DEVELOPMENT OF THE SEMI-AUTOMATIC

TWO-WAY RADIO STATION AS-3

Progress Report No. 4

Progress Report #4

Radio Station AS-3

March 11, 1957

STAT

EA-122-1

GENERAL

REPORTING PERIOD

This report covers the work accomplished by STAT on the development of the AS-3 Semi-Automatic Two-way Radio Station during the period January 1, 1957 to March 11, 1957. At the request of your representative, the report has been held past the normal period ending March 1 to permit inclusion of the results of a conference held March 11.

PERSONNEL ASSIGNED

Personnel assigned to this project on a full-time basis are

STAT Project Engineer

, Development Engineer

In addition, consultive and administrative assistance of STAT Vice President in Charge of Engineering, STAT Director, Development and Research Engineering, and STAT Senior Project Engineer, were drawn upon as required.

CONFERENCES

A conference was held on March 11, 1957, at this company with STAT of your organization, and STAT The purpose of the conference was to (1) discuss improving standards of Progress Reports, (2) review present status of AS-3 equipment, and (3) discuss in so far as possible the operational system of the AS-3 station. The next conference is scheduled in May, the date to be set later. The results of the March 11 conference were as follows:

(1) A discussion of the operational usage as applied to the function switch led to the following proposal for switch positions: (1) start, (2) receive, (3) key, and (4) msg.

(2) Section 3.3.2.3.1 of the specification is to be deleted.

(3) Section 3.3.2.3 of the specification is to include the words "A-1 emission only."

(4) The nomenclature for the cartridge is to be suggested by [redacted] STAT We would like to suggest CA-3.

(5) [redacted] is to delay further design of the method of operational packaging until the choice of the receiver has been made.

(6) [redacted] STAT is to proceed with the design of the combined AC Power Supply AP/AC-3 and Charger ABC-3 as one unit.

TECHNICAL DISCUSSION

TRANSMITTER AT-3

During this period a working model of the transmitter has been completed and packaged in an enclosure measuring 2-1/4 x 4-1/2 x 9 inches. This size is the same as the proposed size of Progress Report #2. Figure 4-1 is a photograph of the unit.

Referring still to Figure 4-1, the tuning train may be observed. Electrically, the transmitter makes use of the continuous tuning principles discussed in Progress Report #3 to permit the entire 3 to 30 mc band to be tuned as one range; and includes a special miniature capacitor and a unique rotary-tuned inductance. Mechanically, the oscillator tank coil, the oscillator tank capacitor, and the final amplifier coil are tuned simultaneously in a single mechanism. This technique reduces the number of presently-needed tuning controls to three - (1) oscillator, (2) final amplifier-tank capacitor, and (3) antenna loading. These controls are shown in Figure 4-2. Further work is in process to include the final amplifier tank capacitor in the tuning train, thereby again reducing the number of controls.

Figure 4-3 is a schematic diagram of the transmitter. Component values have not been specified, as final values are contingent upon evaluation tests currently being performed. As can be observed from the diagram, no transistors are employed. Their use in the low-power stages was explored, but the temperature rise in this compact transmitter enclosure due to the 6883 final amplifier tube alone was sufficient to preclude germanium devices.

A study of the performance characteristics of the various applicable vacuum tube types has resulted in the following tube complement:

V_1	Oscillator	6417
V_2	Final Amplifier	6883
V_3	Keyer	5902/5902A
V_4	Multivibrator	6111A

Oscillator. The oscillator is a modified Pierce oscillator, with the oscillator plate circuit tuned to either the crystal's fundamental, second, or third harmonic, as required. The choice of the 6417 as noted in Progress Reports #2 and #3 has been verified by performance thus far.

Keying Circuit. With respect to the keying circuit of V_3, after breadboarding the final amplifier grid-keying circuit of Progress Report #3 it was found that RF emission did not completely stop during "key-up" conditions. Conference with your technical group verified similar experience, making another approach to keying necessary.

A satisfactory answer in the form of keying in the oscillator cathode circuit (see Figure 4-3 again) is now employed, using a series pentode (5902/5902A) as the keying tube. Other keying techniques, such as keying the oscillator grid, produced erratic oscillation.

A type 6111A tube was first tested as the keyer tube, but the series switching circuit now used allows only about 50 volts on the plate of the keyer tube, V_3. At 50 volts the type 6111A does not have sufficient conduction to deliver the 20 milliamperes required for stable operation of the 6417 oscillator tube. Consideration of available subminiature tube types led to the selection of the five-star pentode 5902/5902A, which can deliver 30 milliamperes at 50 volts.

Figure 4-4 is a photograph of the r-f envelope of the transmitter when the keying circuit has a square wave input, and shows effective modulation amplitude.

A square wave of 6 volts RMS amplitude was used as the input to the keyer tube to produce the R.F. signal shown in Figure 4-4. It is therefore apparent that 6 volts RMS is the minimum output voltage required for the 150 cps multivibrator circuit, and for the AK-3 Keyer.

