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S584R-C

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Navy Department

Report on

Development of an Adapter to Give Simultaneous Radar and D-F Signals on the PPI of a Radar System

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Table of Contents

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1. ABSTRACT.

This report describes a system for transcribing an indication of bearing from the model CXGH direction finding equipment onto a radar plan position indicator. The "figure 8" pattern of the direction finding equipment is superimposed on the regular PPI pattern. The operator can then identify targets when the radar bearing and CXGH bearing coincide. No internal changes are required in the PPI to present this information, and only slight modifications of the CXGH are required. This system is also readily adaptable to other types of direction finding equipment.

2. INTRODUCTION.

A desirable method of presenting bearing would be one in which no separate d-f operator or indicator is required and which would automatically present a uni-directional bearing by the brightening of one or two of the radial sweep-lines of the PPI.

Since the CXGH does not present a uni-directional bearing directly, automatic presentation of a single bearing on the PPI is excluded from further consideration. A manually operated uni-directional bearing indication can be transcribed to the radar PPI. A system of this type is described later in this report.

The next alternative would be the presentation of a bi-directional indication by illuminating two narrow sectors on the PPI. To do this calls for the selection of a certain minimum value of receiver output voltage, below which the sweep will brighten. Since all bearings taken do not have an absolute null, it would be necessary, when first getting a bearing, to use fairly low receiver gain, thus getting broad sectors illuminated on the PPI. The gain would then be gradually increased until suitable narrow sectors are illuminated. Only one indication of the value of the setting is observed per revolution of the PPI. With this speed quite slow, (25 r.p.m. or less), a relatively long period of time is required to obtain a good sharp indication. If the receiver gain is set too high or if the noise level increases, visual indication of the signals would be obtained intermittently or not at all. Too low a gain setting would make the illuminated sectors wide and unduly smear the PPI. When no signals were being received, the adaptation system would have to be de-energized or it would brighten the entire screen of the PPI.

The foregoing circumstances indicate that a presentation on the PPI similar to the narrow "figure 8" or "propellor" pattern on the regular CXGH indicator would be the most practical. It would give a continuous indication for tuning and setting receiver gain and also indicate the nulls, regardless of width, without unduly smearing the PPI with its consequent obliteration of radar echoes. Senso determination could then still be retained and used in a separate operation when needed.

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3. DESCRIPTION OF THE CXGH.

The CXGH equipment uses an Adcock type antenna system of four vertical monopoles and a rotating capacitive goniometer. A bi-directional bearing is indicated by the two nulls obtained as the goniometer is rotated. A uni-directional bearing is determined by introducing sense energy from a fifth monopole and observing the direction in which the pattern shifts. In normal operation, a fairly critical setting of receiver gain is necessary to get good null indication. The sharpness of null depends upon signal strength, purity of polarization (vertical), and prevailing local noise level. Bearing accuracy is affected by the presence of reflecting objects near the antenna.

4. DESCRIPTION OF ADAPTER UNIT.

To present the d-f pattern on the PPI without making any changes in the PPI system necessitates using one short pulse per radar sweep, the position of the pulse along the time base varying with the output of the d-f receiver. The pulse is at maximum range on the PPI sweep when the receiver output is minimum. The series of bright dots on the PPI then traces the narrow "figure 8" or "propellor" d-f pattern.

The circuit shown in Figure 1 was developed to accomplish the foregoing. Its operation is briefly as follows:

The radar sync pulse keys a Phantastron square wave generator (V1, V2), the length of the square wave being directly proportional to the potential on the cathode of the control diode (i.e., the higher the potential, the longer the square wave). This square wave is shaped and amplified by V3.

The goniometer at the d-f antenna is rotated in synchronism with the PPI by driving the goniometer with a selsyn energized from the PPI follow-up system. The output from the receiver detector is a slowly varying potential which is amplified by a direct coupled amplifier V4, whose plate is tied directly to the second cathode of the control diode V2. Thus the length of the Phantastron's square wave is determined by the signal amplitude of the goniometer output.

