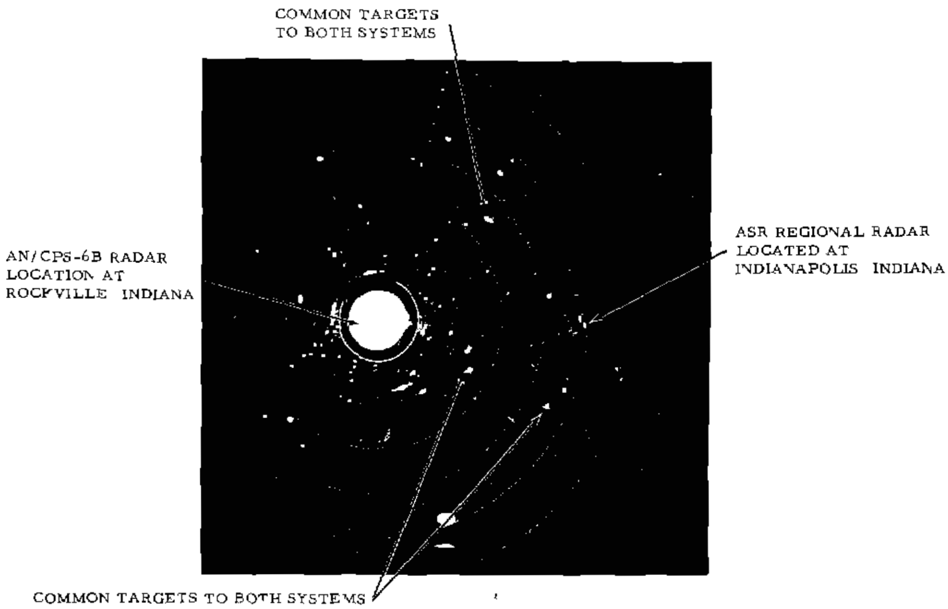
AVIATION RESEARCH AND DEVELOPMENT SERVICE



FINAL REPORT

PPI PRESENTATION OF TWO UNSYNCHRONIZED TIME-SHARED RADAR INPUTS

Task No 59-730

APRIL 1961

Prepared by

TEST AND EXPERIMENTATION DIVISION
Atlantic City New Jersey

FINAL REPORT

PPI PRESENTATION OF TWO UNSYNCHRONIZED TIME-SHARED RADAR INPUTS

TASK NO. 59-730

PREPARED BY

Robert L. Sorensen
Lawrence B. Li

APRIL 1961

This report has been approved for general distribution.

Joseph D. Blatt
Acting Director
Aviation Research & Development Service
Federal Aviation Agency

Test and Experimentation Division
National Aviation Facilities Experimental Center
Atlantic City, New Jersey

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

PPI PRESENTATION OF TWO UNSYNCHRONIZED

TIME-SHARED RADAR INPUTS

TECHNICAL DEVELOPMENT REPORT NO. 415

ABSTRACT

Tests were conducted at the Technical Development Center to determine a method of presenting information from two unsynchronized radar inputs having different geographical locations on both a modified AN/SPA-8A and AN/UPA-35 radar plan position indicator

The modified AN/SPA-8A and AN/UPA-35 plan position indicators proved successful in presenting the composite picture of the beacon and ASR-2 radars, however, the time-sharing circuit used in these tests was not optimum for time utilization in displaying radar information

PURPOSE

The purpose of this task assignment was to develop and outline the basic philosophy for time-sharing two unsynchronized radars, as well as the modification required to a standard AN/UPA-35 radar indicator for presenting a time-shared display

SUMMARY

Two radar plan position indicators, the AN/SPA-8A and the AN/UPA-35, were modified to time-share two unsynchronized radar inputs having different geographical locations The results consisted of an apparent simultaneous display of the coverages of both radars with registration between common targets presented on a single-gun cathode-ray tube This report outlines the basic philosophy for time-sharing the unsynchronized radars, as well as the modifications to a standard AN/UPA-35 radar indicator for presenting a time-shared display

INTRODUCTION

In an earlier report[1] on time-shared displays, it was pointed out that a problem facing implementation of the Common System radar beacon into the Federal Airways air traffic control system was that of displaying on the same indicator both primary radar and beacon radar information Also, this display problem was discussed in a study report[2] on the radar beacon system. In the first report, a partial solution to the problem of combining information from two radars in a system on a time-shared basis using a single-gun cathode-ray tube (CRT) was offered It was pointed out that the location of these two radars could be different geographically and possess different antenna rotational rates, however, time synchronization between the two radar videos was a prerequisite Since this time synchronization limited the system flexibility, a new approach was made to develop a time-sharing circuit capable of displaying both radar videos unsynchronized

BASIC DESIGN CONSIDERATIONS

The basic time-sharing circuits are outlined in the block diagram of Fig. 1. The radar indicator displays the two unsynchronized radar inputs with a display range adjustable for each radar from 50 to 65 nautical miles To obtain the maximum utilization of time for displaying radar information, a priority recognition concept was used to give priority to the radar having the lowest pulse repetition frequency (prf) For this application, the beacon radar, having a prf of 300, was given control of the time-sharing circuit while the airport surveillance radar (ASR), having a prf of 1200, was allowed to free-run This priority concept of time-sharing two videos of wide prf variation, such as the beacon radar and ASR, gave much better utilization of time than if time-sharing was based on a countdown 1 1, 1 2, or 1 n type of philosophy. In applying this time-sharing to the beacon/airport surveillance radars, the total time not used to display the ASR information was required for (1) coil recovery

