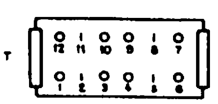


FIG. 2.62



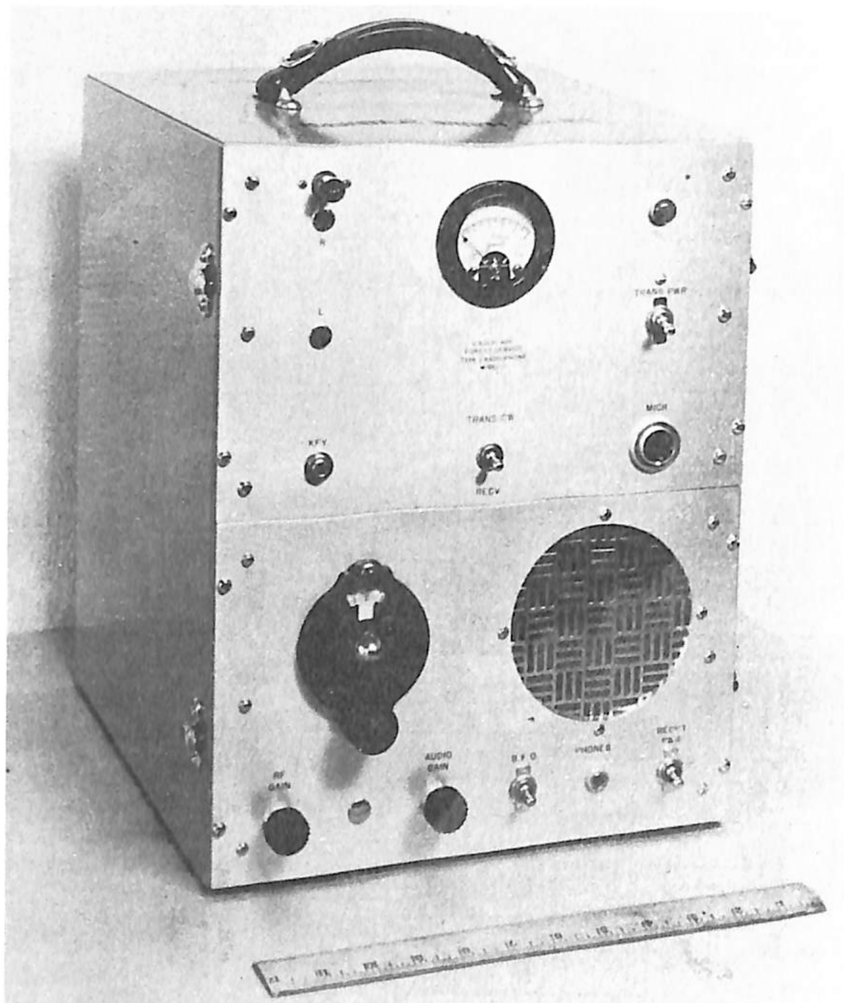
Rear view of switch SW1
Numbers are same as shown in diagram

BATTERY CABLE

1 Red = B+180
2 Green = B+135
3 Brown = A+
4. Blue = B-, Black = A-

U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SPF RADIOPHONE
MODEL AA

Schematic Diagram, Type SPF-Model AA



(Forest Service photo, History Section)

<u>Type I</u>*

'Intermediate power'

Designed by:	Radio Laboratory staff, 1937
Number produced:	52
Prince:	$280
Models:	A, B, C (Belleville), D
Frequency:	3 MHz, two channel
Transmitter:	9 1/2 watts, voice-c.w., AM, xtal
Receiver:	Superheterodyne, simplex w/standby
Power:	6-volt storage battery
Antenna:	Half wave, fed off center
Weight:	66# w/accessories, including batteries
Dimensions:	17 1/2 x 19 1/4 x 12 1/4"
Principal use:	Fire camps and temporary bases
*Comments	Intermediate in power between SPF and M sets

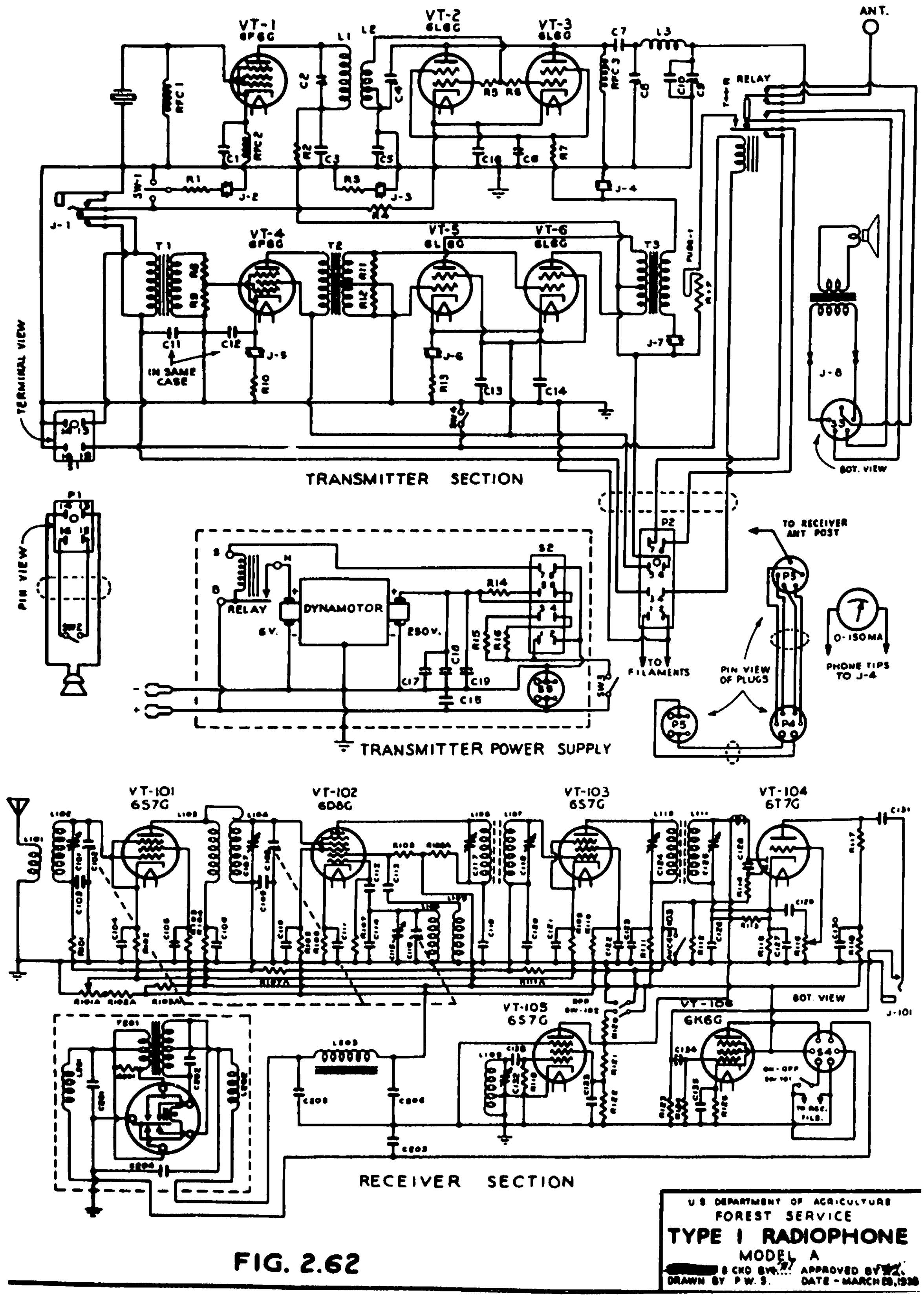
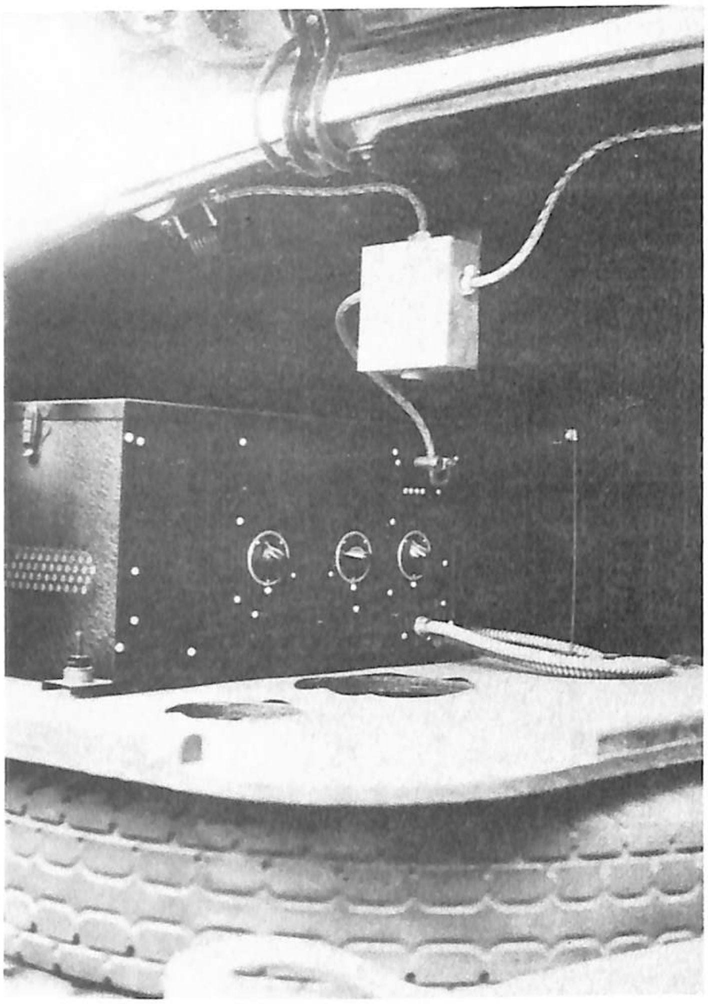
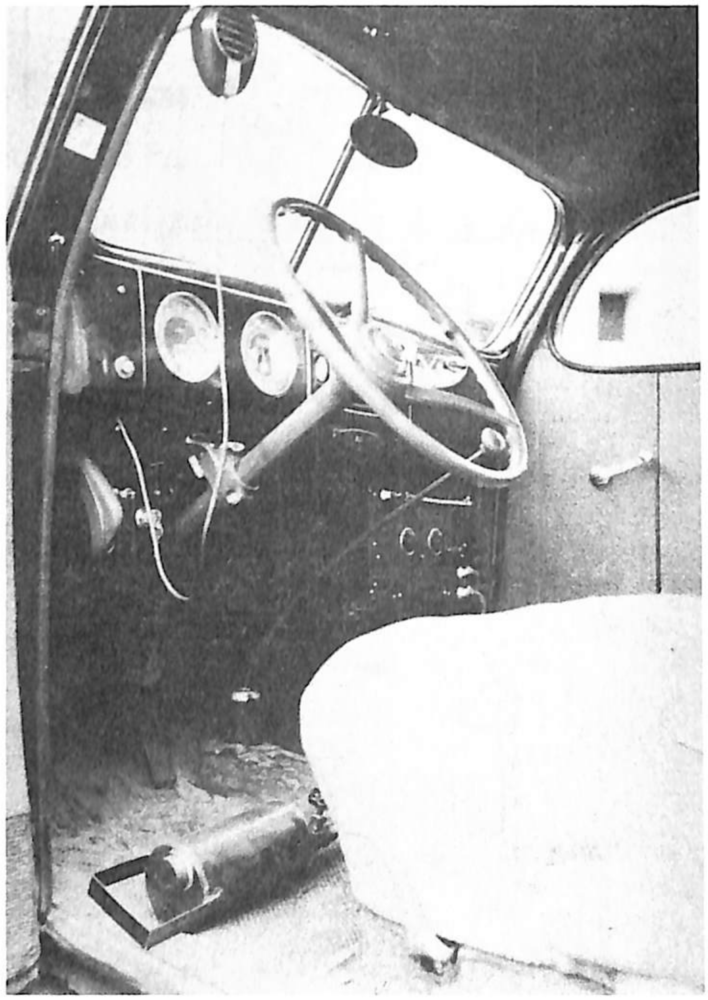


FIG. 2.62

Schematic Diagram, Type I-Model A

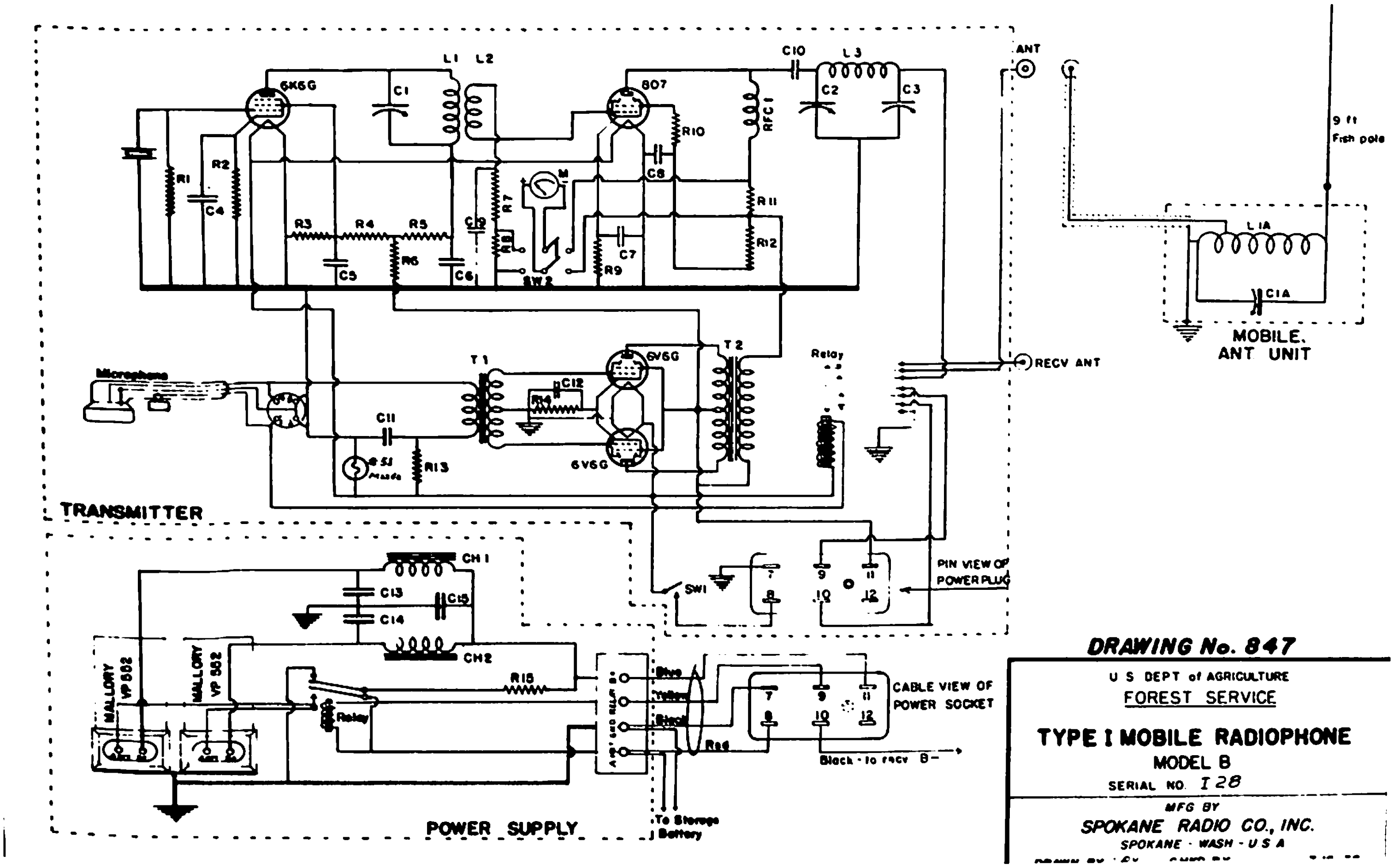
 

(Forest Service photos, History Section)

Type K*

'Kar'

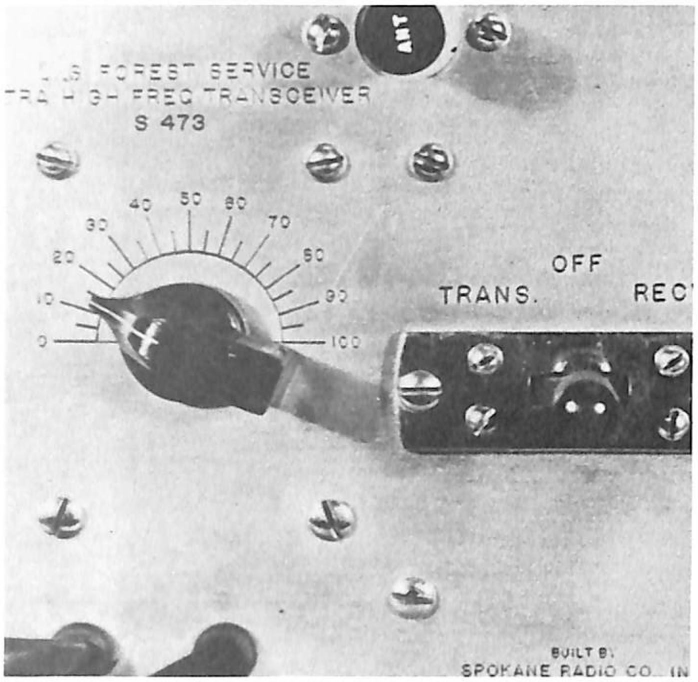
Designed by:	Radio Laboratory staff, 1937
Number produced:	63
Price:	$270
Models:	A, B, AA, AB*
Frequency:	3 MHz
Transmitter:	9 1/2 watts, voice, AM, xtal
Receiver:	Motorola Police Cruiser (AA-AB), pushbutton
Power:	6-volt car battery
Antenna:	Rod type on tuning box
Dimensions:	Four packages
Principal use:	Mobile
*Comments:	Originally designated Type I-mobile (A and B) Type KA ('Kar-Airplane') was for airplane use

