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HISTORY OF THE SQUAD RADIO

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report details the history of the squad radio from its inception as an idea to its culmination as an end item.

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HISTORY OF THE SQUAD RADIO

1. REQUIREMENTS FOR RADIO SET AN/PRC-6 STATED

Requirements for Radio Set AN/PRC-6 were formally stated in March 1945 Intended primarily as a replacement for Radio Set SCR-536, the PRC-6 was to be used as a means of communication between foot troops of the most forward elements (company-platoon) and between infantry and close-support armored elements. This new set had to be compatible with Radio Sets SCR-300 and GRC-3 through 8 (B) and had to have a range of 300 yards in jungle and 1 mile in rolling terrain. As to weight, it could weigh a maximum of nine pounds, but six pounds was considered desirable. Its size and shape had to be such that it could easily be concealed. The radio set and its battery could be separate to facilitate concealment on the body. Its mode of operation was to be FM-voice modulation, with 1 preset and 44 possible channels. The battery had to have a minimum life of 4 hours, with a 2:1 receive-transmit ratio. And, lastly, shape of microphone and headset had to be such as to permit free use of the hands.

2. DEVELOPMENT OF THE "HANDI-TALKIE"

At the outset, as a result of opinions from Army personnel as to the most desirable form the AN/PRC-6 should take, several configurations were made. The initial development model was made by Motorola and was curved to fit the body to facilitate concealment (Figure S1A). In comparison with other FM equipment, this receiver-transmitter using miniature tubes was very light, but required an 11-pound battery for operation.

While the contractual development of the PRC-6 was taking place, the laboratories were carrying on a parallel development of this equipment, utilizing newly developed subminiature tubes. These new tubes enabled the

laboratories to design and employ a new FM circuit which eliminated the requirement for a chain of multiplier stages. The resultant circuit substantially reduced the radio's power input requirements, permitting a realistic design for the AN/PRC-6. To continue development of the set along these lines, a contract was let to Raytheon with the ultimate aim of producing a squad radio which could be manufactured. Raytheon succeeded in its final laboratory model in reuniting the receiver-transmitter and battery in one case, resulting in the production of the final model of the AN/PRC-6, known as the "Handi-Talkie" (Figure 1), whose technical characteristics are shown in Figure 2.

3. REQUIREMENTS FOR A PLATOON-TO-SQUAD RADIO: the AN/PRC-15

After the development of the AN/PRC-6, designed as a means of communication between foot troops in the most forward elements and between infantry and close-support armored elements, came the requirement for a radio set capable of providing communications from platoon to squad. Designated the AN/PRC-15, it was designed as a portable short-range transceiver specifically for communication between infantry squad leaders and platoon leaders. Its technical characteristics were to be those given in Figure 3.

4. DEVELOPMENT OF THE AN/PRC-15

To achieve these, the laboratories in their design of the AN/PRC-15 embarked on an intensive development of applicable circuitry and assembly techniques. In so doing, the designers were confronted with two alternatives. Should they begin with a radio set such as the AN/PRC-6 which had the required performance characteristics and progressively reduce its dimensions as new components and techniques became available, or begin

Figure 1. Production model of Radio Set AN/PRC-6 ("Handi-Talkie").

A. General:

1. Frequency Range: 47 - 55.4 Mc
2. Available Channels: 43 @ 200 kc spacing
3. Number of Preset Frequencies: 1
4. Range: 1 mile
5. Dimensions: 14" x 5 1/2" x 4 1/4"
6. Weight: 6.75 pounds

B. Receiver:

1. Sensitivity: 0.7 microvolts
2. Power Drain: 490 Ma @ 1.25 volts (.613 watts))
) 1.288 watts
   15 Ma @ 45 volts (.675 watts))

C. Transmitter:

1. Power Output: 250 milliwatts
2. Type of Modulation: Voice, FM, 15 kc deviation
3. Power Drain: 1.05 amperes @ 1.25 volts (1.30 watts)
   45 Ma @ 45 volts (2.03 watts)
   30 Ma @ 90 volts (2.70 watts)

   Total: 6.0 watts

Figure 2. Technical characteristics of Radio Set AN/PRC-6 .

Date: July 1947

Purpose: To provide a portable, short-range transceiver designed specifically for communication between Infantry Squad Leaders and Platoon Leaders.

1. Frequency: Capable of netting with AN/PRC-6
2. Number of Channels: 6 minimum
3. Number of Presets: 2
4. Range: 500 yards
5. Size: 8 cubic inches maximum desirable
6. Weight: 1 pound maximum desired
7. Form Factor: 1 package arm mounted
8. Battery Life: 10 hours.

NOTE: The Laboratories stated that the desired size and weight were considerably beyond the state of the art. On 3 December 1947, Hq AGF BD No.1, Fort Bragg approved a 2.5 pound weight and a 40 cu in volume for experimental models.

Figure 3. Technical characteristics of Radio Set AN/PRC-15.

with a set that had the required dimensions but not the required performance and progressively improve the performance?

5. DEVELOPMENT OF THE SUB-MINIATURE CIGARETTE CASE RADIO

In investigating these alternatives, the most outstanding result, and one which achieved nationwide attention, was the development of a 12-ounce radio, whose size was no bigger than a "king-size" package of cigarettes (Figure 4). When one considers the stage of development of electronics at the time, the size and weight that were achieved with this transceiver are indeed incredible. However, its military potential was not too bright. Operational tests of the set in the 50 mc region indicated that its reliable range was 200 yards over average rolling terrain. These tests also indicated that the state of electronics, as exemplified by this set, had not advanced to the point where this equipment could be offered as a military radio set. In addition, during tests such problems as frequency stability and receiver radiation were encountered which indicated that the radio would not be able to fulfill its systems requirements. Add to this that the technique used for the equipment's construction made it impossible for the AN/PRC-15 to meet its implied requirements because it could not be produced rapidly and economically. What the development of this radio only served to bring out was that its design had limitations and that the number of problems involved in getting the set to meet its governing military requirements would be many. Yet, the great quantities in which this set would have to be turned out made it imperative that its design be such that it could be manufactured easily and economically.

6. SERVICE TEST MODELS OF THE AN/PRC-15 ARE PROCURED

The outcome of this investigation and testing was a technical development specification and a decision to procure service test models of the

Figure 4. Sub-miniature cigarette case radio.

PRC-15. For this, a contract was let to Mitchel Industries, Mineral Wells, Texas for the development and fabrication of these models. It was acknowledged at the outset that this contract would not result in equipment that would be of the required size and weight specified by the military characteristics. However, it was felt that interim models and advancement in the design of subminiature radio sets would result.

7. OTHER FORMS CONSIDERED FOR THE AN/PRC-15

Inasmuch, then, that the desired weight and size could not be achieved, other forms for the PRC-15 were considered other than those which could be strapped on the arm. The first of these was a bib model, which could be carried on the chest directly under the chin, and whose microphone was attached to an arm which, when pushed by the chin, actuated a transmitter.

The AFF Board No. 1 before whom this model was demonstrated in January 1951 expressed dissatisfaction with its size, weight, and shape. Instead, it suggested that the radio be shaped like a pistol holder, in which form it could be carried under the arm. For this the laboratories projected an ultimate size of 50 cubic inches and weight of 3 to 3½ pounds. The question of a firm requirement for the equipment described by the MC's arose, and the Board indicated the characteristics would be reviewed. Even with its obvious deficiencies, the test model had some advantages over the AN/PRC-6 in that it could be used with artillery and infantry heavy weapons units. It was agreed that the remainder of the test units should be fabricated with some modifications and delivered to the board for test (Figure 5). Final models of the AN/PRC-15 were delivered early in 1954 and had the technical characteristics listed in Figure 6. Service test of this final model showed that it met one of the military characteristics in that it did have a transmission range in excess of 500 yards. However, it failed to meet the

Figure 5. Radio Set AN/PRC-15 (Service-test model).

A. General:

1. Frequency Range: 47.0 - 55.4 Mc
2. Available Channels: 43 @ 200 kc spacing
3. Number of Preset Frequencies: 2
4. Range: 500 - 1000 yards
5. Dimensions: 2 3/8" x 2 1/2" x 10 1/2"
6. Weight: 3 pounds 6 ounces

B. Receiver:

1. Sensitivity: 1.5 microvolts
2. Power Drain: 12 Ma @ 45 volts (0.54 watts))) 1.17 watts
   500 Ma @ 1.25 volts (0.63 watts))

C. Transmitter:

1. Power Output: 100 milliwatts
2. Type of Modulation: Voice, FM
3. Power Drain: 24 Ma @ 45 volts (1.08 watts))) 1.78 watts
   560 Ma @ 1.25 volts (0.70 watts))

Figure 6. Technical characteristics of Radio Set AN/PRC-15.

requirements of size, weight, form, battery life, and volume control. The draft of the service reports in which these failures were enumerated also went on to state that the set could not be worn and concealed on the arm, but had to be held in the hand and was actually a miniature version of Radio Set AN/PRC-6, but without the facilities for external audio accessories. The report concluded that the set would have to be completely redesigned to meet the required military characteristics. Neither the Infantry School nor the Armor School recommended the adoption of Radio Set AN/PRC-15 as a standard type.

8. DEVELOPMENT OF TRANSISTORS AND RADIO SET AN/PRC-30

These conclusions came as no surprise for the Laboratories had stated that the requirements for the AN/PRC-15 could not be achieved, considering the current state of electronics. However, the development of transistors of military quality and performance in 1953 gave new impetus to satisfying the requirements for a small, lightweight transceiver. In 1954, a contract was let to Galvin Industries (Motorola) for the development of Radio Set AN/PRC-30 (Figure 7). In 1958, the final model was delivered, whose technical characteristics were those listed in Figure 8. But the PRC-30 was not submitted for service test because CONARC, as a result of re-evaluating the tactical portable equipment program, withdrew the military characteristics for this equipment.

9. CHANGES IN REQUIREMENTS FOR ARMY FIELD COMMUNICATIONS

In fact, between 1953 and 1958 two important changes took place in the requirements for army field communications. The first was that the requirement of 500 yards for the AN/PRC-15 and AN/PRC-30 was increased to one mile. And the second was the first statement of a recognized potential need for radio communications from squad leader to all or key members of his squad.

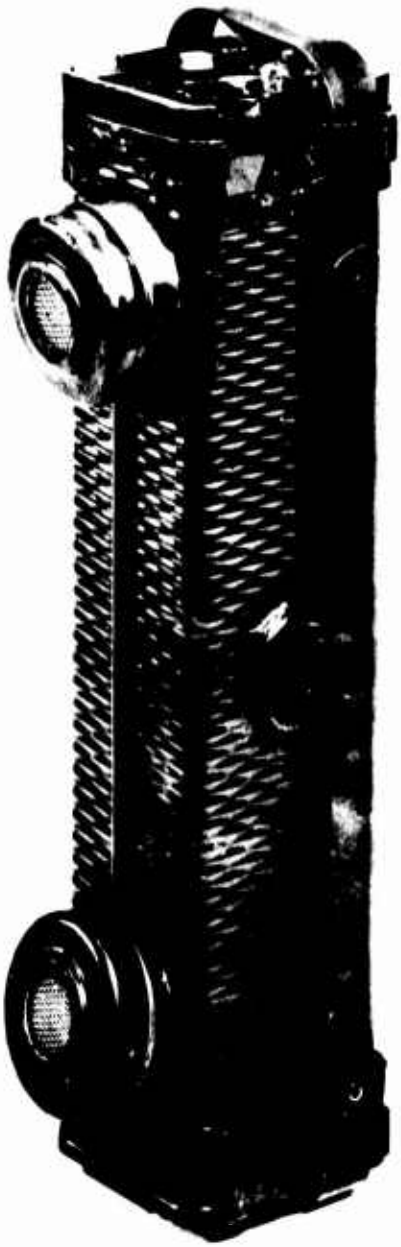

Figure 7. Radio Set AN/PRC-30.

A. General:

1. Frequency Range: 25 - 50 Mc
2. Available Channels: 500 @ 50 kc spacing
3. Number of Preset Frequencies: 2
4. Range: 500 - 1000 yards
5. Dimensions: 2" x 2" x 8 ½"
6. Weight: 2 pounds 12 ounces with antenna and battery

B. Receiver:

1. Sensitivity: 2 microvolts
2. Power Drain: 15 Ma @ 4.5 volts (.068 watts))) .076 watts
   5 Ma @ 1.5 volts (.008 watts))

C. Transmitter:

1. Power Output: 100 milliwatts
2. Type of Modulation: Voice, FM, 7 to 20 kc deviation
3. Power Drain: 250 Ma @ 4.5 volts (1.13 watts))) 1.81 watts
   450 Ma @ 1.5 volts (.68 watts))

Figure 8. Technical characteristics of Radio Set AN/PRC-30.

10. FOREIGN RADIO EQUIPMENT.

One must always keep in mind that during this same period, 1952-1958, the Canadians, Danes, and French, motivated not only by national pride but also dissatisfied with the AN/PRC-6's shape and number of available channels, began to develop their own equipment. At the same time, considerable disagreement existed within the US Army concerning the optimum number of channels that a squad leader should have. The need for maximum flexibility to permit movement from unusable channels indicated a need for 2, 4, or 6 channels. But the possibility of chaos resulting from an operator operating on unauthorized frequencies or a squad leader monitoring one channel while being called on another gave strong support to the argument for the Army's remaining with the single-channel AN/PRC-6. And, so, against this background and during this period, the Canadians produced a squad radio with the nomenclature of CPRC-26 (Figure 9). Its characteristics are listed in Figure 10. It was tested and evaluated in the field but was rejected as offering no significant advantage over the PRC-6. The Danes produced the DA/PRC-260 (Figure 11), a transistorized version of the Canadian equipment, putting it in the same box and using a smaller battery. Its technical characteristics are shown in Figure 12. But they only succeeded in reducing the weight of the equipment one pound. The French produced a smaller version of the AN/PRC-6 with six channels and gave it the nomenclature of TR-PP-11A (Figure 13). It received a US field evaluation but was not recommended for adoption. Its technical characteristics are described in Figure 14.

11. REQUIREMENTS ESTABLISHED FOR RADIO SET AN/PRC-35

In the requirements for the family of Radio Sets AN/VRC-12 and AN/PRC-25 was included one that they replace the AN/PRC-6. This equipment was given the nomenclature of Radio Set AN/PRC-26 but was later changed to AN/PRC-35 to avoid confusion with the Canadian CPRC-26. The Laboratories attempt to incorporate all the required features of a squad radio into the PRC-35 (Figure 15).

Figure 9. Canadian Squad Radio CPRC-26.

A. General:

1. Frequency Range: 47-55.4 Mc
2. Available Channels: 43 @ 200 kc spacing
3. Number of preset frequencies: 6
4. Range: 1 mile
5. Dimensions: 10 5/8" x 5" x 3 1/8"
6. Weight: 6.5 pounds

B. Receiver:

1. Sensitivity: 2 microvolts
2. Power Drain: 550 Ma @ 1.5 volts (.825 watts)
   14 Ma @ 45 volts (.63 watts)
   3 Ma @ 90 volts (.27 watts)

C. Transmitter:

1. Power Output: 150 - 350 Milliwatts
2. Type of Modulation: Voice, FM, 15 kc deviation
3. Power Drain: 900 Ma @ 1.5 volts (1.35 watts)
   8 Ma @ 45 volts (0.36 watts)
   32 Ma @ 90 volts (2.88 watts)
   0 @ -3 volts (0 watts)

Figure 10. Technical characteristics of Canadian Squad Radio CPRC-26.

