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An Ultra High Frequency Aircraft Receiver Using an Electronic Power Supply

by

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## 1. ABSTRACT

This report covers the development of a "dynamotorless" ultra high frequency aircraft receiver designed to operate from a 28 volt D.C. supply and to be used to replace the standard A.R.A. receiver.

The ultra high frequency receiver was constructed on the same type of chassis as the A.R.A. so that the A.R.A. rack and control box could be used without change. The necessity for the dynamotor as used on the A.R.A. was eliminated by the use of an electronic power supply. The tuning range of the receiver was 235-285 M.C./S. and the sensitivity was approximately 3 microvolts.

## 2. INTRODUCTION

It was desired to develop an ultra high frequency receiver which could be used as an exact replacement for the low frequency A.R.A. aircraft type receiver. Consequently, this requirement fixed the size of the chassis, type of connectors, control box, and supply voltage. Due to the shortage of rotating electrical machinery, it was required that this receiver operate directly from the 28 volt D.C. aircraft supply without the use of a dynamotor. It was also required that the receiver deliver approximately 300 milliwatts into a 300 ohm load and have a sensitivity of at least 5 microvolts for 50 milliwatts output.

The receiver as developed consists of a 955 converter, a 955 oscillator, three intermediate frequency amplifier stages using 6AG7/1352 tubes, a 6SQ7 diode detector and first audio, a 28D7 power amplifier, three 28D7 tubes and a V.R. 105/30 in the electronic power supply. The construction of the receiver is straight forward in every respect; the only unique feature being the electronic power supply. This consists essentially of a 20 kilocycle oscillator operating from the 28 volt D.C. primary source. Rectified grid current from this oscillator is placed in series with the 28 volt primary source thus giving a power supply capable of furnishing 105 volts D.C. at 35 milliamperes.

The frequency range covered was 235-285 megacycles per second and the sensitivity for 50 milliwatts output varied from three to six microvolts over the tuning range.

## 3. OSCILLATOR AND CONVERTER

From plate 1, it is seen that the radio frequency section of the receiver consists of a 955 oscillator and a 955 converter. The oscillator is of the Hartley type and is coupled to the converter by means of a small wire placed near the converter coil. In order to obtain good oscillator stability, it was necessary to regulate the voltage from the electronic power supply by means of a V.R. 105-30.

Preselection is obtained by means of a double tuned transformer coupling the antenna to the converter grid; the antenna being tapped approx-

imately one third of the distance up the primary coil. The voltage gain of this circuit is two to three times and the image rejection is around 30 decibels. Since this circuit is rather "broad", the overall bandwidth of the receiver may be taken essentially as that of the intermediate frequency amplifier. In order to obtain a single control receiver the oscillator tuning condenser is ganged with the two tuning condensers of the antenna coupling network; partial tracking being obtained by means of a small disc-shaped condenser placed across the primary coil.

In plate number 6, the arrangement of the components of the radio frequency section may be seen. The oscillator is mounted vertically in the lower left hand corner and the converter is mounted horizontally in the center of the unit; the three tuning condensers may be seen below the converter. This unit is quite compact, the maximum dimensions being 4" x 3" x 3-3/8".

Due to the necessity of "conserving" current, the total current drawn by the oscillator and converter was adjusted to approximately 5 milliamperes.

#### 4. INTERMEDIATE FREQUENCY AMPLIFIER

The intermediate frequency amplifier consists of three double tuned 15 M.C. stages using 6AC7/1852 tubes. These tubes were adjusted so that the cathode current drawn by each tube was approximately five milliamperes thus making the total current drawn by the i.f. amplifier about 15 milliamperes.

The construction of the i.f. transformers are shown in plate 2. This type of transformer was used because the effect of the tuning slugs on the mutual inductance is negligibly small. These transformers were loaded by a resistance of 2700 ohms on the secondary and the mutual inductance was adjusted to critical coupling, thus giving an overall bandwidth at the half energy point of 2.0 M.C./S. and a stage gain of about 24 decibels. Curves of the i.f. response are shown in plate 3. As mentioned before, this curve corresponds to the overall selectivity of the receiver.