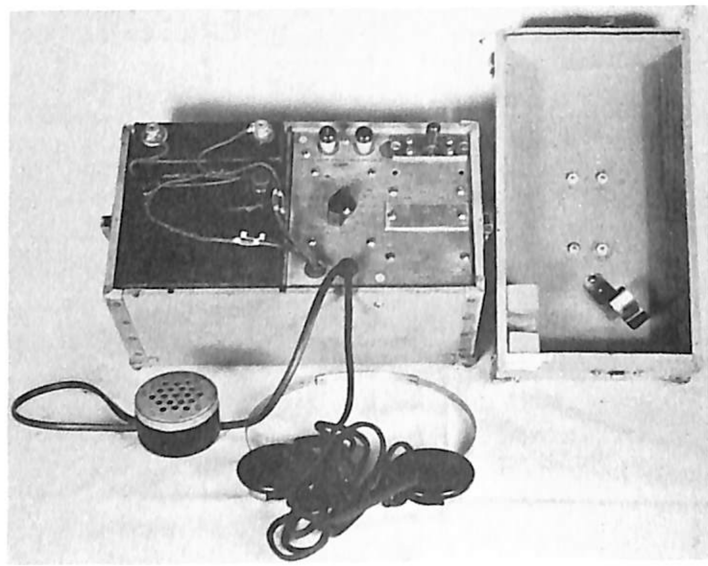


Schematic Diagram, Type K (Type I-Mobile)

Vhf Types

10 Meters (30 – 40 MHz)





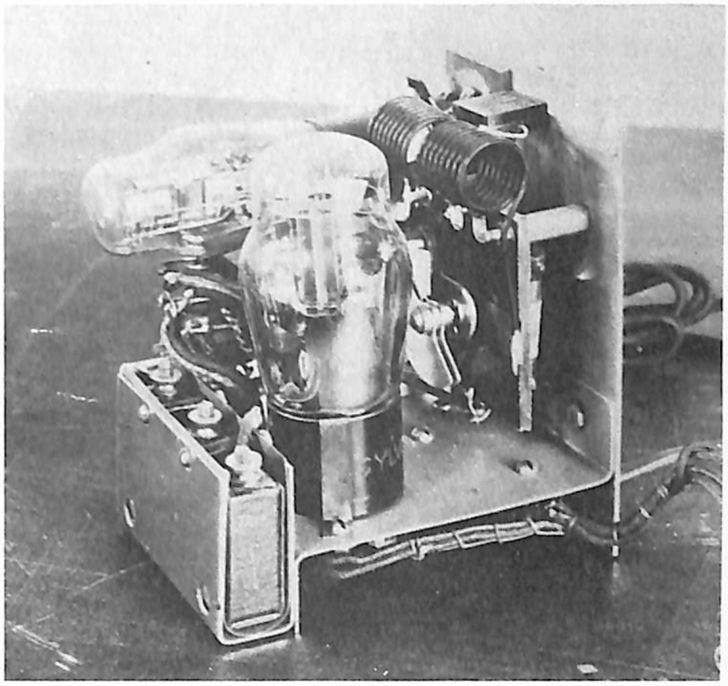
(Forest Service photos, History Section)

Type S*

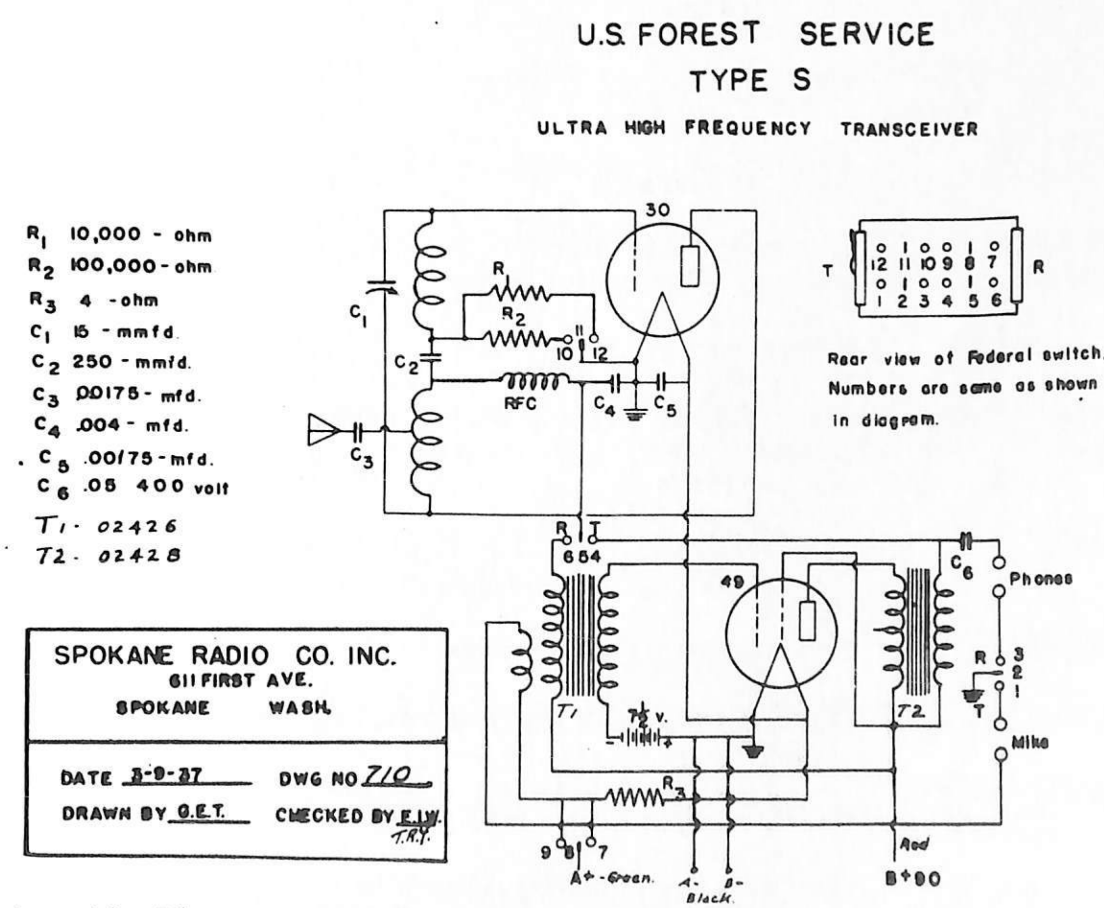
'Superregenerative'

Designed by:	Harold K. Lawson, 1935
Number produced:	781
Price:	$47
Models:	A, B*
Frequency:	30-40 MHz
Transmitter:	1/10 watt, voice, AM self-excited oscillator, simplex, transceiver
Receiver:	Superregenerative, tunable
Power:	Dry batteries
Antenna:	14' 7" half wave wire or rod type
Dimensions:	7 x 6 x 11"
Weight:	9# w/batteries
Principal use:	Smokechasers, scouts and fire chiefs; occasionally with moving vehicles
*Comments:	Offset transmitter-receiver frequencies Model B added separate transmitter tuning control and slightly more power Often criticized for spurious signals

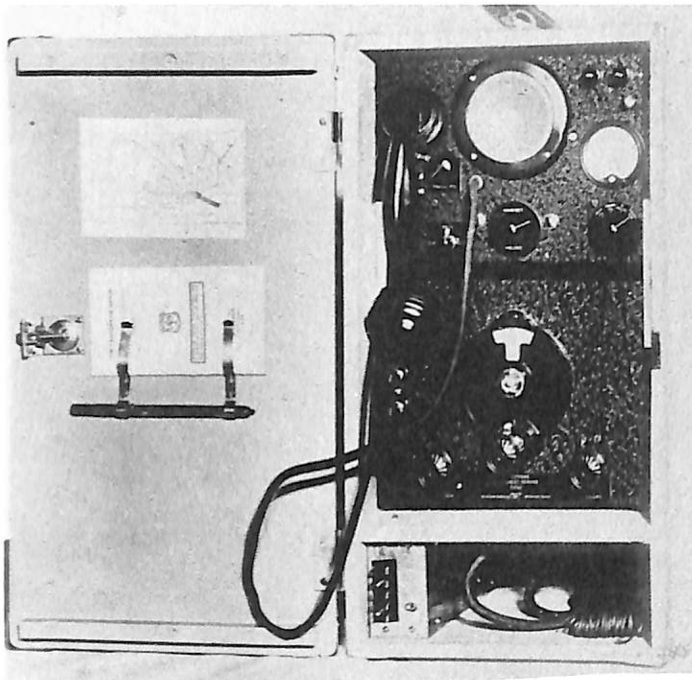
Interior view,
Type S

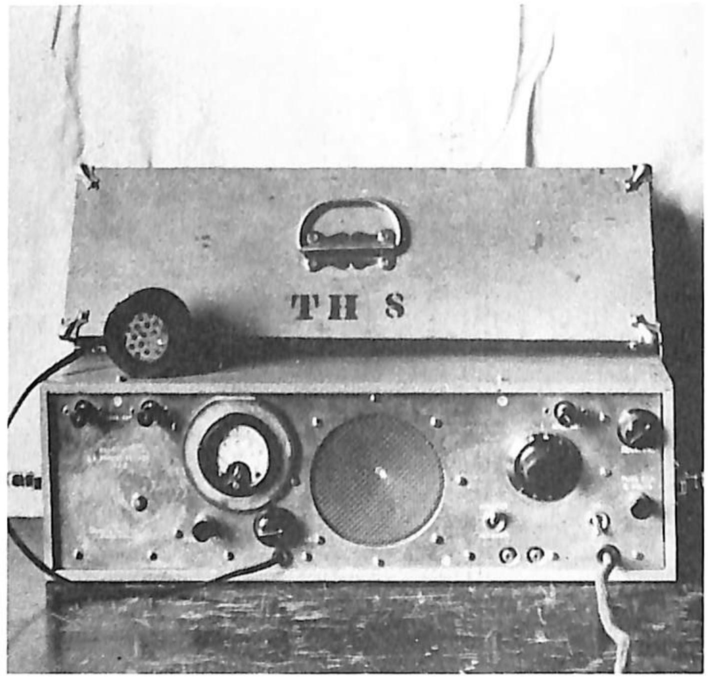


(Forest Service photo,
History Section)



Schematic Diagram, Type S





(Forest Service photos, History Section)

<u>Type T*</u>

'Ten meters'

Designed by:	W. Foy Squibb, 1935
Number produced:	Numbers included with T-D
Price:	$130
Models:	TH-TL; CA, CB, CC
Frequency:	30-40 MHz
Transmitter:	2 1/4 watts, voice, AM, standby, master oscillator
Receiver:	National SW-3; superregenerative
Power:	Dry batteries
Antenna:	Half wave doublet
Dimensions:	22 x 15 x 19"
Weight:	29# including batteries and antenna
Principal use:	Lookouts and semi-permanent locations
*Comments:	Spurious signals in receiver led to TH-TL for the separation of transmitter-receiver channels, thus H is High and L is Low frequency Model CC operated simplex; CA and CB duplex Provisions to connect to telephone line Required 2 frequency assignments for each National Forest No relationship to Type T-Model D

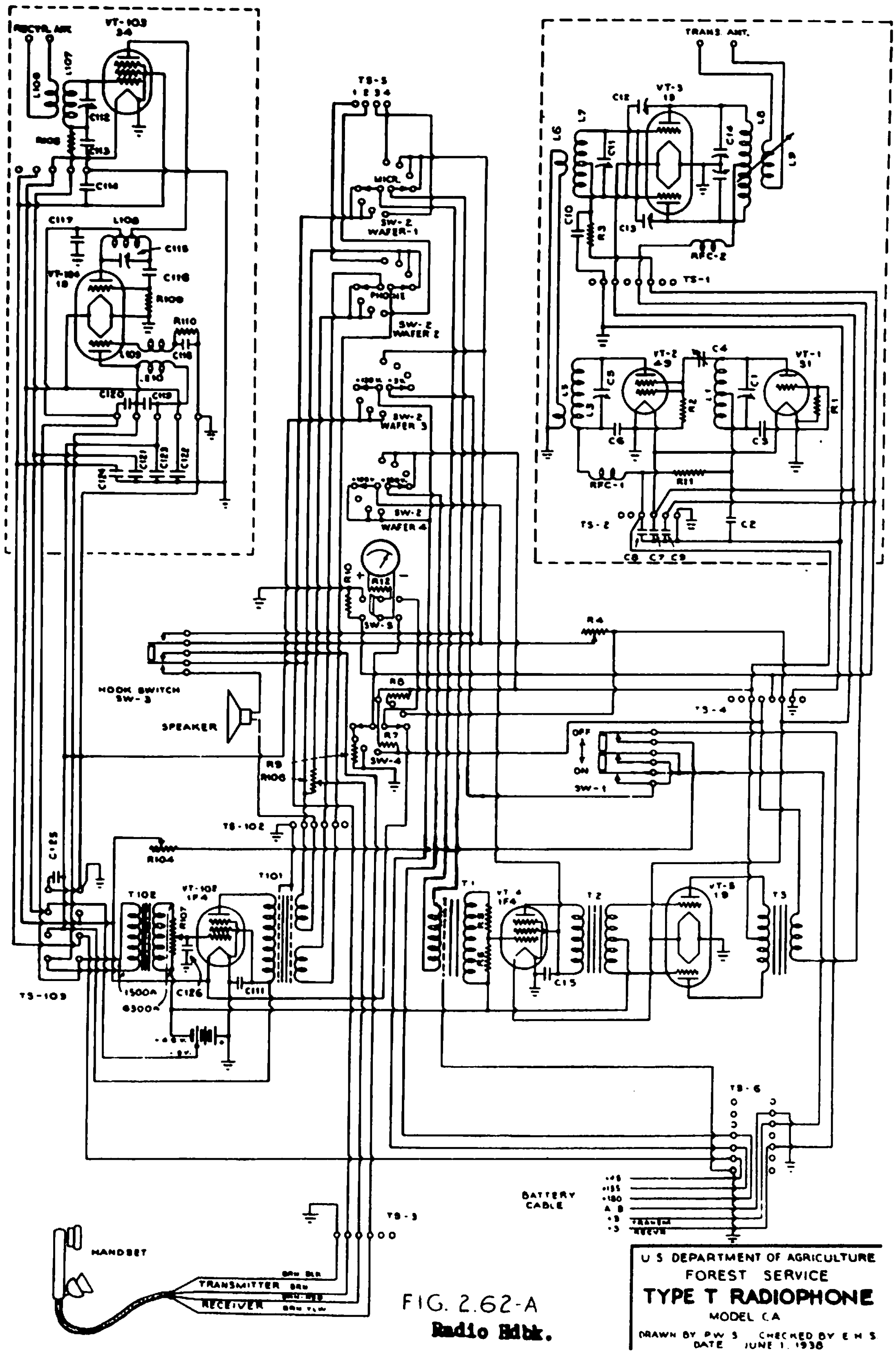
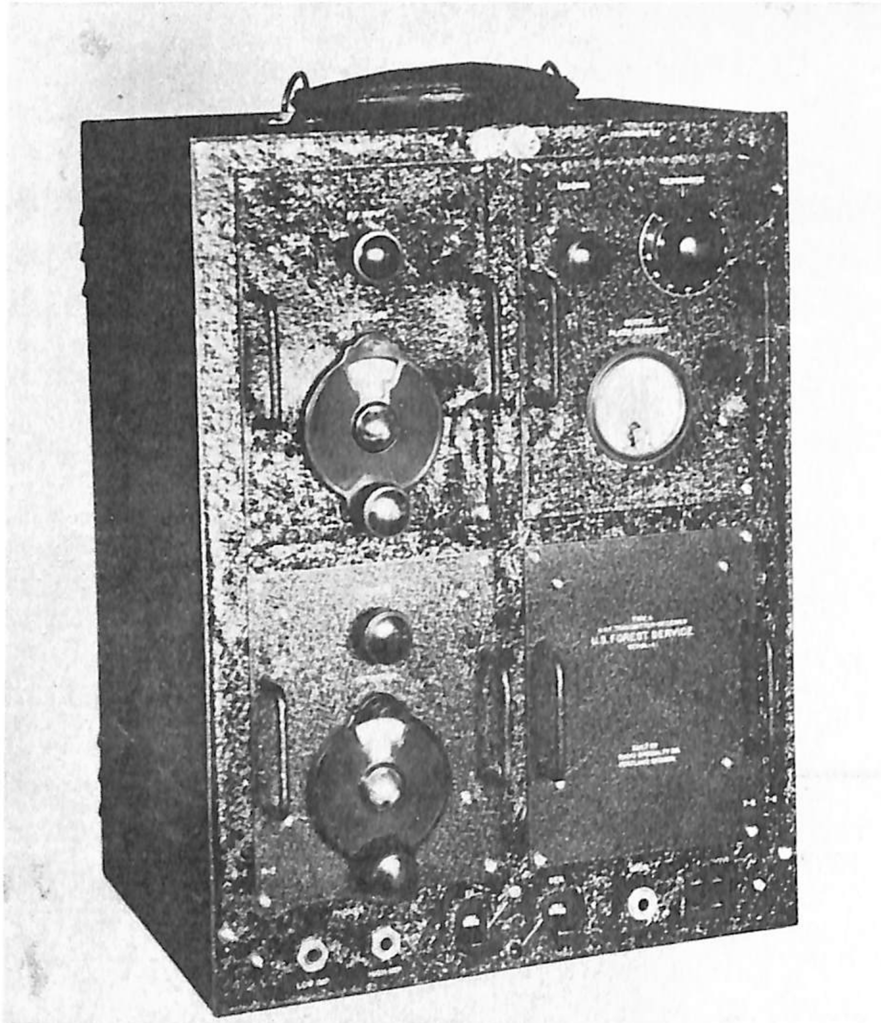


FIG. 2.62-A
Radio Hdbk.