Multivibrator. Referring anew to the multivibrator stage (Figure 4-3), the type 6111A tube generates a square wave output of the desired 150 cps frequency, at an amplitude of 8 volts.

It will be noted that both the keyer tube, a type 5902/5902A, and the type 6111A multivibrator tube have 6.3-volt filaments. As a 12-volt filament supply is being used, it was necessary to place the filaments of these two tubes in series, with a resistor across the 6111A filament to bring the series current up to the 450 milliamperes required by the 5902/5902A.

A type 5635 tube was considered instead of the 6111A as it has the same heater current as the 5902/5902A, but the idea was discarded when the 5635 was found to be an obsolete type.

Final Amplifier. Performance of the type 6883 tube in the final amplifier circuit is substantially as anticipated in Progress Report #1. As can be seen from Figure 4-1, the final amplifier tank coil is gang-tuned with the oscillator tank coil and capacitor. Although this method of tuning is satisfactory in performance, operationally it is not satisfactory in that it is possible to tune the final amplifier tank capacitor, a separate control, to the wrong crystal harmonic. To overcome this operational difficulty, a revision in the tuning chain to include the final amplifier capacitor is being investigated.

Preliminary measurement of output power into the specified loads indicate a minimum of more than 25 watts at all frequencies in the tuning range. Quantitative measurements will be made as soon as accurate resistive loads can be obtained. It is our proposal that your technical group confer with us so that early correlation of measuring technique may be achieved.

Current work in process on the multivibrator is concerned with optimization of circuit constants. Finalization of this part of the transmitter circuit should complete the transmitter circuitry except for the output matching network design.

As already noted, loads and techniques for quantitative measurement of output power are being devised.

Work to reduce the harmonic content of the output is in process. We have adequate equipment available in our laboratories to make the necessary tests.

During the next report period the design of the output terminal arrangement, the antenna loading switch, and the function switch should proceed to the point where samples can be ordered and evaluated.

Measurement of transmitter harmonic content will be undertaken.

Further conferences to establish your requirements as to the method of unit interconnection - such as plug-in or lock-in - will be necessary before work on the power connector can go ahead.

KEYER AK-3

The work completed on the keyer to date is represented by the design and fabrication of the motor-drive train, and the accumulation of necessary data and samples of the dual pickup head.

The motor-drive train incorporates a slip-clutch with teflon disks as the friction medium, using a coil spring tensioning device to permit adjustment of friction to any desired value. This drive train produces a starting torque at its output gear of over one inch-ounce, quite sufficient to drive the cartridge.

The first samples of the dual pickup head were received from the supplier, the Nortronics Company of Minneapolis, Minn.

These heads show an inductance of 1 henry, making the use of a grounded emitter transistor amplifier desirable. When tested with a sample tape, the output level of the pickup head was found to be about 1 millivolt. As this is considerably less than anticipated, it will be necessary to investigate the reason for this deficiency.

A commercial tape recorder is now being modified to accept the dual head. A special tape is also being prepared, with pulse impressions on it which duplicate those which Coder AC-3 will produce. The output of the dual head thus serves as an accurate input signal for the design of the transistor amplifier and multivibrator circuitry.

Design of the transistor circuitry is scheduled to be started in the immediate future. An enclosure for the keyer is to be fabricated, although it now appears that a variation from the overall dimensions of Progress Report #2 may prove desirable. The final dimensions of this unit are contingent upon the operational location of the unit.

CODER AC-3

A preliminary package of the coder has been completed, with dimensions of 3-3/8 x 2-3/4 x 2-1/8 inches. This size is considerably less than that proposed in Progress Report #2.

The coder uses the push-button method of magnetic recording on a tape as discussed in the preceding Progress Report. The mechanical system has been designed and fabricated to perform the complete coding operation, with the exception of a part of the linkage which acts to displace one of the heads for the dash code. The mechanism appears to be rugged enough to withstand hard usage, in its present state of assembly, so that the final design will be satisfactory on this important count.

The problem of 3.7.1 of the equipment specification, which requires that the push buttons be interlocked such that only one can be depressed at a time, has been solved. A system of laterally-moving balls has been devised, which move to block any two of the keys when the third is pressed. The device is simple, jam-proof, and maintenance-free.

A dual coding head, using Alnico V with soft-iron pole pieces and a mechanical gap of .0003 inches, has been constructed, which should provide a flux density sufficient to saturate the recording tape. Used with a standard tape, and played back on a commercial tape recorder, an output pulse of one millivolt from the recorder's pick-up head was observed. The use of this type of coding system is therefore deemed feasible.

The coding heads are cast in epoxy resin, and have a size of 5/16 x 5/32 x 13/32 inches.

Currently, the linkage to position the magnetic head for the dash code is being finalized and fabricated.