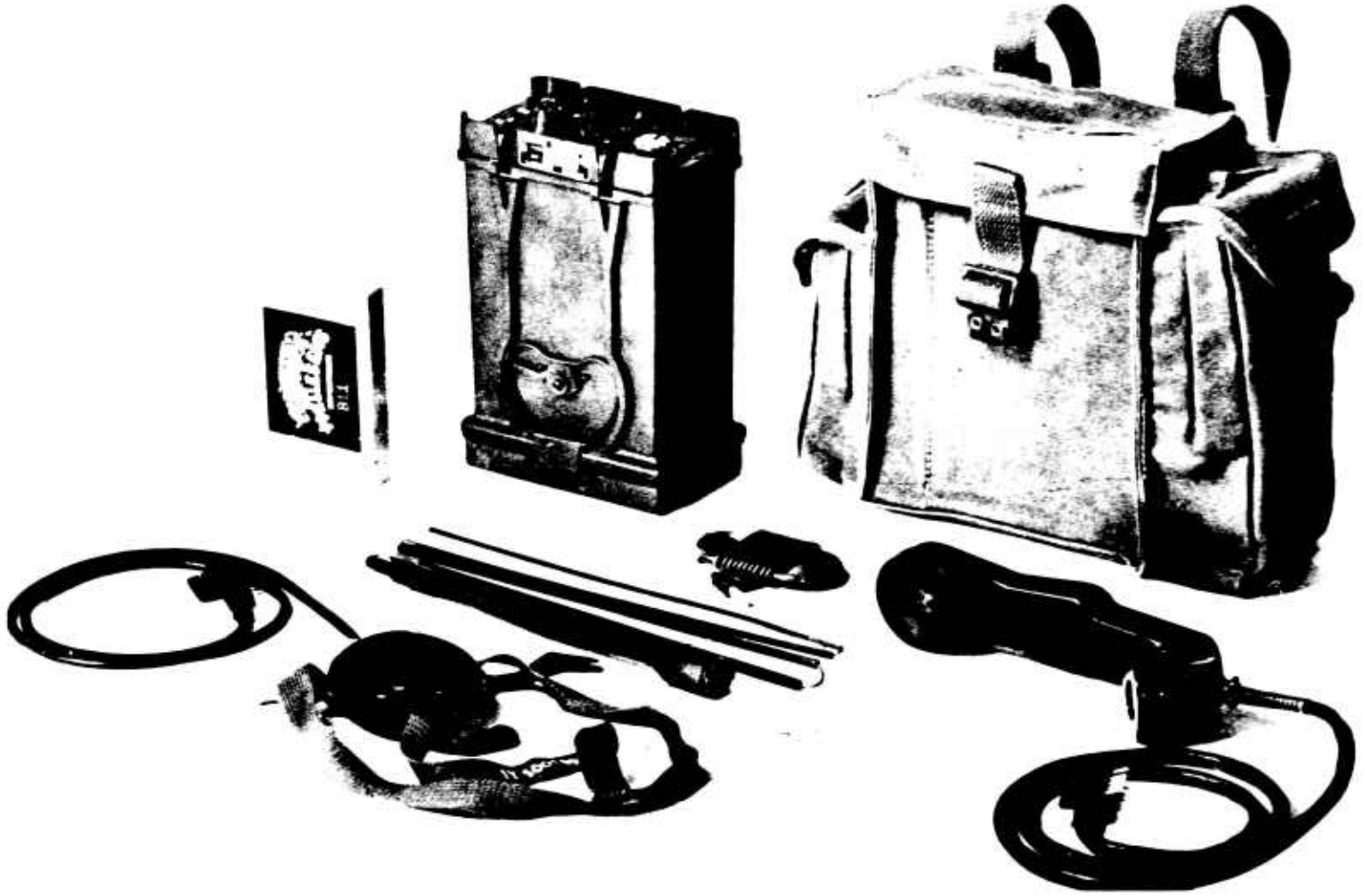

Figure 11. Danish Radio Set DA/PRC-260.

A. General:

1. Frequency Range: 47 - 55.4 Mc
2. Available Channels: 170 @ 50 kc spacing
3. Number of Preset Frequencies: 6
4. Range: 1 mile
5. Dimensions: 8 1/2" x 5 1/4" x 3 1/2"
6. Weight: 5.5 pounds

B. Receiver:

1. Sensitivity: 0.8 microvolts
2. Power Drain: 25 Ma @ 12.5 volts (.313 watts)

C. Transmitter:

1. Power Output: 300 milliwatts
2. Type of Modulation: Voice, FM, 15 kc deviation.
3. Power Drain: 125 Ma @ 12.5 volts (1.56 watts)

Figure 12. Technical characteristics of Danish Radio Set DA/PRC-260.

Figure 13. French Radio Set TR-PP-11A.

A. General:

1. Frequency Range: 47 - 55.4 Mc
2. Available Channels: 85 @ 100 kc spacing
3. Number of Preset Frequencies: 6
4. Range: 1 mile
5. Dimensions: 12 1/2" X 5 3/16" X 3"
6. Weight: 4 pounds 9 ounces

B. Receiver:

1. Sensitivity: 0.4 microvolts
2. Power Drain: 11 Ma @ 1.5 volts (.017 watts)
   12 Ma @ 15 volts (.180 watts)

C. Transmitter:

1. Power Output: 250 milliwatts
2. Type of Modulation: Voice, FM, 10 kc deviation
3. Power Drain: 130 Ma @ 1.5 volts (.20 watts)
   150 Ma @ 15 volts (1.65 watts)

Figure 14. Technical characteristics of Radio Set TR-PP-11A.

resulted in a piece of equipment that was too large, too heavy, and too costly for its prime mission. A description of its technical characteristics is given in Figure 16. The estimated production cost of this equipment was $1,500 to $2,000 a unit. Today, its probable cost per unit, based on the current price of the PRC-77, would be about $500. The AN/PRC-35 marked the end of the search for a replacement for the AN/PRC-6, essentially a search for replacing the SCR-536 as a means of company-platoon communications.

12. DEVELOPMENT OF RADIO RECEIVER FOR INDIVIDUAL RIFLEMAN

Another search, however, one for directing individual riflemen by equipping each one with a radio receiver, had begun as early as World War II. This search and interest had been spurred by problems encountered during the Korean Conflict. In July 1952, the Baker Electronics and Communication Mission to Korea (BEACON Mission) in its final report recommended that a simple low-power receiver be provided to squad members. In addition, the final report of Project VISTA recommended that a better means of communications be provided to individuals during combat. During this time, the Armored Center had also expressed a need for a helmet-mounted transmitter-receiver with about a 100-yard range to be used by a tank platoon leader. Consequently, as a result of BEACON Mission and VISTA reports, the Office of the Chief of Army Field Forces prepared military characteristics for a "radio receiver for individual riflemen," specifying range, size, and weight. The range was to be the perimeter of the squad when the receiver was used with the AN/PRC-15. The set was to be 8 cubic inches, weigh one pound, and have a battery life commensurate with the size and weight of the battery.

It must be understood that the Signal Corps Engineering Laboratories had periodically investigated the feasibility of developing equipment which would satisfy both the infantry and armor requirements. Experimental radios

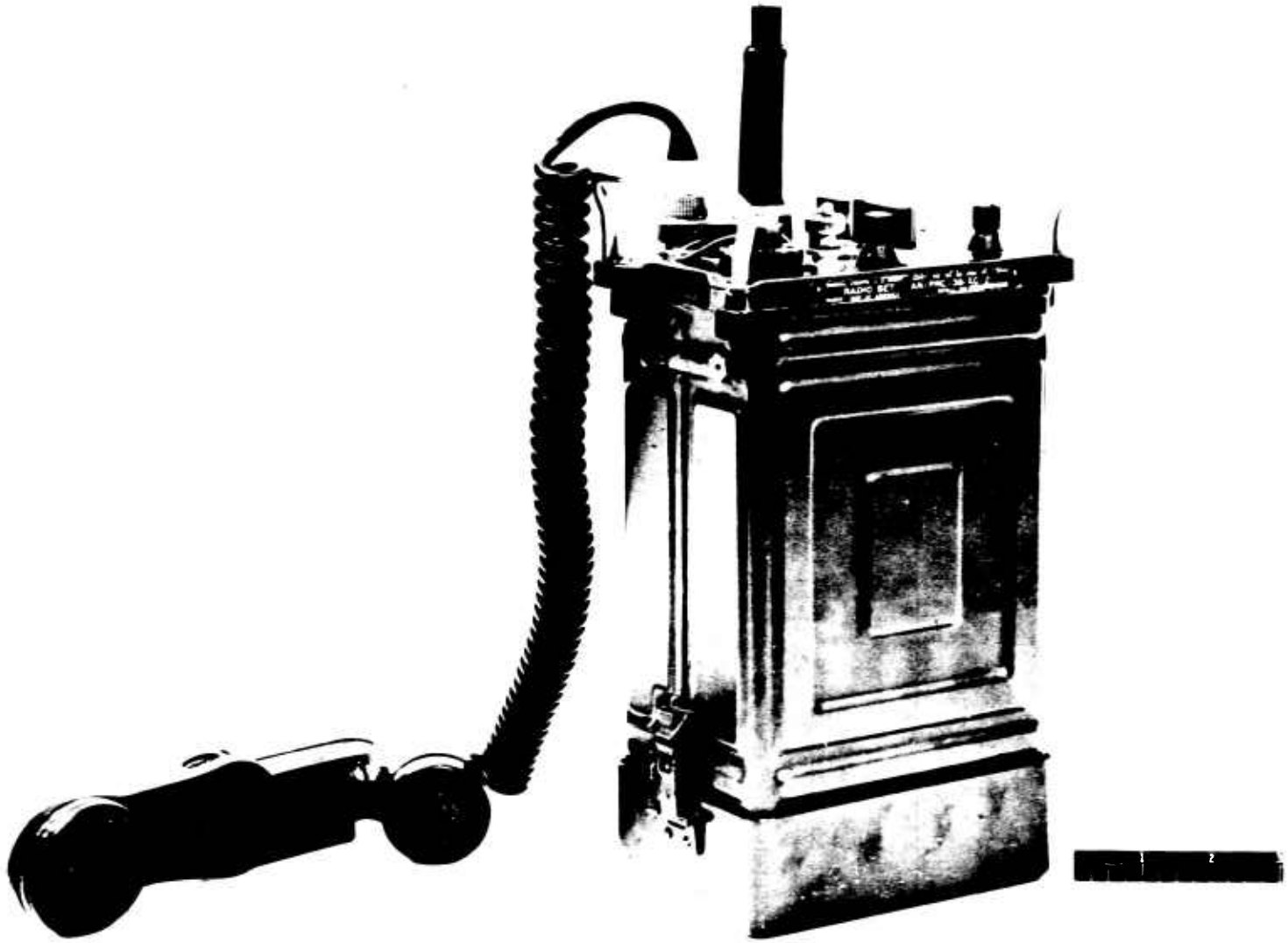

Figure 15. Radio Set AN/PRC-35.

A. General:

1. Frequency Range: 30 - 69.95 Mc
2. Available Channels: 800 @ 50 kc spacing (all supplied by internal synthesizer.)
3. Number of Preset Frequencies: 4
4. Range: 1 mile
5. Dimensions: 11" x 6 3/8" x 3 3/4"
6. Weight: 9.5 pounds

B. Receiver:

1. Sensitivity: 0.4 microvolts
2. Power Drain: 56 Ma @ 11.7 volts (.66 watts)
   7.3 Ma @ 26 volts (.19 watts)

C. Transmitter:

1. Power Output: 350 - 600 Milliwatts
2. Type of Modulation: Voice, FM, 10 kc deviation
3. Power Drain: 71 Ma @ 11.7 volts (.83 watts)
   120 Ma @ 26 volts (3.13 watts)

Figure 16. Technical characteristics of Radio Set AN/PRC-35.

incorporating miniature and sub-miniature tubes proved too large and their power consumption too great for them to be carried by individual soldiers without seriously compromising the soldiers' combat effectiveness.

13. SEARCH FOR A HELMET RADIO

In late 1953, the Laboratories initiated a full-scale investigation of the feasibility of installing radio equipment in helmets. Small commercial transistorized receivers and receiver-transmitters were installed in composition helmets, and communication over a range of 200 yards was established with Radio Sets AN/PRC-6 and -10. As a result of this, the laboratories received work directive CE-29-R to investigate further means of "improving portability of small radio sets by the combat soldier." The directive went on to state that a soldier's primary weapon was his rifle and that he should be able to keep it in the ready position while carrying out radio communication. The arrangement of radio and rifle as separate items, each requiring individual use of the hands, was inconsistent with what was desired. CE-29-R suggested that two methods of mounting the squad radio should be investigated: either attaching it to the stock of a rifle or fitting it inside a helmet liner. Finally, the work directive concluded by stating that the radio be designed for automatic assembly so that it could be treated as an expendable item.

To investigate one of the alternatives, that of combining radio and stock of the rifle, RCA developed a receiver which was built into the stock. But the radio proved awkward to use unless the rifle was in the firing position. The other alternative proposed by the work directive, that of mounting the radio set inside a helmet, was then investigated. One advantage of this, of course, was that the helmet could be used to protect the electronic circuitry and thus reduce the required weight of the transceiver-

transmitter. But it was also discovered that the shape of the helmet, designed to fit the form of the rifleman's head, allowed no room for mounting electronic circuitry. An attempt was then made to mount the set in the apex of the helmet, but this only raised the helmet's center of gravity, causing the helmet to topple from the head. Outside of the apex, there was not sufficient space within a standard helmet or liner to mount a receiver-transmitter.

The only solution, then, was to create a plastic helmet especially to accommodate the set (Figure 17). In this model, components of the set were mounted at the base and underside of the helmet: the receiver-transmitter at one side and the battery, earpiece, volume control, and on-off switch at the other. The set, with its antenna built into the helmet, had a range of 300 yards between like equipment and 500 yards between it and PRC-6's or -10's.

14. CONCEPT TEST OF HELMET RADIOS

In July 1955, the Signal Corps Engineering Laboratories proposed that large number of helmet radios be procured and given a concept test by a full division. The Chief Signal Officer repeated this proposal to higher headquarters, but was informed that the Continental Army Command (CONARC) had "no requirement" for this item. However, LG James M. Gavin became personally interested in the project and, in late 1955, decided to proceed with a large-scale test of helmet-radios at a division level.

The project had to be coordinated with the Quartermaster General because incorporating the squad radio in the helmet would involve altering the shape of the helmet. At this time, the Quartermaster Development Laboratories had been experimenting with plastic and fiberglass helmets, and it was thought possible that a suitable ballistic-resistant non-metallic helmet might be available for use with the radio set.

Figure 17. Radio Set AN/PRC-34 mounted in helmet (experimental).

Against this background, a contract was placed with RCA in June 1950 to design and fabricate 1600 Radio Sets AN/PRC-34 to be mounted in helmets and 1000 Radio Sets AN/PRC-36 to be worn on belts. Both sets were to use the basic circuitry and layout developed by the Signal Corps Engineering Laboratories and both were to be used to test, evaluate, and develop the concept of the squad radio. In 1959, all the equipment was delivered. Figures 18 and 19 show these experimental sets as worn by operators. The technical characteristics of both sets are given in Figure 20.

15. FIELD TESTS OF HELMET RADIOS

In 1959 and 1960, the 101st Airborne Division, CONARC, and the Combat Development Electronics Command (CDEC) carried out field tests of the sets, with the same equipment going to the other military services and the Canadian Army for comment. Essentially, the comments which came back were that:

1. The radio set improved the combat efficiency of the individual soldier.
2. The logistical problems associated with this equipment were realistic, with the exception of the initial cost.
3. Only a receiver was needed for the individual rifleman.
4. The cords associated with the AN/PRC-36 tangled in the underbrush, making this equipment unsuitable for field use.

The concept test of the equipment took the form of a troop test, carried out by the 101st Airborne Division at Fort Campbell, Kentucky. The testing showed that using the radio facilitated and expedited the transmission of orders and information, contributed significantly to small unit effectiveness, and enabled the individual soldier to display increased initiative. As a result, the 101st Airborne recommended that the concept

Figure 18. Radio Set AN/PRC-34 (development model). Overall view showing operator using microphone.

Figure 19. Radio Set AN/PRC-36 (development model). Overall view showing antenna mounted on helmet liner and operator using tone button.

A. General:

1. Frequency Range AN/PRC-34 38 - 38.8 Mc
   47.8-51.0 Mc
   AN/PRC-36 47.8-51.0 Mc
2. Available Channels: One of 12 factory preset. Frequency change by exchange of R. F. and transmitter modules.
3. Range: PRC-34 350 yards antenna restrained
   500 yards antenna extended
   PRC-36 600 yards
4. Dimensions: 4 9/16" x 2 7/8" x 3/4" (Receiver-Transmitter Unit)
5. Weight: PRC-34 3 1/2 pounds incl Helmet
   PRC-36 2 3/4 pounds incl Battery

B. Receiver

1. Sensitivity: 3 microvolts
2. Power Drain: 8 Ma @ 1.5 volts (.012 watts)) .072 watts
   13 Ma @ 4.5 volts (.060 watts))

C. Transmitter:

1. Power Output: 50 milliwatts
2. Type of Modulation: Voice, FM, 15 kc deviation
3. Power Drain: 8 Ma @ 1.5 volts (.012 watts)) .612 watts
   13 Ma @ 4.5 volts (.060 watts))
   12 Ma @ 45 volts (.540 watts))

Figure 20. Technical characteristics of Radio Sets AN/PRC-34 and AN/PRC-36.

of an individual soldier's radio be approved for use by the Army Tactical units. Although the models used for the concept test were not suitable in their existing form, it was felt that the noise-free control obtained while using the PRC-34's and PRC-36's at unit level justified the continued research toward the development of an acceptable model of squad radio.