Schematic Diagram, Type T



(Forest Service photo, History Section)

<u>Type A</u>*

'Airplane'

Designed by:	Radio Laboratory staff, 1936
Number produced:	50
Price:	$260
Frequency:	30-40 MHz, w/second channel 160-425 kHz
Transmitter:	3 1/2 watts, voice, AM, xtal push-to-talk
Receiver:	Regenerative, w/tuning
Power:	6-volt battery
Antenna:	13' half wave doublet
Weight:	25#, or 40# w/dynamotor
Dimensions:	18 x 13 x 10 1/2"
Principal use:	Air to ground
*Comments	Advertised 5-mile range in unshielded airplane Could be used with moving vehicles

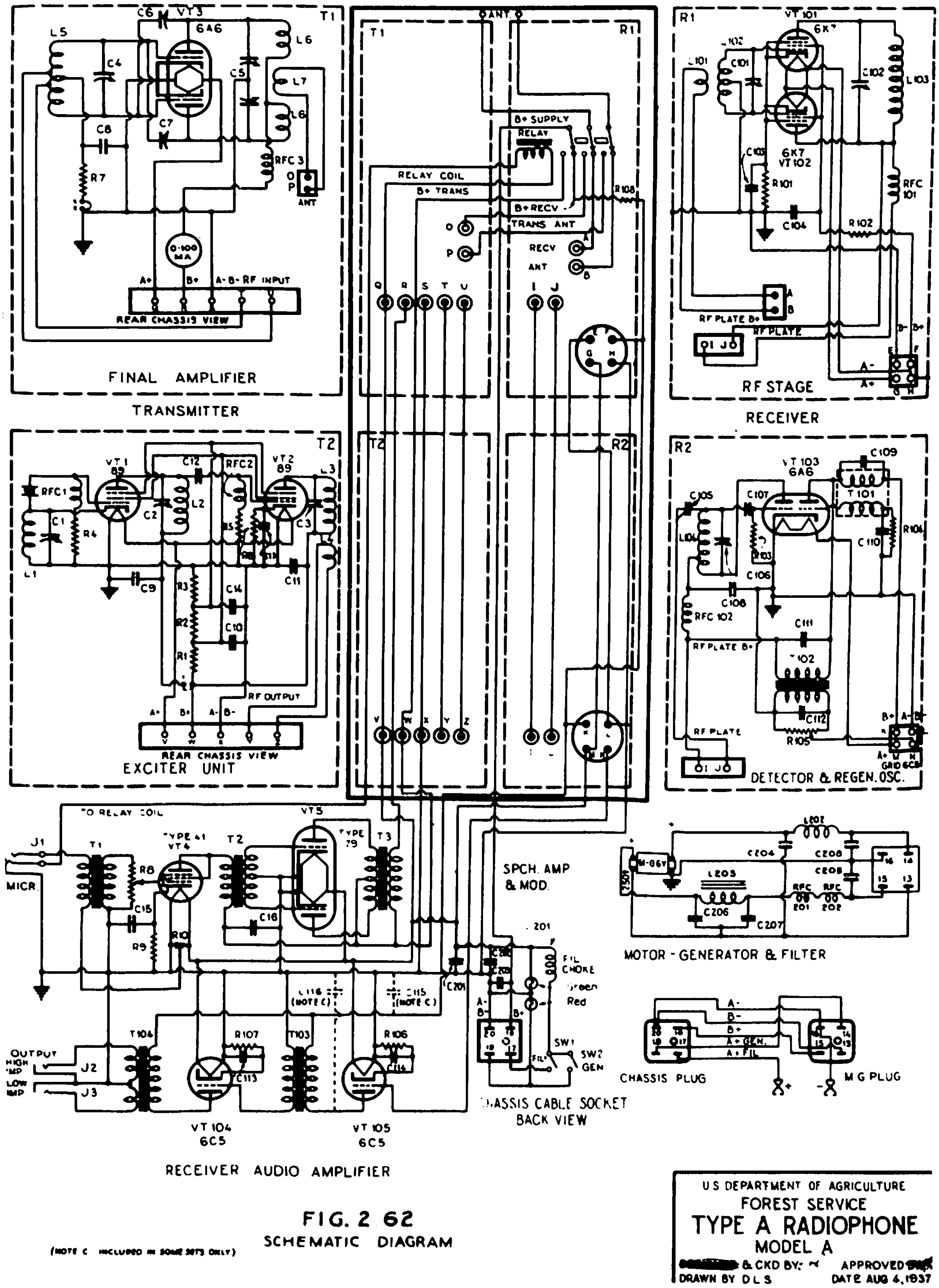
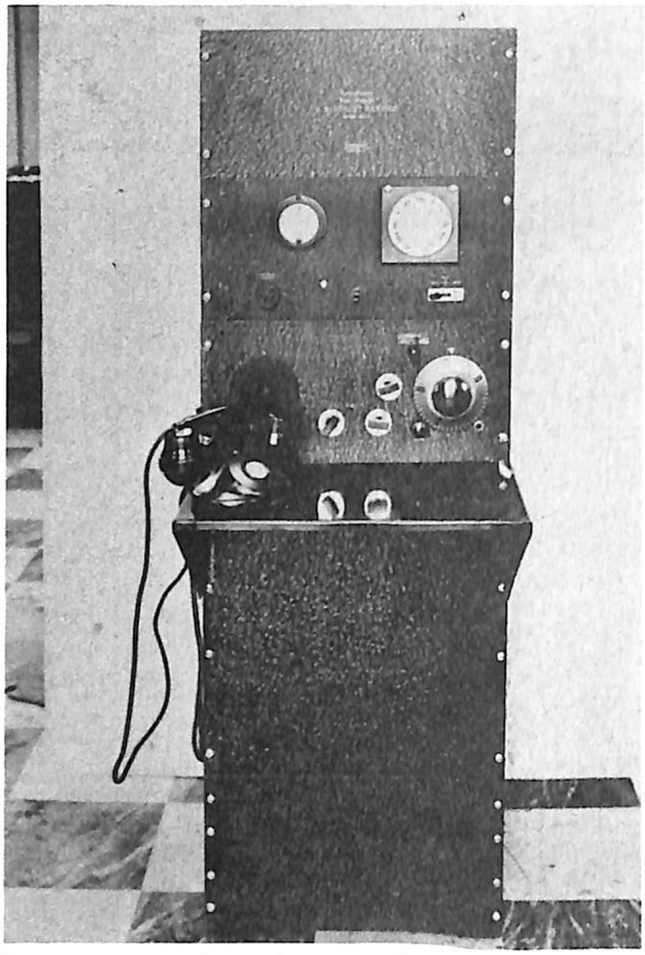


FIG. 2 62
SCHEMATIC DIAGRAM

(NOTE C INCLUDED IN SOME SETS ONLY)

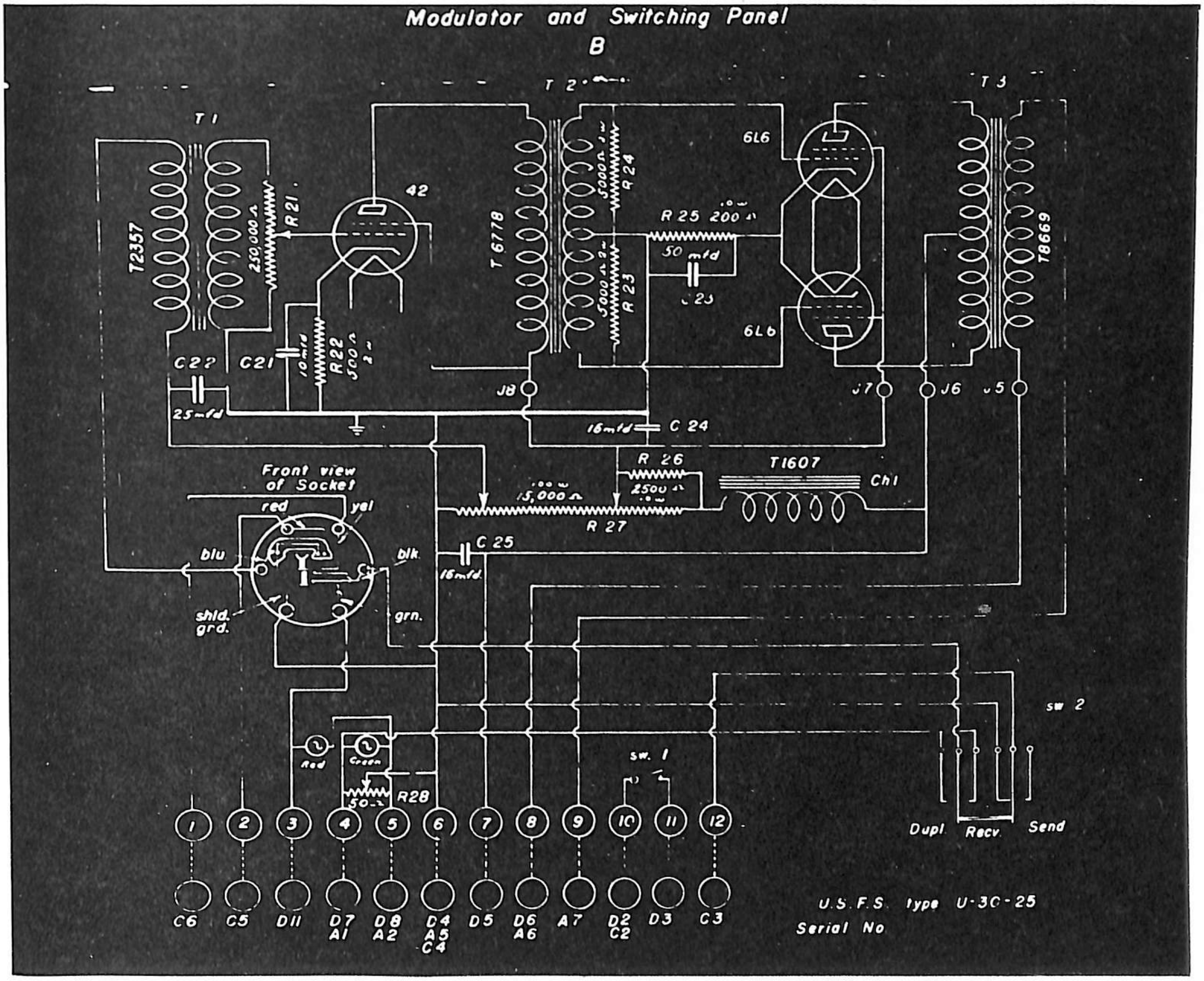


(Forest Service photo, History Section)

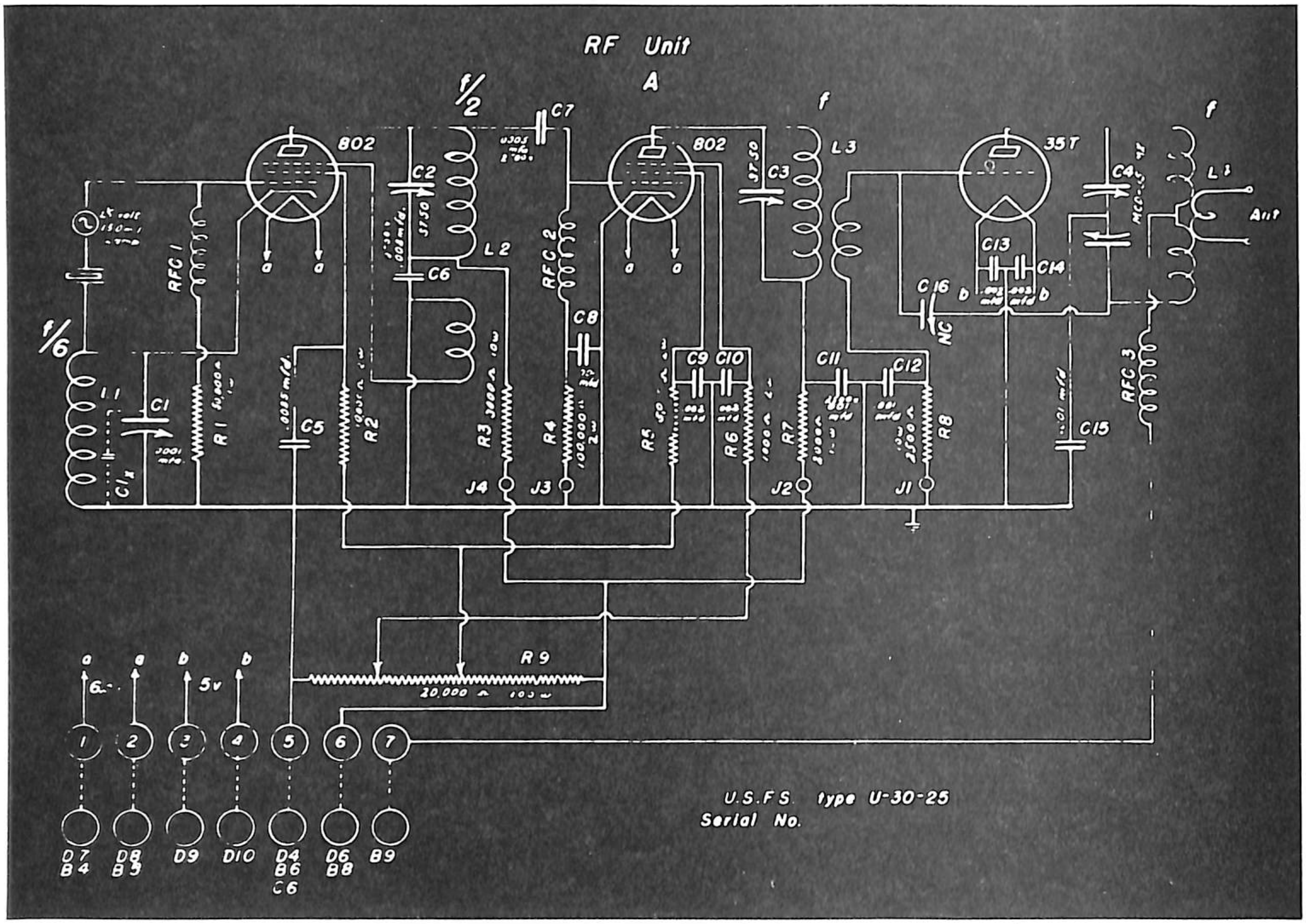
Type U*

'UHF'

Designed by:	Logan Belleville, 1936
Number designed:	200
Price:	$400
Models:	A
Frequency:	30-40 MHz
Transmitter:	20 watts, voice, AM, simplex
Receiver:	National superregenerative
Power:	110 volts (a.c.)
Antenna:	Constructed at locations
Dimensions:	4'9" x 19" x 12"
Weight	300# (shipping weight)
Principal use:	Central station, fixed base
*Comments:	Speaker on standby, transmitter turned on by lifting handset from cradle No relationship to U-R/U-T series