An additional head is being built. Upon its completion, a test tape will be prepared for use with the Keyer AK-3.

BATTERY ABA-3

A preliminary model of the case for the battery has been completed (see Figure 5-7), with dimensions of 2-3/8 x 4-1/4 x 7-1/2 inches. These dimensions are in close agreement with those proposed in Progress Report #2. It is anticipated, however, that the 7-1/2 inch dimension will be increased when a power connection is added.

The weight of 10 type ACT8X Ni-Cad cells and the present case is 5 pounds 2 ounces, total.

It is planned to design a power connector after the method of interconnection between units is established. It will be necessary to redesign the case to include the connector and make provision for adequate venting.

DC POWER SUPPLY AP/BA-3

Work on the basic DC power supply design is limited, at present, until your choice of receiver, hence receiver power supply requirements, has been made.

Two different types of supplies are possible, applicable to two different types of receiver. Figure 4-6 is a block diagram of one type, where the receiver requires B+ as well as filament power. Included in this package would be two transistorized power supplies - one for receiver filament and plate voltage, and probably transmitter bias, the other for transmitter plate voltage.

In the event that a receiver needing only a 12-volt DC input is chosen, the first power supply can be omitted, and only the second one - modified to provide also transmitter vias voltage - be used. The saving in space and weight in the latter case is obvious.

Figure 4-7 is an interconnection diagram for the entire AS-3 radio station. As can be readily seen from this diagram, the choice of receiver will greatly affect the interconnection problem, and hence the design of the power supply case.

As soon as the choice of receiver is made, power requirements and interconnections can be finalized, and circuit design begun. [redacted] will be consulted on this task. STAT

AC POWER SUPPLY AP/AC-3

Conferences with your representatives have established the principle that it will be the function of the AC Supply AP/AC-3 to provide input voltage directly to the DC Supply AP/DC-3 whenever AC operation is desired instead of battery operation. It has been further agreed that the AC Supply (AP/AC-3) will be capable of serving as the Battery Charger (ABC-3), the type of service expected being chosen by means of a switch.

Figure 4-8 is a schematic of the proposed design.

Component design and placing of orders for samples are now being done.

CARTRIDGE CA-3

A choice of in-line (rather than parallel) spool placement in the cartridge has resulted in a unit which is both compact and easily operated. This design gives a cartridge with an overall size of

4-5/8 x 2-3/4 x 3/4 inches, a variation from the dimensions of Progress Report #2. Figure 4-9 is a photograph of the cartridge mechanism.

The operation of the cartridge is as follows: (Refer to Figure 4-9 again) the gear at the lower right is the drive gear for the left-hand spool, which, when driven, pulls the tape off the right-hand spool across the tape guide. The large gear in the center has a pile-up of bent washers on its shaft, which act as stops in both directions. Thus the length of tape is kept a constant. The start position is also obviously a constant.

A negator-type spring motor is built within the right-hand spool. This spring motor performs the automatic rewind function (required by Section 5.6.3.1 of the equipment specification) and maintains proper tape tension.

Current work involves investigating the use of nylon gears wherever feasible. Different spring motors are also being worked with to try to reduce the system torque of the cartridge, and thus the amount of drive torque required from the Keyer AK-3 motor.

The design and fabrication of the cartridge cover are still to be done. The use of light-weight materials is to be investigated to accomplish weight reduction wherever possible.

SUMMARY

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REQUESTED ACTION

would like to request a conference at an early date for the purpose of discussing the following two major items:

(1) Method of operational packaging and (2) the type of connecting devices to be used between units. It is desired to determine whether plug-in or a sliding locking type device is most applicable.

(3) Our work has reached a position where it is desirable to have a Printer (ATP-3) and Receiver (RR-) to facilitate further design of the complete system. STAT

Prepared by:

Approved by:

STAT

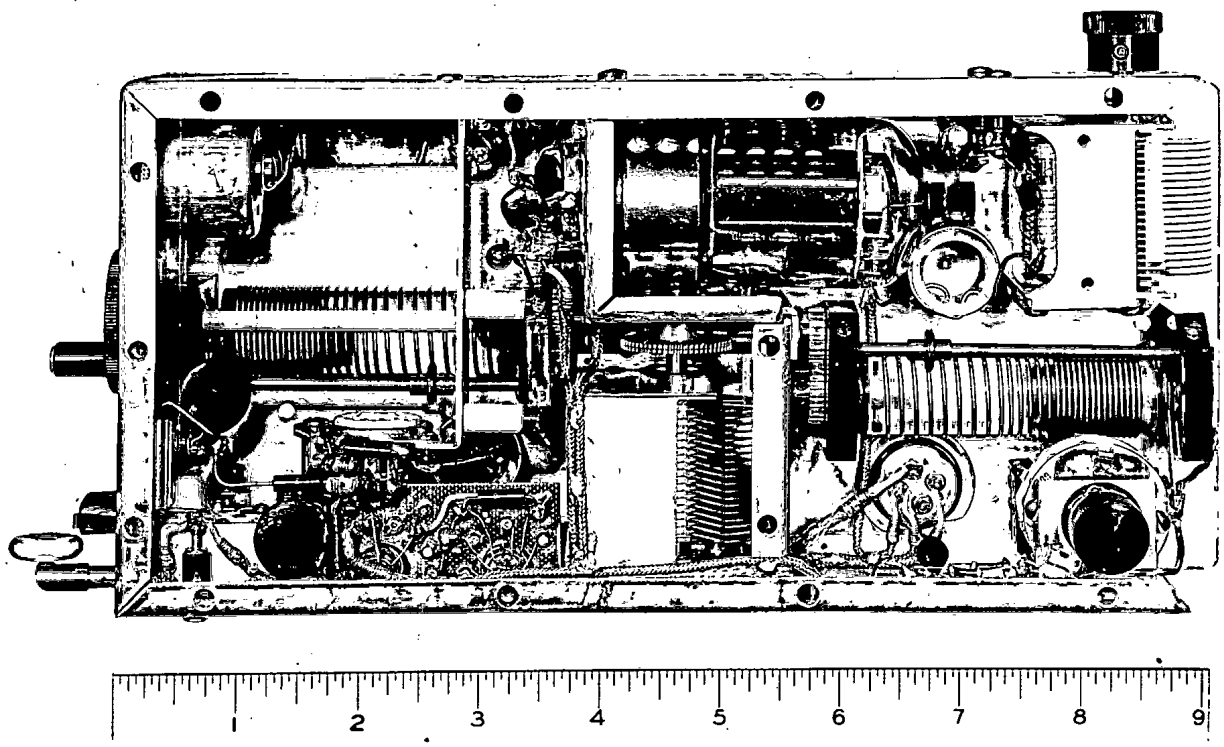

Figure 4-1. AT-3 Transmitter, Side View Showing Tuning Train of Engineering Model