[1]William E Miller and Lawrence B Li, "PPI Presentation of Time-Shared Videos Having Synchronized or Unsynchronized Antenna Rotation Rates," Technical Development Report No 290, June 1957

[2]Joseph E Herrmann, Jr , "A Study of the Air Traffic Control Radar Beacon System Characteristics," Technical Development Report No. 329, October 1957.

preceding the beacon display sweep (130 microseconds), (2) beacon display sweep (50 to 65 nautical miles), and (3) coil recovery following the beacon sweep (130 microseconds)

It will be recognized that this type of time-shared display also has limitations. For example, should a 65-nautical-mile beacon display be a requirement, approximately 795 microseconds for the display sweep plus 260 microseconds for coil recovery would be subtracted from 3, 333 microseconds (time for one beacon trigger) This would leave 2, 278 microseconds to display ASR video This allowable time would be sufficient to display a maximum of three continuous ASR display sweeps for 50 nautical miles, or a minimum of two continuous ASR display sweeps and a portion of a third display sweep Thus, as the time requirement for the beacon display sweep increases, there is a consequent decrease in allowable display time for the ASR

The sequence of operation for the time-sharing circuits is as follows in Fig 1 The beacon trigger initiates the display gate generator (B) This beacon trigger is counted down by (A) to provide less off-time for the ASR when practicable The trailing edge of the beacon gate triggers a phantastron delay generator (D) which is preset to trigger a coil recovery gate generator (E) to generate a blanking pulse 130 microseconds long just prior to the beacon display gate (B). The trailing edge of the beacon display gate (B) also triggers the same coil recovery gate generator (E) to generate a gate 130 microseconds long following the beacon display gate The coil recovery gates then are mixed in (F) with the beacon display gate (C) to provide the necessary blanking gate (H) for the ASR trigger and display gates, as well as for the center shift and video amplifier blanking gates (G and H) The ASR display trigger is blanked in (I) by the output of (H) during the coil recovery sweep time of the beacon radar Thus, the ASR display sweep always starts from range zero. The output of (I) triggers the ASR display gate generator (J) The output of (J) is blanked in (K) by the blanking output (H). The output of (K) is mixed in (L) with the beacon display gates (C) to provide composite clamp gates The output of (L) is amplified and inverted in (M) to provide composite intensity gates The outputs from (C), (G), (H), (K), (L), and (M) provide the necessary time-sharing gate outputs to display two unsynchronized radars on a single-gun CRT indicator, such as used in the AN/SPA-8A and AN/UPA-35 radar indicators. Figure 2 is a schematic diagram of the time-sharing circuits outlined in Fig 1

MODIFICATIONS TO THE AN/UPA-35 INDICATOR TO DISPLAY TIME-SHARED INPUTS FROM TWO UNSYNCHRONIZED RADARS

Although an AN/SPA-8A, as well as an AN/UPA-35, radar indicator was modified for an unsynchronized time-shared display, only the modifications to the AN/UPA-35 radar indicator are presented in this report Figure 3 illustrates the resistance values used to couple the outputs from the time-sharing circuits in Fig. 2 to the AN/UPA-35 circuits Since the cursor resolver was used for one of the two radar inputs, an additional servo system was required for the radar azimuth information For this application, the radar with the lower prf (beacon radar) was selected for the cursor input since the off-center switching requirements would be at a lower repetition rate Also required in this modification was an additional video amplifier, shown in Fig 4, for the beacon radar video

EQUIPMENT EVALUATION

There has been no extensive operational evaluation conducted on either the AN/SPA-8A or AN/UPA-35 time-shared indicators Since no beacon radar data were available to display with the ASR-2 during the period of this evaluation, the AN/CPS-6B radar (300 prf and 6-rpm scan rate) was employed as a substitute The AN/CPS-6B radar was located at Rockville, Indiana, a distance of approximately 45 radar miles from Indianapolis This radar information was remoted to Indianapolis by microwave equipment Photographs of the plan position indicator (PPI) time-shared display are shown in Figs 5a, 5b, 5c, 5d, and 5e for different conditions of operation

When employing a countdown of the long-range prf, less ASR-2 video was blanked and consequently, less AN/CPS-6B radar video is displayed These photographs of Figs 5a through 5e were taken for one complete radar scan and illustrate a comparison of picture quality for given conditions of operation An earlier report[3] discussed some of the problems of time-sharing two radar videos

An important feature of this type of time-shared display was target registration between common targets to both radars. Figure 6 is a photograph of the AN/CPS-6B and ASR-2 radar videos time-shared As will be observed from this photograph, very good registration was apparent between common targets Since this time-shared indicator employed one deflection system and a single-gun CRT, registration was

[3]Miller and Ii, op cit

not as serious a problem as encountered when using a two-gun CRT The worst condition foreseen for registration on a time-shared display is when the centers of the two radars are placed diametrically opposite each other on the periphery of the CRT Since most fixed-coil type deflection systems have sweep distortion resulting in bending of the sweep, as illustrated in Fig 7, this would be the limiting factor for good registration between common targets For the AN/UPA-35 and AN/SPA-8A indicators, registration in all quadrants was very good However, better results would have been obtained with a shorter sweep recovery time

CONCLUSIONS

It is concluded that

1 The modified AN/UPA-35 radar indicator provided a successful approach to the problem of presenting a composite picture of the information from two unsynchronized radars, however, the time-sharing circuits described in this report were not the optimum in time utilization for displaying asynchronous radar data simultaneously

2 The sweep recovery time of the AN/UPA-35 was considered too long for use in displaying asynchronous radar data from a beacon and an ASR radar