Schematic Diagram, Modulator and Switching Panel, Type U



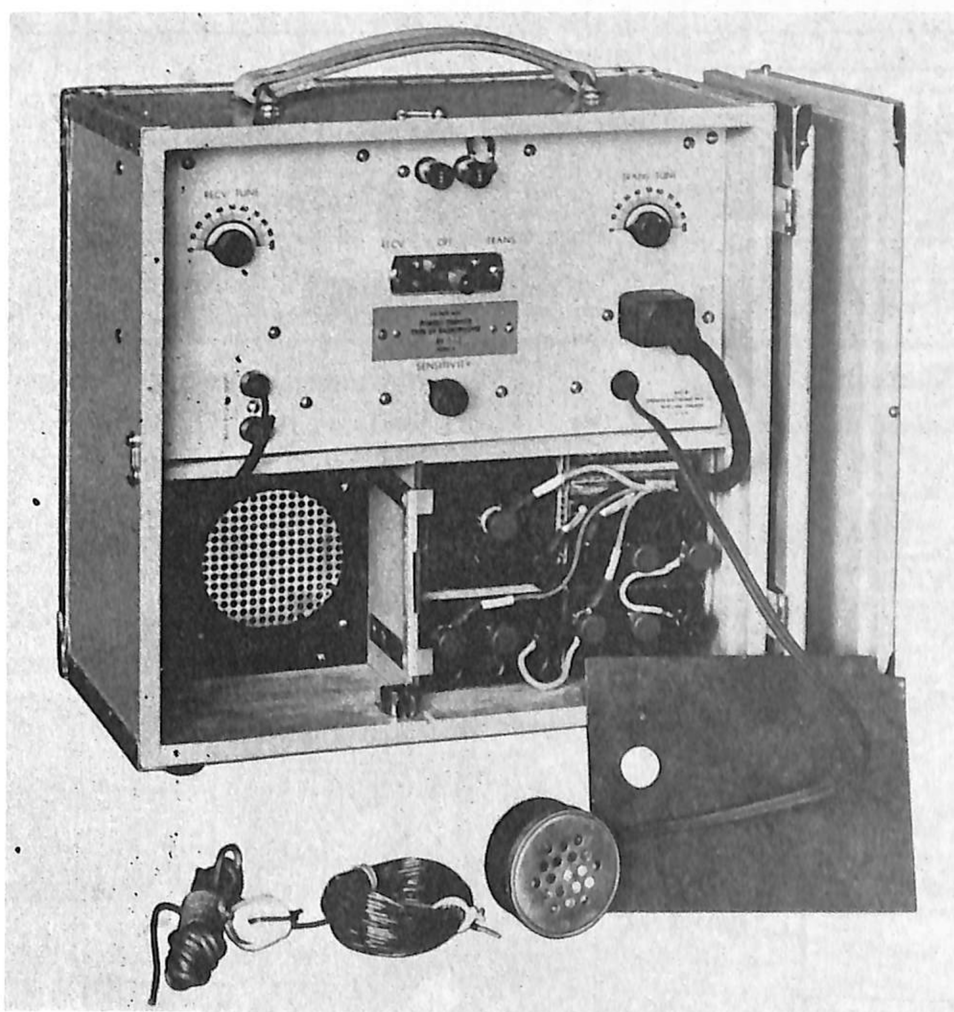
Schematic Diagram, RF Unit, Type U

<u>Type SV*</u>

'Superregenerative Variable' Frequency

Designed by:	Radio Laboratory staff, 1937-38
Number produced:	330
Price:	$61
Frequency:	30-40 MHz
Transmitter	1 watt, voice, AM, simplex, self-oscillating
Receiver:	Superregenerative
Power:	Dry batteries
Antenna:	Three-quarter wave, single wire
Dimensions:	6 x 10 x 5" or 12 x 12 x 7" overall
Weight:	18#
Principal use:	Where extreme portability was not essential
*Comments:	Independent transmitter/receiver sections

(Forest Service photo, History Section, 15472)



U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE TYPE SV RADIOPHONE

MODLE A

SERIAL Nos. SV 1 to SV 30

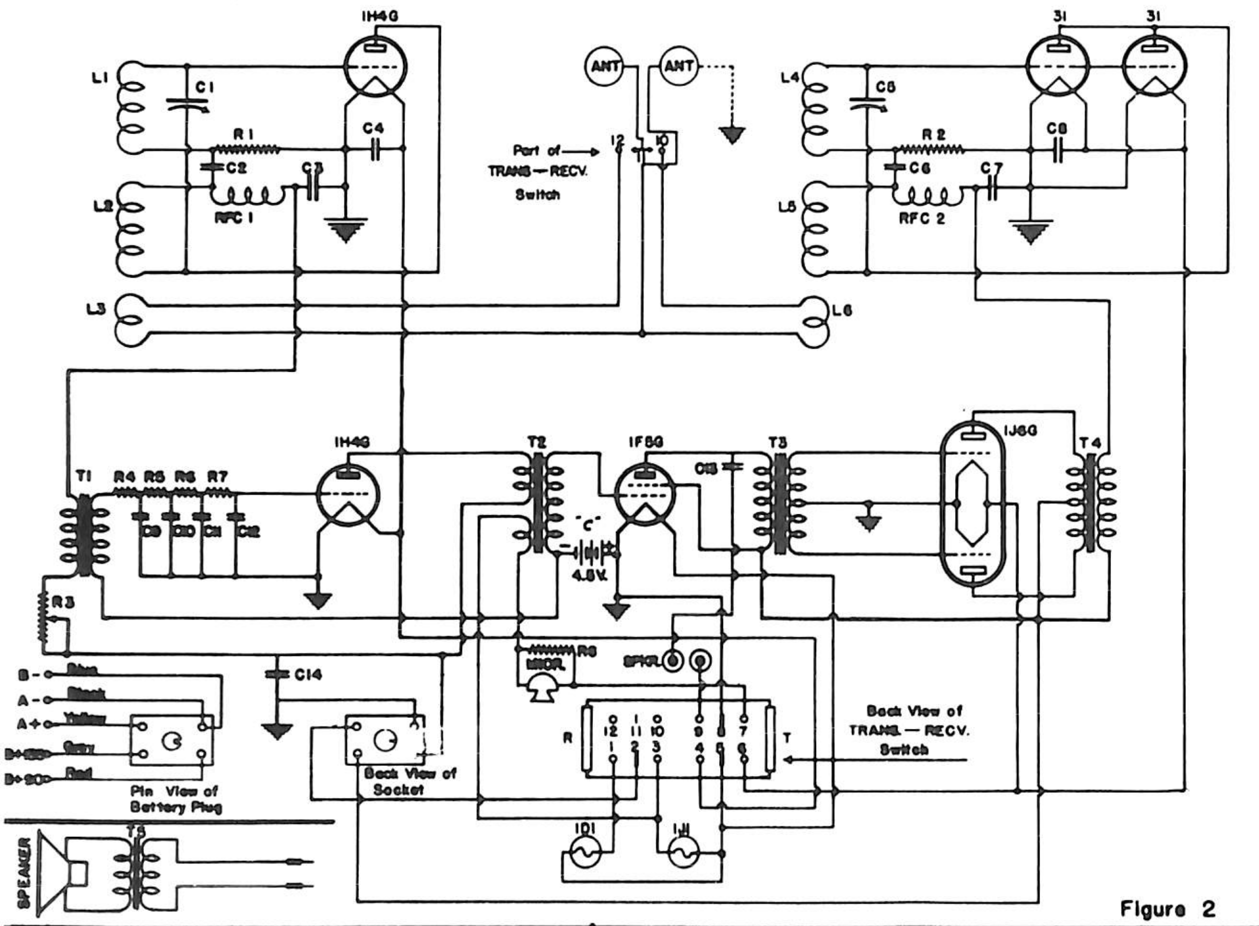


Figure 2

TYPE SV PARTS LIST

WHEN ORDERING REPLACEMENT PARTS, ALWAYS GIVE MODEL AND SERIAL NUMBER

C 1 - 16 mmf. Special Hammarlund
C 2 - .001 mfd. mica C-D 1R-5D1
C 3 - .003 mfd. mica C-D 1R-5D3
C 4 - .0015 mfd. mica C-D 1R-5D15
C 5 - 22 mmf. Special Hammarlund
C 6 - .00025 mfd. mica C-D 5R-5T25LL
C 7 - .002 mfd. mica C-D 1R-5D2
C 8 - .002 mfd. mica C-D 1R-5D2
C 9 - .0001 mfd. mica C-D 5R-5T1
C10 - .0001 mfd. mica C-D 5R-5T1
C11 - .0001 mfd. mica C-D 5R-5T1
C12 - .0001 mfd. mica C-D 5R-5T1
C13 - .25 mfd. 400 V. Mallory TP430
C14 - .25 mfd. 200 V. Mallory TP440
R 1 - 75000 ohms, ½ W. IRC BT-½
R 2 - 10000 ohms, 1 W. IRC BT-1
R 3 - 100000 ohms, Var. IRC 11-128
R 4 - 100000 ohms ½ W. IRC BT-½
R 5 - 100000 ohms ½ W. IRC BT-½
R 6 - 100000 ohms ½ W. IRC BT-½
R 7 - 100000 ohms ½ W. IRC BT-½
R 8 - 100 ohms, ½ W. IRC BW-½
T 1 - Inca 02425
T 2 - Inca 02426
T 3 - Inca 04792
T 4 - Inca 06066
T 5 - Oxford #21A162
Speaker - Oxford # 3-AMP
RFC-1 5 meter choke - COTO CI-13
RFC-2 5 meter choke - COTO CI-13
Battery Plug - Jones PM5, plug only
Battery Socket - Jones PM5 socket
Speaker Jack - Yaxley 432
ANT. posts - X-L Push type
TRANS.-RECV. Switch - Federal 1424W
"C" Battery - General H-3-AF

A complete stock of parts and accessories is maintained in Spokane, Washington by the Spokane Radio Co., Inc., manufacturer of this set.

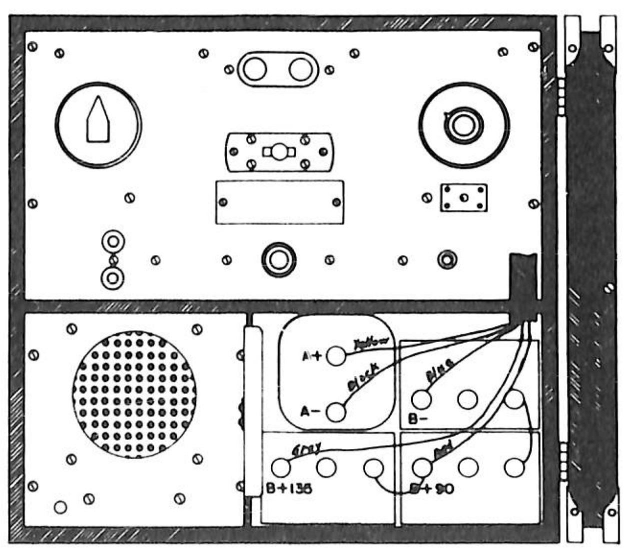
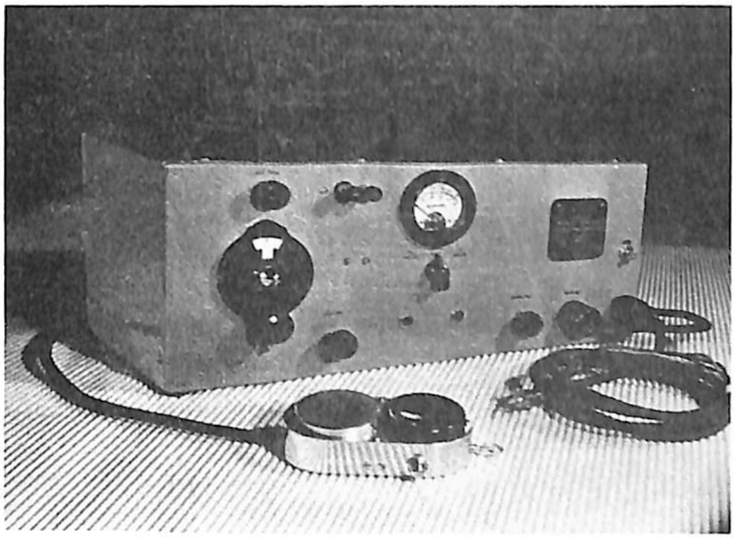


Figure 1

SPOKANE RADIO CO., INC.
MFG. DEPT.
SPOKANE, WASH. U. S. A.
Drawing by I.R.Y. Date 5/7/38
Checked by R.D.O.

DRAWING NO. 861

Schematic Diagram, Type SV-Model A



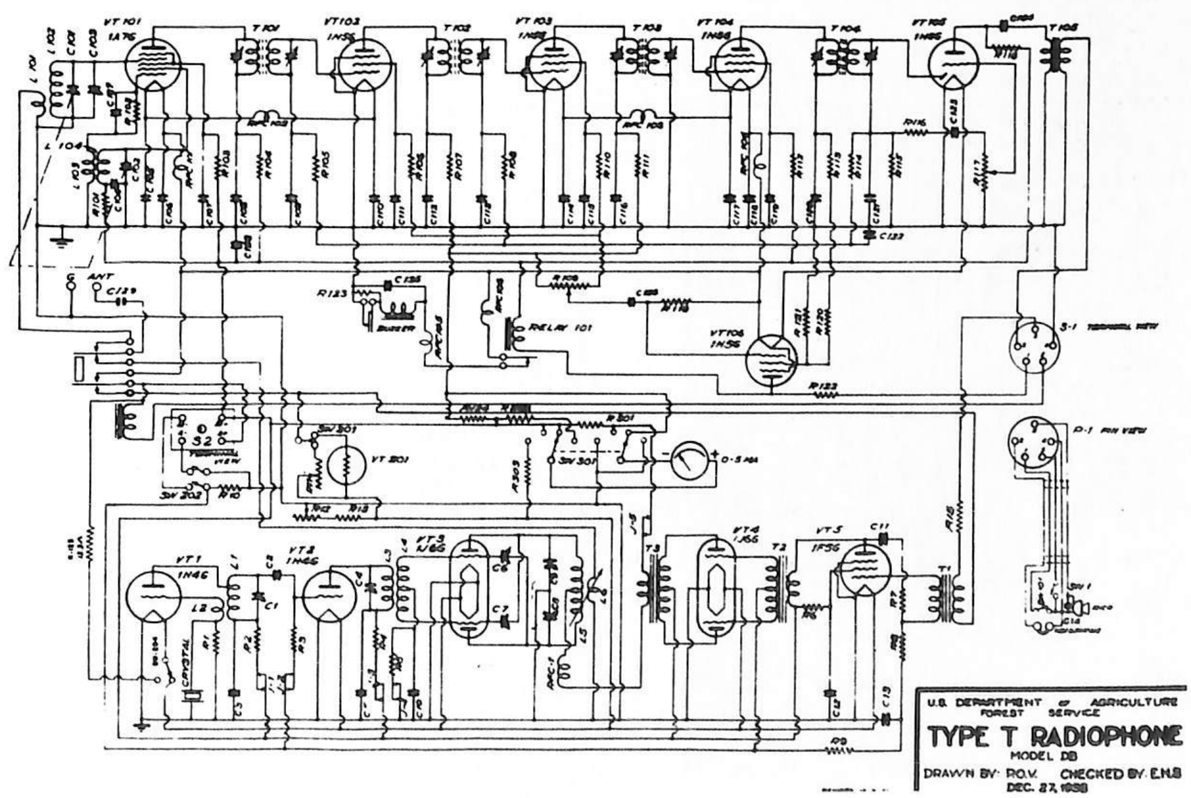
(Forest Service photo, History Section)

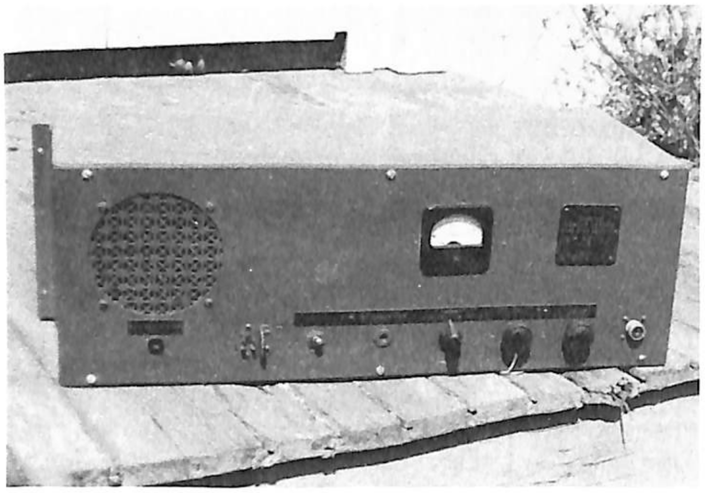
Type T-Model D*

'Ten meter'

Designed by:	Logan M. Belleville, 1938
Number produced:	630
Price:	$250
Models:	D, DA, DB, DE, DF
Frequency:	30-40 MHz
Transmitter:	2 watts, voice, AM, push-to-talk, simplex, xtal osc.
Receiver:	Superheterodyne, silent standby
Power:	Dry batteries
Antenna:	USFS Type J or RSMC coaxial skirt dipole
Dimensions:	7 x 17 x 7"
Weight:	30# in shipping case, including batteries
Principal use:	Lookouts
*Comments:	No relationship to earlier type T Incorporated a calling bell