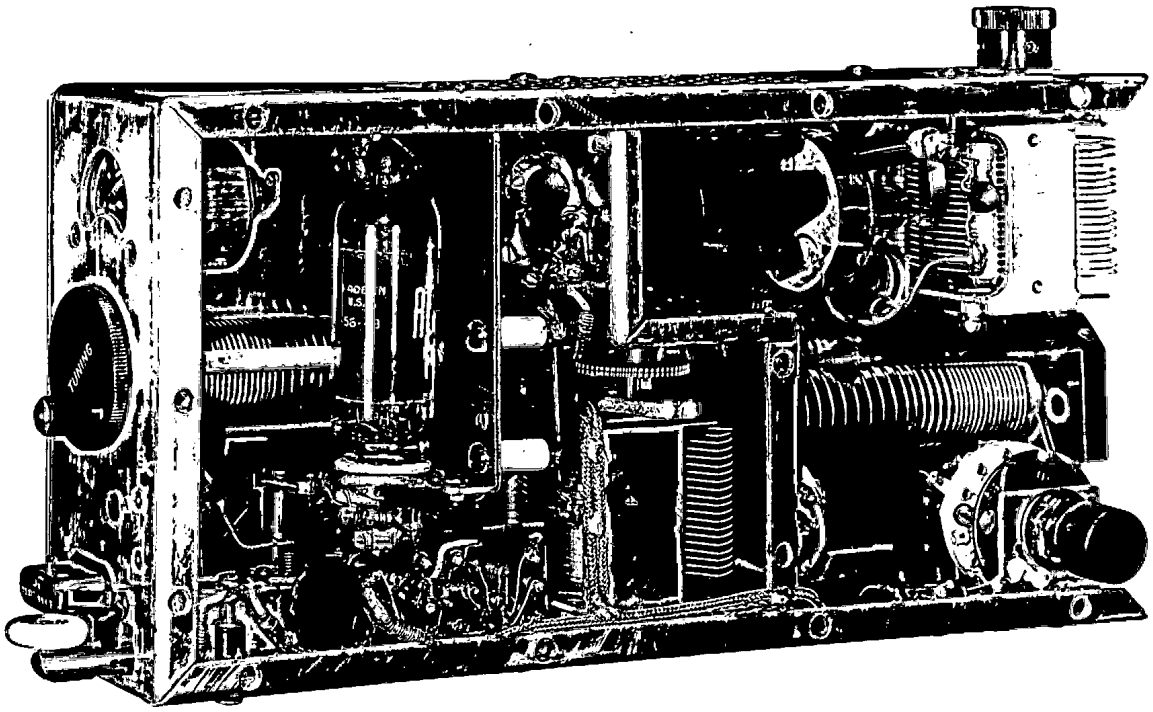

Figure 4-2. AT-3 Transmitter, View Showing Tuning Control and Hand Key

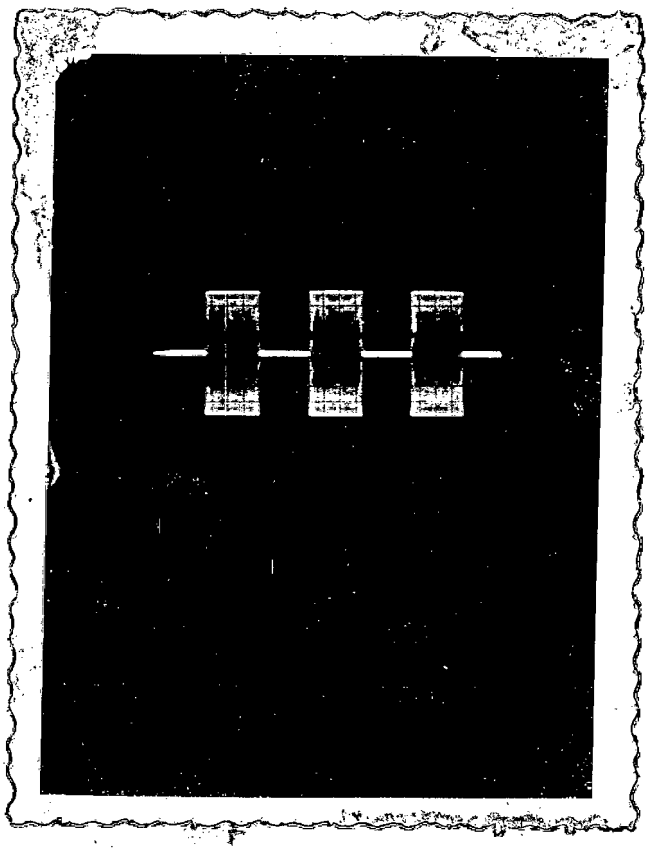

Figure 4-3. AT-3 Transmitter, Oscillogram of RF Envelope with 150-cps Square-wave Modulation

