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]

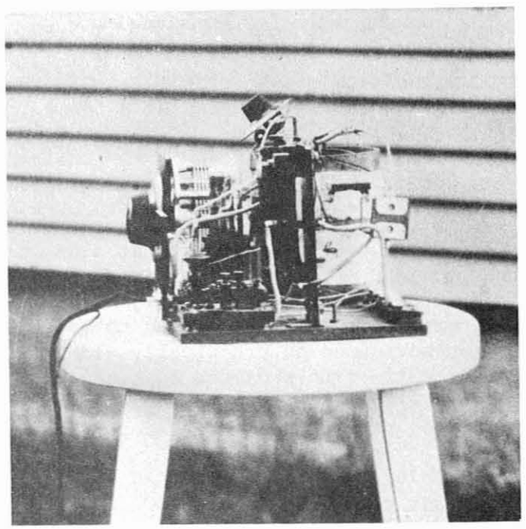

Figure 22. Dwight Beatty's "crude little contraption of coils and condensers...a fairly efficient radio receiver and code transmitter," which was demonstrated to Forest Service leaders at the 1927 Fire Conference in Missoula, Mont. As a result, the agency again encouraged the use of lightweight radios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

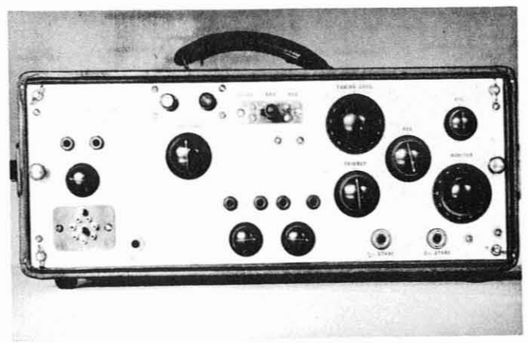

Figure 24. Front view of the SP-1930 set built by Dwight Beatty. The code transmitter-receiver proved a great success in mountainous terrain, even at distances of 40 miles, earning high praise from Government radio experts. Enclosed in a leatherette-covered nightcase for easy carrying, it weighed just 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 screwdriver 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 careful study, and every detail was an efficient arrangement from an engineering standpoint."[49] (Diamond was an ordnance expert who developed the military proximity fuse and later formed his own company.)

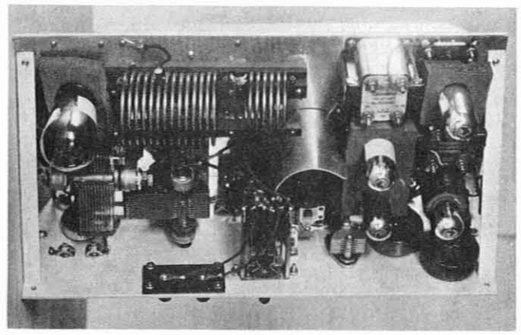

Figure 25. Top view of SP-1930 with cover removed. Note sponge rubber at base of tubes for protection from rough handling. Battery, antenna, and other equipment brought total weight to just under 80 pounds. See also figure 29. (Forest Service photo, History Section)

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 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).

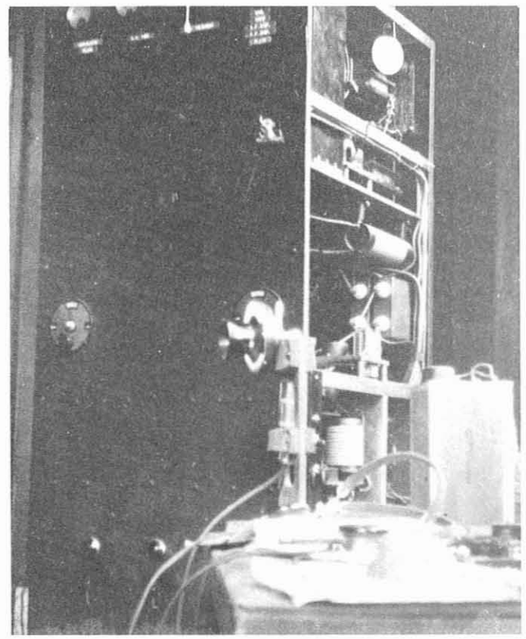

Figure 30. Radiophone transmitter of the Northern Electric Company, used by the Forest Service at Hemlock Ranger Station, Wind River, Wash., in a field test in 1930. (Forest Service photo, History Section).

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 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.

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).

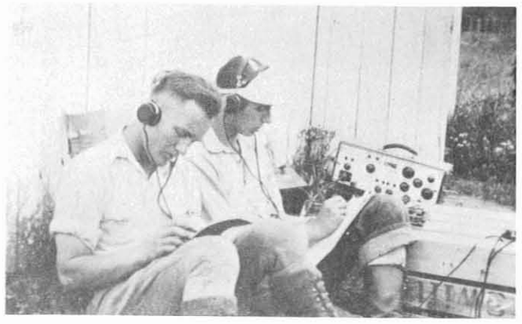

Figure 32. Code practice session for fire crew operating the SP-1930 set (in background) on the Columbia (now Gifford Pinchot) National Forest, Wash., 1930. (Forest Service photo, History Section).

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 insistance 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 1928, 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.