Schematic Diagram, Type T-Model DB





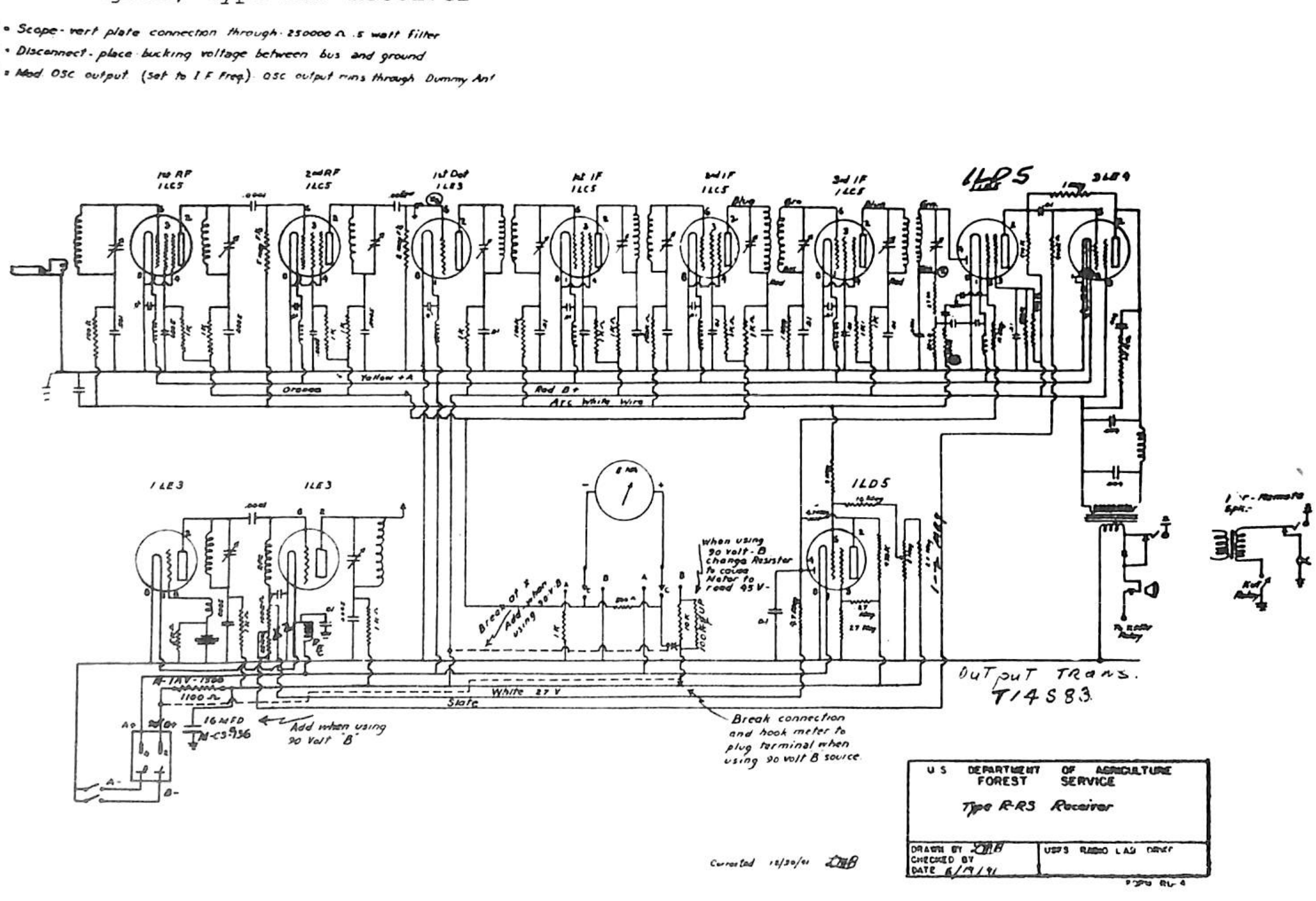
(Forest Service photo, History Section)

Type RRS*

'Relay Repeater Station'

Designed by:	Radio Laboratory staff, 1939-40
Number produced:	470
Models:	RA, RB, RD, RF, RG, R-DR, R-D6T, R-D2T, TRT-F7, R-RS-16
Frequency:	30-40MHz
Principal use:	Relay repeater stations Used extensively in AWS program Some use in lookout towers as a receiver
*Comments:	Specifications varied by model

Schematic Diagram, Type RRS Receiver

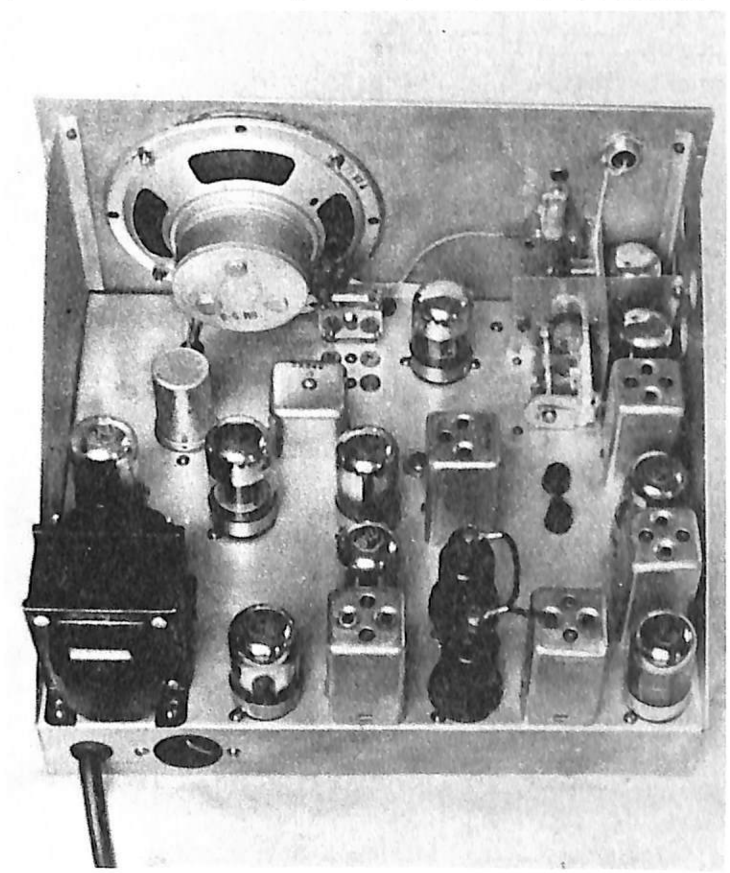


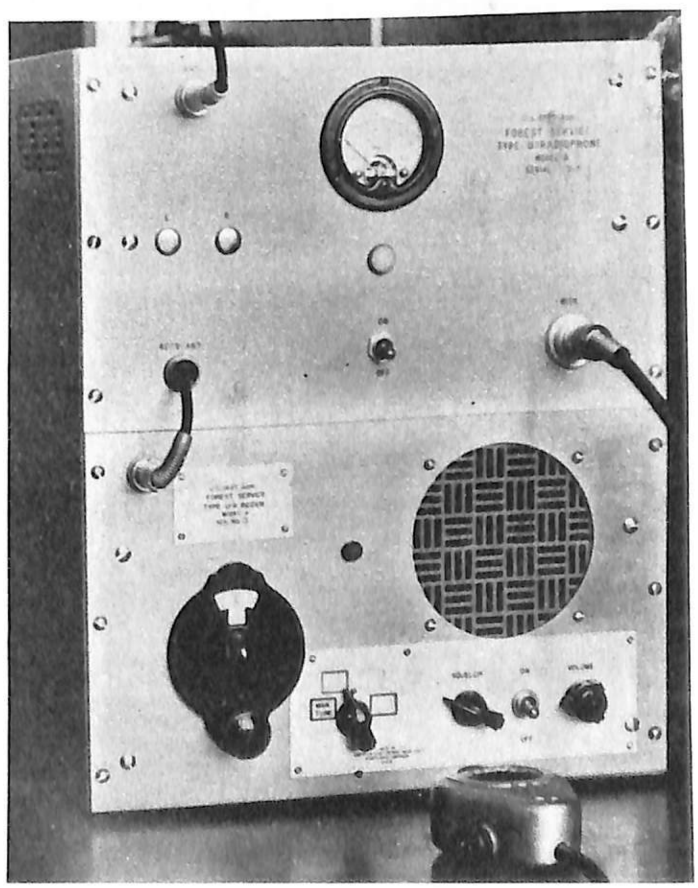
<u>Type KU*</u>

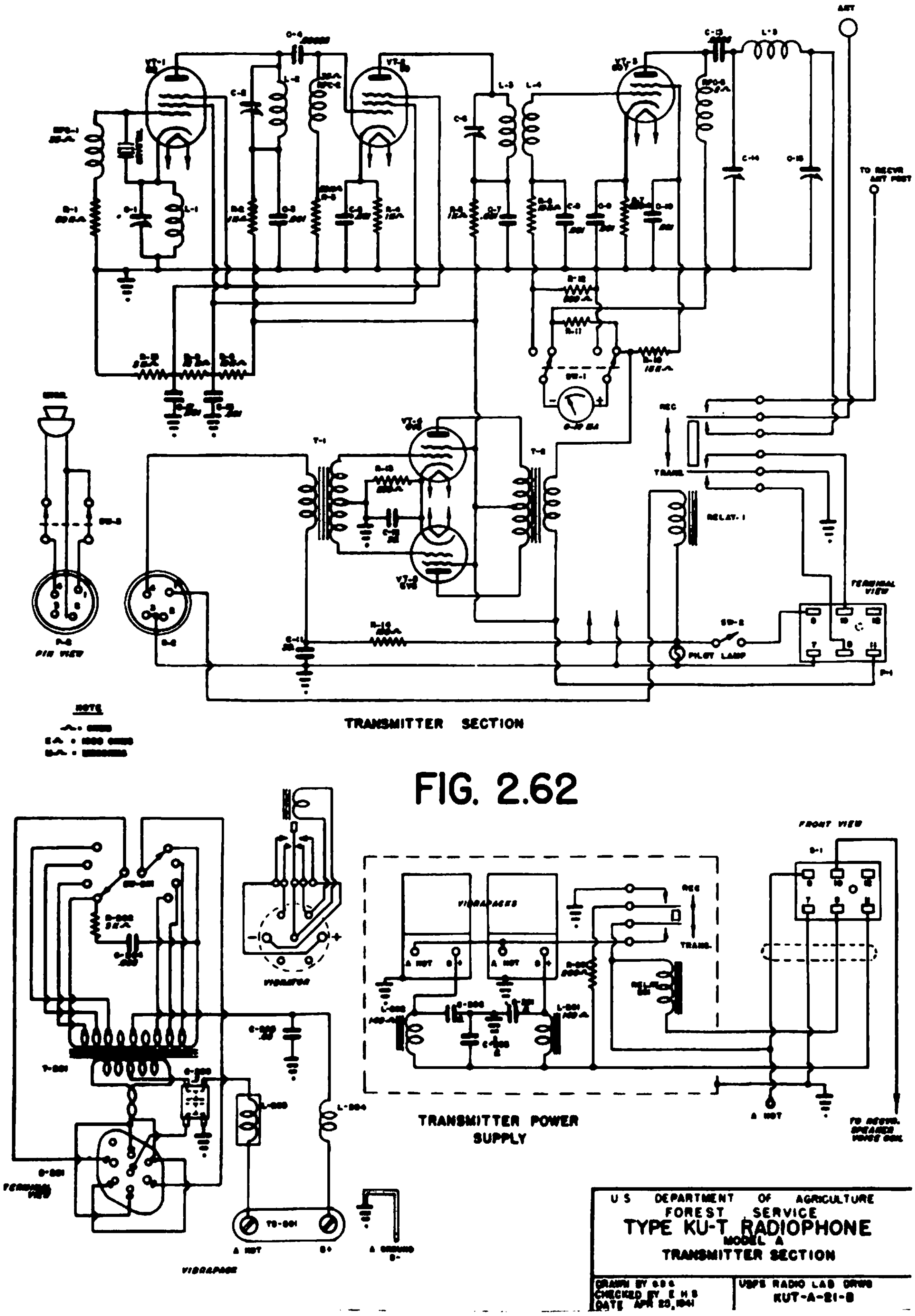
'Kar UHF'

Designed by:	Logan M. Belleville, 1940
Number produced:	575
Price:	$270
Models:	R-A; T-A, T-AA, T2; A, B in Type U
Frequency:	30-40 MHz
Transmitter:	9 watts, voice, AM, simplex, xtal controlled
Receiver:	Tunable w/single xtal standby
Power:	6-volt vehicle battery
Antenna:	Quarter-wave whip
Dimensions:	Housed in several units (see figure 74 and text)
Principal use:	Mobile
*Comments:	Converted to semiportable for lookout use and designated U-R/U-T Effective squelch and essentially free of ignition interference No relationship to earlier type U

Type U-R/U-T*
(Forest Service photos, History Section)







Schematic Drawing, Type KU-T, Model A, Transmitter

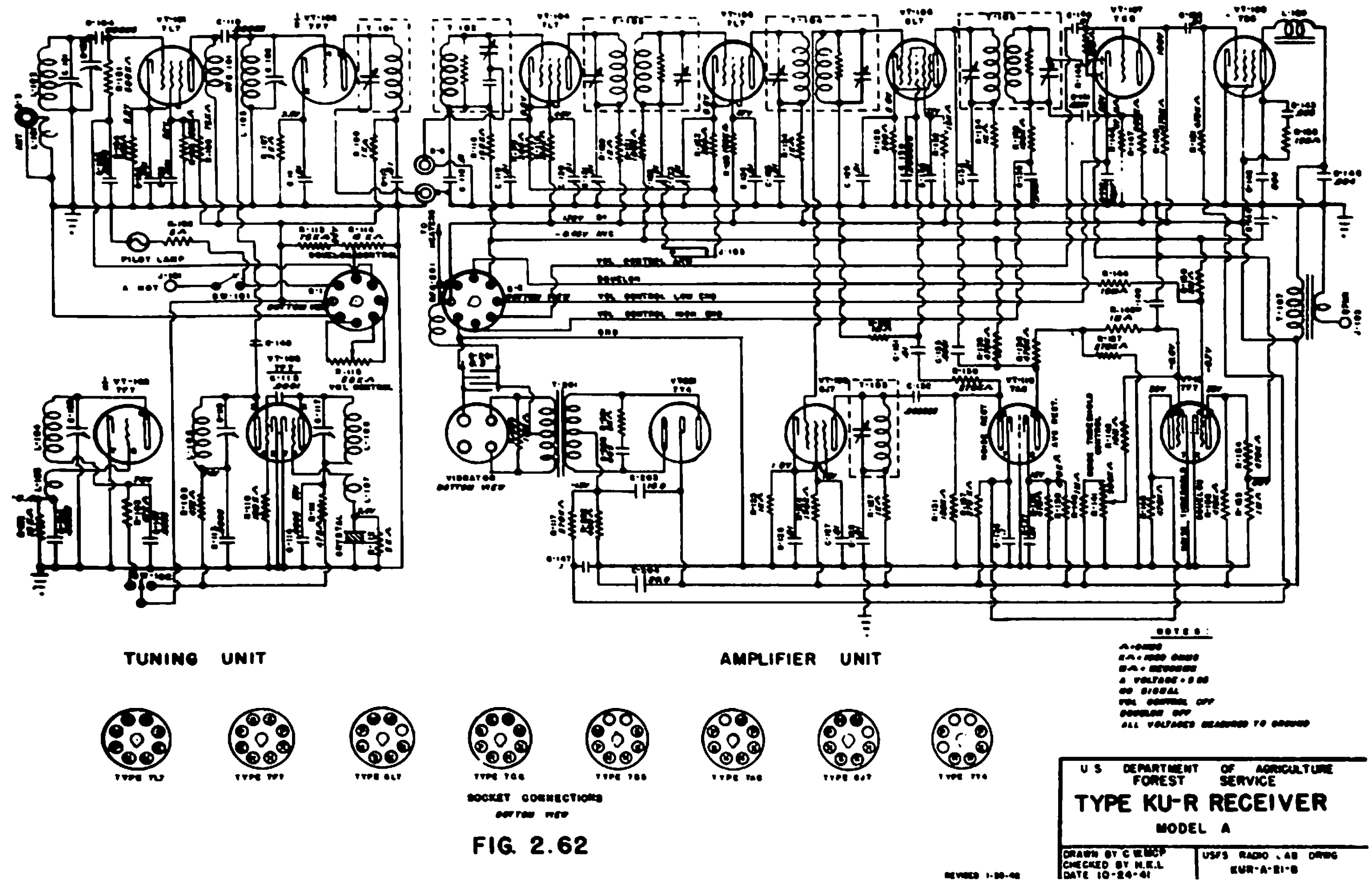


FIG. 2.62

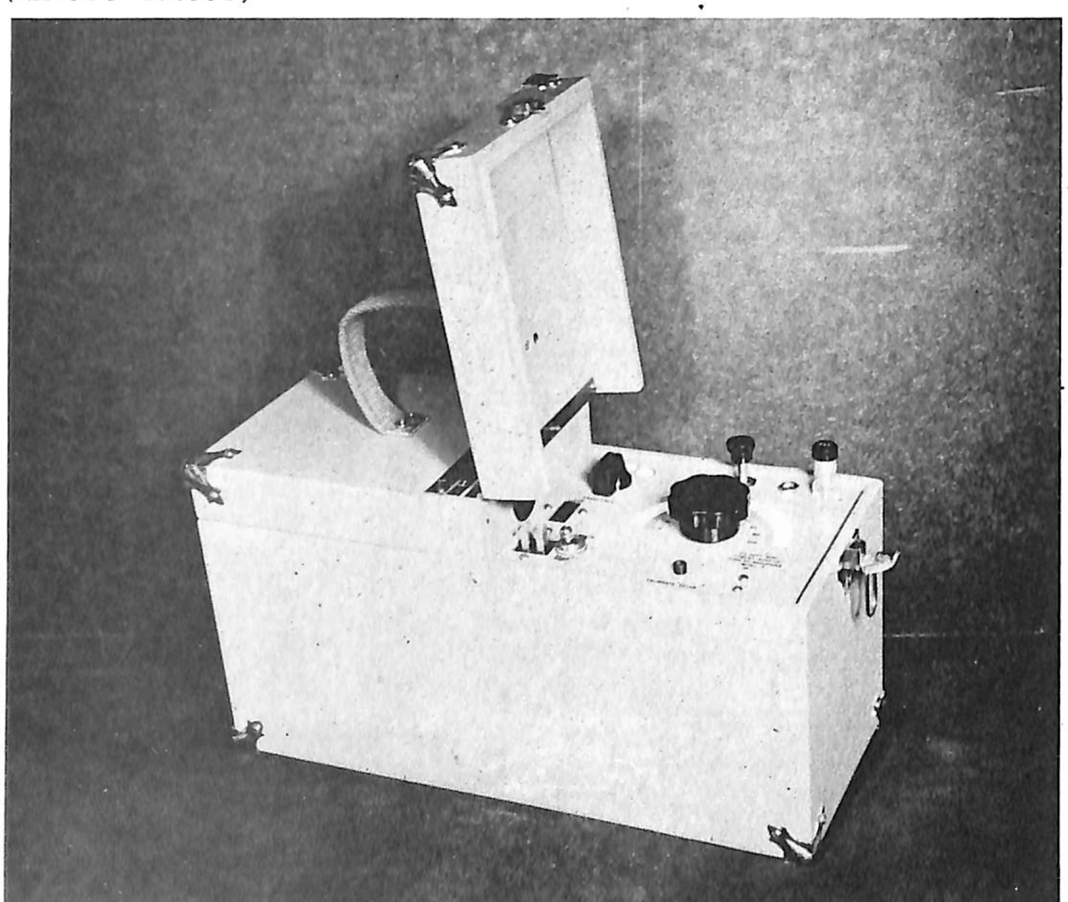
Schematic Drawing, Type KU-R, Model A, Receiver