16. USING MICROMODULES FOR RADIO EQUIPMENT

While the results of the concept test were being analyzed, the Signal Corps Engineering Laboratories were in the midst of a study to determine the technical feasibility of using micromodules for communications equipment. So, it seemed only logical to use the radio for individual rifleman as a vehicle for demonstrating the potential reduction in size and weight of radios that could be achieved with this new assembly technique. In addition, micromodules were being designed for automatic assembly and thus gave promise that they could be produced in great quantity at low cost.

17. FINAL DESIGN OF THE SQUAD RADIO

When it came to deciding the specific form to be used for the squad radio, several configurations were considered. In the end, it was decided to separate the receiver and transmitter and to adopt one simple design, which would make possible maximum output and save costs when automated production methods were used. Once this basic concept of separating receiver and transmitter had been agreed upon, the way was then open for various refinements in design. In the first place, the receiver could now be mounted on the outside of the steel helmet, and the success of the radio's design would not have to depend on a suitable ballistic-resistant plastic helmet being developed. Secondly, mounting the receiver on the outside of the helmet, with one earpiece projecting under the rim of the helmet, would enable an operator to monitor his receiver continuously without using his

hands and so remove a cause of ear blockage, as was the case with the PRC-34, and do away with the cordage which inevitably entangled itself in the underbrush, as was the case with the AN/PRC-36. Thirdly, it was reasoned that the transmitter could be stored in the pocket or clipped to the clothing and that it did not have to be in the ready position at all times since the operator could determine when he wanted to use it.

A meeting held at USCONARC headquarters to discuss the proposed form factors for the new helmet radio ended with the conferees satisfied with the factors presented and deciding to send the QMR for that equipment back to the infantry so that the equipment could be modified in accordance with the QMR change. A proposed QMR for a lightweight radio transmitter and receiver was received by the Signal Corps Engineering Laboratories in January 1961. Its salient features are listed in Figure 21.

18. OBJECTIONS TO COMMERCIAL EQUIPMENT

The various agencies that would use this equipment indicated strongly that the cost of the final helmet radios produced had to be low in order for the sets to be economically feasible in the quantities required. A cost of 50 dollars for the receiver and 75 dollars for the transmitter was considered maximum. Mention was made of available miniature commercial broadcast receivers that cost as little as 10 to 25 dollars, but the agencies raised various objections. One of these was that the commercial equipment would not operate reliably over an extended period of time in a military environment. Another was that these sets worked against several kilowatt transmitters with elevated antennas. Therefore, changes in performance of as much as 10:1 from one set to the next and from one day to the next were not as critical as when these sets would be operating against low power equipment with limited antennas where calculated path loss would not leave a

20 January 1961

Salient Features

1. Separate transmitter and receiver
2. Weight less than one pound (R & T total)
3. Two channel transmitter
4. 500 meters transmitter/receiver range
5. One mile netted with AN/PRC-25
6. 55 channels
7. Compatible with VRC-12 & PRC-25
8. Transmitter and Receiver intended for squad leaders, team leaders, and weapon crew chiefs. (rec issued to selected rifle squad and weapon crew members)
9. Receiver attachable to standard steel helmet
10. Transmitter carried in pocket
11. Battery life 24 hours
12. Tone signaling required
13. One receiver earphone - not against ear
14. Receiver Squelch required
15. Equipment required not later than FY 64

Figure 21. Proposed QMR for a lightweight radio transmitter and receiver.

significant margin. In addition, the quantities required for the potential military market even for this equipment would not approach those required for the commercial market. A developmental manufacturer had stated that it would not pay him to design, set up, and program automation equipment for less than one million units per year. In light of these objections, it was proposed to the Office of the Chief Signal Officer (OCSIGO) that a program be initiated to procure equipment which the manufacturer would warrant to meet stated field performance requirements for 6 months to one year. No other requirement would be imposed. In July 1961, OCSIGO directed SCEL to proceed with the necessary documentation to carry this out.

19. MAJOR CHANGE IN THE QUALITATIVE MATERIEL REQUIREMENT (QMR)

Under this proposed approach, several commercial corporations became interested in supplying equipment to meet the infantry's need for intra-squad radios. Some of these companies presented preliminary mockups and experimental models of the proposed equipment, some of which came reasonably close to meeting the gross requirements. The Laboratories then proceeded to request quotation for the equipment, but just before they could carry this out, they received word of a major change in the QMR.

The new requirement stated that the equipment had to be replacement for the PRC-6 as well as performing as an intra-squad radio. The old QMR was withdrawn, and a proposed new one was issued for comment. The major changes proposed are listed in Figure 22.

The Laboratories stated that the required weights were considered unrealistic and that the commercial approach was not considered feasible for the new requirements. Performance over a range of one mile with the allowable antenna systems would require the ultimate in performance from available components, with no allowance made for variation over temperature or with

1. Range - one mile on channel 1

   500 meters on channel 2

   (both between companion equipment not PRC-25)

2. 90 to 110 possible channels
3. Compatability with PRC-25, VRC-12, PRC-6 desired
4. Must serve as replacement for PRC-6
5. Receiver wearable in pocket as well as helmet
6. No external squelch adjustment on receiver
   a. (squelch on/off sw allowed)
   b. squelch should be compatible with PRC-25
7. Receiver weight 6 to 8 ounces
8. Transmitter weight 8 to 10 ounces
9. Battery type common to receiver and transmitter
   a. Battery life 72 hours desired
   b. 1:24 Trans - Rec ratio
10. Priority of Characteristics
    a. Range
    b. Two preset channels
    c. Size and weight
    d. Cost
    e. Battery life

    . . . . . .

11. Use of proven conventional, military or commercially acceptable electronic parts.

Figure 22. Major changes in previously proposed QMR.

time. Consequently, efforts toward obtaining a commercial intra-squad radio were ended, and the equipment specification was rewritten, requiring the use of approved military parts, materials, and processes.

20. SCEL RECEIVES FINAL APPROVED QMR

In May 1962, SCEL received the approved QMR and was directed to initiate an immediate in-house development program as well as place an external development contract. Figure 23 gives a resume of the major requirements of the approved final QMR. Looking at Figure 23, it is interesting to note that under "Priority of Characteristics" "cost" had dropped from fourth place to seventh place, behind such factors as "reliability" and "channel changeability at second echelon."

21. PROBLEMS WITH FINAL DESIGNS

With the issuance of the final approved QMR for the squad radio, several designs of receiver and transmitter cases, antennas, and switches were mocked up for evaluation. Figure 24 shows the various mock-ups of case designs that were proposed for Radio Receiver AN/PRR-9. Designs for various types of switches and antennas are shown in Figures 25, 26, and 27. Switches, always a difficult problem, proved especially so when it came to sealing them. Push-to-talk switches, for instances, were notably bad in this respect. One solution which did not work out in practice was the use of magnetic reed switches actuated by permanent magnets sliding on the outside of the case. It did not work out because the resultant switches were too large and the tolerance problem too difficult to handle. Similar difficulties were encountered in the transmitter antenna. Figures 25, 26, and 27 show some of the solutions proposed, ranging from folding antennas (Figure 25) to telescopic antennas (Figures 26, 27). Figure 26 shows a mock-up of the AN/PRT-4 with flexible telescopic antenna having a spring-

Dated: 10 May 1962

Resume of major requirements

1. Range: 500 meters and 1 mile between companion equipment
2. Weight: 30 ounces total

   Receiver: 6 to 10 ounces

   Transmitter: 10 to 20 ounces
3. Channels:
   a. Single channel receiver
   b. Two channel transmitter
   c. 80 to 110 channels possible
4. Should be compatible with VRC-12 and PRC-25

   Must be compatible with AN/PRC-6
5. Voice and tone provision
6. Collapsible transmitter antenna, sufficiently pliable to minimize breaking
7. Receiver ear plug and cord required
8. Degraded performance acceptable when not mounted on helmet
9. Priority of Characteristics
   a. Range
   b. Two channel transmitter
   c. Size, weight, and configuration
   d. Durability and reliability
   e. Battery life
   f. Channel changeability at second echelon
   g. Cost

. . . . . .

Figure 23. Approved final QMR for intra-squad radio.

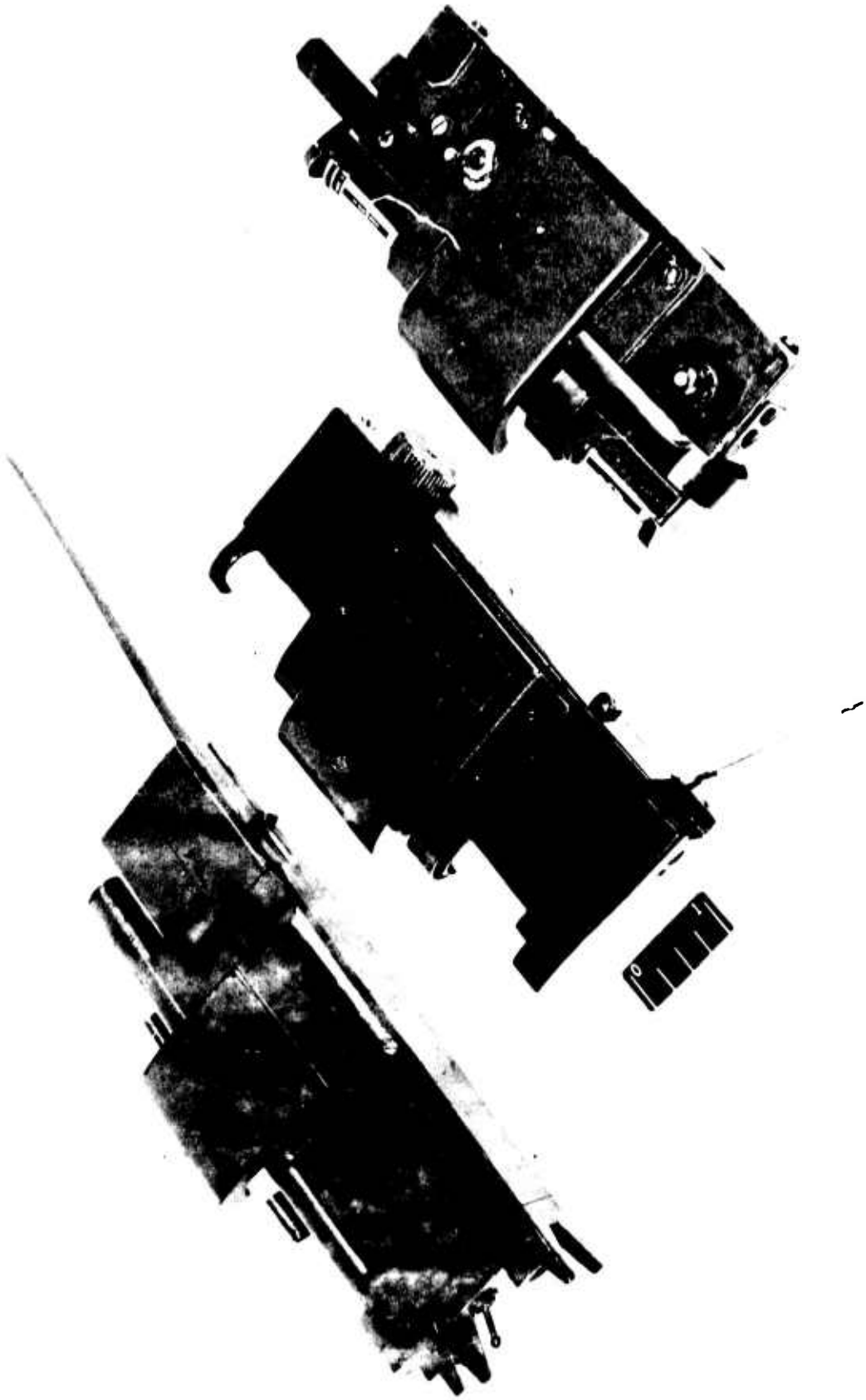

Figure 24. Various mock-ups of case designs proposed for Radio Receiver AN/PRR-9.

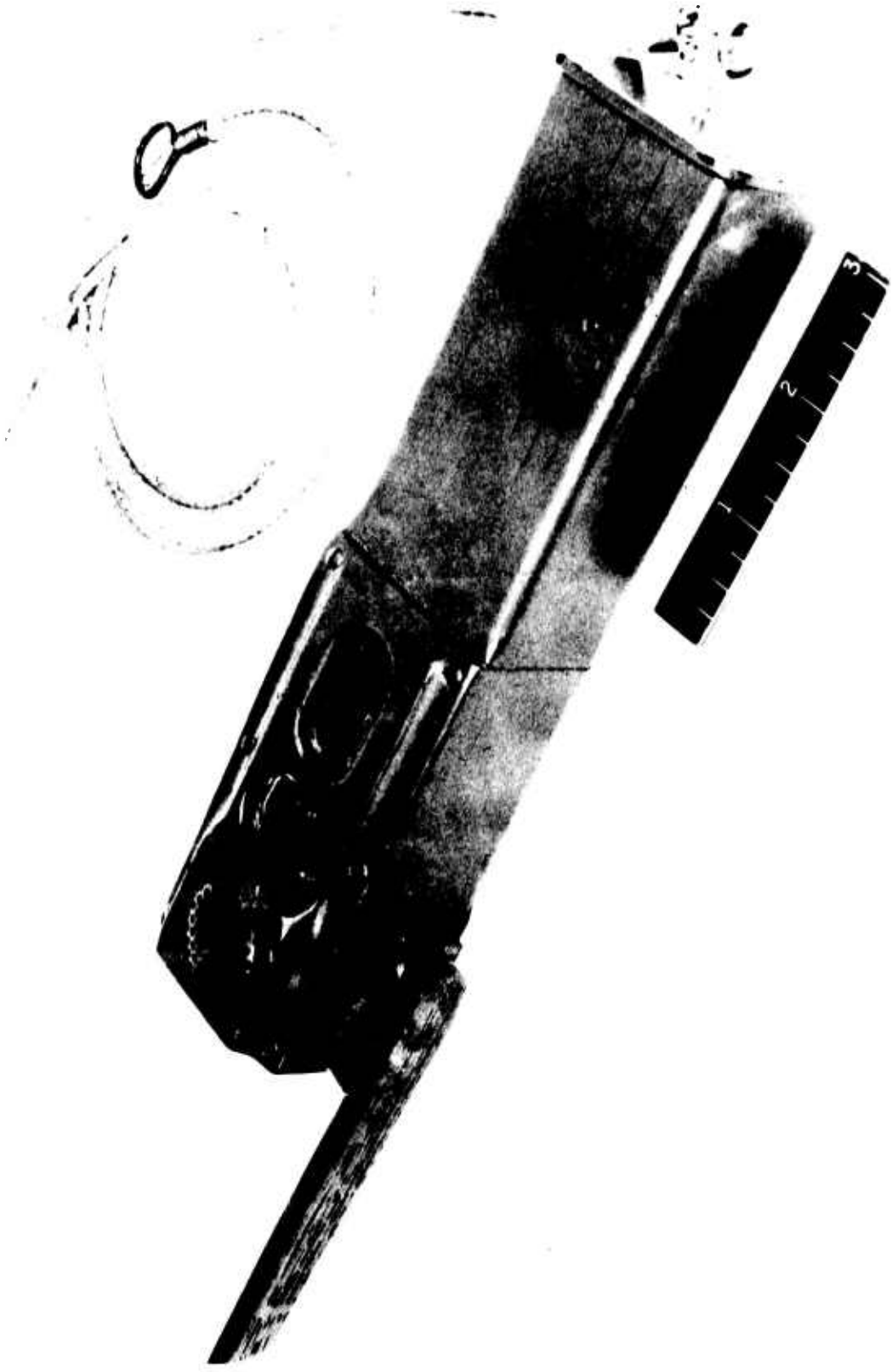

Figure 25. Mock-up of Radio Transmitter AN/PRT-4 showing proposed lanyard and folding antenna.