The constants of the Phantastron are such that its maximum length square wave, (no signal to d-c amplifier), corresponds to the radar PPI sweep length being used. By differentiating the back edge of this square wave a pulse is obtained, the time interval after the radar sync pulse being inversely proportional to the d-f signal intensity. This pulse is amplified by V5 and fed into a PPI video system using the standard IFF mixer channel. V6 is a similar circuit which allows mixing this d-f signal with the regular radar signals to be applied to the intensity grid of the PPI, should it not be desirable to use the IFF channel.

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Changes necessary in the CXGH receiver detector to get correct polarity output are also shown in Figure 1.

With no signal input to the d-f receiver, a bright trace appears at maximum range on the PPI. This position can be varied by the control R10. A signal to the receiver drives the trace towards minimum range. Proper adjustment of d-f receiver gain allows the nulls to be shown in the same manner as on the regular type CXGH indicator. Sense patterns can be taken in the usual manner but appear at 90° to the bilateral pattern since no switching of deflection plates can be done in this system as in the regular CXGH indicator. The correct bearing is then that half of the bilateral pattern appearing either 90° clockwise or counter-clockwise, depending upon the phase of the sense energy introduced into the antenna system. This direction always remains the same, once determined for any particular system.

This type of adaptation introduces no further errors into the system. It will present the bearings as accurately as they can be taken with the d-f system itself.

It can be adapted to operate with any d-f equipment giving either minima or maxima as bearing presentation.

Interconnections to the radar system required are synchronizing pulse, video input to PPI, and selsyn energy at 1-speed to energize the selsyn that rotates the goniometer.

5. DISCUSSION OF RESULTS.

Operational tests of the equipment at both the Naval Research Laboratory and at Chesapeake Bay have shown that the equipment can be adjusted to give good bearing indications easily and without obliteration of any echoes on the PPI. The tests at Chesapeake Bay Annex used the SC-2 radar system with a TBM plane flying a SCR-274N transmitter as a target and signal source. Good bearing indications were obtained at ranges as far as 50 miles (over water). The patterns obtained varied between approximately 10° and 15° in width.

Plates 1 and 2 show patterns obtained during these tests.

The patterns shown in Plate 1 were obtained on a Remote PPI not connected into a radar system. The antenna location as shown in Plate 3 was good and there were no reflecting objects near the antenna. The signal source for these patterns was a small test oscillator located about 100 feet away. Similar patterns were obtained from an ARC-5 transmitter flown by a SBD plane in flight tests at this location. In all cases indicated bearing corresponded with the positions reported by the plane during flight and also with the known bearing of the test oscillator when placed in various locations.

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The antenna location available for the tests at Chesapeake Bay Annex was poor. Numerous metallic structures were within 25 feet of the antenna. At very few times did the radar and d-f bearings coincide. However, since the accuracy was checked previously, the primary purpose of these tests was to determine the usable range and the degree of conflict between the two systems when operated together.

6. ALTERNATE SYSTEMS.

A simpler and more direct method of presenting bearing information to the PPI, although not the more desirable, is one in which correct bearings are set up manually at the d-f equipment and then transcribed to the PPI by mechanical or electronic means.

The CXGH equipment would be operated independently of the radar, retaining its present indicator and goniometer speed of 1800 r.p.m. A transparent rotatable screen with an engraved cursor line would be placed over the present indicator. The operator at the d-f equipment would manually set the cursor to the correct bearing when it is determined.

Once the bearing was set up, it could be transmitted to the PPI in several ways.

A selsyn could be mechanically coupled to the cursor screen at a 1:1 ratio. A repeater selsyn at the PPI would drive an indicator disc over the PPI tube or in its projection path.

The rotatable screen could be mechanically coupled to an opaque disc approximately 3" in diameter and having an aperture approximately 1° in width. A like disc would be mounted parallel to it and coaxially driven by a repeater selsyn energized from the PPI follow-up system. A light source behind one disc and a photo-tube behind the other would provide a means of generating a short pulse when the two apertures pass each other. This pulse properly shaped and amplified would be applied to the PPI intensity grid. The length of this pulse should be equal to the reciprocal of the repetition rate of the radar. When a correct bearing is obtained, the d-f operator would set the cursor and energize the adapter thus giving a bright radial line on the PPI which should bisect the correct echo.