3 The problem of common target registration inherent in two-gun CRT displays was minimized as well as limiting the dual equipments required by a two-gun system

RECOMMENDATIONS

It is recommended that

1 Further development be performed in the area of time-sharing asynchronous radar data on a single indicator

2 A radar indicator having a sweep recovery time of approximately 50 microseconds be used or that the sweep circuits of the AN/UPA-35 be modified for a faster recovery time

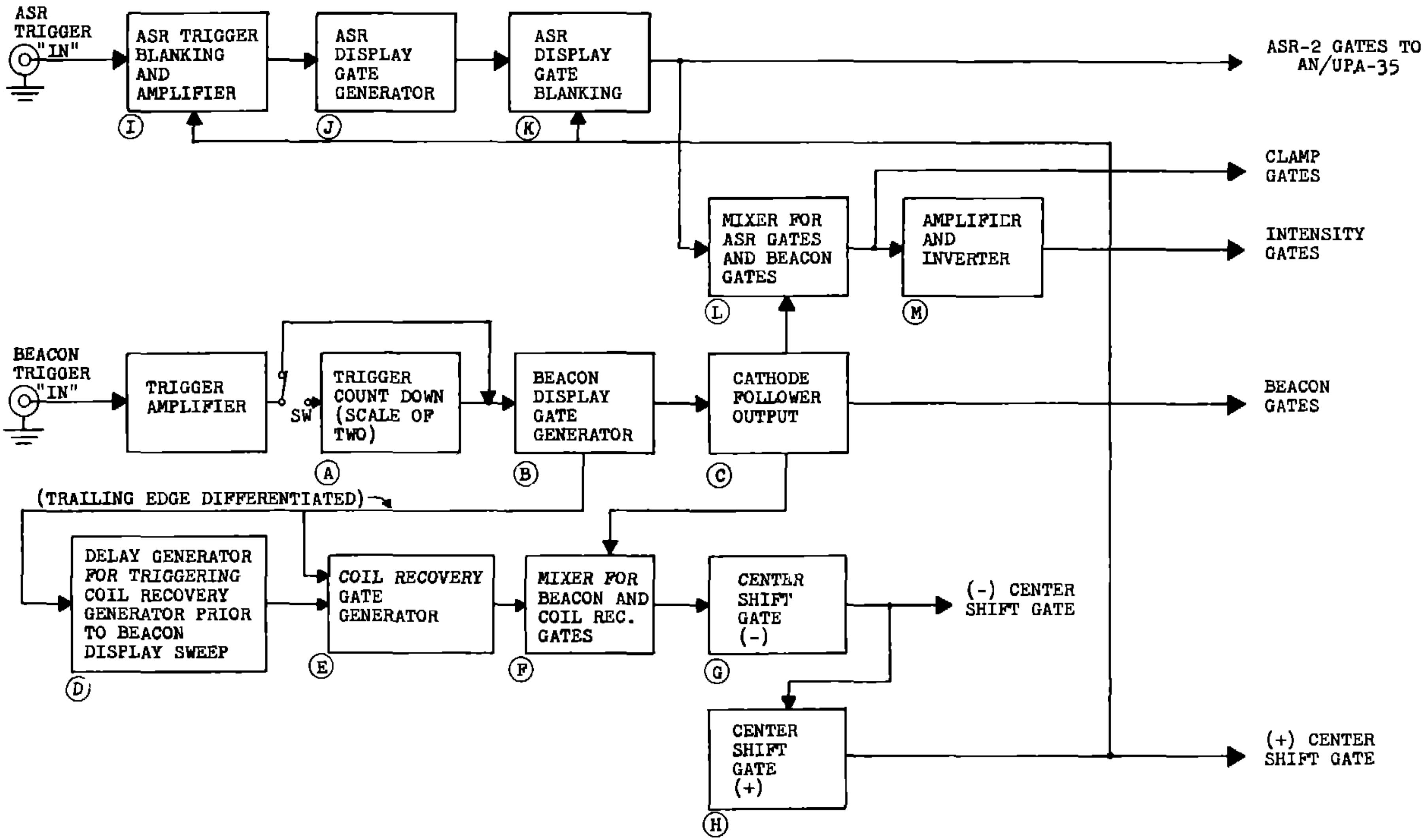