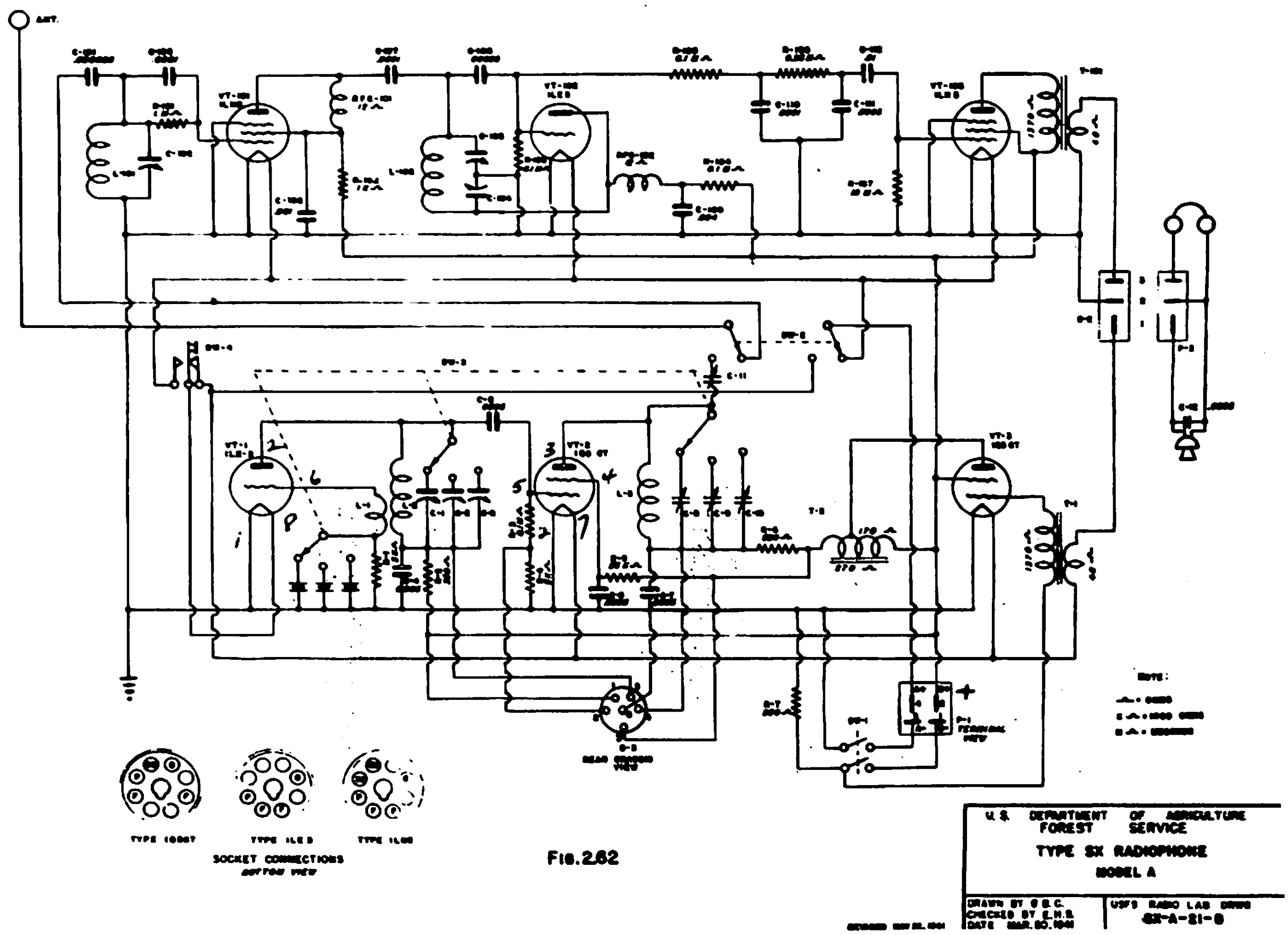
Type SX*/SJ*

'Superregenerative Xtals/Smoke Jumper'

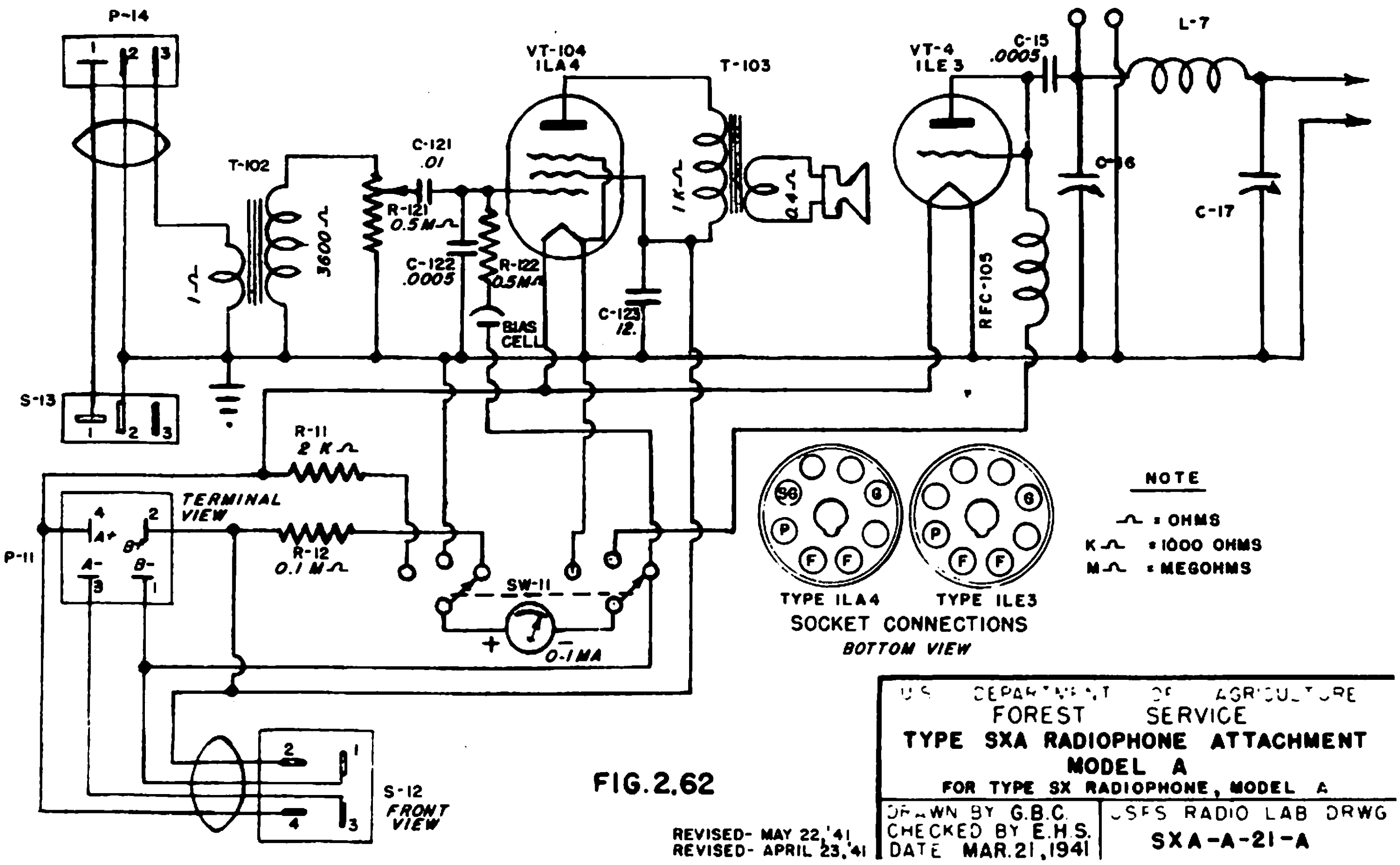
Designed by:	Radio Laboratory staff, 1940-41 (SX/SJ)
Number produced:	800/22
Price:	$70/not available
Frequency:	30-40 MHz/34.22 MHz only
Transmitter:	1/4 watt, voice, AM, 3 xtals/1 xtal
Receiver:	Superregenerative
Power:	Dry batteries/6-10 hrs. intermittant operation
Antenna:	Type J/rod type
Weight:	6# 14 oz. net/n.a.
Dimensions:	13 1/2 x 5 1/2 x 7"/n.a.
Principal use:	Portable/smokejumpers
Comments:	SJ was a condensed version of the SX (see figures 75, 76) SXA ("A" for attachment) was an audio amplifier accessory for semiportable use and added $45 to the price of the SX SX replaced type S; SXA replaced type SV

(NA:95G-406995)





Schematic Drawing, Type SX-Model A



Schematic Drawing, Type SXA-Model A

(Forest Service photo, History Section)

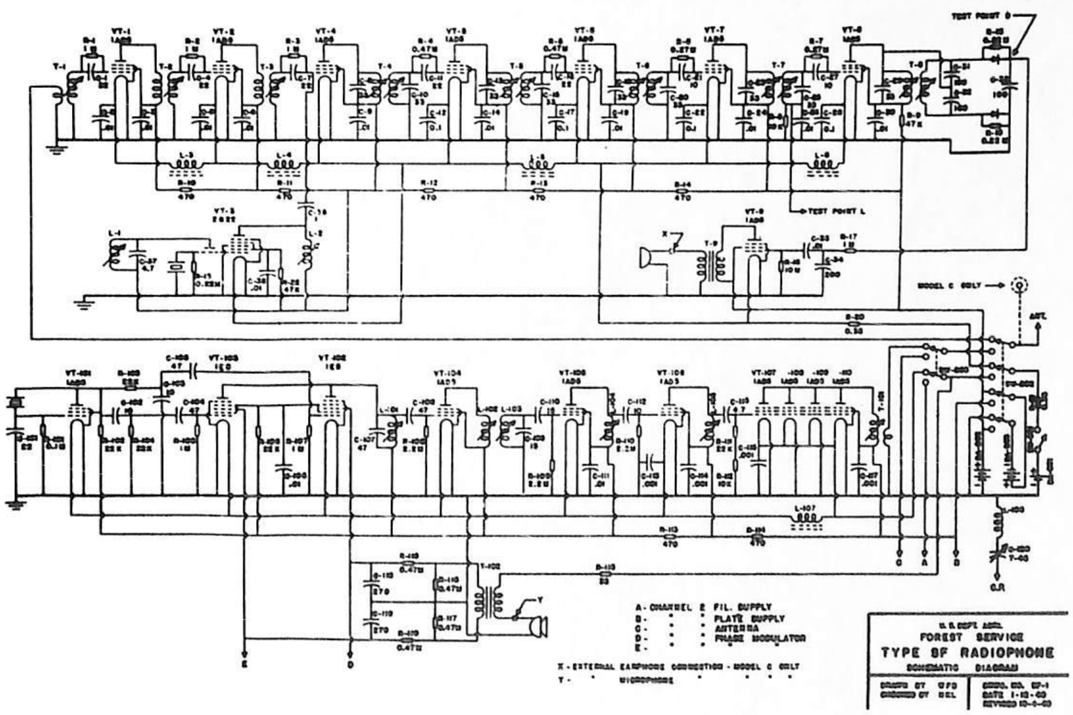
Type SF*

Handie-Talkie with kitbox

Designed by:	Logan M. Belleville, 1947
Number produced:	200+
Price:	Not available
Models:	A-T2-R, B-2, C
Frequency:	30-40 MHz
Transmitter:	200 mw, dual channel, FM
Receiver:	Superheterodyne, 1 channel
Power:	Dry batteries
Antenna:	7' collapsible rod
Dimensions:	4 x 6 x 14"
Weight:	9# w/batteries
Principal use:	Smokechasers and fire scouts

*Comments: Related to type S only in manner of use ("F" for FM) Latter versions included telephone handset as part of carrying handle. A unit with earphones and sensitive microphone was produced for communications with airplanes.

