## 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 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.

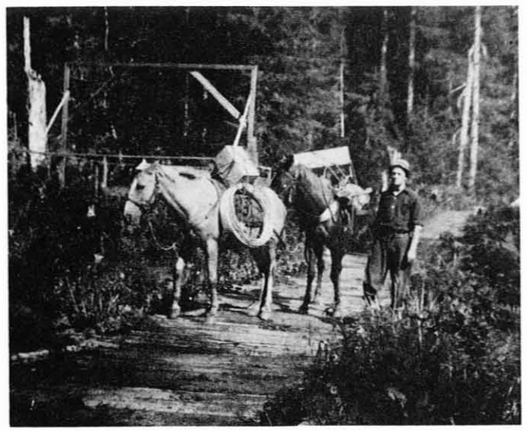

*Figure 3. Ranger carrying telephone equipment and wire by pack horse along trail, Snoqualmie National Forest, Wash., 1911. (NA: 95G-31509A)*

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]

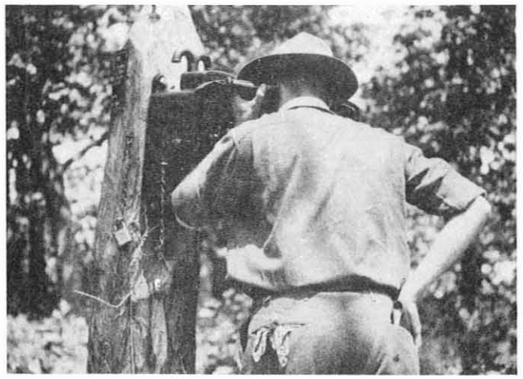

*Figure 6. Francis Kiefer, Supervisor, Ozark National Forest, Ark., receiving a telephone message during a fire on Kitcherside Mountain, 1911. The outdoor phone box is mounted on a pole at a lookout site. Also see phone closeup, figure 7. (NA:95G-52645)*

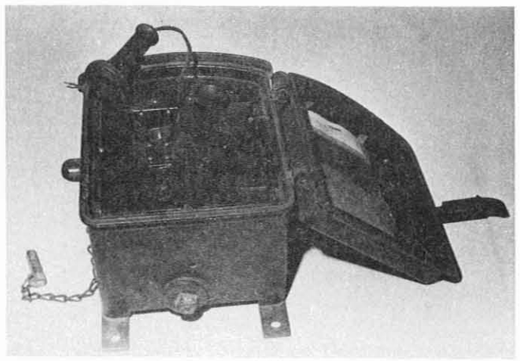

*Figure 7. Heavy, very rugged cast-iron telephone box used at exposed permanent field locations, such as lookout points, in the early days of the Forest Service. This Western Electric Co. model labeled Mine Type, was made for use in mines and was resistant to explosions and vandalism. (Forest Service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

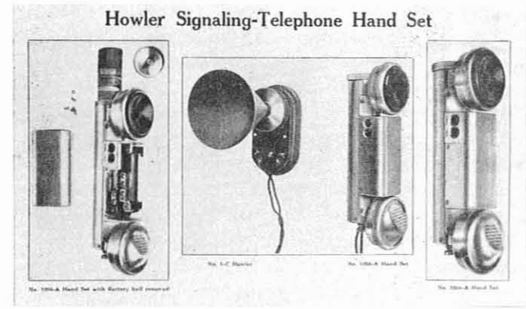


*Figure 8. Portable telephone handset and "howler" signaling device, both designed by R. B. Adams, first Northern Distric (now Region) telephone engineer. The handset, first perfected about 1914, was clipped onto telephone wires for use. The howler emitted a loud noise to get the attention of work crews 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 fire-line 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.

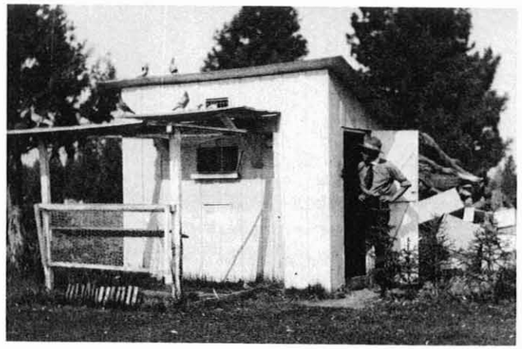

*Figure 10. Carrier pigeon cote used by the Forest Service on Deschutes National Forest, central Oregon, ca. 1920, for fire messages. Though successfully used on a small scale in the Northwest from 1919 through 1921, carrier pigeons were abandoned by the Forest Service in 1922. (NA:95G-48244A)*

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.

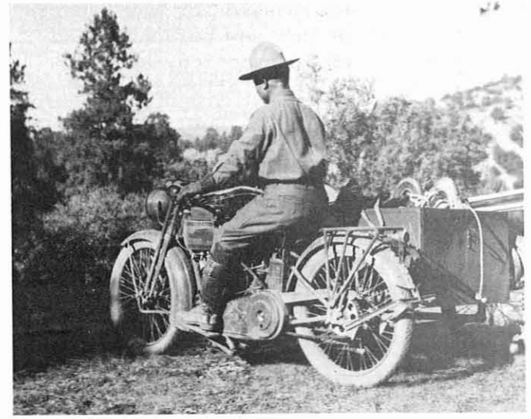

*Figure 14. Ranger on motorcycle, sidecar loaded with firefighting tools. One method of "getting there as soon as possible," ca. 1915. (NA:95G-32684A)*

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, 0- 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 every-