FIG. 1 BLOCK DIAGRAM OF TIME-SHARING CIRCUITS

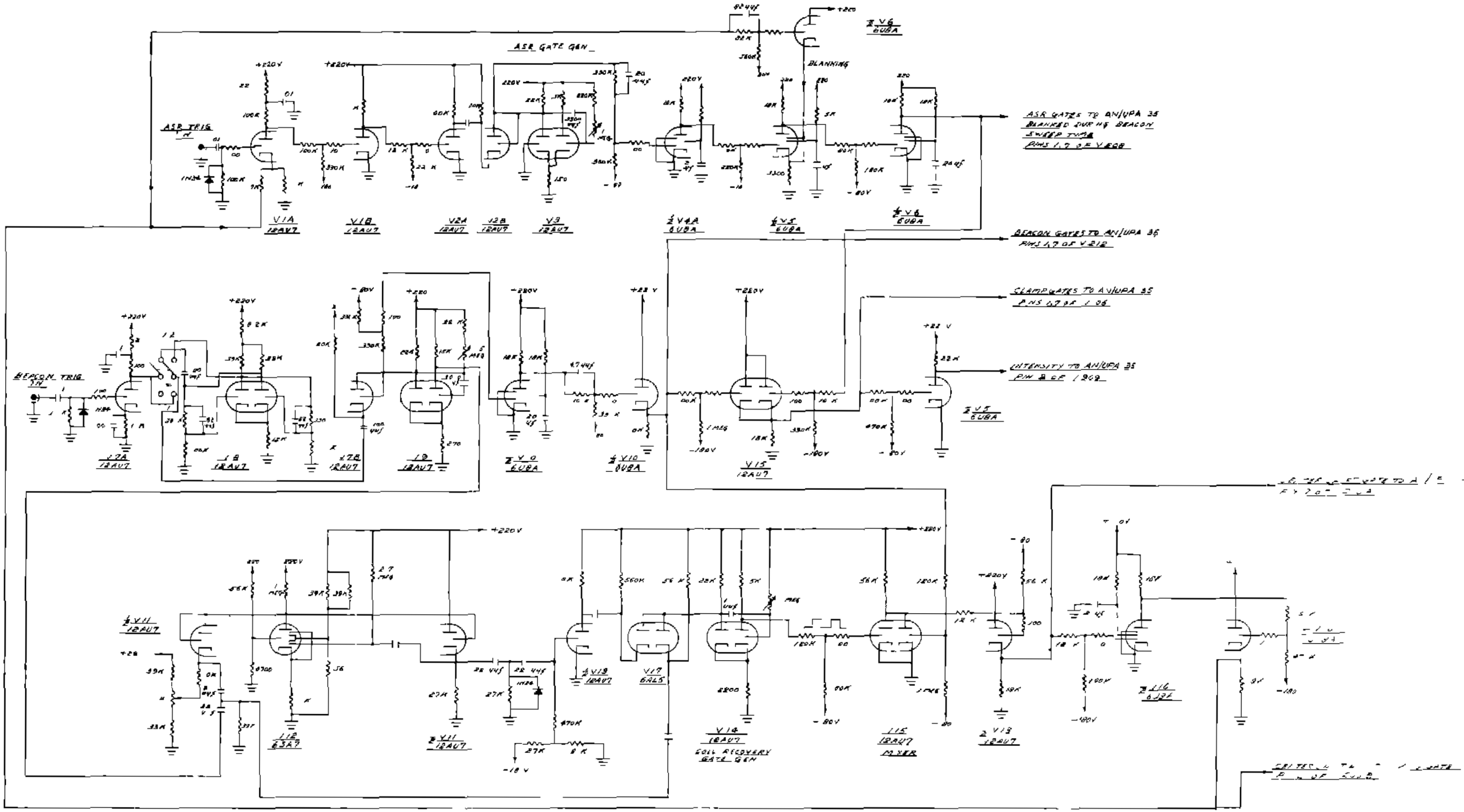


FIG. 2 SCHEMATIC OF TIME-SHARING CIRCUITS IN AN/UPA-35 MODIFICATION

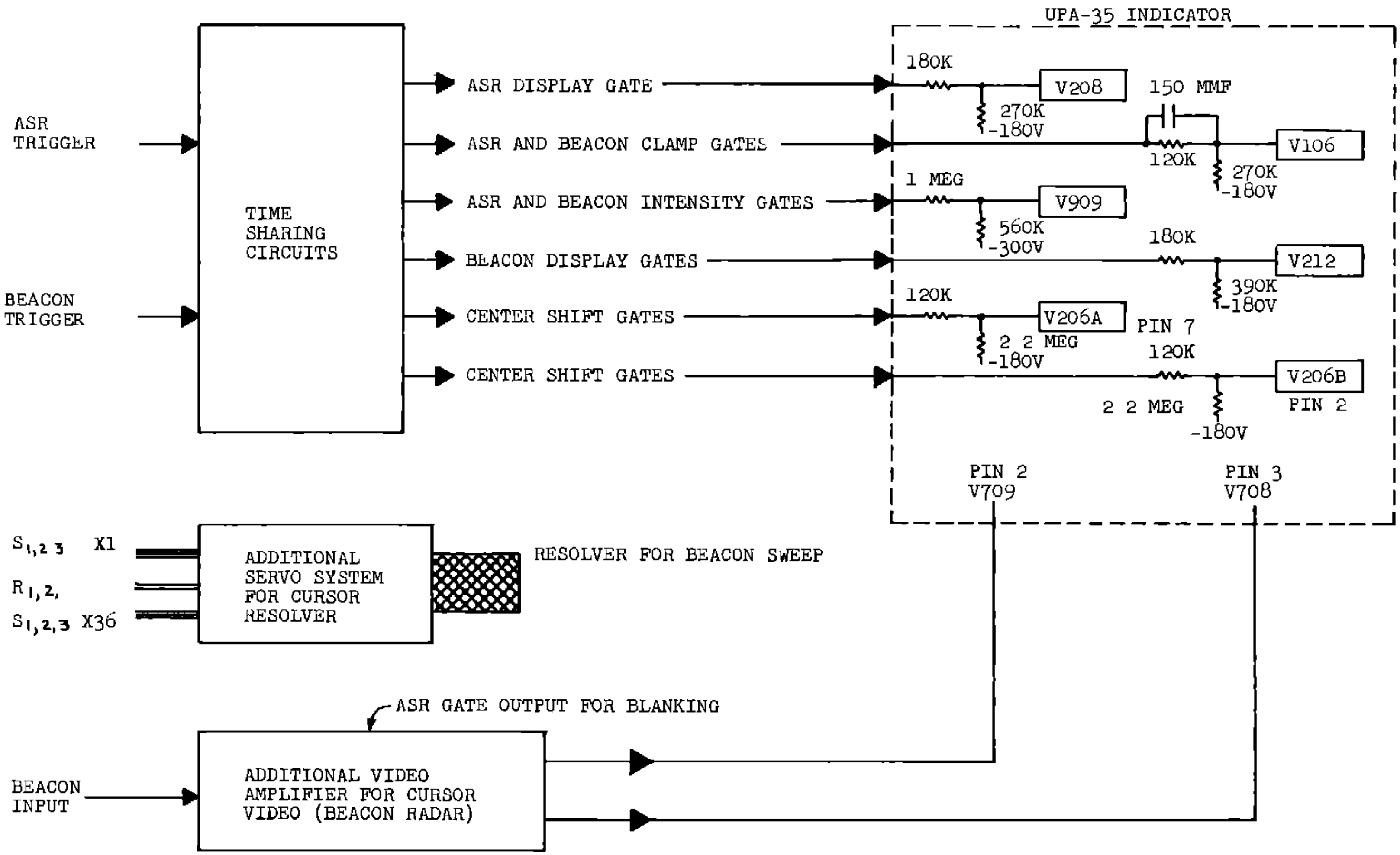
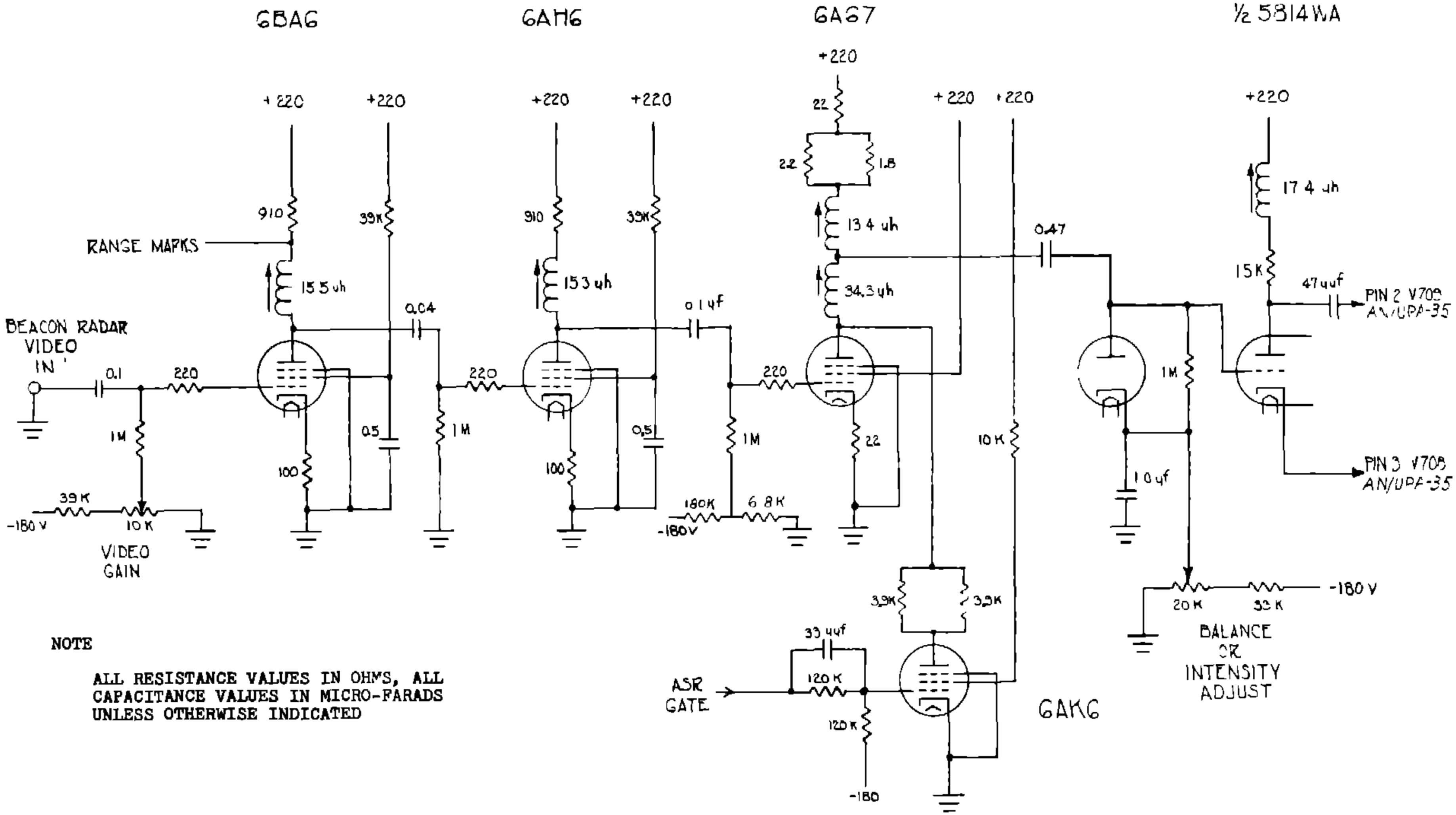