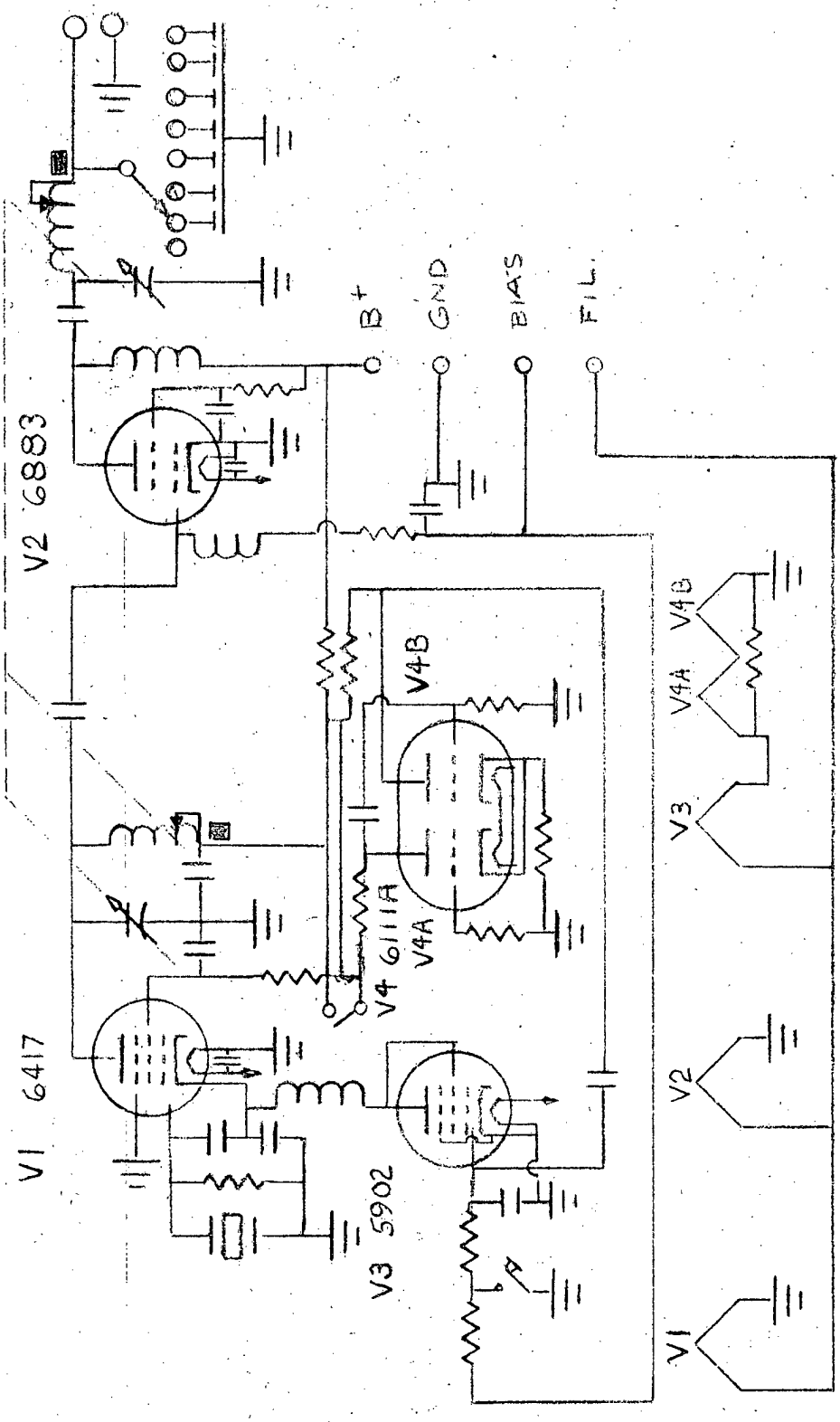

FIG. 4-4

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SCHEMATIC AT-3

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FORM 422

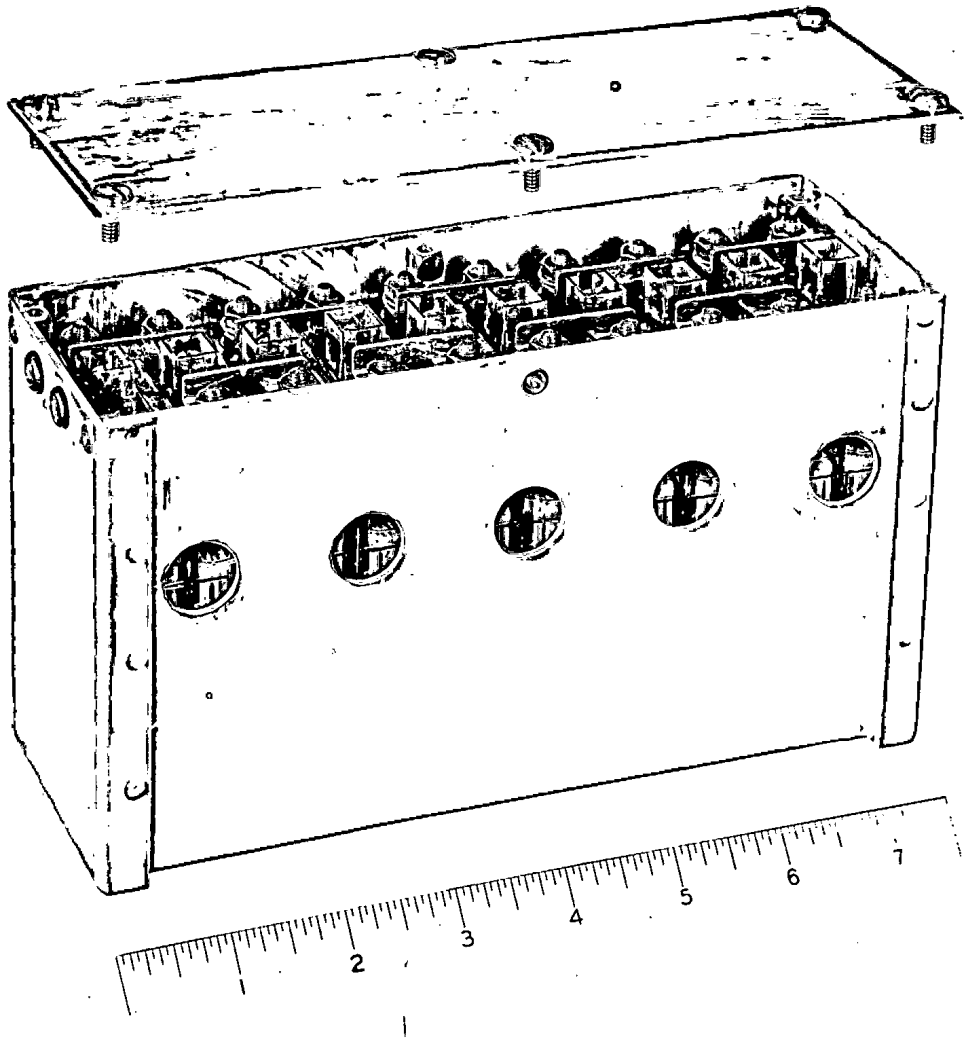

Figure 4-5. ABA-3 Battery, Engineering Model of Case, Less Connector, Battery Installed