Schematic Diagram, Type SF

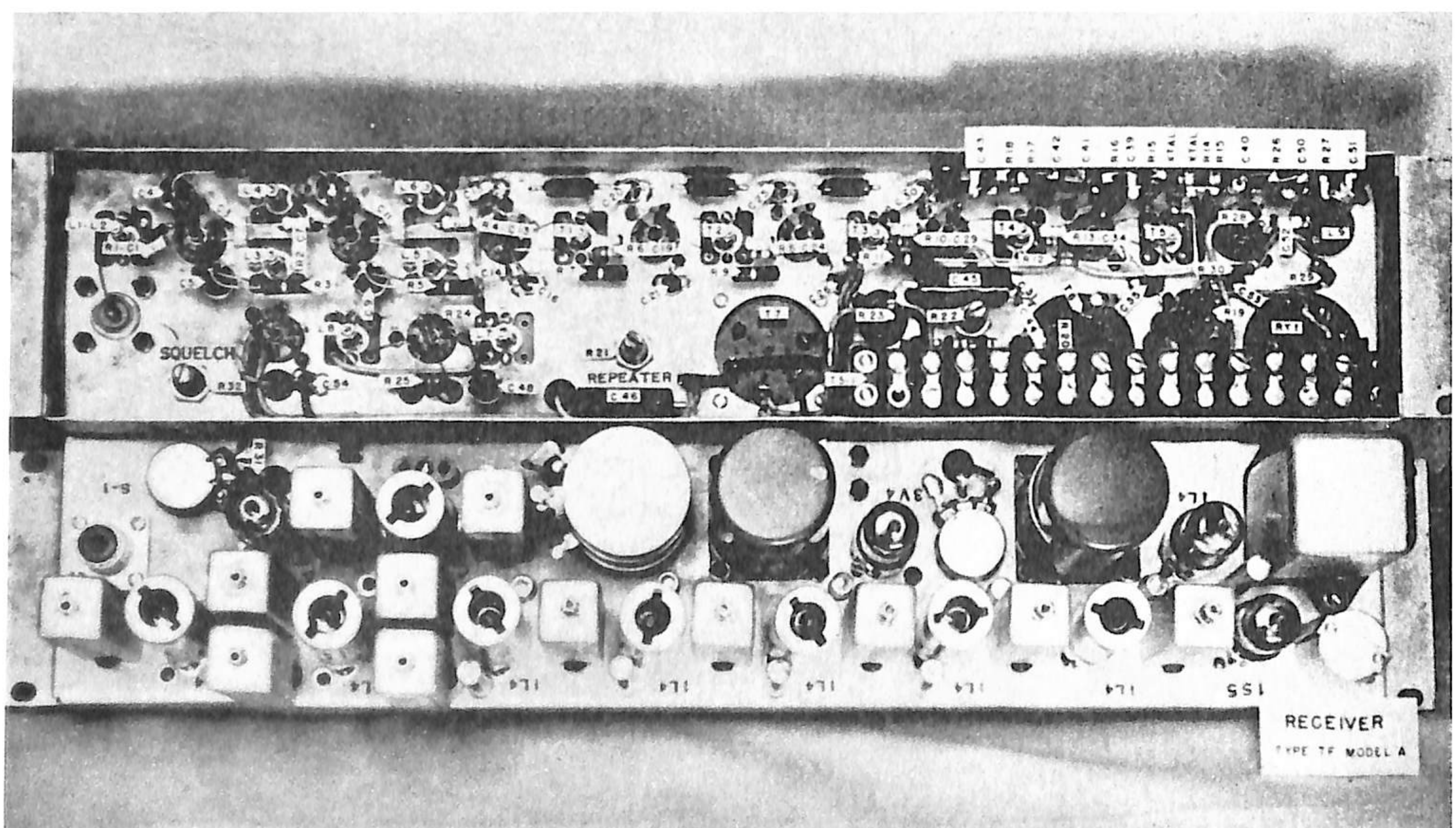


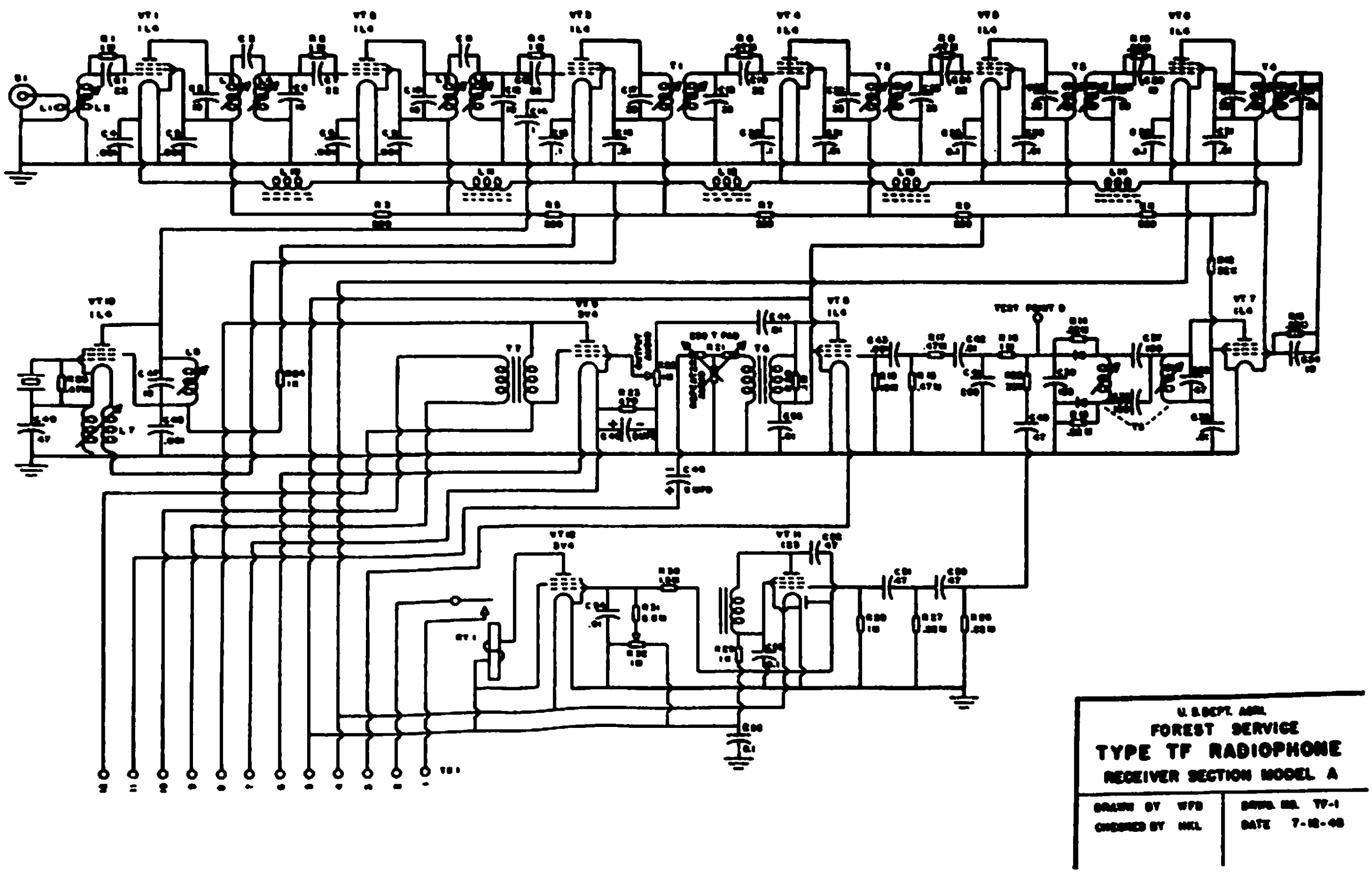
Type TF*

Lookout FM

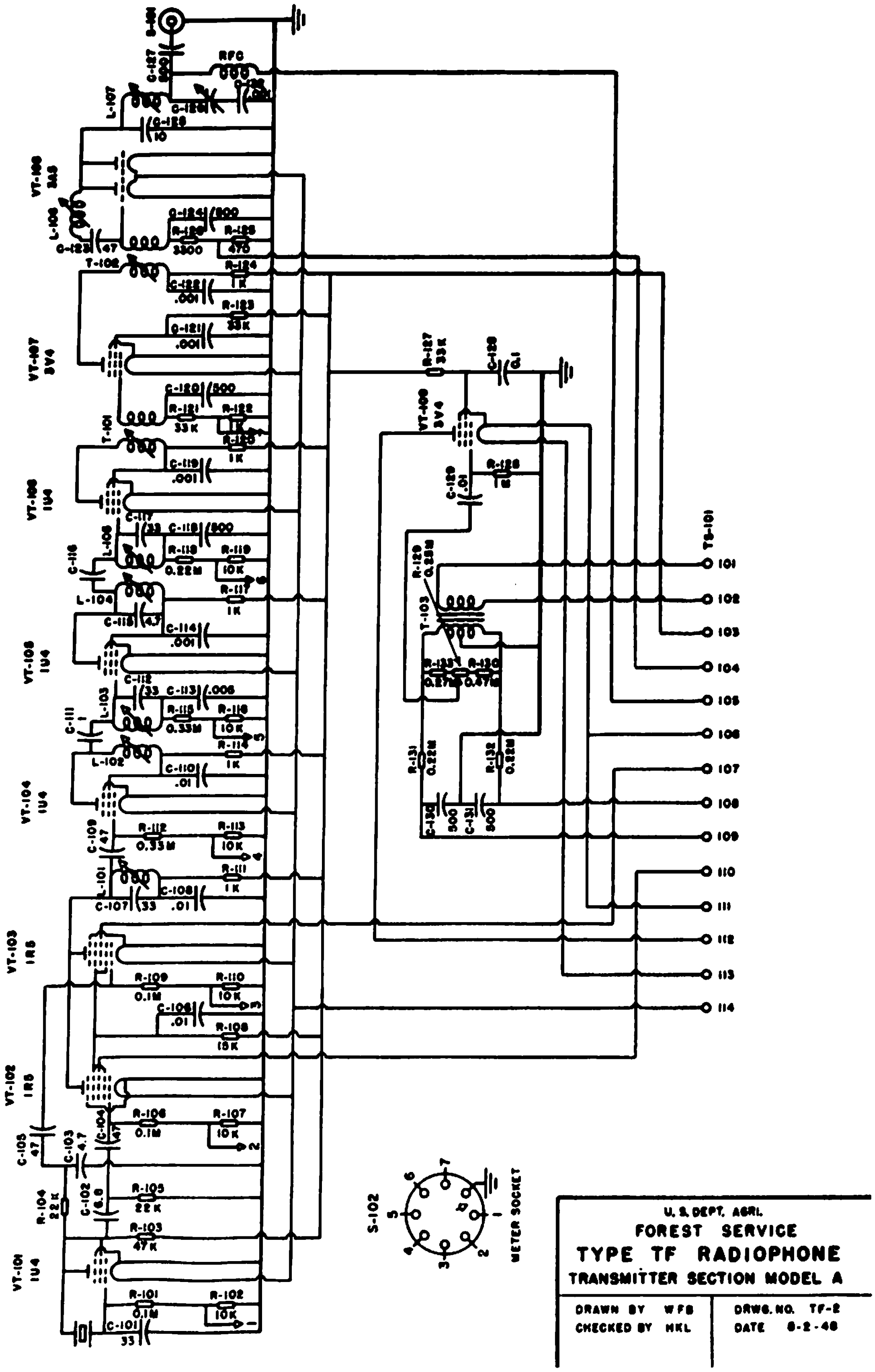
Designed by:	Radio Laboratory staff, 1947-48
Number produced:	Not available
Price:	Not available
Frequency:	30-40 MHz
Transmitter:	2 watts, 2 channel xtal, voice, FM, duplex
Receiver:	Superheterodyne single channel
Power:	Dry batteries
Antenna:	Coaxial or GP
Dimensions:	13 x 10 x 26" plus battery box
Weight:	60# w/control unit
Principal use:	Lookouts
*Comments	2 antennas required for all sets to be used as automatic repeaters Main circuitry remotely located in magnesium cast weatherproof enclosure Receiver only is pictured

(Forest Service photo, History Section)





Schematic Diagram, Type TF-Model A, Receiver

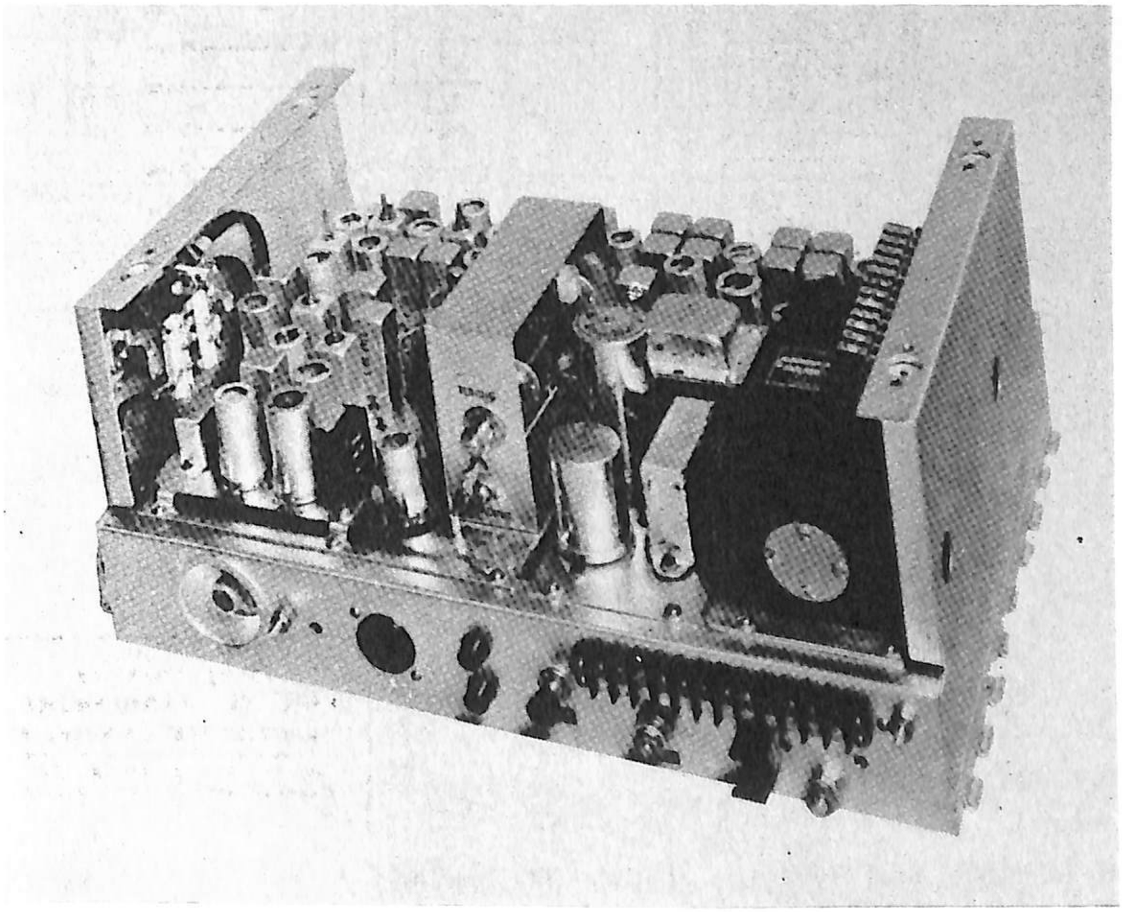


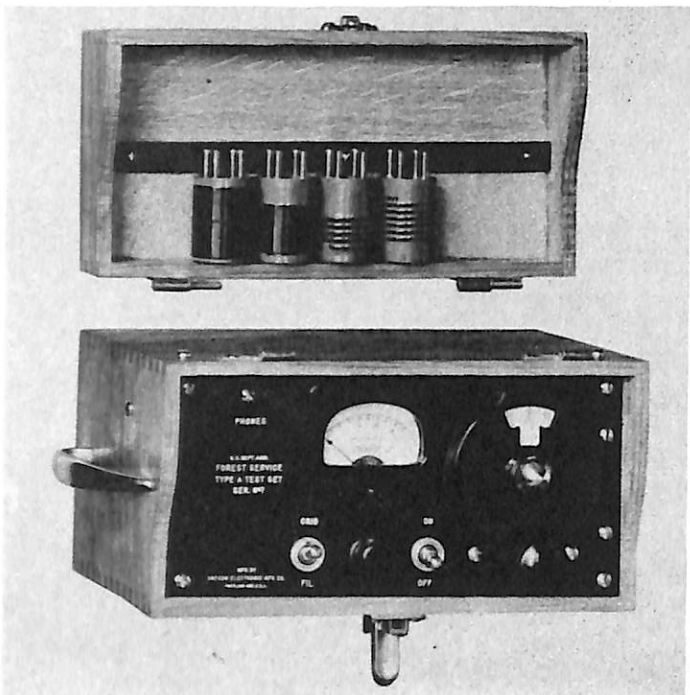
Schematic Diagram, Type TF-Model A, Transmitter

Type KF*

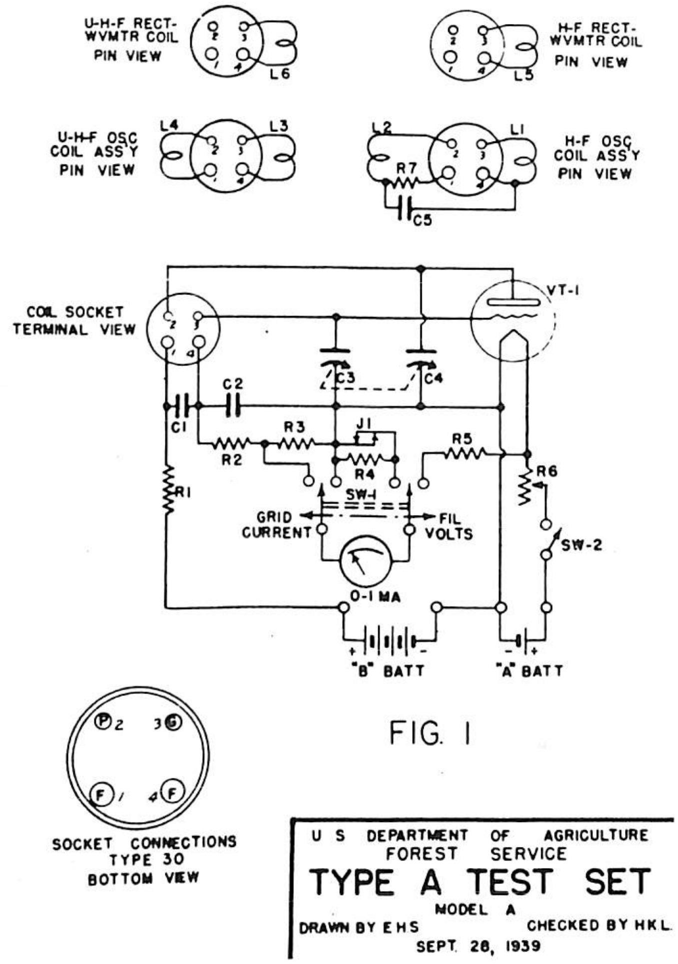
'Mobile FM'

Designed by:	W. F. Biggerstaff, 1947-48
Number produced:	10
Price:	Not available
Models:	A-T2-R
Frequency:	30-40 MHz
Transmitter:	25 watts, 2 channel, xtal, FM
Receiver:	Superheterodyne, 1 channel, xtal
Power:	6-volt auto battery
Antenna:	Mobile rod type
Dimensions:	16 1/2 x 8 1/2 x 15" circuitry 3 x 4 1/2 x 2" controls
Weight:	60#
Principal use:	Mobile
*Comments:	Current drain - 12 amps on standby, 22 amps to transmit Photo is of the first commercially produced model of this set. It is a RSMC-Type 1147 No photo of Lab prototype available



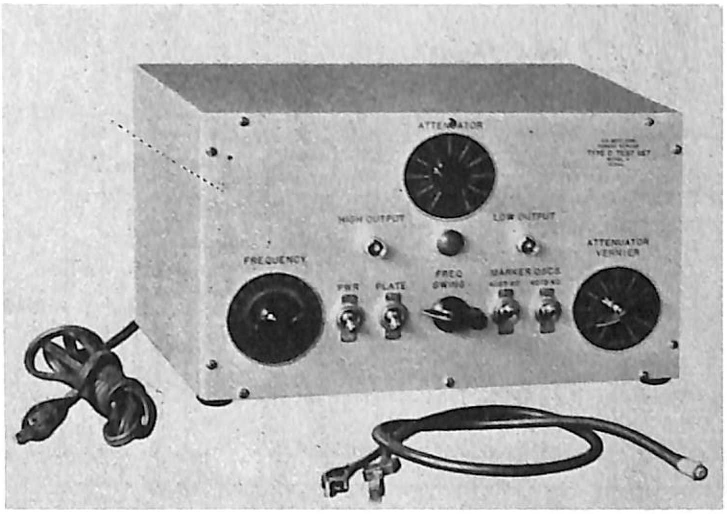


(Forest Service photo, History Section)
Test Set, Type A



Schematic Diagram,
Test Set, Type A-Model A

Test Set, Type D



(Forest Service photo, History Section, 15511)