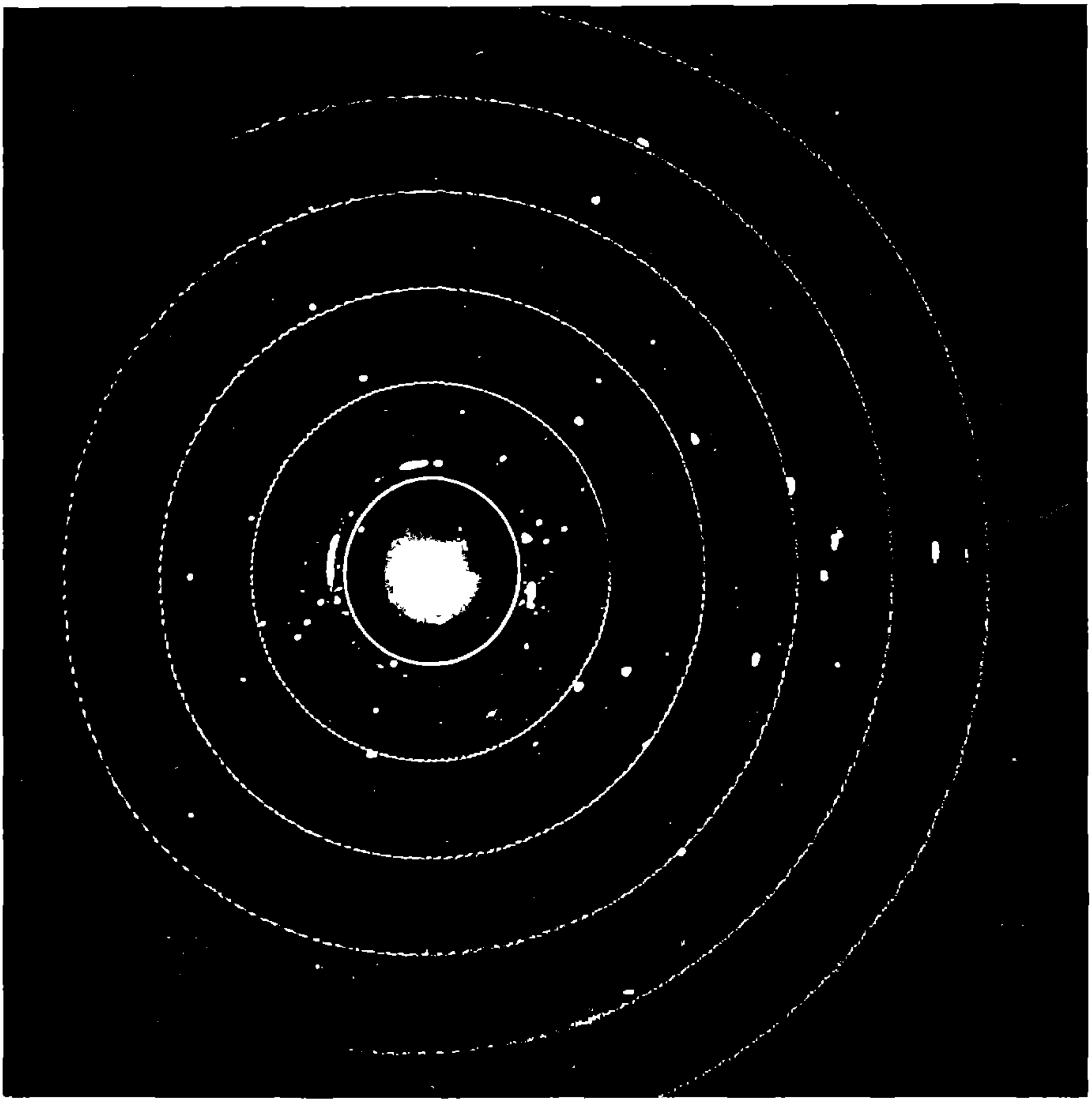
FIG. 3 MODIFICATIONS TO AN/UPA-35 FOR TIME-SHARING TWO UNSYNCHRONIZED RADARS



NOTE

ALL RESISTANCE VALUES IN OHMS, ALL CAPACITANCE VALUES IN MICRO-FARADS UNLESS OTHERWISE INDICATED

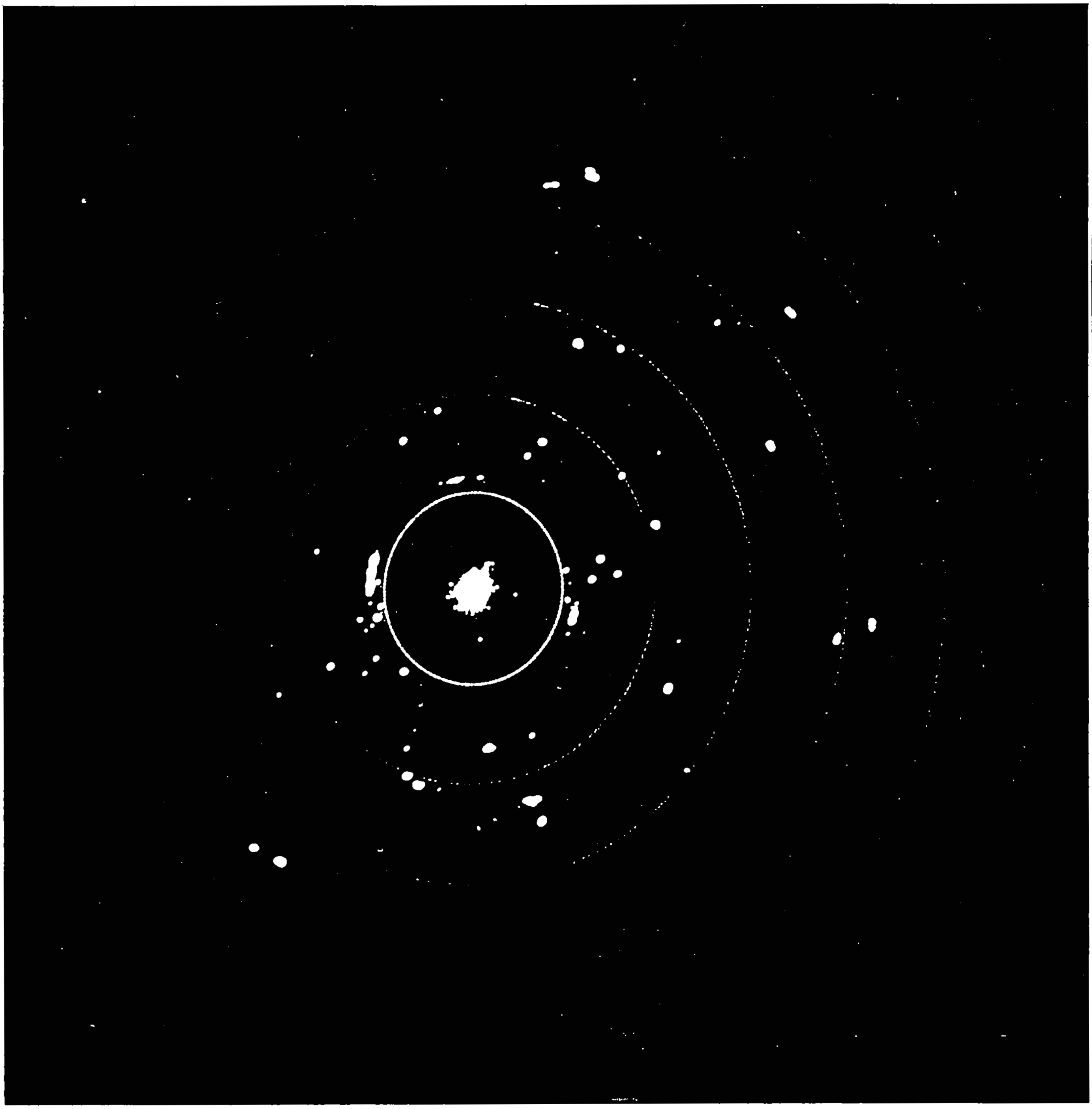
FIG 4 ADDITIONAL VIDEO AMPLIFIER REQUIRED FOR TIME-SHARED AN/UPA-35 RADAR INDICATOR



NOTE AN/CPS-6B COUNTDOWN CIRCUIT IN THE "ON" POSITION THIS DISPLAYS EVERY OTHER TRIGGER SWEEP OF THE AN/CPS-6B RADAR.