A variation of this method would be the use of mechanical contacts on the discs actuating a pulse generator instead of the apertures with light source and photocell.

Various modifications of these systems could be used depending upon the particular requisites of the problems encountered.

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Adapter Circuit
Components List

R-1	47K	1 Watt	
2	10M	½ Watt	
3	12K	5 Watt	
4	1.2M	½ Watt	
5	5.6K	1 Watt	
6	10K	2 Watt	
7	5.6K	1 Watt	
8	82K	1 Watt	
9	47K	2 Watt	
10	25K	2 Watt	Potentiometer
11	47K	2 Watt	
12	33K	10 Watt	
13	1M	1 Watt	
14	12K	10 Watt	
15	33K	10 Watt	
16	33K	½ Watt	
17	5.6K	½ Watt	
18	47K	1 Watt	
19	1M	½ Watt	
20	1K	2 Watt	Potentiometer
21	.5K	20 Watt	
22	.1K	20 Watt	
23	120K	½ Watt	
24	120K	½ Watt	
25	150K	½ Watt	
26	1M	½ Watt	
27	1K	2 Watt	Potentiometer

V-1	6SA7
V-2	6SN7
V-3	6AG7
V-4	6AG7
V-5	6SN7
V-6	6SN7
V-7	6H6
V-8	5Z3-G
V-9	VR-150
V-10	VR-150

C-1	100 mmfd	400 V	Mica
2	200 mmfd	400 V	Mica
3	.001 mfd	400 V	Mica
4	.0025 mfd	400 V	Mica
5	.005 mfd	400 V	Mica
6	.5 mfd	400 V	Paper
7	.25 mfd	400 V	Paper
8	.25 mfd	400 V	Paper
9	25 mmfd	400 V	Mica.
10	.005 mfd	400 V	Paper
11	.1 mfd	400 V	Paper
12	10 mfd x 3	400 V	Electrolytic.
13	.05 mfd	400 V	Mica

Sw1	4 pos. wafer switch
T 1	Power Trans. 350-0-350 100 Ma
L 1	Filter Choke 30 H. 100 Ma.

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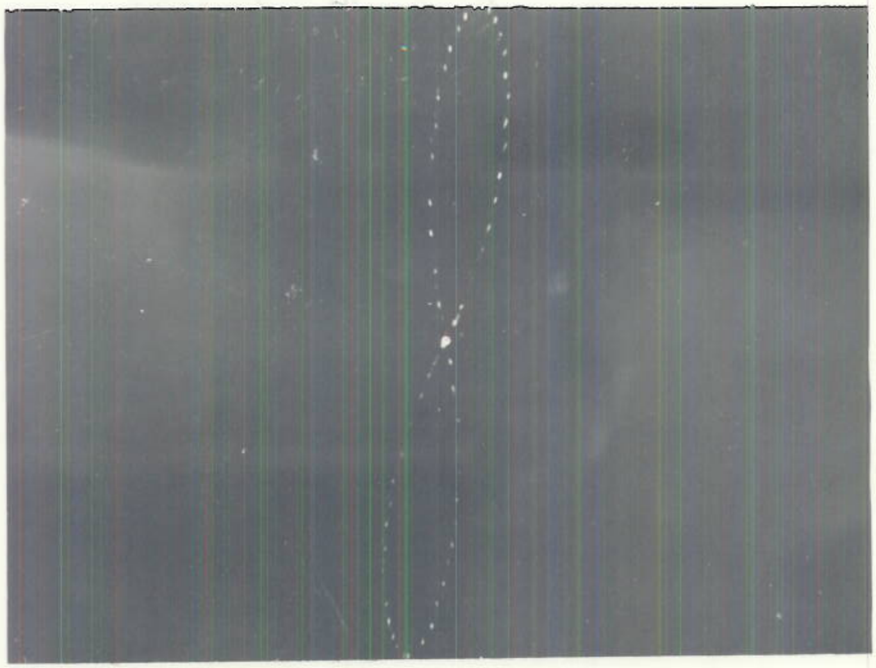