Figure 26. Mock-up of Radio Transmitter AN/PRT-4 showing flexibility of telescopic antenna with spring-loaded bead base.

Figure 27. Mock-up of Radio Transmitter AN/PRT-4 showing telescopic antenna with ball swivel base (collapsed).

loaded bead base. Although some trouble with the antenna was reported in the S/T report, no major difficulty with it was encountered, and it was expected that this design could be improved somewhat for the production models. Figure 24 shows another attempt at solving the problem by providing a ball swivel joint at the base of the antenna. Both designs added serious electrical problems by increasing antenna base capacitance.

Problems were also encountered in trying to reduce the weight of the transmitter by eliminating the battery box and attaching the battery with an elastic strap. This is shown in Figure 28. Another proposal for holding the battery in place is shown in Figure 29. This involved using an adjustable strap to hold the battery in place. After both proposals were evaluated, it was decided that a battery case was needed to provide a reasonable ground plane for the antenna.

After many of the problems with the size of receiver and transmitter cases, types of antennas and switches, and batteries had been resolved, the first working laboratory models of the receiver and transmitter were produced. These are shown in Figure 30. The receiver weighed 10.5 ounces and the transmitter 23 ounces, both exceeding the QMR. However, the models did perform satisfactorily over a one-mile test range, demonstrating the feasibility of the stated requirements. In spite of this, Fort Benning remained dissatisfied with the size and length of both and requested a demonstration of other sizes and shapes. After much experimentation, a final laboratory model (Figure 31) was produced which demonstrated the ultimate that was possible in reducing transmitter and receiver to their smallest possible sizes with available components.

The transmitter is shown with a small battery container intended for a magnesium battery. Although Fort Benning found this arrangement

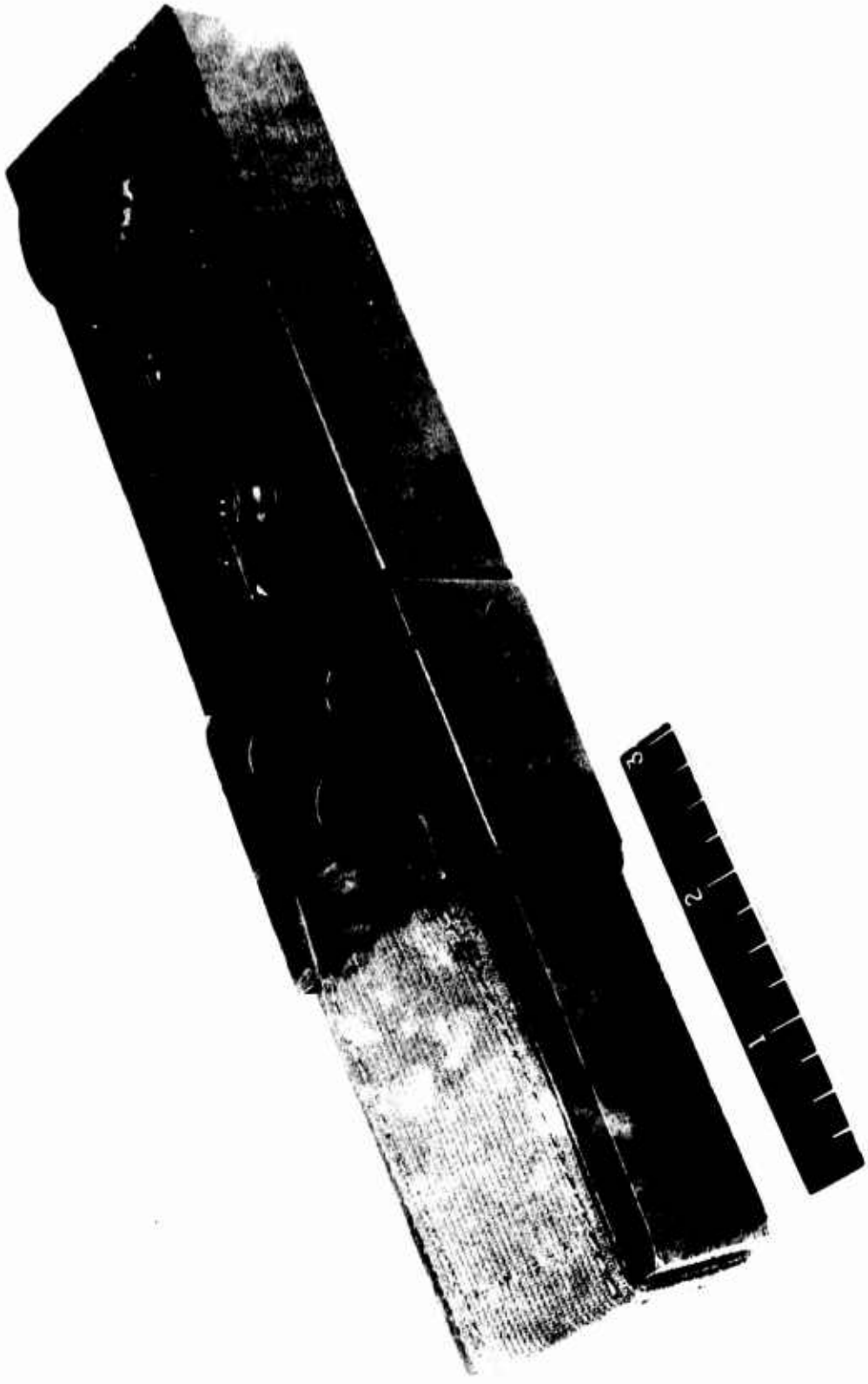

Figure 28. Mock-up of Radio Transmitter AN/PRT-4 showing battery held in position with a proposed elastic strap.

Figure 29. Mock-up of Radio Transmitter AN/PRT-4 showing adjustable battery strap.

Figure 30. Radio Receiver AN/PRR-9 (XE-1) and Radio Transmitter AN/PRT-4 (XE-1).

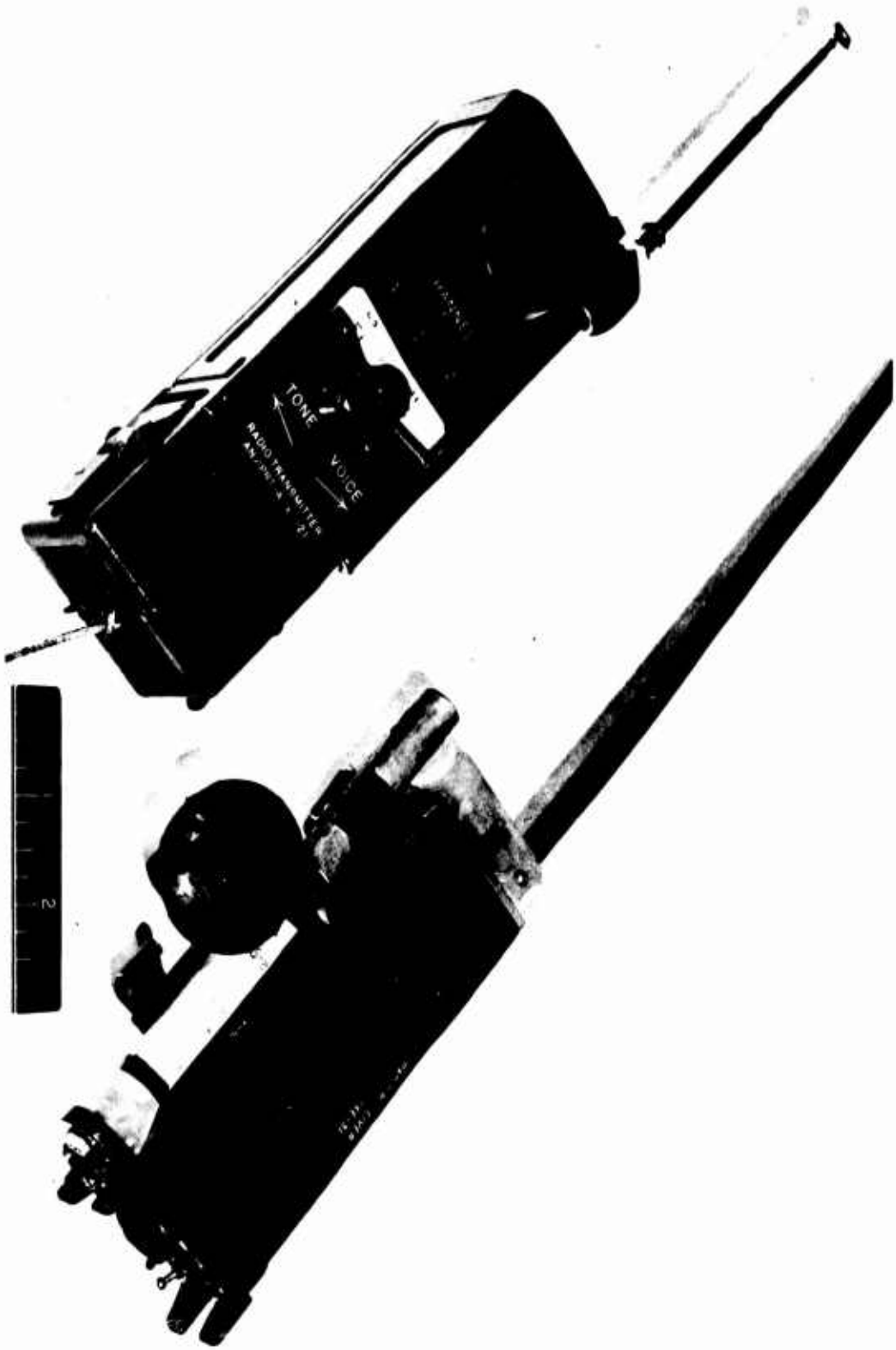

Figure 31. Radio Transmitter AN/PRT-4 (XE-2) and Radio Receiver AN/PRR-9 (XE-3).

satisfactory, the battery did not materialize, and a small Le Clanche battery had to be designed to fit the container. The Laboratory did manage, however, to reduce the overall length of the transmitter case approximately one inch. A detailed and complete discussion of the internal development of the AN/PRR-9 and the AN/PRT-4 will be found in this writer's Technical Report ECOM-2482.[1]

22. CONTRACT PLACED WITH DELCO RADIO

In August 1962, a contract was placed with the Delco Radio Division of General Motors Corporation for 66 receivers and 41 transmitters. Fifty receivers and 25 transmitters were slated for engineering and service tests, 6 were to be used by the Quartermaster for studies of the equipment's compatibility with all types of clothing, and 10 were for experimental use and demonstration. The equipment resulting from this contract is shown in Figure 37 and 38.

The final model of the transmitter had a short battery container and appears in Figure 32; the final model of the receiver is shown in Figure 33. For the latter, the contractor was able to develop a very efficient audio horn.

The final technical characteristics of both transmitter and receiver are presented in Figure 34.

23. OTHER ITEMS REQUIRED ON DELCO RADIO CONTRACT

Also required on this contract were an alignment jig, crystal unit sets, a radio test set, and a battery test set. The alignment jig with all of its signal sources, meters, and tools necessary for the alignment of receiver and transmitter is shown in Figure 35.

The final models of the receiver and transmitter used identical but separate crystals. For the service test, each crystal kit (Figure 36) contained 110 crystals, but the production units contained only 100. The ratio of crystal sets to the number of pieces of equipment was not determined.

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[1] Curtis, M.W. "USAEL Internal Development of Radio Receiver AN/PRR-9 and Radio Radio Transmitter AN/PRT-4." Technical Report ECOM-2482. September 1964.

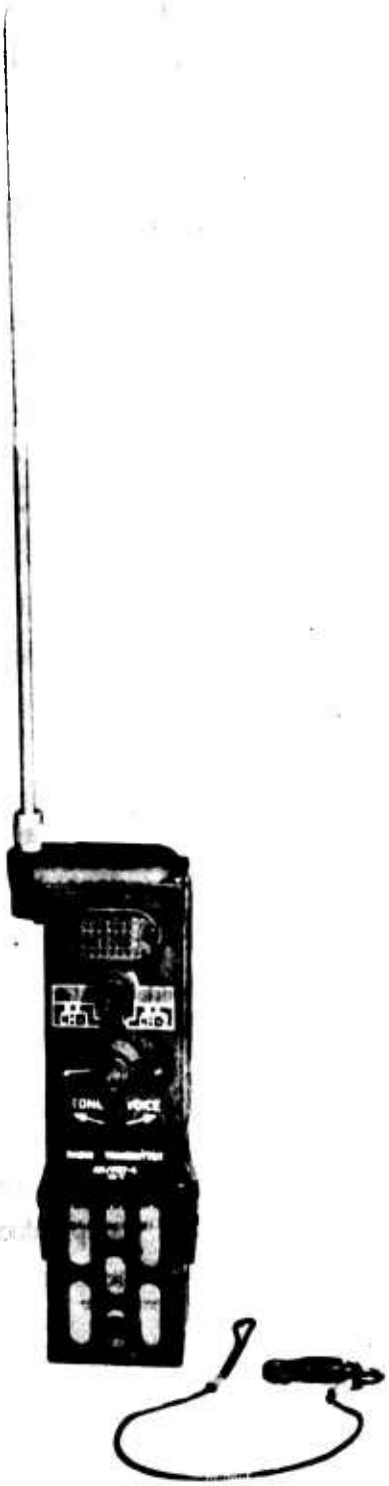

Figure 32. Preproduction model of Radio Transmitter AN/PRT-4.

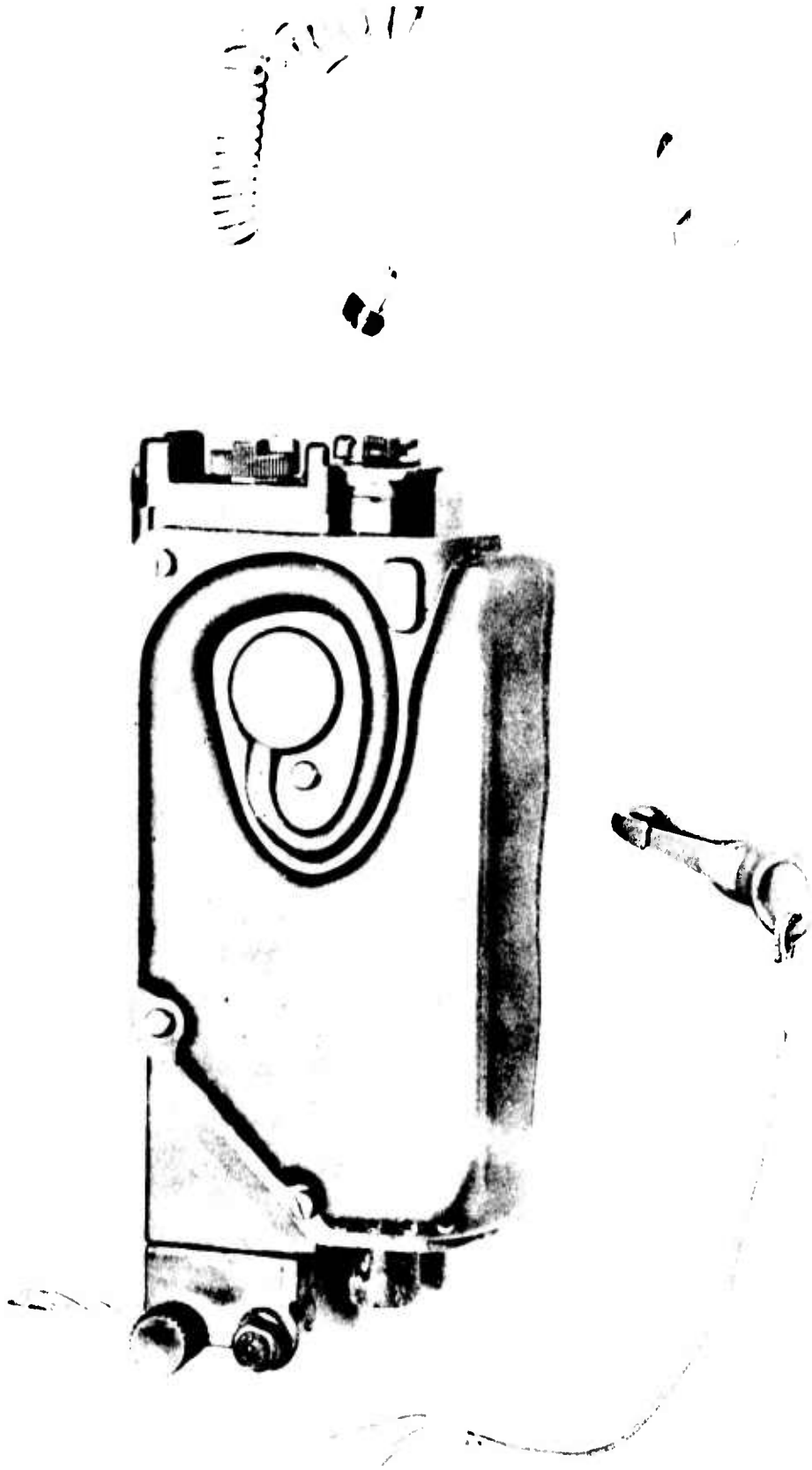

Figure 33. Preproduction model of Radio Receiver AN/PRR-9.