SWEEP INTENSITY OF THE ASR RADAR TURNED DOWN SO AS NOT TO BE VISIBLE

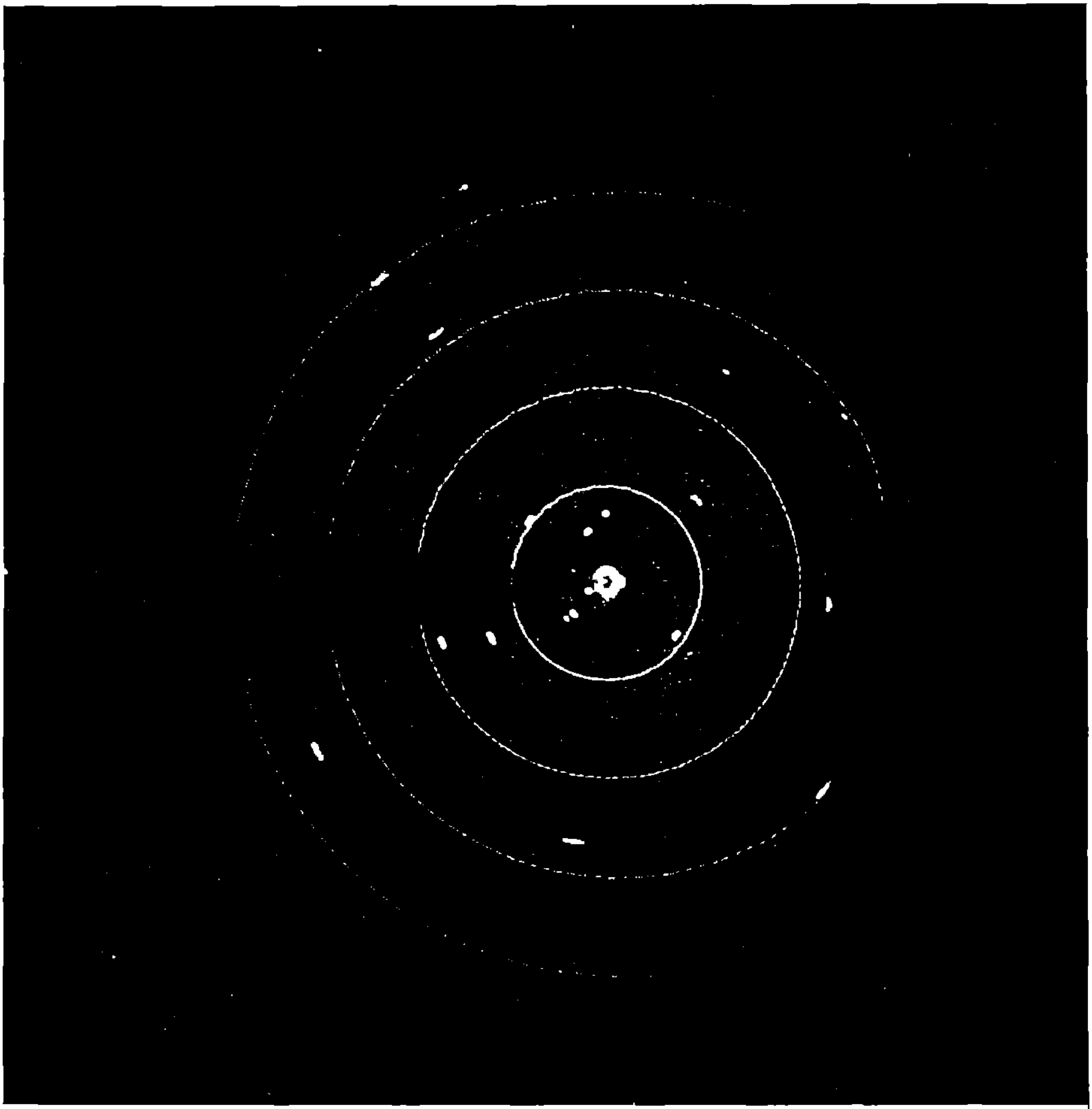
FIG 5a PPI PATTERN OF AN/CPS-6B RADAR



NOTE: SWEEP INTENSITY OF ASR RADAR TURNED DOWN SO AS NOT TO BE VISIBLE.

AN/CPS-6B COUNTDOWN CIRCUIT IN THE "OFF" POSITION.