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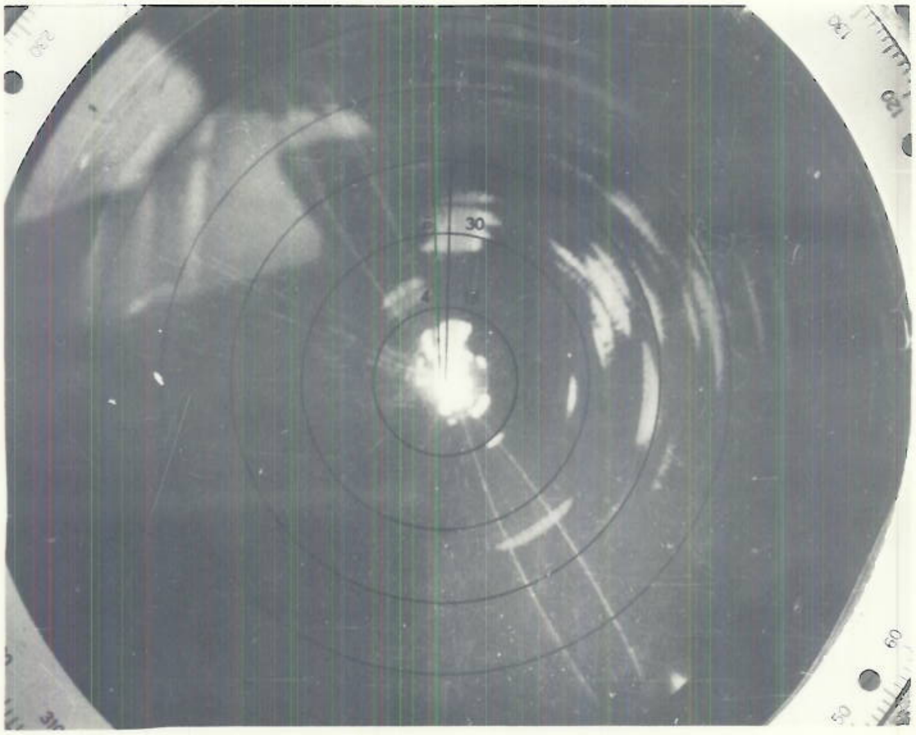
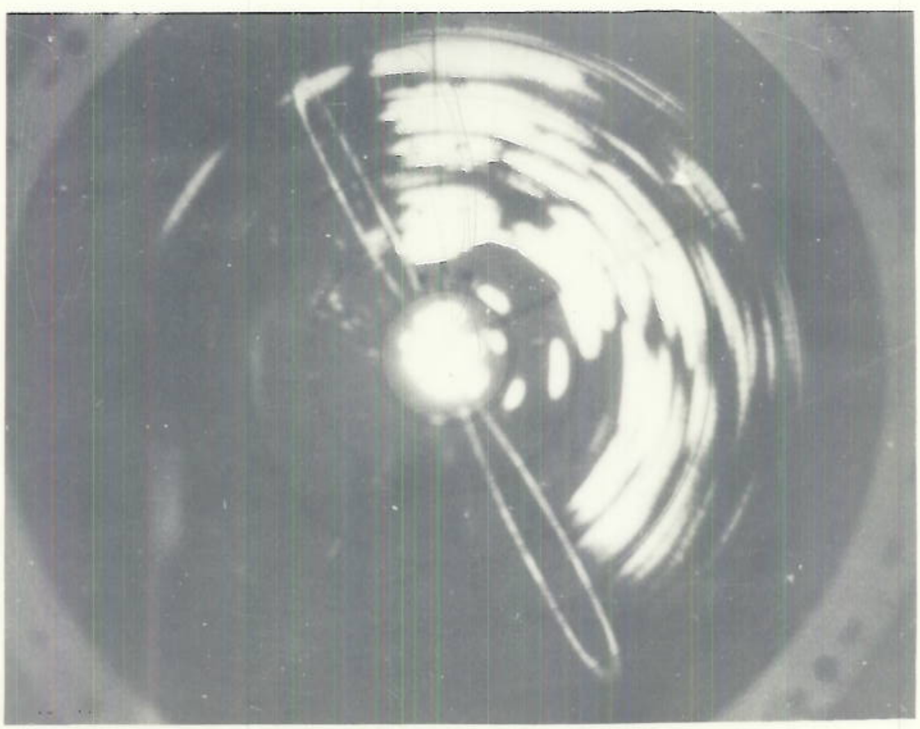
TESTS AT N. R. L.
PATTERN OF TEST OSCILLATOR ON
REMOTE PLAN POSITION INDICATOR
NOT CONNECTED TO A RADAR SYSTEM.