A. General:

1. Frequency Range: 47 - 57 Mc
2. Available Channels: 200 @ 50 kc spacing (100 crystals provided)
3. Range: 1600 meters (1 mile) on high transmitter power.
   500 meters on low transmitter power.

B. Receiver:

1. Sensitivity: 0.5 microvolts
2. Number of Preset Frequencies: 1
3. Power Drain: 13 Ma @ 5 volts w/o signal input (.065 watts)
   25 Ma @ 5 volts with signal input (.125 watts)
4. Dimensions: 6 1/2" x 3" x 1 1/8"
5. Weight: 8.6 ounces

C. Transmitter:

1. Power Output: 500 milliwatts on channel 1
   50 milliwatts on channel 2
2. Number of Preset Frequencies: 2
3. Type of Modulation: Voice or tone, FM, 8 kc deviation.
4. Power Drain: 120 Ma @ 12 volts (1.44 watts)
5. Dimensions: 8" x 2 1/4" x 1 1/2" w (XC-1) battery
   6 1/2" x 2 1/4" x 1 1/2" w (XE-3) battery
6. Weight: 18 ounces w (XC-1) battery
   17 ounces w (XE-3) battery

Figure 34. Final technical characteristics of Radio Transmitter AN/PRT-4 and Radio Receiver AN/PRR-9.

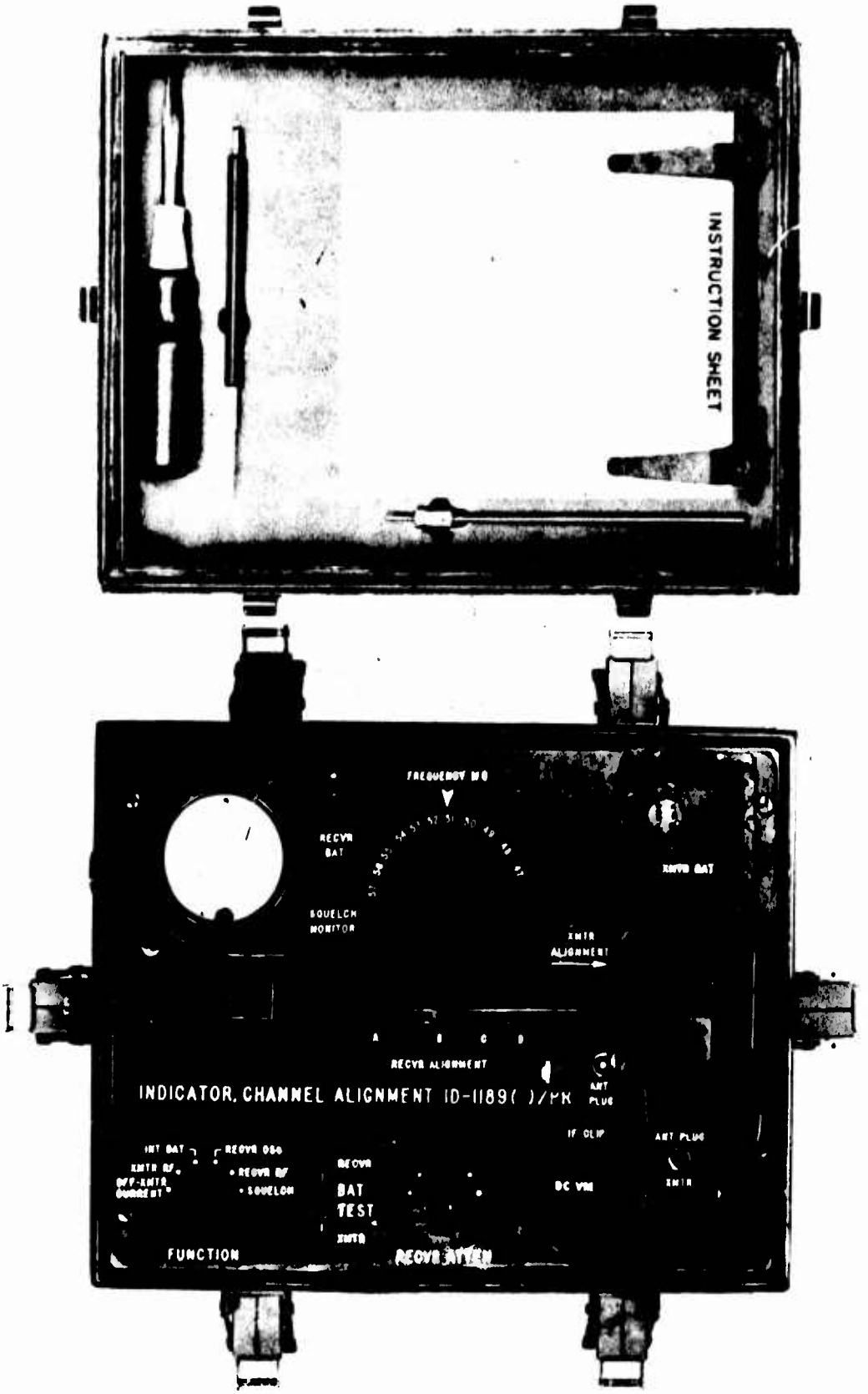

Figure 35. Alignment jig for final models of Radio Transmitter AN/PRT-4 and Radio Receiver AN/PRR-9.

Figure 36. Crystal kit for final models of Radio Transmitter AN/PRT-4 and Radio Receiver AN/PRR-9.

although estimates of 1:10 and 1:25 were made, depending on the number of sets being aligned at a particular service point. The Department of Defense (DOD) Value Engineering (VE) Office conceded that no more than 50 or 60 were required, indicating that a substantial savings could be realized by supplying partial kits to some operating units.

DOD's VE Office carried out an exhaustive study, making several suggestions which ranged all the way from redesigning the equipment for AM rather than FM to the use of a boy scout snap on the lanyard rather than the stock item used on antenna guys. The Delco radio was designed by the same engineers who designed the company's commercial radios, which were intended to meet the demands of customers for performance and reliability at an absolute minimum cost. None of the VE suggestions, however, could be adopted without sufficiently reducing performance.

Although a radio test set (Figure 37 was required and supplied under this contract, the actual development of a test set was dropped when it became evident that the cost of producing it would be excessive. The battery tester (Figure 38 provided under this contract was built but not developed under the squad radio program. The round blocks shown in the figure are the proper leads and metering resistors, which are tailored to fit the battery under test.

24. SERVICE TEST OF THE SQUAD RADIO

The final models were shipped to AEPG for engineering tests on April 1, 1964. After the tests, the equipment was returned to the Signal Corps Engineering Laboratories for certain changes and checks. A redesigned electronic chassis was installed in the transmitter, and a check was made of receiver performance. The sets were then shipped to Fort Bragg for a service test on September 15, 1964, with 4 transmitters and receivers going

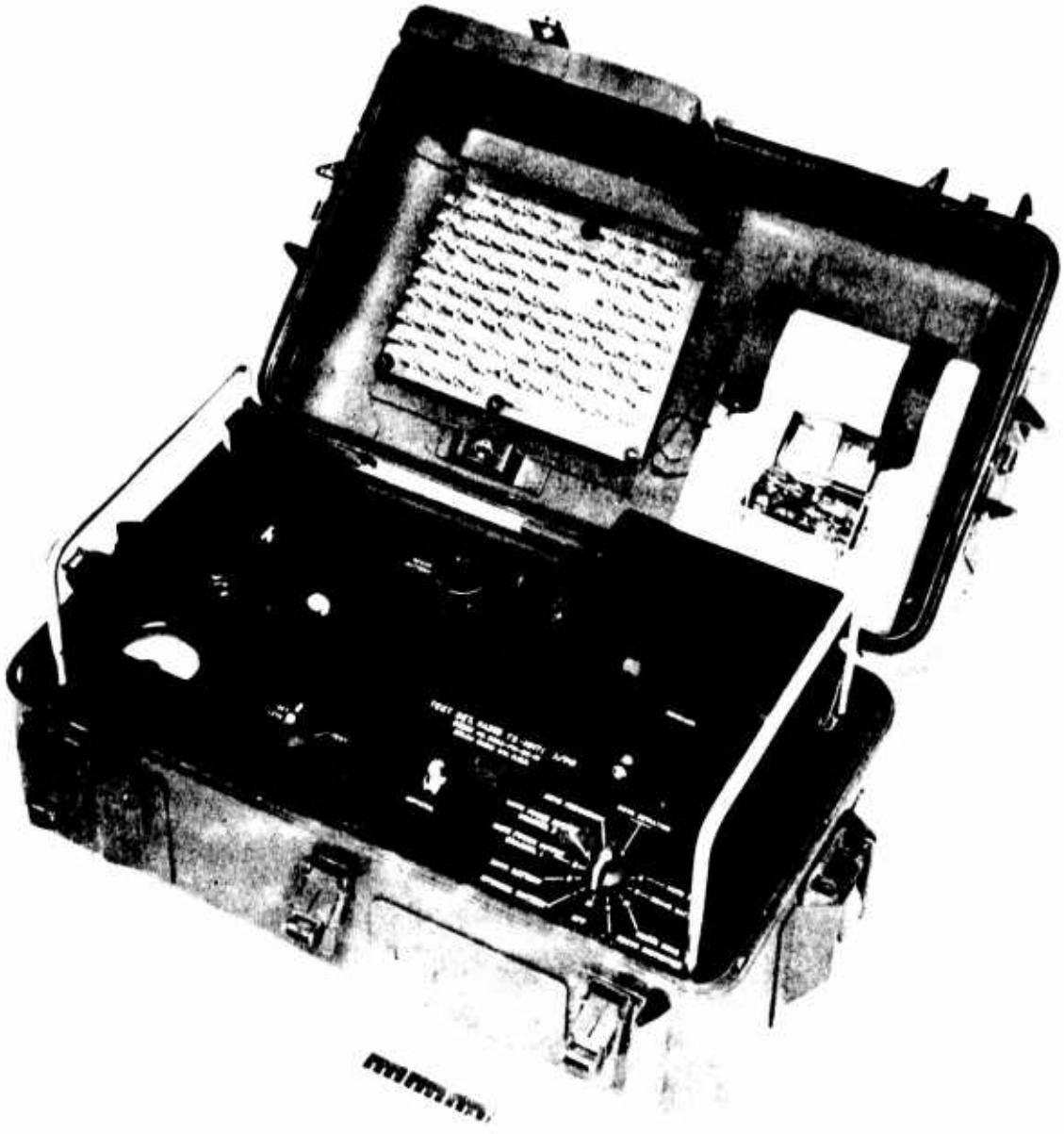

Figure 37. Radio test set for final models of Radio Transmitter AN/PRT-4 and Radio Receiver AN/PRR-9.

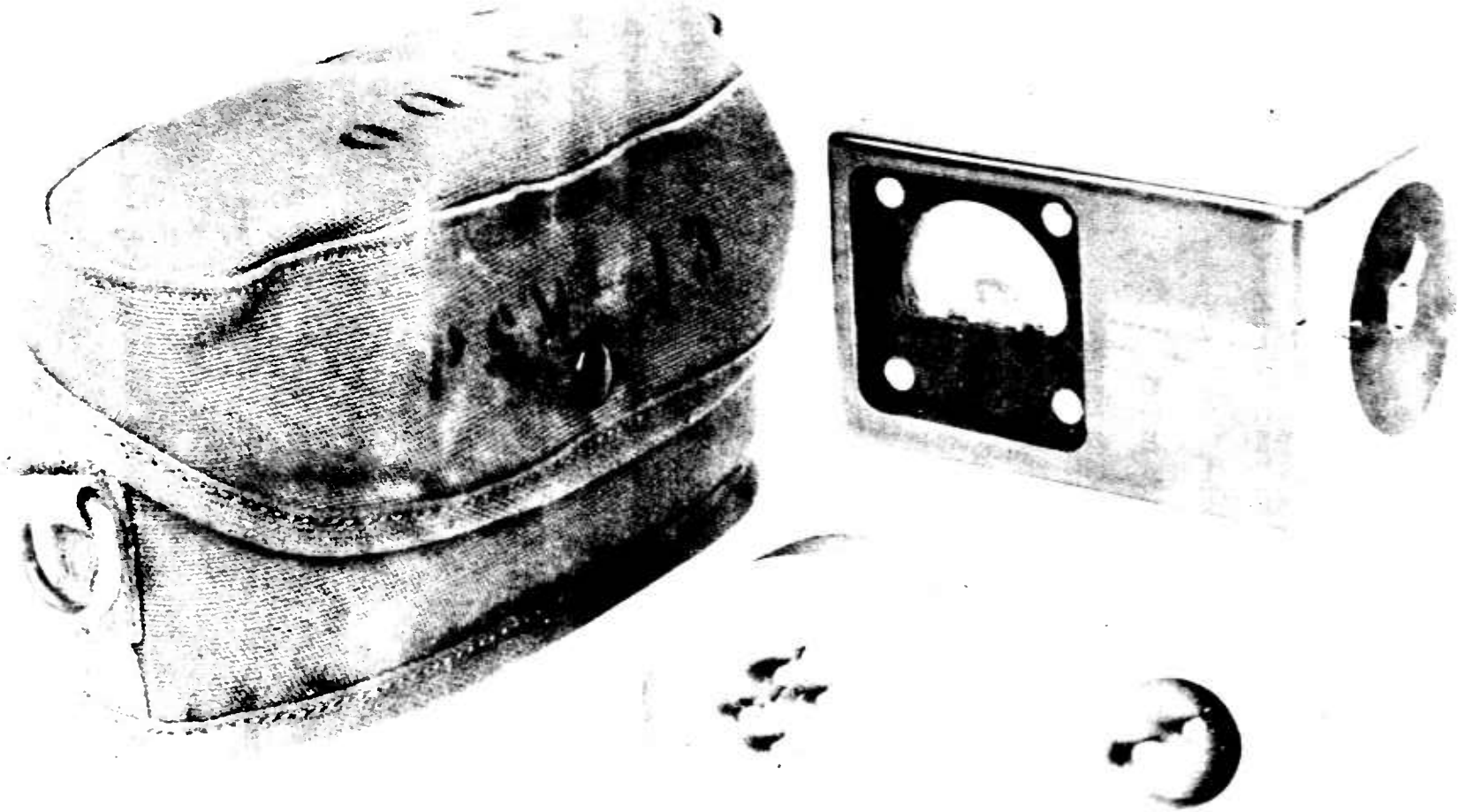

Figure 38. Battery tester for final models of Radio Transmitter AN/PPT-4 and Radio Receiver AN/PRR-9.

to AEPG for engineering tests on the new transmitter model XE-6A. Another 6 transmitters and 12 receivers were shipped to AEPG for completion of electromagnetic vulnerability and compatibility tests, and 6 transmitters and 12 receivers were sent to CDEC for test. A number of units also went to the 7th Army in Europe for demonstration. And to complete testing, jungle and desert tests were planned for later in 1964.

25. THE DEVELOPMENT ACCEPTANCE IN PROCESS REVIEW

At the final In Process Review (IPR), a representative of the Combat Development Command (CDC) stated that CDC did not like the concept of a two-part helmet radio in which the transmitter was held in the hand and the receiver was mounted on a helmet. To add to this dissatisfaction, the Marine Corps had long been clamoring for a single-unit design, such as the AN/PRC-6.