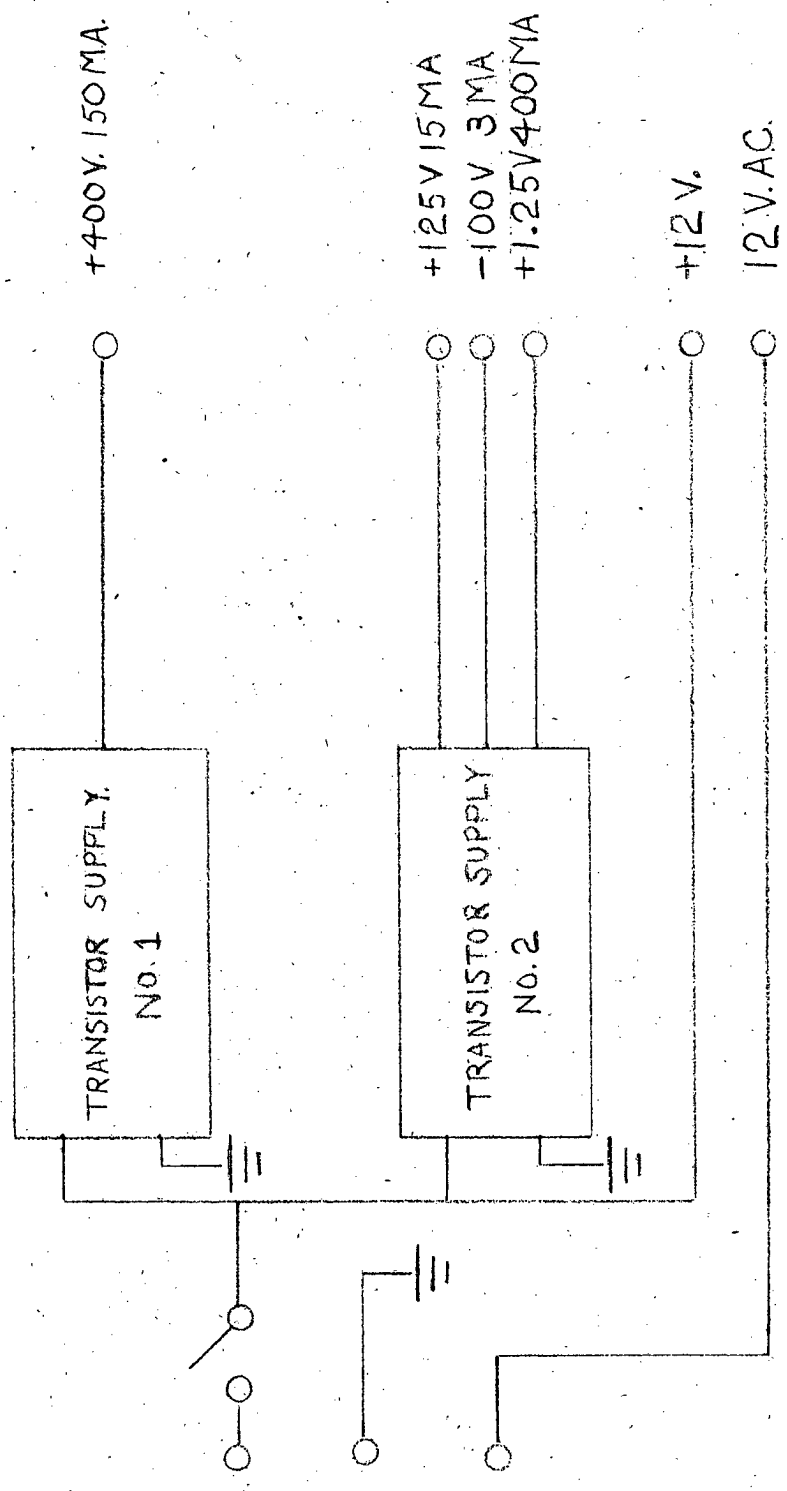

FIG. 4-6

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BLOCK DIAGRAM D.C. SUPPLY AP/BA-3