CONFIDENTIAL

PLATE I





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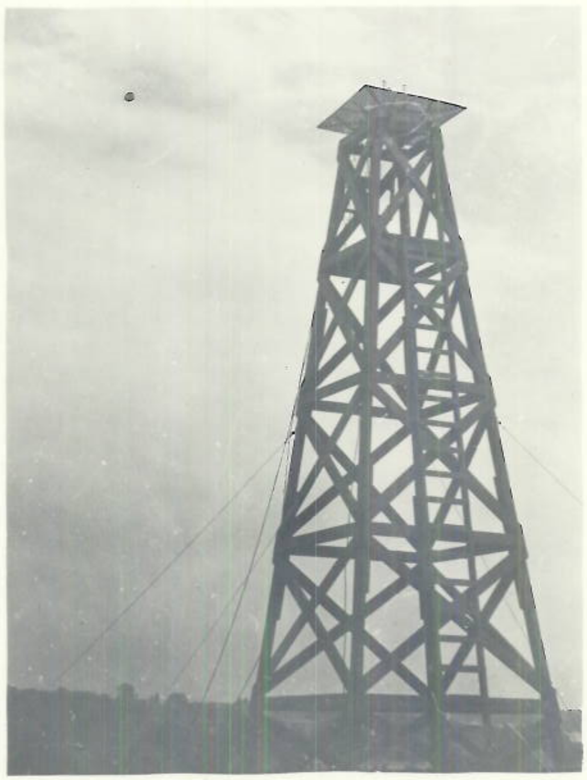
TESTS AT CHESAPEAKE BAY ANNEX
FLIGHT TEST ON SC-2 RADAR.

PLATE 2



ANTENNA INSTALLATION AT N. R. L.
(SEE PATTERNS IN PLATE I)

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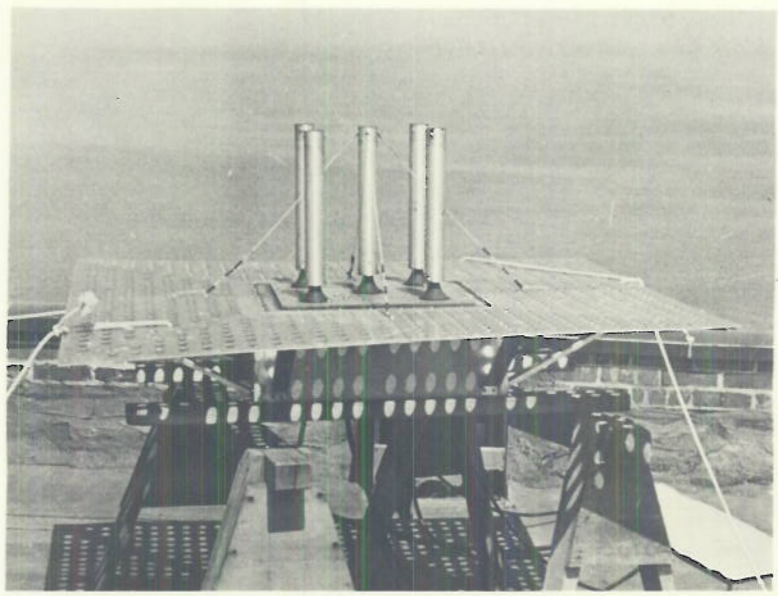