In reply to CDC, the Department of the Army (DA) representative claimed that inasmuch as this was the concept called for in the qualitative materiel requirement, the only way in which the basic idea could be altered would be for CDC to request an official change to the QMR. This CDC chose not to do.

26. PRODUCTION

The outcome of all this was that fifty squad radios were built to meet active test requirements in Vietnam, where initial reaction turned out to be good. As a result, production was increased to 5,000 units, and subsequent orders raised this amount to more than 25,000 sets.

27. FIELDING

Yet, though initial reaction to the set had been good, its use in

full-scale operations in Vietnam proved disappointing. In the dense, humid jungles of Southeast Asia, the range of the AN/PRC-77 was reduced to a few hundred yards and that of the squad radio to a few hundred feet. In addition, other problems arose. One lay with the difficulty in properly aligning the equipment when channels were changed in the field. Another with the battery which disintegrated because to save weight it had purposely been left unprotected. And still another when operators contrary to the equipment's capabilities, tried to obtain full range from receivers not mounted on helmets.

All these difficulties served once again to revive the controversy over whether the helmet radio should be a single unit or a two-part affair. One conclusion that was reached at this time was that the Army had no need to provide individual members of squads with radio receivers. Still another conclusion was that under the harsh necessities of war and because required quantities of sets had been drastically reduced from 250,000 to 30-40,000 units, extreme low cost in producing this equipment was no longer a primary objective.

One had the impression at this time that many of the faults ascribed by users to the helmet radio were really disguised dislike of the two-piece design of the equipment and the peculiarities of small radio operation. This dislike took the form of finding fault with the equipment and expressed itself in a vague desire to want something "different." But this is purely a personal impression and not meant to suggest that anyone purposely or willfully condemned the equipment. It was simply that the potentialities of the helmet radio on the drawing board had not materialized on the battlefield and so antagonized acceptance. One has only to read the letter (Appendix I) recently sent by the 2nd Ranger Battalion of the 75th Infantry to pertinent organizations to realize that dissatisfaction with squad radios is still with

us.

28. CURRENT STATUS

The final chapter of the squad radio is yet to be written. At this writing, several thousand sets languish in depots unissued, with the Army finding it difficult to devise at a reasonable cost requirements for a modified or new squad radio which will satisfy users. As presently designed, the components of a squad radio cost $107 for the receiver and $139 for the transmitter.

The Marine Corps' counterpart to the squad radio is the AN/PRC-68, a one-piece transceiver complete with synthesizer (no crystal banks needed), but having a much shorter range (one-third to one-half mile) at an estimated production cost of $1400. In addition to having less range, another of its disadvantages is that its battery costs four to ten times that of the Army's radio.

In an attempt to satisfy users and meet the current requirements for small unit transceivers (SUT), the Army is considering using several foreign radios. Some other sets are also being considered. One is the Marine Corps' AN/PRC-68 or a version of it that can be modified at low cost. Another is a repackaged version of the squad radio (the AN/PRC-88, consisting of one AN/PRR-9 and one AN/PRT-4), a configuration that places the receiver and transmitter in one hand-held case.

29. THE FUTURE

And this is how matters stand at the present with the squad radio. What the future will bring remains unclear. At the final IPR, representatives of users of the set pointed out that the radio did not have to net with larger manpack and vehicular radios, even though the QMR stated that it "should."

Even before the first production units had come off the assembly line,

users had requested that the radio transmitter be modified by adding a tone squelch generator that would make the set "fully compatible and interoperable" in all voice modes with larger equipment. Concurrently, a program has been initiated for a new family of manpack and vehicular equipment with built in security and anti-jamming (AJ) capability, with this capability taking the form of pseudo random frequency hopping. A new squad radio with features which would insure complete compatibility with this new family of sets would by present engineering estimates be prohibitive in size, weight, cost, and battery consumption and complex in operation. So present plans call for the new single channel ground airborne radio system (SINCGARS) to be able to operate in the nonsecure mode while remaining on a single frequency to assure interoperability with current VHF-FM tactical manpack and vehicular equipment. This, at least, would provide a degree of compatibility with practical squad radios or small unit transceivers that the state of the art could support. But, in the last analysis, only time, technology, and the representatives of future users will determine the future of the squad radio.

Appendix I Letter sent by 2nd Ranger Battalion on Field Testing of Squad Radios

Page 1

ROUTINE

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RUEDHIA/CDR ECOM FT MONMOUTH NJ //AMSEL-NL//
REUDHIA/CDR AMC ALEX VA//AMCRD-SI//
R 252207Z NOV 75
FM CDR 9TH INF DIV & FT LEWIS WA //AFZH-DPIPO//
TO CDR FORSCOM FT MCPHERSON GA //AZCE//
INFO CDR TRADOC FT MONROE VA //ATCD-SC-E//
CDR USA ARMY INF CEN FT BENNING GA //ATZB-CD-MS-E//
CDR 1ST BN (RANGER) 75TH INF FT STEWART GA //AFZR-IL-CE//
BT
UNCLAS
SUBJ: SQUAD RADIOS
1. THE 2D BN (RGR) 75TH INF HAS FOUND THE SQUAD RADIOS. AN/PRT-4 AND AN/PRR-9 TO BE INADEQUATE FOR RANGER OPERATIONS. INTENSIVE FIELD TRAINING HAS PROVED THE RADIO TO BE INCOMPATIBLE WITH TYPES OF OPERATIONS AND MOVEMENT TECHNIQUES EMPLOYED BY RANGER UNITS. THE SUCCESS OF RANGER OPERATIONS DEPENDS ON THE ABILITY OF THE PLATOON LEADER TO EFFECTIVELY CONTROL HIS SUBORDINATES AND THE LACK OF

Appendix I Letter sent by 2nd Ranger Battalion on Field Testing of Squad Radios

Page 2

PAGE 2 RUBLAIA1732 UNCLAS
COMMUNICATIONS HINDERS HIS CONTROL. IT IS URGENT THAT A RELIABLE PLATOON COMMAND NET RADIO BE ISSUED RANGER BATTALIONS IN ORDER TO ACCOMPLISH ASSIGNED MISSIONS.
2. THE 1ST BN (RANGER) 75TH ENCOUNTERED SIMILAR COMMUNICATIONS PROBLEMS WITH THE SQUAD RADIOS. TRADOC CONCURRED IN THE DEFICIENCY OF THE RADIOS (MESSAGE ATCD-SC-E, 271926Z NOV 74, SUBJ: TEST OF RADIO SET AN/URC-68 .) THE URC-68 RADIOS WERE ISSUED: HOWEVER, REPAIR PARTS ARE NOT READILY AVAILABLE AND MAINTENANCE SUPPORT POSES A SERIOUS PROBLEM. THE RANGER BATTALIONS FEEL THAT THE AN/URC-68 IS NOT THE SOLUTION TO THE PROBLEM.
3. COORDINATION HAS BEEN MADE WITH TRADOC AND THE INFANTRY SCHOOL C-E REPRESENTATIVES CONCERNING THE REQUIREMENT FOR A RELIABLE SQUAD RADIO. RADIO SETS AN/PRC-68 AND THE SEM-52 ARE BEING DEVELOPED AS A PLATOON COMMAND NET RADIO AND ARE READY FOR FIELD TESTING. THE 2ND BATTALION WOULD PROVIDE AN IDEAL TEST UNIT FOR THESE NEWLY DEVELOPED RADIOS AS VARIOUS CLIMATIC TRAINING IS PROGRAMMED FOR THE BATTALION DURING THE 3D AND 4TH QUARTERS OF FY 76. THE BATTALION DESIRES TO ASSIST IN TESTING THE PLATOON COMMAND RADIOS AT THE EARLIEST POSSIBLE DATE
BT
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ROUTINE

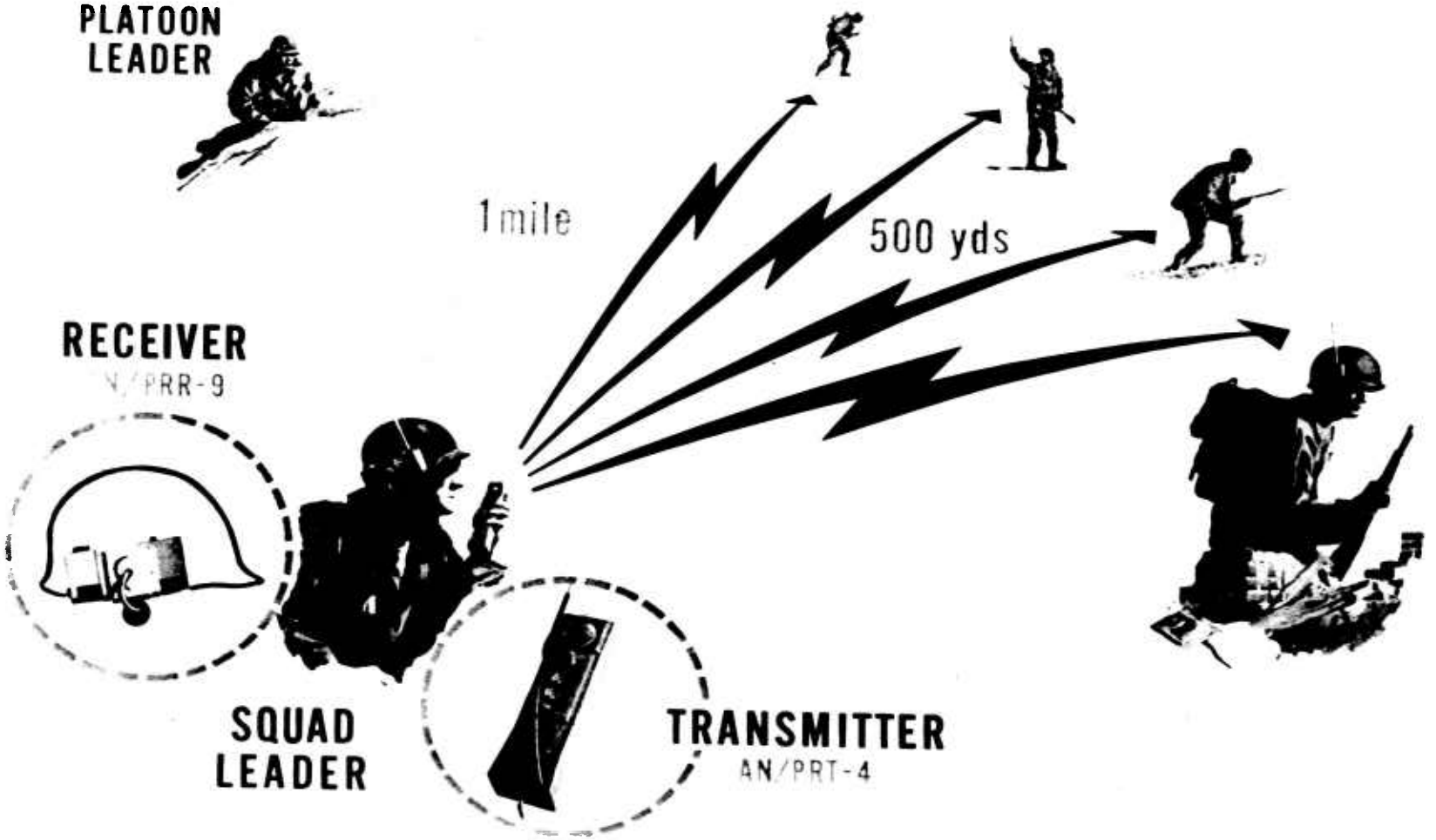

Figure S1. Individual radio concept.

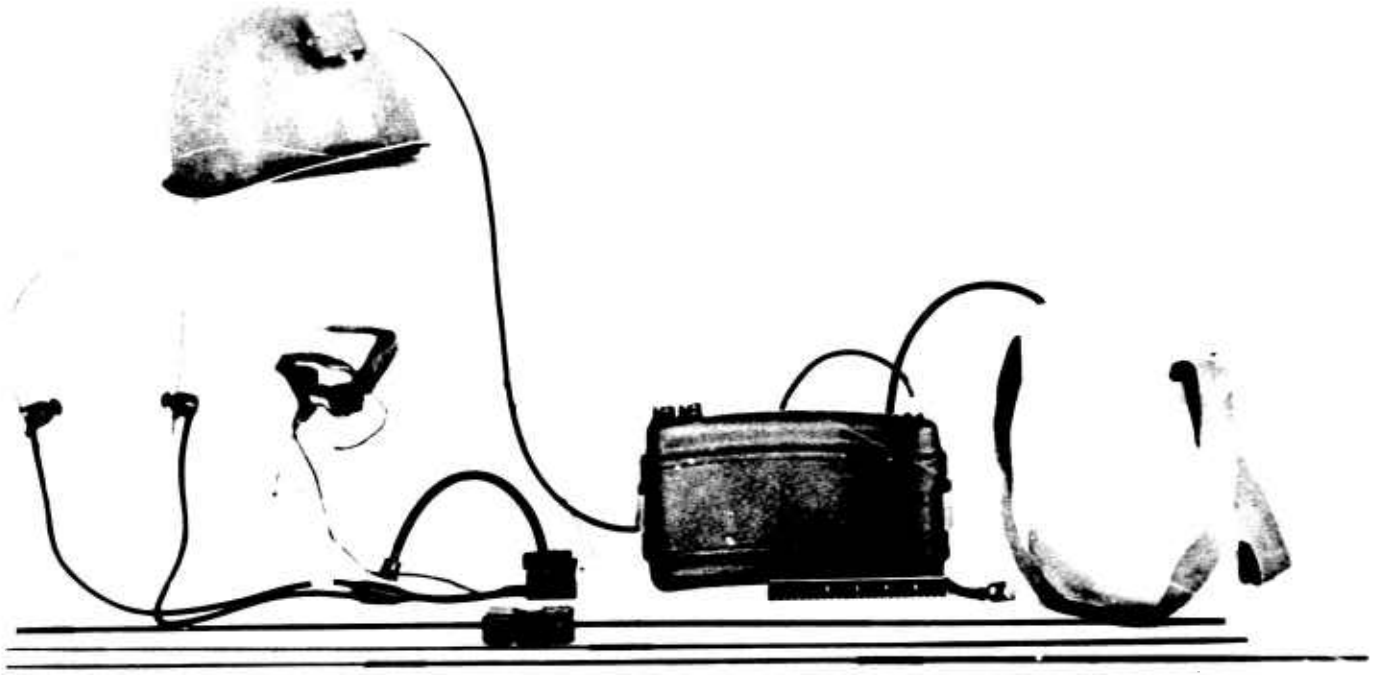

Figure S2. Curved model of Radio Set AN/PRC-6.