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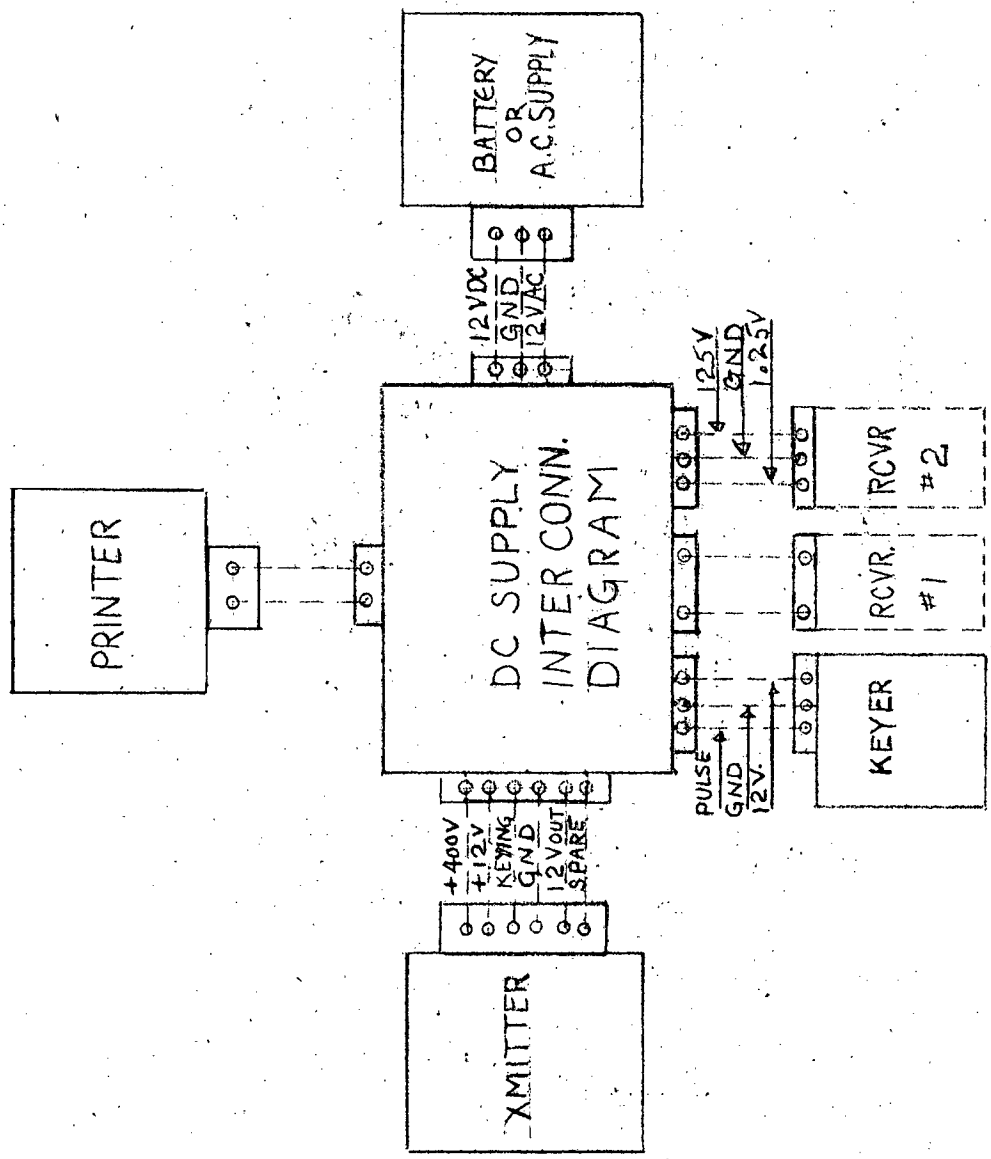

FIG. 4-7

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CONNECTION DIAGRAM AS-43

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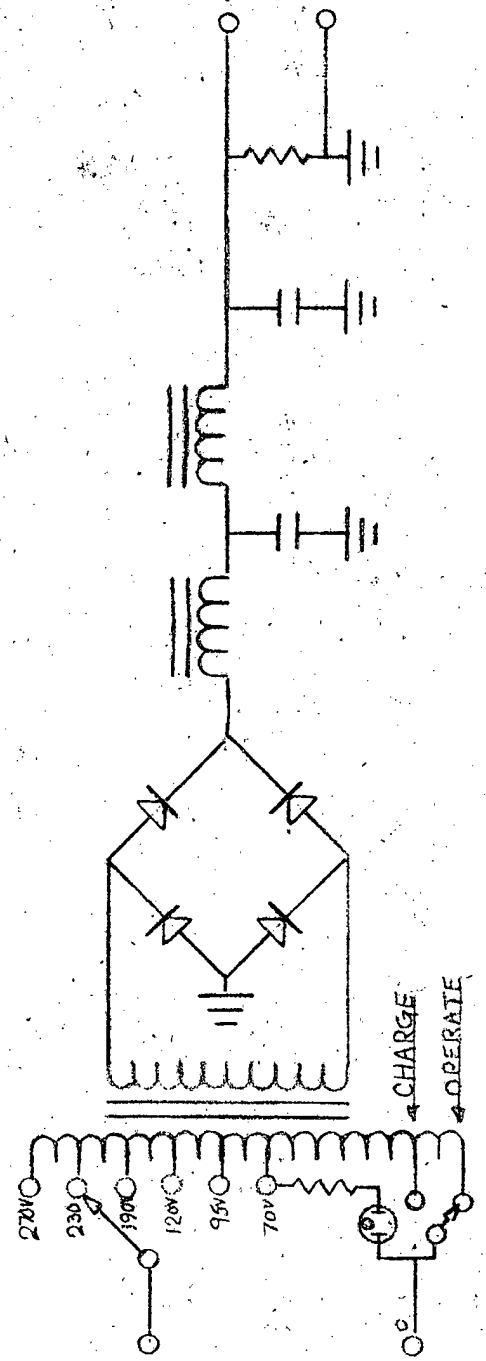

FIG. 4-8

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FORM 1470A

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