Automatic volume control is applied to the grids from the rectified signal appearing across a portion of the diode load.

It should be noted that the anodes of the i.f. tubes are tied directly to the 250 volt primary source while the cathodes are connected to the negative output of the electronic power supply. This arrangement then places the anode at a positive potential of 105 volts as determined by the V.R. tube with respect to the cathodes. Since "ground" is at a positive potential of 80 volts with respect to the cathodes, the screen supply is obtained directly from "ground". The gain is controlled by means of a potentiometer in the control box which varies the screen voltage with respect to cathode.

## 5. DETECTOR AND AUDIO

The output of the i.f. amplifier is coupled to the diode section of the 6SQ7 which is used as the second detector. A portion of the D.C. output of the diode is fed back to the grids of the i.f. amplifier tubes for A.V.C. purposes. Also the signal output is taken from across the diode load and is coupled to the triode section of the 6SQ7 by means of a resistance capacity network. The output from the 6SQ7 triode is then coupled on to the grid of 28D7 which is used as the power amplifier tube and operates through a transformer into a 300 ohm load.

It should be noted that the 28D7 power amplifier obtains its anode supply directly from the 28 volt primary source and not from the electronic power supply, while the triode section of the 6SQ7 obtains its power from the electronic supply in series with the 28 volt source. The triode amplifier draws about normal current, (.9 milliamperes) and has a voltage gain of 34 decibels. The frequency response of the audio system is 300 to 3000 cycles. Due to the low anode voltage on the 28D7, the maximum obtainable power output is approximately 250 milliwatts.

## 6. ELECTRONIC POWER SUPPLY

This section of the receiver consists of three type 28D7 tubes used as a 20 kilocycle oscillator and designed so that the rectified grid current is used to supply the power requirements of the V.R. 105, oscillator i.f. and first audio tubes which amounts to a total of about 35 milliamperes. By placing the output of this oscillator in series with the 28 volt primary source a power supply is obtained that furnishes 105 volts as determined by the V.R. tubes at 35 milliamperes. It should be noted that the output of this supply is negative so that the following scheme was used: The cathodes of the tubes requiring high voltage were connected to the output of the electronic supply and the anodes to the positive of the 28 volt source. This arrangement thus placed the anodes at a potential of 105 volts with respect to the cathodes and permitted the screen of the i.f. amplifier tube to be grounded directly.

Power was supplied from the 28 volt D.C. source to drive the 20 kilocycle oscillator. The reason for using the low frequency oscillator is obvious; i. e., it is easier to make an oscillator work with reduced plate voltages at lower frequencies, and the output from this oscillator can be stepped up by means of a transformer, rectified and used as a high-tension source. This is essentially what was done with the exception that the rectified grid current of the oscillator was used instead of using a separate rectifier.

## 7. PERFORMANCE DATA AND DISCUSSION

Results of tests on the receiver indicate the following:

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- (a) Tuning range. 235-235 M.C./S.
- (b) Sensitivity 3-5 microvolts for 50 milliwatt output.
- (c) For a signal to noise ratio of 4:1, the input was 1.5 microvolts with a 30% 400 cycle modulated signal.
- (d) Maximum power output, 260 milliwatts.
- (e) Bandwidth is 2.0 M.C. at the half energy point.
- (f) Image rejection, 30 decibels.
- (g) Audio pass band, 300-3000 cycles.

Plates 4, 5, 6, and 7 show various views of the completed receiver. The receiver was constructed on the same size chassis as the standard A.R.A aircraft receiver, thus making the overall dimensions of the completed unit  $10\text{-}\frac{3}{4}\text{"}$  x  $4\text{-}\frac{11}{16}\text{"}$  x  $5\text{-}\frac{3}{8}\text{"}$ . The tuning control may be operated locally or may be connected to the remote control box by means of a flexible mechanical coupling.