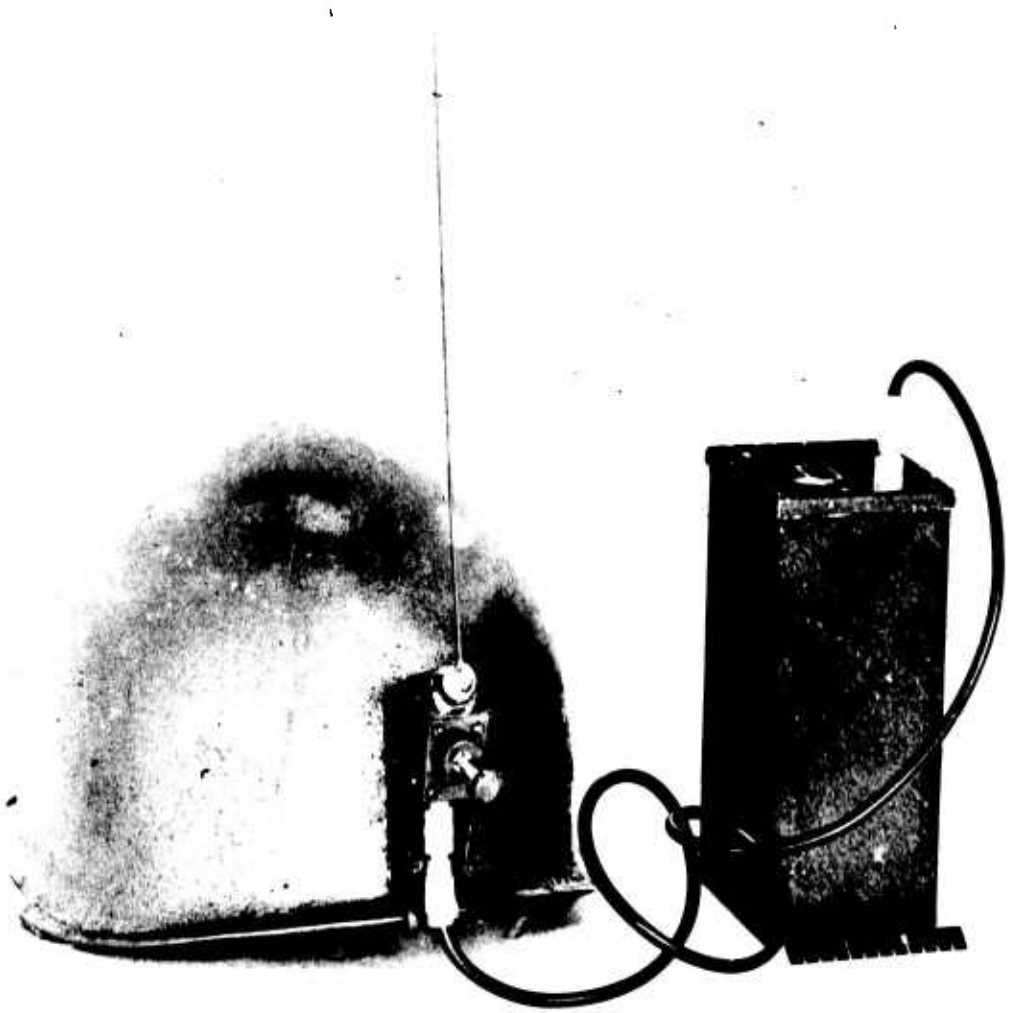

Figure S3. Receiver-Transmitter RT- ( )/PRC-6 (XC-2) and Antenna AT- ( )/PRC-6 (XC-2), part of Radio Set AN/PRC-6 (XC-2). Antenna shown connected to receiver-transmitter.

Figure 54. Radio Set AN/PRC-34 (development model). Receiver-transmitter (less microphone) shown mounted in interior of helmet.

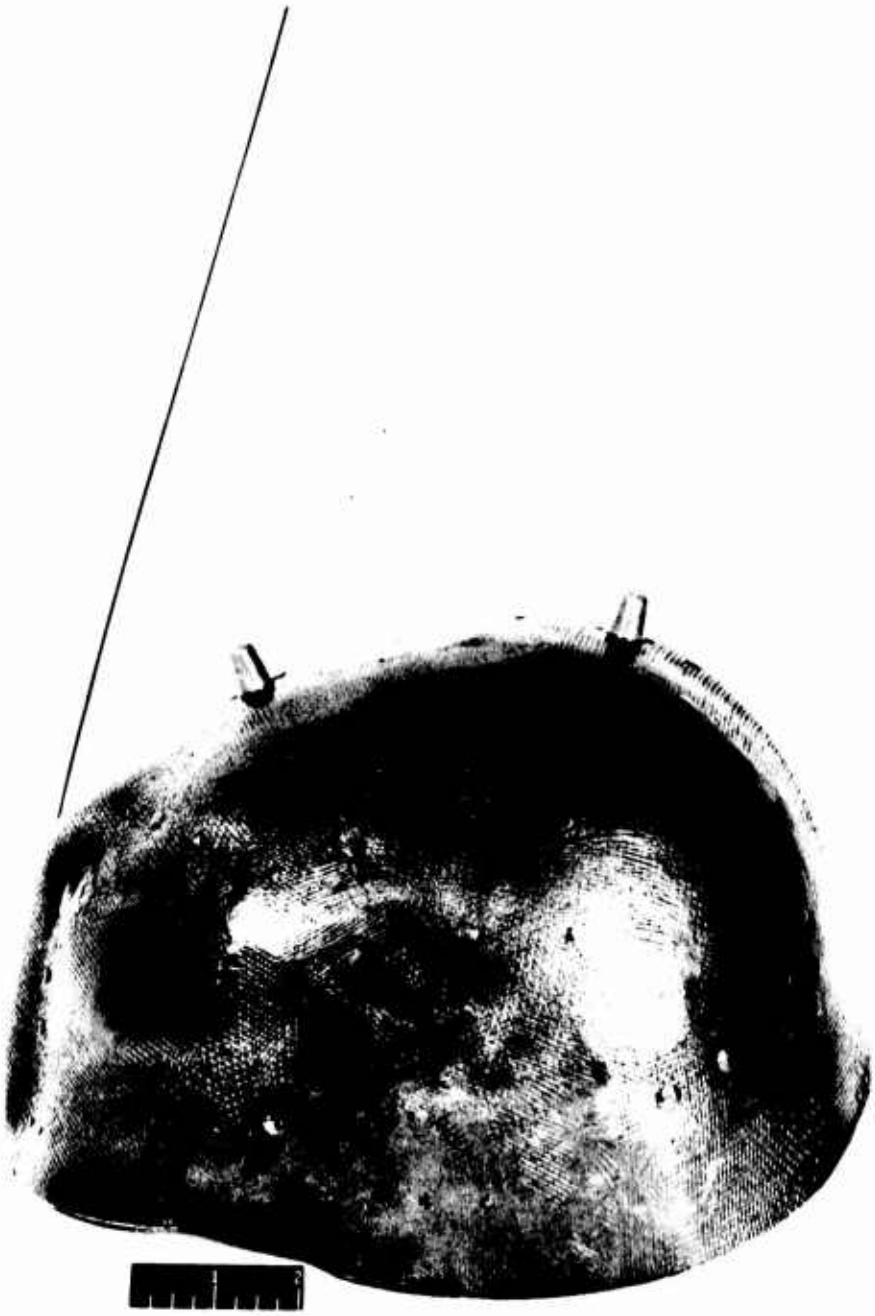

Figure 55. Radio Set AN/PRC-34 (service-test model). Helmet (less microphone) shown with antenna up.

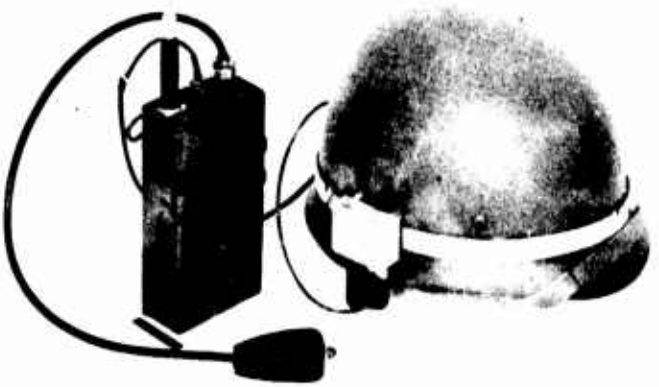

Figure 86. Radio Set AN/PRC-36 (development model). Antenna shown mounted on radio set and acoustic accessories mounted on standard helmet liner.

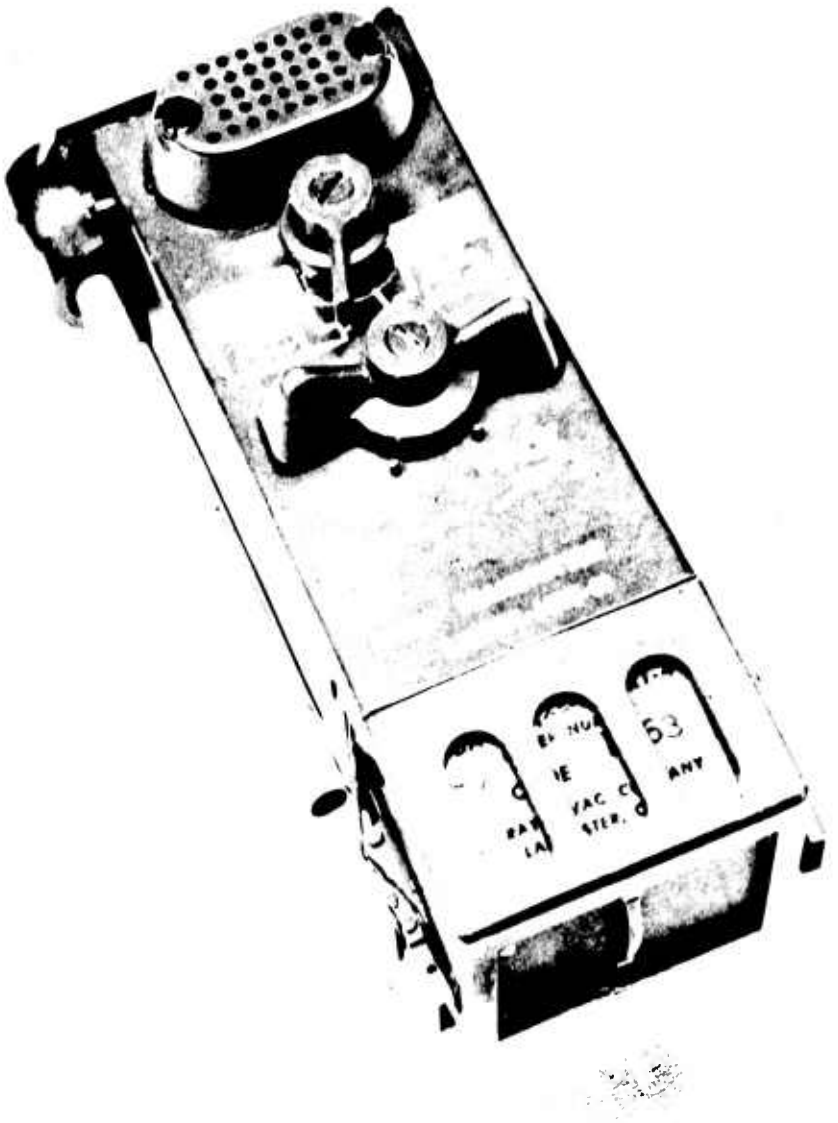

Figure S7. Developmental model of Radio Transmitter AN/PRT-4.

Figure 58. Final model of Radio Receiver AN/PRR-9.

Figure S9. Radio Receiver AN/PRR-9 and Radio Transmitter AN/PRT-4 (showing set in operation, with receiver mounted on helmet).

Figure S10. Radio Transmitter AN/PRT-4 and Radio Receiver AN/PRR-9 (showing transmitter on harness, with transmitter antenna extended and receiver mounted on helmet).

Figure S11. Radio transmitter AN/PRT-4 and Radio Receiver AN/PRR-9 (showing receiver and transmitter in operator's pockets, with ear plug in use).

Figure S12. Radio transmitter AN/PRT-4 and Radio Receiver AN/PRR-9 (showing transmitter hooked on harness, with antenna collapsed and receiver mounted on helmet).

APPENDIX III. SUPPLEMENTARY MEMORANDA

NOTE

The underlining in the letters found in APPENDIX III was done by the writer of this report to emphasize those aspects which specifically pertain to the evolution of the squad radio. Some sections, however, were deleted to make the letters suitable as viewgraphs for presentation at the final In Process Review (IPR). The complete originals were not readily available for this report.

Headquarters Board No 1
Office, Chief of Army Field Forces
Fort Bragg, N. C.

ATBA-CE4752

SUBJECT: Draft Report of Project No. CE 4752, Military Characteristics For Radio Receiver for Individual Rifleman

TO: Commandant
The Infantry School
Fort Benning, Georgia

1. Reference letter, GNBA-CE 413.44 (CE 4752), this board to your agency, 18 March 1953, subject as above, with one inclosure, which invited comments and recommendations on subject report.

2. Military characteristics contained in report referenced above were considered too restrictive by Office, Chief of Army Field Forces and this board has been directed to rewrite the military characteristics in "problem form." The directive further stated that these should only specify the use desired of the equipment and that no limiting factors should be included except as pertains to environment, weight, and size.

3. Attached is draft report of Project No. CE 4752, "Military Characteristics for Radio Receiver for Individual Rifleman," prepared by Communication and Electronics Service Test Division in accordance with paragraph 2, above.

4. Request comments and recommendations by 28 August 1953.

FOR THE PRESIDENT:

1 Incl
Draft Report of
Proj CE 4752

C. W. DAVIS
CWO, USA
Adjutant

SM-2

MEMO FOR RECORD:

B/L G3 413.44 (18 Nov 53), ACofS, G3, Operations to OCAFF, dtd 18 Nov 53, subj: Miniature Radio Receiver

1. Ref is made to Appendix I of the ORO Dept, "A Study of Combat Communications, Korea, Jan-July 52", ORO-T-43 (FEC), dtd 29 Dec 52.

2. It is rqst that you examine possible rqmts for miniature rad receivers which can be used in conjunction with current tactical rad sets to facilitate and extend control within frontline combat units. A commercial version of such a miniature rad receiver has been developed and can be made available for evaluation. Thru the use of miniaturized components, incl transistors, the proposed rad receivers can be produced in the approx size of a typical rad ear phone used by the USAF. The miniature receivers might then be readily fitted to man's head under a helmet.

3. A similar suggestion for both a miniature rad receiver and transmitter appears in the ref of para 1 abv. Such equip, however, has not yet been developed and would undoubtedly be somewhat greater in size than the proposed earphone receiver. Although the miniature receiver would be designed for simplicity to receive only one preset frequency, the utility to a platoon, squad, or weapons unit leader under combat conditions might be immeasurable.

4. If your reply to this query indicates a rqmt for the miniature radio receivers, it is requested that you specify in detail the usage and distribution which you propose.

/s/ C.D. EDDLEMAN, Maj Gen, GS, ACofS, G-3

ATDEV-5 413.4 (18 Nov 53) 1st Ind
SUBJECT: Miniature Radio Receiver

Office, Chief of Army Field Forces, Fort Monroe, Virginia 23 Dec 1953

TO: Assistant Chief of Staff, C-3,Operations, Department of the Army, Washington 25, D. C.

1. Reference is made to:

a. Final Report of the Baker Electronics and Communication Mission to Korea, BEACON Mission, July 1952, which recommended on page 16, that a simple low-power receiver be provided squad members.

b. Final Report, Project VISTA, Volume h, Chapter 11, which recommends, under paragraph 11b3, that a better means of communication be provided individuals during combat.

2. It is considered by this Office that the statements by the BEACON Mission and Project VISTA, as well as the Operations Research Organization study, are expressions of military needs and not formal statements of requirements. A requirement for an item of military equipment is formally established only after thorough consideration is given to its operational and logistical role in the battlefield environment. This consideration includes its envisaged cost, complexity and the competence requirements for maintenance and operator personnel.

3. On 18 April 1952, Board No 1, OCAFF, was directed to study the requirement for a radio receiver for individual rifleman. This study and subsequent coordination with interested agencies, including Zone of Interior Armies and the Signal Corps Engineering Laboratories have encompassed most of the factors cited as requirement considerations in paragraph 2.

4. However, due to the lack of factual field experience, the operational role of subject equipment in the battlefield environment and its logistical implications has not been determined. Therefore, a specific requirement for a miniature radio receiver for the individual rifleman can not be established at this time.

5. In order to validate current concepts and information, it is planned that a field evaluation be conducted by a T/O&E rifle company equipped with various distributions of the commercial miniature radio receivers cited in paragraph 2 of the basic letter.

6. If the field evaluation results in a definite statement of requirement, such will be forwarded to your office at the earliest possible date.

7. It is requested that this Office be furnished with detailed information as to availability, cost, and characteristics of the commercial miniature radio receivers, in order that quantitative requirements may be determined for the field evaluation.

FOR THE CHIEF OF ARMY FIELD FORCES:

SM-4

C-3 Plans
Headquarters, The Armored Center
Fort Knox, Kentucky

AIDIT 420 14 December 1954

SUBJECT: Tank Helmet Radio

TO: Chief, Signal Corps
Engineering Laboratories
Fort Monmouth, New Jersey

1. It is believed that the effectiveness of a tank platoon leader could be substantially enhanced if he were provided with communications which would always keep him in contact with his command tank. It is visualized that a helmet with a transmitter-receiver built-in, having an effective range of approximately 100 yards, netted with a similar transmitter-receiver within the tank, which in turn could feed into the present radio would permit the platoon leader to better perform the personal reconnaissance on foot, that is part of proper technique of commanding a tank platoon, and still retain control. All too often there is a reluctance to dismount and walk to the crest of a hill, or reconnoiter a questionable piece of ground for trafficability, because this action requires disconnecting from the radio equipment and interrupts his command and control of his unit. Also, such a device would facilitate contact with the small unit tank leader who may be dismounted, for example, conferring with the accompanying infantry leader in a covered and concealed position. A PRC-6 of current design does not fulfill the requirements because of it could not be used both in and outside the tank. In addition, it requires use of hands which prevents the platoon leader, from using a map or binoculars or from performing other tasks simultaneously.