Schematic Diagram, Test Set, Type D-Model A

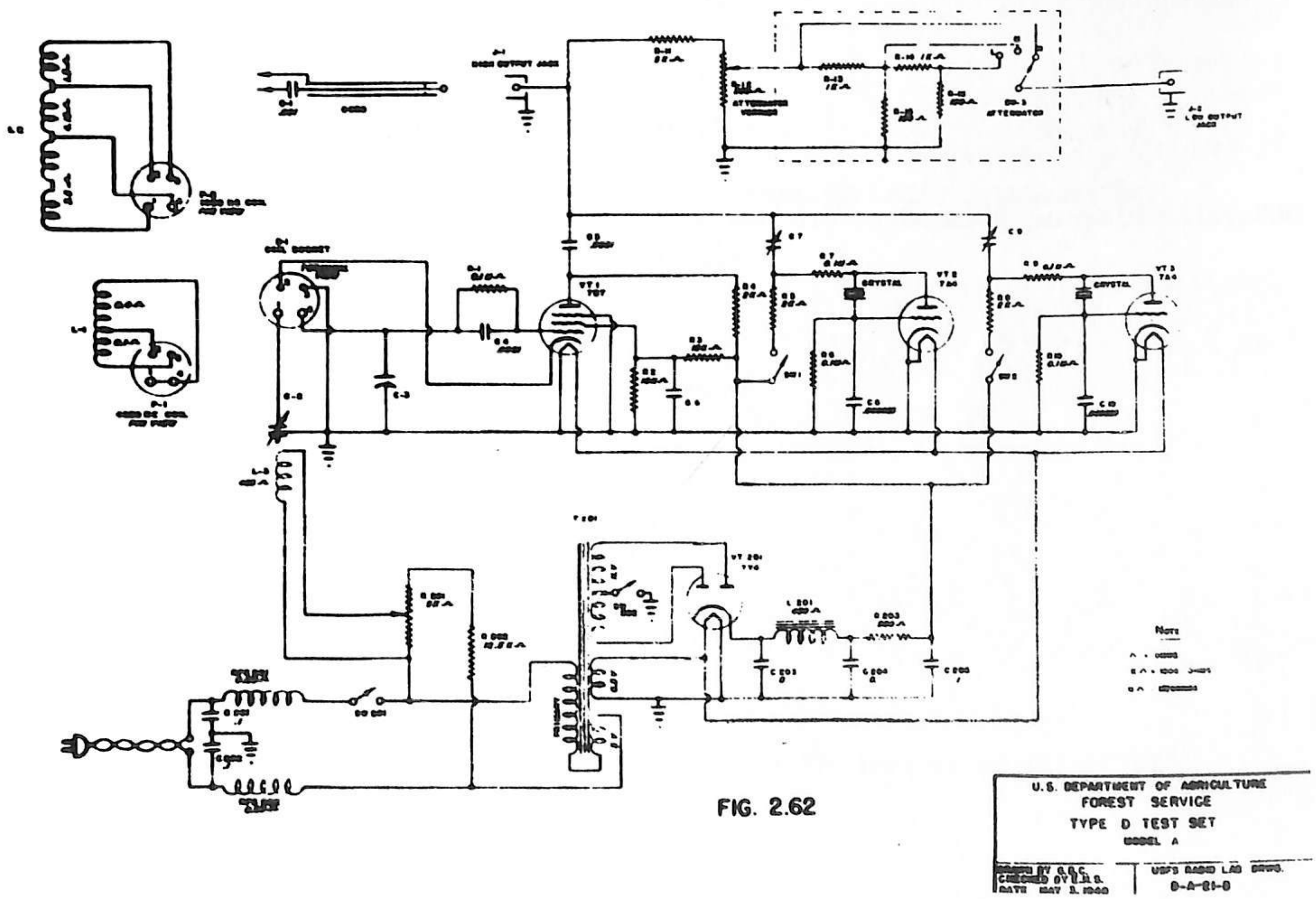
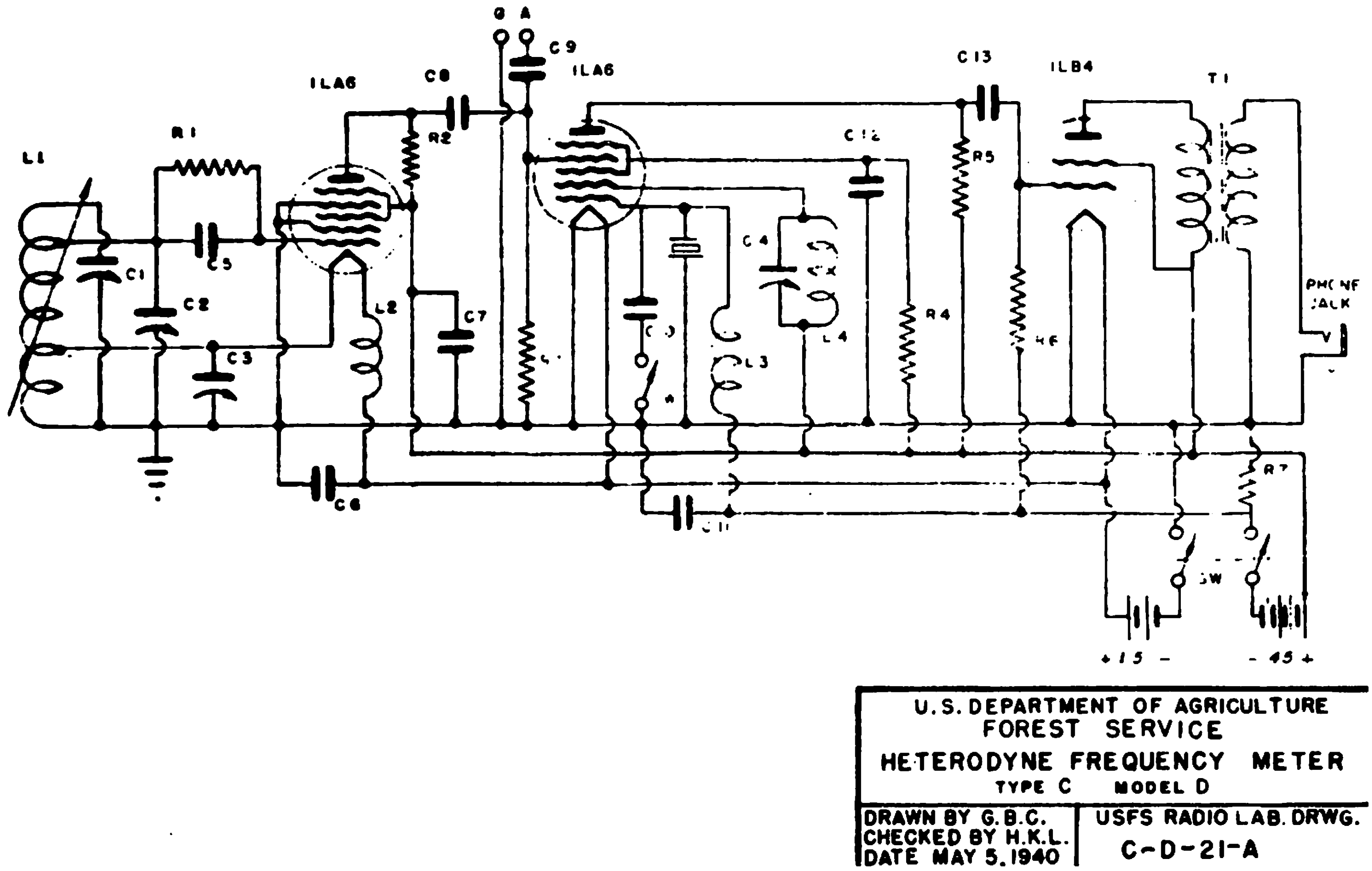


FIG. 2.62



Schematic Diagram, Heterodyne Frequency Meter, Type C-Model D

Appendix II

Abbreviations Used in Text and Reference Notes

a.c.	-	alternating current
af	-	audiofrequency
a.f.c.	-	automatic frequency control
AM	-	amplitude modulation (the early form of radio broadcasting)
ARRL	-	American Radio Relay League
A. T. & T.	-	American Telephone and Telegraph Co.
AWS	-	Aircraft Warning System (Service)
BIFC	-	Boise Interagency Fire Center
BRC	-	Blister Rust Control
CCC	-	Civilian Conservation Corps
c.w.	-	continuous wave (used for transmitting signals in Morse code)
dB	-	decibel (measure of sound level)
Dx	-	long distance
EIA	-	Electrical Industries Association
FM	-	frequency modulation (the later form of radio broadcasting)
FCC	-	Federal Communications Commission
FPL	-	Forest Products Laboratory
FTS	-	Federal Telecommunications System
GAK	-	Gaylord A. Knight Collection
GE	-	General Electric Co.
GPO	-	Government Printing Office
GSA	-	Government Services Administration
hf	-	high frequency
Hz	-	hertz (unit of electromagnetic wave frequency; one cycle per second)
if	-	intermediate frequency

IRAC	-	Interdepartment Radio Advisory Committee
IRC	-	International Radio Conference
IRE	-	Institute of Radio Engineers
kc	-	kilocycle(s)
kHz	-	kilohertz
KBAA	-	control radio station of Forest Service Radio Laboratory, Portland, Ore.
KBCX	-	control radio station of Northern Region at Missoula, Mont.
mA	-	milliampere(s)
Mc	-	megacycle(s)
MHz	-	megahertz
MIT	-	Massachusetts Institute of Technology
MST&T	-	Mountain States Telephone and Telegraph Co.
NA	-	National Archives, Washington, D.C.
NA:95G-	-	National Archives, Record Group 95, Photograph
NBC	-	National Broadcasting Company
NBS	-	National Bureau of Standards
NETSA	-	Northeastern Timber Salvage Administration
NRL	-	Naval Research Laboratory
P	-	a Forest Service portable radio
PF	-	a Forest Service portable radiophone (voice)
PSW	-	Pacific Southwest Forest and Range Experiment Station
PTT	-	push-to-talk
QRM	-	radio audio interference
RCA	-	Radio Corporation of America
RF	-	radio frequency

REA	-	Rural Electrification Administration
RRS	-	Radio Relay Station (an automatic remote repeater transmitter on fixed frequency)
RSMC	-	Radio Specialty Manufacturing Co.
SNUTS	-	Something New Under the Sun
SP	-	a Forest Service semiportable radio transmitter-receiver
SRC	-	Spokane Radio Co.
3M	-	Minnesota Mining and Manufacturing Co.
uhf	-	ultra high frequency
UR	-	Unsatisfactory Report (Equipment)
VFO	-	variable frequency oscillator
vhf	-	very high frequency
w	-	watt(s)
W7XAQ	-	radio transmitter of Forest Service Radio Laboratory, Vancouver, Wash.
Xtal	-	crystal

Appendix III

Source Materials

The Gaylord A. Knight Collection (GAK) consists of approximately 6 cubic feet of primary source materials relating to Forest Service communications history. Knight began to compile it before his retirement from the Forest Service. The materials represented some 75 unique documents at the start of the project to produce this history. Over the life of the project, I made additions from the files of the Forest Service Electronics Center and materials I gathered on numerous research trips. They included originals, carbons, and reproductions of correspondence between various individuals involved in the communications program. These documents, filed chronologically in the collection and fully referenced in the notes following each chapter, make up the vast majority of source materials used in this book. In addition, some 40 hours of taped interviews that I made with two dozen people are included in the collection. I have cited these conversations throughout the text and relied on them to fill many gaps not documented by other resource materials.

Because of the nature of the subject matter, a sizeable representation of photographs and schematic drawings was also included in the history. Those marked "NA:95G" are from the Forest Service negative collection (Record Group 95G) in the Still Pictures Division, National Archives, Washington, D.C. Other numbered photos are in the Forest Service photo library. A third group, referenced "History Section" was originally contributed to the Electronics Center by W. Foy Squibb, Harold K. Lawson, and Logan M. Belleville, and these pictures are also to be included in the Knight Collection. The collection also includes miscellaneous published and unpublished documents used in the history: communication conference reports, copies of Regional newsletters, Radio Laboratory newsletters, radio equipment bulletins, and National Forest communication plans. Several sets of field diaries from Laboratory personnel were also used, but it was not known at the time of publication whether these would be retained in the collection or returned to their respective owners.

Few secondary source materials were available for this history. Among the most relevant--principally materials in *American Forestry, Forestry Kaiman, American Forests and Forest Life,* and *Journal of Forestry,* the texts had often been supplied originally by the staff of the Radio Laboratory and, therefore, were available in other Laboratory documents. These, too, are cited in the notes following each chapter.

Another category of source materials, perhaps unique to the subject involved, was the actual radio and telephone hardware. Gaylord Knight also initiated this collection, which was completed by William B. Morton. It includes one each of all but two of the various Forest Service radio types and models, as well as an incomplete composite of telephones and switchboards. On several occasions, I returned to the storage facility on the grounds of the Department of Agriculture's Agricultural Research Center at Beltsville, Md., to turn the dials, tweek the knobs, flip the switches, and obtain a feel for these instruments. I was thus able to identify subtle differences in construction, evolutionary design stages, size, shape, and component layout, gaining a more thorough understanding of the Radio Laboratory engineering effort.

An overview of the Forest Service is available from numerous publications. I placed considerable reliance upon Dr. Harold K. Steen's *The U.S. Forest Service: A History* (Seattle: University of Washington Press, 1976) and Herbert Kaufman's *The Forest Ranger: A Study in Administrative Behavior* (Baltimore: Johns Hopkins University Press, 1960) for the administrative context in which the radio and telephone history took place. Also worthy of note was the four-volume set of personal reminiscences published by Region 1, *Early Days in the Forest Service* (Missoula, Mont.: Forest Service, Region 1, 1944, 1956, 1962, 1976).

The expanded archival (Knight) collection used to document this history was stored in the Forest Service's Southern Regional Office in Atlanta, Ga., at the time of publication. Some historical radio file material and many photos were stored in the Electronics Center at Beltsville, Md. Access to the documentation may be secured by contacting the Forest Service History Section, Washington, D.C. Some radio sets are stored in the Forest Service's Southern Regional Office in Atlanta, Ga. The main collection is at the Electronics Center. There were no plans at the time of publication to make the radio and telephone equipment available for public display or inspection.

Appendix IV

Early Communications on the Clearwater National Forest, Idaho

(The following summary is excerpted from The Clearwater Story, *an anecdotal history of the Clearwater National Forest, Northern Region, by Ralph C. Space, former Forest Supervisor, published by the Region and revised in 1981. This portion is on pages 58 and 60 of the revision and has been edited for reproduction.)*

One of the greatest handicaps to the early day Forest Ranger was lack of an adequate communication system. Up to 1910, there was no means of transmitting messages faster than by saddle horse. The need for better communications was so emphasized during the severe 1910 fire season that the Forest Service embarked on a telephone line construction program. It also equipped lookouts with heliographs.

The heliograph was an instrument for conveying messages by code using mirrors and a shutter to flash rays of light from the sun. It was not very effective for Forest Service work because of its limitations. It could not be used at night; cloudy weather made it inoperable; many men were not patient enough to learn the code; it took a lot of time to send a message; the instrument had to be reoriented almost continuously due to the earth's rotation; and it could not penetrate smoke or haze. It was better than nothing, however, because some messages did get through.

The Forest Service recognized these handicaps and set out to establish a telephone system that would link every lookout to a Ranger station and every Ranger station to the Supervisor's office. The first few of these lines were made of No. 12 galvanized wire hung on solid insulators spiked to trees. Maintenance on these lines was slow and expensive. Trees often fell across and broke lines, tearing off the insulator as well.

In 1911, Ranger William Daughs invented the split tree insulator. He whittled the first model out of a piece of Douglas-fir bark. Its two parts were wired together so that the telephone line rode in an oval hole in the center. The ends of the wire binding the insulator together were bent into hooks and hung on a staple driven into the tree at the proper height.

The insulator let the telephone line ride free so that when a tree fell across it, the line seldom broke. Slack wire would be pulled from both directions to let the line fall to the ground with the tree. If more than one tree fell across the line, the insulator unhooked from the staple and came to the ground. The maintenance men would cut the windfall off the line and replace the insulator on the staple. The split tree insulator was soon adopted, and No. 9 galvanized wire, which was much stronger than No. 12, became the standard. These innovations made telephone line maintenance easier and cheaper, but it still required a lot of tree climbing.

By 1915, there was a telephone line to each Ranger station except the Fish Lake District on the Lochsa. A few lookouts also had lines. Chamberlain Meadows, Elk Summit, and the North Fork-Fish Lake Districts were connected by lines to Montana. By 1917, almost all working lookouts and Ranger stations on the National Forest had telephones.

After World War I, the Forest Service was able to get "outpost wire" from Army Surplus. It was an insulated wire that was hung on trees or other natural supports without insulators. It was a big help in providing communication to trail and fire camps. The "outpost wire" came in quarter or half-mile rolls placed in a frame attached to a man's back like a pack board so that the wire reeled out as the man walked. Another man followed and placed the wire over tree branches and bushes with a forked stick to get it off the ground and above wandering big game. However, where there were no tree branches or other vegetation to hang it on, game frequently got tangled in it.

In 1933, the first practical radios made an appearance. They were used to communicate from fire camps to Ranger stations and from Ranger stations to the Supervisor's office. These sets were very temperamental and special training was needed to keep them in operation. "Ham" operators were hired to operate the sets on fires.

The conversion of the communication system from telephone lines to radios was very gradual, spanning a 40-year period from 1934 to 1975. Starting in 1934, a number of Forests and Ranger Districts in the Northern Region (R-1) were combined; this cut down the need for telephone lines. When smokejumping became practical, some firemen and lookout stations used primarily in fire suppression became outdated. The major change came when air detection replaced lookout detection, starting as an experiment in 1944 on the Bob Marshall Wilderness Area and soon spreading to all Forests. The transition was so slow that telephone lines gradually fell into disuse without being removed from the ground. The wires were a hazard to game and, although a special effort was made to get them out of the woods, sections of the old telephone lines can still be found.

After World War II, the Forest Service moved rapidly to the use of improved radios. The Clearwater now has none of its own telephone lines; the last one was taken down in 1975. Today the Clearwater Forest uses an extensive radio system and the modern commercial telephone system for communication.

☆U.S. GOVERNMENT PRINTING OFFICE 1982 370-921/8169