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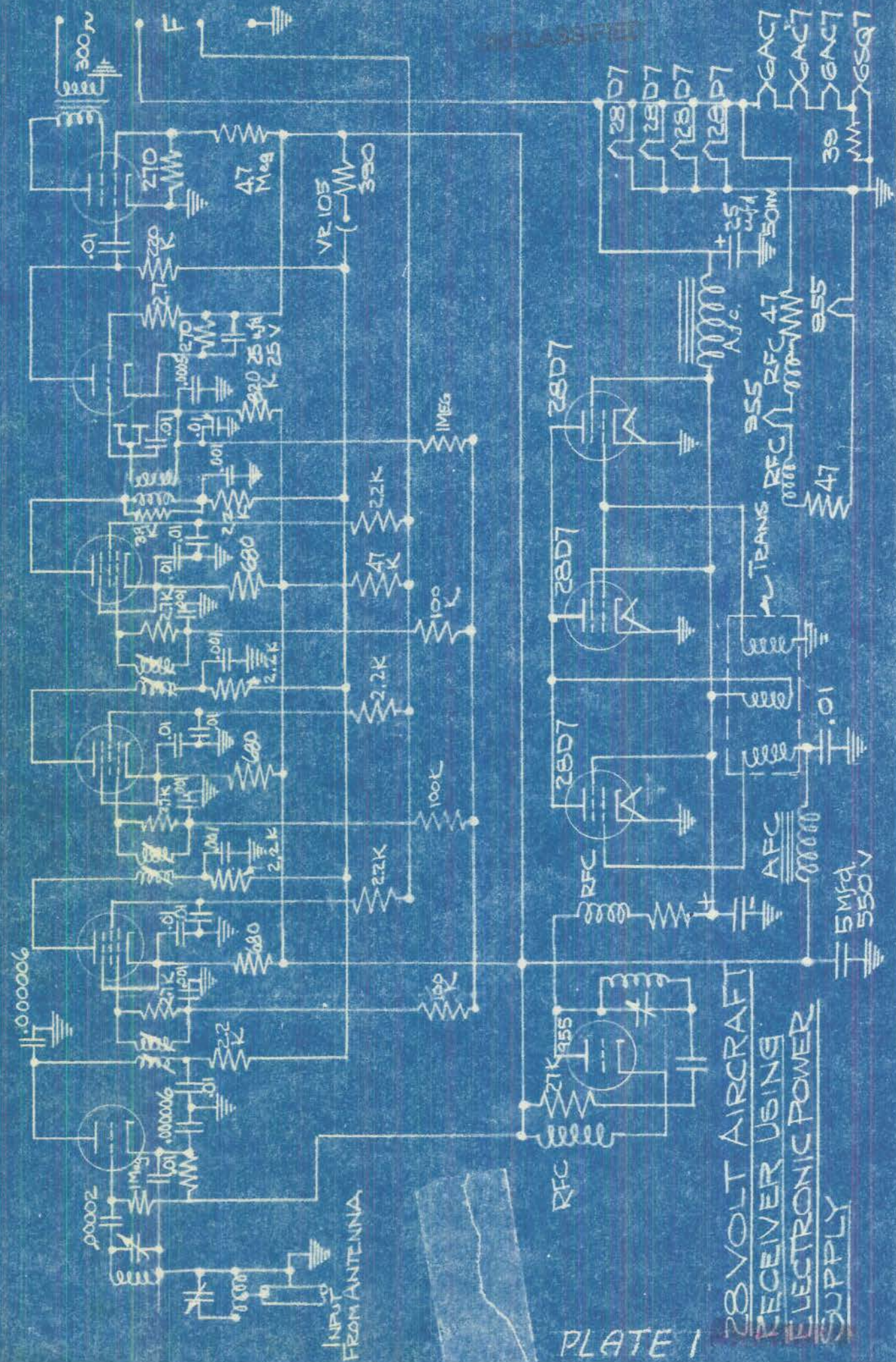