ANTENNA INSTALLATION AT N. R. L. CHESAPEAKE BAY ANNEX
(SEE PATTERNS ON PLATE 2)

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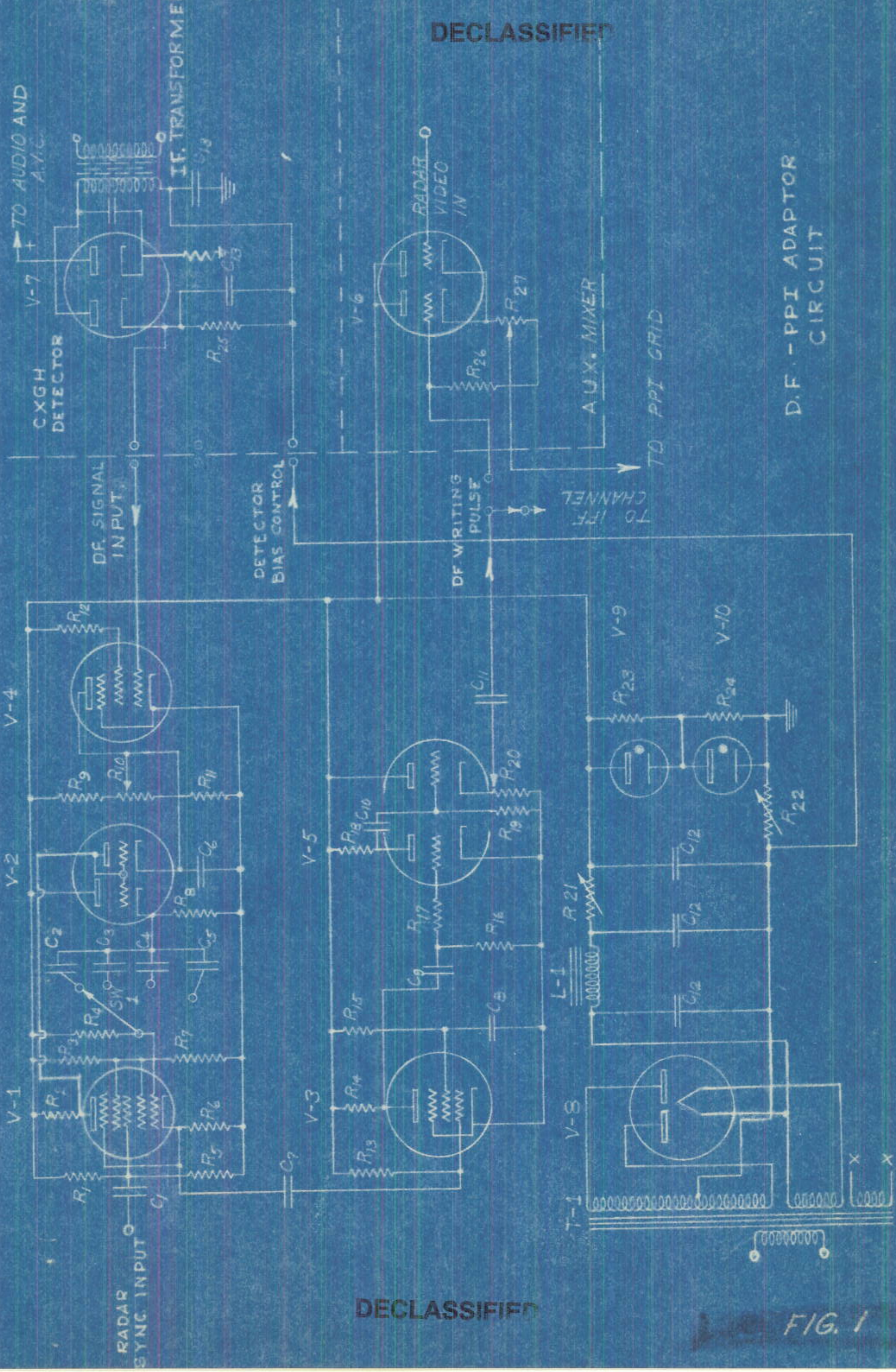

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FIG. 1