2. If by use of printed currents in a laminated nylon helmet the cost could be reduced sufficiently, such a helmet radio netted with the platoon command channel would be of great use to every tank commander. It would place him in constant communications with his tank and would be useful, for example, in leading his tank into a covered and concealed firing position or into a bivouac area at night. Such a unit should be self-contained with no outside power connections necessary, which should be possible through the use of printed circuits and transistors to reduce cost and power requirements. Power could be supplied by a battery contoured to fit the front or back surface of the helmet.

/s/ ROLLIN T. STEINMETZ
Lt Colonel, GS

WSM/JHessel/nrs
Rewrite by Mr.Hessel
CSL 6660
HP 44659
D 134634

1st Ind

SIGEL-CRB-4, Project SC1R (14 Dec 54)
SUBJECT: Tank Helmet Radio

Headquarters, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

THRU CONARC Liaison Officer, Fort Monmouth, New Jersey

TO Commanding Officer, Headquarters, The Armored Center, Fort Knox, Kentucky, ATTN: AIDIT

1. For several years these Laboratories have been experimenting with the idea of very small radio equipment for use by the Infantry rifleman. Progress has been somewhat slow, first because there has been no stated requirement for such equipment, and second because the battery requirements made the achievement of really small size impractical so long as it was necessary to use vacuum tubes.

2. Within the past year varieties of transistors suitable for this application have appeared, and experimental models of sets have been built and tested. Inclosed herewith is a memorandum Report, RCB-76-55, dated 8 June 1955 which summarizes results to date.

3. It is suggested that the views of the Armored Center on this subject be made known to CONARC and that suitable military characteristics be formulated.

4. Apology is made for the delay in answering your letter which was caused by the desire to include the attached report giving results of field tests rather than laboratory measurements.

FOR THE COMMANDING OFFICER:

1 Incl
Memo Report RCB-76-55
dd 8 June 55

GEORGE METCALFE
Lt Colonel, Signal Corps
Actng Director, Coles Signal Lab

Copies furnished:
CONARC Ln/O, Fort Monmouth, w/prev corres, w/Incl
Marine Ln/O, Fort Monmouth, w/prev corres, w/Incl
Admin Div, Hq, SCEL, thence to
Comm Sec, Hq, SCEL w/o prev corres, w/o Incl
M&R, CSL w/prev corres, w/ incl

COLES SIGNAL LABORATORY, SCEL
RADIO COMMUNICATION BRANCH
FORT MONMOUTH, NEW JERSEY

SIGEL-CRB-4
Project 801R

RCB-75-55
8 June 55

M E M O R A N D U M R E P O R T

MEMORANDUM TO: Chief, Radio Communication Branch, CSL

S U B J E C T: Communications Equipment for Forward Area Combat Personnel

1. PURPOSE: This memorandum covers the results of a preliminary investigation to determine the feasibility of communication with small radio equipments installed in composition helmets.

2. CONCLUSIONS: It is concluded that:

a. It is feasible to install in a composition helmet a radio set which will provide about 200 yards communication range.

b. The standard composition helmet design is not suitable. It will be necessary to provide space in the form of bulges at either side of the helmet for the radio equipment. The outer surface of the proposed radio helmet should be contoured to closely resemble that of the standard helmet so as not to reveal the presence of radio equipment.

c. The equipment described can be materially improved by reducing regenerative tendencies, increasing sensitivity of the receivers, better limiting, and providing more audio output.

3. RECOMMENDATIONS: In the event that this project is continued, it is recommended that the following be accomplished:

a. Design a new radio set which would include the foregoing modifications and which would satisfy military environmental requirements.

b. Procure composition helmets contoured to provide mounting facilities for the radio equipment.

GCE-R
SUBJECT: Work Directive CE-29 R

L. Purpose of Project and Comments:

1. This investigation is for the purpose of study and experiment on various means for improving the portability of small radio sets by the combat soldier. Fighting effectiveness is compromised by any equipment or mission which the soldier cannot easily combine with his offensive operations.

2. The soldier's primary weapon is his rifle. He should be able to keep his rifle in ready position while performing necessary radio communication. The present provision of rifle and radio as separate items, each requiring use of the hands, is inconsistent with the desired situation.

3. We are aware of numerous ideas for affixing the radio to the wearer. Radio Set SCR-511, intended for the horse-mounted cavalryman, is an example of the idea of adapting the package to the user's mission. Other suggestions have received less attention.

4. It is requested that your Laboratories investigate the problem outlined above.

a. It is desired that special attention be given to the possibility of affixing a Radio Set to a rifle stock; the mounting should permit adjustability of the set to various positions to conform to particular user needs, and should permit easy attachment and detachment of the set. Modification of the rifle, if required at all, should be kept to an absolute minimum.

b. Also, it is desired that special consideration be given to design of a radio set packaged in the form and dimensions of a standard rifle stock, so that it may be quickly substituted for the standard stock as required. In this form, microphone, earphone (and/or earphone connection), collapsible antenna, and batteries should be provided as a unit.

c. Particular study should be given to the feasibility of mechanical construction of a radio set that would fit the liner of a helmet, above the webbing, with an earphone fixed to the liner and provision for a throat or boom microphone. Voice actuation of the talk circuit in lieu of a mechanical push-to-talk device would be desirable.

5. It is requested that at least mock-up models, two in number, of the arrangement considered most feasible be fabricated. Disposition instructions will be furnished later.

6. In this investigation it is most important that the contemplated design of the radio be such as to permit manufacture by automatic processes to the maximum extent, to result in an item that is practicallly expendable.

413.44 (8 Sept 55)
CSRD/D 10 September 1955

MEMORANDUM FOR: LIEUTENANT GENERAL JAMES M. GAVIN

SUBJECT: Division Test of Individual Soldier's Radio

1. In response to your query of 8 September, the following outlines the status of provision of radio communication to squad leaders in a test division on an experimental basis.

2. RCA recently made a descriptive proposal to the Signal Corps covering individual transmitter-receivers capable of operating in the 47-50 mc band. This is a portion of the band used by the Infantry. Attached is a copy of RCA's proposal. It should be emphasized that this proposal does not constitute a bid, and I would appreciate it if you would return the proposal to me.

3. Chief Signal Officer proposes procurement of a sufficient quantity of these sets for a division test. A portion would be belt-mounted and the majority carried in a special helmet. The cost would be $2 million at most with delivery in about twenty-one months. This estimate is based on 5000 sets, which is probably considerably more than we need. The actual number required for a valid test will be worked out with G3.

4. CONARC stated "no requirement" for such a device some months ago. A CONARC reply to G3's recent request for reconsideration is expected within two weeks. We have learned informally that CONARC will restate "no requirement".

5. We have agreed with G3 to withhold final action on this matter until CONARC's position has been analyzed.

SIGNED

ANDREW P. O'MEARA
Brigadier General, GS
Chief of Research and Development

1 Incl
RCA's proposal

Copies Furnished:
ACofS, G3
Chief Signal Officer

SIGRD-6-b6 (9 Jan 56) 2nd Ind
SUBJECT: Portable Radio Sets for Riflemen

DA, OCSigO, Washington 25, D. C., 25 January 1956

TO: Office of the Quartermaster General, Department of the Army, Washington 25, D. C. Attn: QMGRD-D

1. For several years operations research has indicated the possibility that front line activity of squads might be conducted more efficiently, more expeditiously, and with fewer casualties, if individual soldiers were equipped with radio communication equipment. However, there have been no statements of requirements for such a widespread issue of signal equipment.

2. In order to determine whether there is a real requirement , and its extent, DCS, Log, USA, is presently considering a proposal to procure some 2600 miniature radio sets for use in extensive field exercises. Approximately half of the procurement will be of the helmet mounted type. At present, it is expected that the helmets will be of a special nonconductive material, such as thermosetting plastic, with the antenna buried or fastened inside to avoid projections which might call special attention to the wearer. The radio receiver will be mounted in the bulge over one ear while the transmitter will occupy the bulge over the other ear. For these exercises, the helmet will be considered a part of the radio set and will be procured with it.

3. If the exercise is conducted and a real requirement is revealed, the basis for development of the radio equipment and of the helmet will be established. Following approval of the proposal, a period of about two years will be required for procurement and completion of the tests. Definite infomation relative to the helmet will not be available until that time when full coordination with the Quartermaster Corps will be effected.

FOR THE ACTING CHIEF SIGNAL OFFICER:

A. M. RICCIARDELLY
Colonel, Signal Corps
Chief, Communication Equipment Branch

SM-10

COMMUNICATIONS DEPARTMENT, USASRDL
TRANSMISSION FACILITIES DIVISION
FORT MONMOUTH, NEW JERSEY

SIGFM/EL-NRC
3B24-01-001-06

28 April 1960

M E M O R A N D U M R E P O R T

MEMORANDUM TO: Director, Transmission Facilities Division, CD

S U B J E C T: Report of Trip to Hq, USCONARC, Fort Monroe, Virginia on 26 Apr 60, re: Helmet Radio Set

1. In accordance with the request of letter from OCSigO, dated 1 Apr 60, the undersigned attended a conference at USCONARC Headquarters, Fort Monroe, Virginia, on 26 April 1960, with the following personnel:

Bruger, E. J.	Lt. Col.	CD, USCONARC
Durrer, J. H.	Civ	USASRDL
Emrich, R. F.	Major	R&D, OCSigO
Gillette, G. V.	Lt. Col.	USAAMS
Hardin, G. B.	Major	Commo Dept, USAARMS
Hill, R. J., Jr.	Col.	USAAMS
Lee, R. P.	Civ	USASRDL, LnO
Murray, J. H.	Lt. Col.	CDO - USAIS
Raymond, R. E.	Capt.	A&E BD
Robers, J. B.	Major	G4, USCONARC
Russel, C. R.	Major	QM, USCONARC
Smith, H. R.	Lt. Col.	A&E BD
Tanner, R. K.	Lt. Col.	CD, USCONARC
Van Sandt, W. A.	Lt. Col.	CD, USCONARC
Walnes, P. A.	Major	Med, USCONARC
Ware, A. L.	Civ	OCSigO
Ware, M.	Civ	OCSigO
White, J. C.	Civ	A&E BD
Williams, H. O.	Major	MD, USCONARC

2. The conferees were satisfied with the form factors of the helmet radio receiver and transmitter proposed by this Laboratory and it was decided to send the QMR covering this equipment back to infantry for modification which would cover this type form factor. Essentially it consists of an individual receiver completely independent of the transmitter mounted on the helmet. It is hoped that a standard helmet can be used. The transmitter would be a separate unit with its own antenna and would be carried in the breast pocket or hung from a strap when not in use. When in use it would be held in the manner of the standard handy talky.

SM-11

Headquarters
DEPARTMENT OF THE ARMY
Office of the Chief Signal Officer
Washington 25, D. C.

SIGRD-6-a2

SUBJECT: Squad Radio Set July 27, 1961

TO: Commanding Officer
U. S. Army Signal Research and Development Laboratory
Fort Monmouth, New Jersey

1. REFERENCES:

2. Considerable efforts have been expended by both your Laboratory and this office in evaluating the many applicable solutions for a relatively inexpensive radio set which will fulfill the requirement of an inexpensive and unsophisticated radio set for squad use. Utilizing the guidance provided by the U. S. Continental Army Command, the many applicable solutions were narrowed to the development of a hand-held transmitter and a helmet-mounted receiver similar to those described in references 1a, 1b, 1c, and 1e above. Because of the emphasis being placed upon low unit costs for these equipments, procurements of these units were proposed on an "equipment performance" basis with a relaxation in component testing and certification procedures as well as the requirements for extreme environmental operations and standardization. Procurement of 1000 transmitters and 5000 receivers was proposed based upon the stated utilization factors.

3. By reference 1g, your Laboratory was advised that $1,550,000 had been programmed in FY-1962 Research, Development, Test and Evaluation (RDT&E) Program for the contractual obligations regarding the development of this radio set. Consequently, it is requested that your Laboratory expedite the following:

a. Preparation of necessary specifications and procurement documents.

b. Establishment of a separate task under Project 3B24-07-001, "Short Range Radio Communications," (See Reference 1d).

c. Coordination with U. S. Army Signal Materiel Support Agency and the USCONARC's agency to be designated later.

d. Rendering of technical assistance to the U. S. Army Airborne and Electronics Board for the preparation of military characteristics.

FOR THE CHIEF SIGNAL OFFICER:

R. F. BRADY
Chief, Communications Branch
Research and Development Division

Miniature Radios

Chief of Staff CD Lt Col Pierce/2416/ab

1. REFERENCES:

a. Extract para 1a, DF, 10 Oct 61, subj: "Items of Interest to General Powell (U)." (TAB A)

b. DF, MD to CofS, 12 Oct 61, subj: "Miniature Radio." (TAB B)

2. PROBLEM: To provide for the development of a miniature radio to communicate between platoon and squad, and between squad leader and selected squad members.

3. DISCUSSION:

a. This headquarters was informed by DA on 19 Oct that the miniature radio proposed in our present QMR must be a replacement for the AN/PRC-6 radio. The AN/PRC-6 has a 1 mile range, and is used for communications between platoon and squad leaders. To assure development of an adequate radio, meet infantry requirements for communication between squad leader and squad, and provide a replacement for the AN/PRC-6, it is necessary to change the existing QMR to provide a two channel, one mile/500 meter capability.

b. The Infantry School (TIS) indicated they would withdraw the request for a troop test of the industry produced, off-the-shelf version of a miniature radio contingent on the QMR change.

c. TIS objects to the time required for normal R&D cycle and requests the development be expedited. The Signal Laboratory engineers have indicated there will be a requirement for R&D effort to produce this new radio.

d. The cost of the receivers will remain the same as estimated for the originally proposed set, i.e., $75. The transmitter is expected to cost about $250. Total cost to equip an infantry division, to include issuing receivers to selected members of the squad (e.g., fire team leaders) is not expected to exceed $350,000. To similarly equip with the AN/PRC-6 radios would cost approximately $250,000. There are sufficient AN/PRC-6 radios on hand to fulfill communication requirements pending an orderly development cycle.

4. CONCLUSIONS:

a. By developing a suitable replacement for the AN/PRC-6 radio the requirements of TIS will be met.

b. There is not apparent need for an early and accelerated troop test.

c. There will be a requirement for some research and development effort.

5. RECOMMENDATIONS:

a. Change the present QMR to assure the development of a radio that will suitably replace the AN/PRC-6 and meet TIS stated requirements.

b. Conduct no troop test until completion of service test by Airborne and Electronics Board.

2 Incl (Cont'd) VAN MATTA

SM-13

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF SIGNAL OFFICER
WASHINGTON 25, D. C.

SIGRD-6

SUBJECT: Squad Radio Set

TO: Commanding Officer
U. S. Army Signal Research and Development Laboratory
Fort Monmouth, New Jersey

1. References:

2. On 30 March 1962, the Materiel Requirements Review Committee approved without change the proposed QMR for a Squad Radio Set, and directed that development proceed immediately. An advance copy of the approved QMR is inclosed, for information and guidance.

3. It is requested that you continue and expedite actions already under way pursuant to reference 1a, with the objective of placing a contract for this equipment with the FY-1962 funds presently authorized therefor.

4. It is requested, also, that you proceed immediately on an in-house program to produce one or more engineering models of the transmitter and receiver. ...

6. The in-house effort should not interfere with or delay action toward placement of a contract, as now contemplated. Instead, progress on the in-house models may necessitate revision of the contract, once placed, either to curtail the development phase or to specify the Laboratory model as the prototype for Service Test models.

7. Request you furnish cost and time estimates for both the external and internal programs as soon as possible. In this connection, it is noted that $1,800,000 is programmed against this task in FY-63, primarily for the purpose of accelerating the availability of this item for limited war purposes. To the extent that your in-house effort contributes to this objective, the FY-63 funds are applicable to the in-house effort.

FOR THE CHIEF SIGNAL OFFICER

STUART S. HOFF
Major, General USA
Chief, Research and Development
Division

1 Incl
Advance Copy-QMR

DEPARTMENT OF THE ARMY
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UNITED STATES ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY 07703
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