PLATE 1

28 VOLT AIRCRAFT  
RECEIVER USING  
ELECTRONIC POWER  
SUPPLY



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PLATE 4

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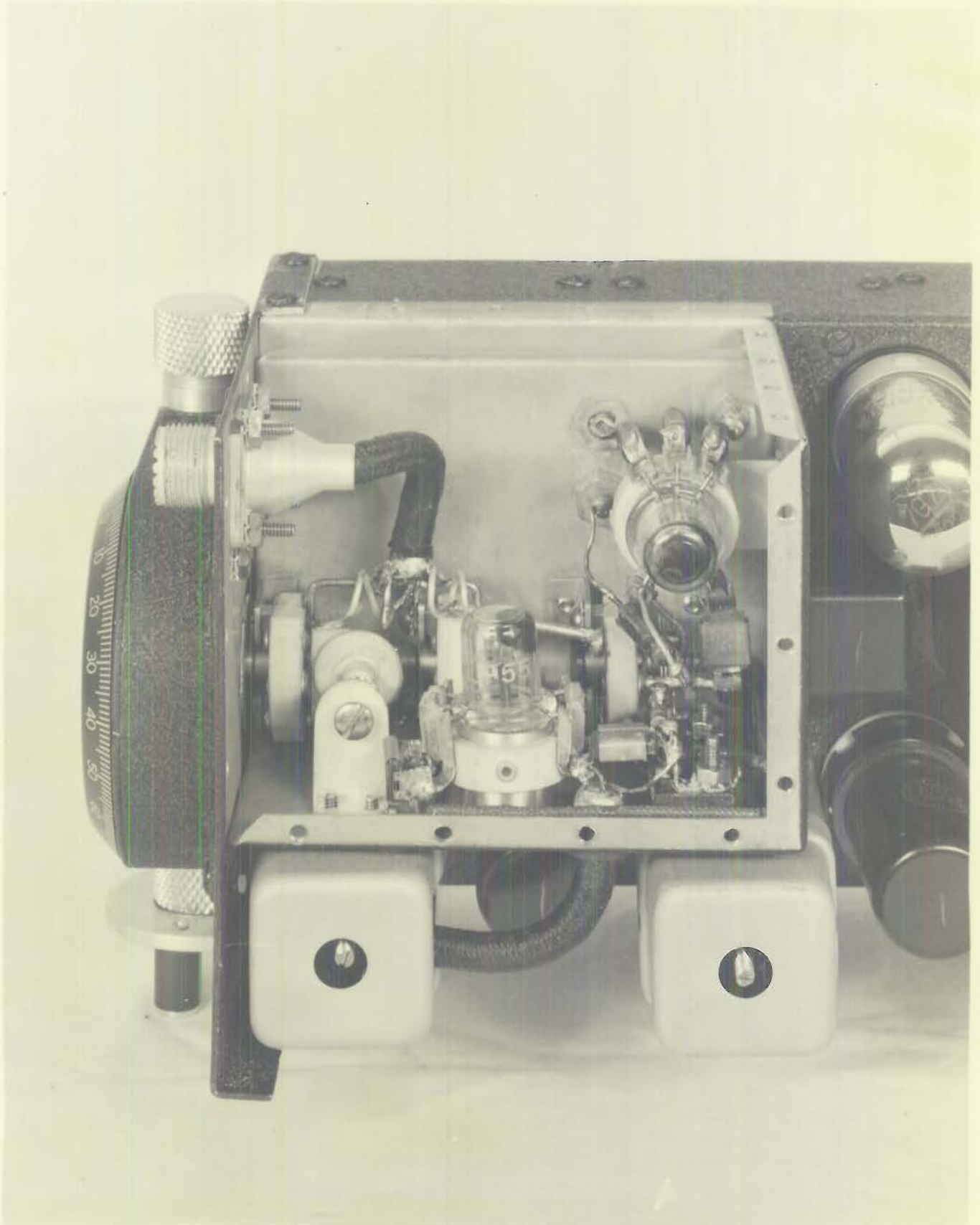


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PLATE 5

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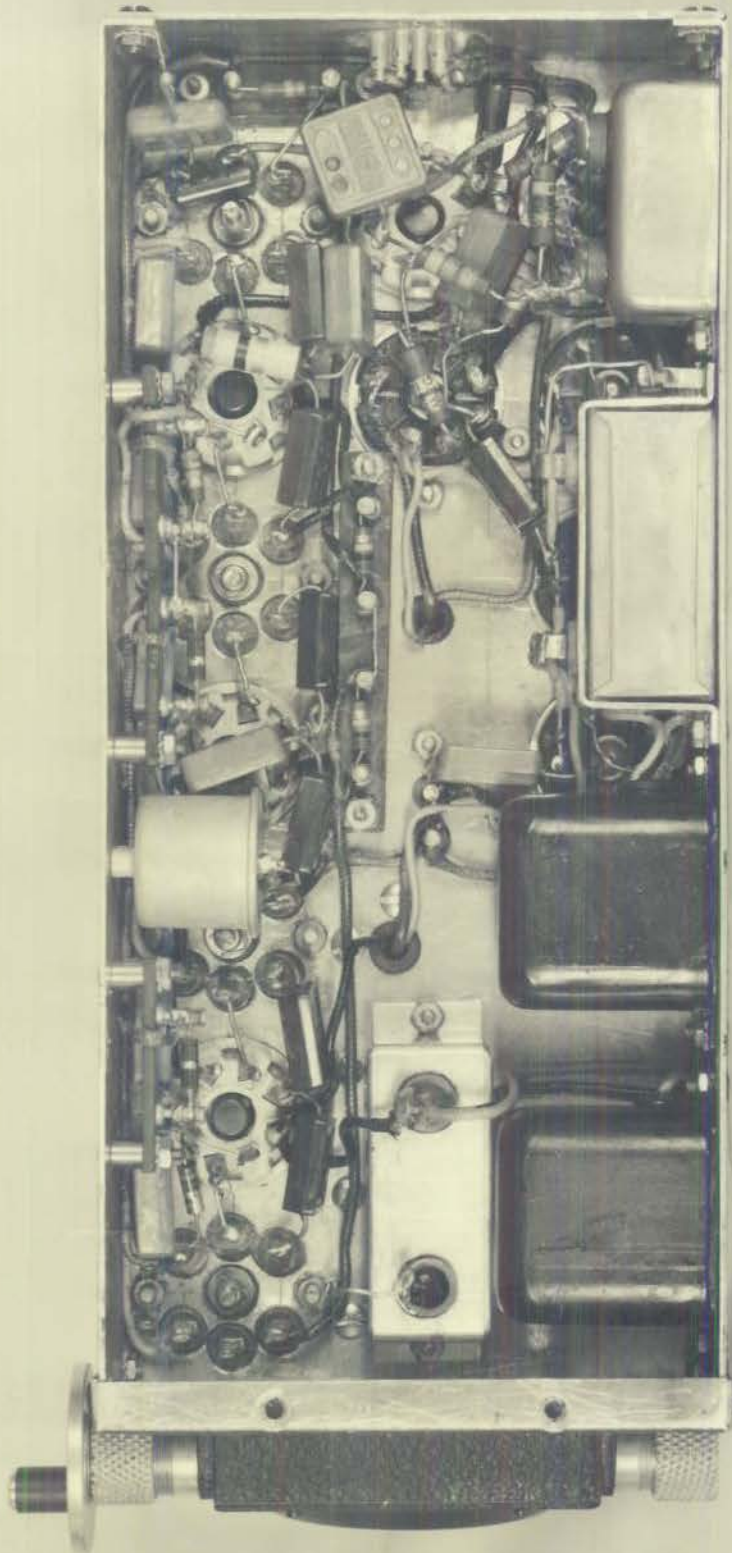


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PLATE 6

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PLATE 7