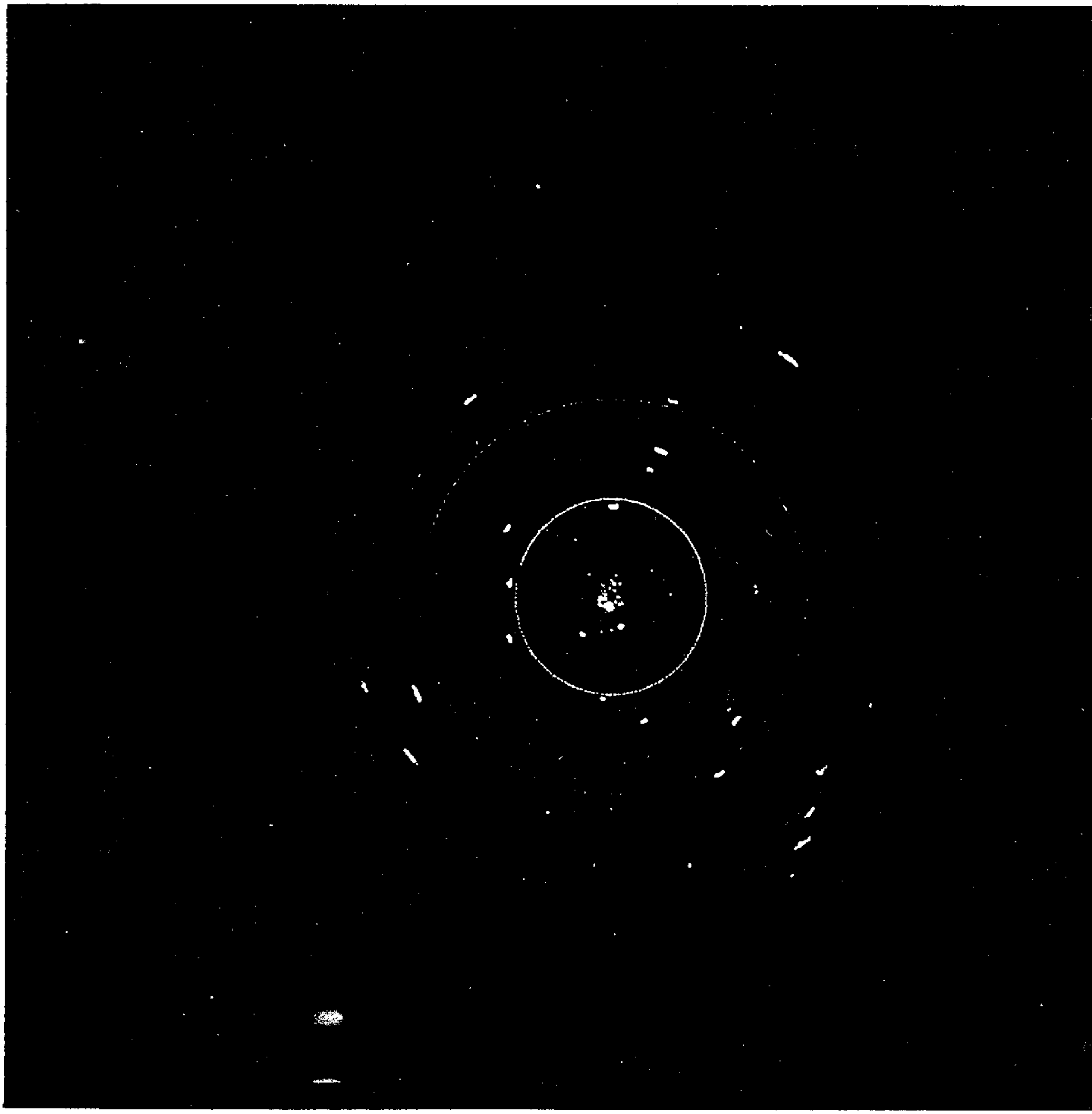
FIG. 5b PPI PATTERN OF AN/CPS-6B RADAR



NOTE COUNTDOWN OF THE AN/CPS-6B RADAR IN THE "ON" POSITION AND THE ASR RADAR FREE RUNNING.

SWEEP INTENSITY OF THE AN/CPS-6B RADAR TURNED DOWN SO AS NOT TO BE VISIBLE.

FIG 5c PPI PATTERN OF ASR-2 RADAR



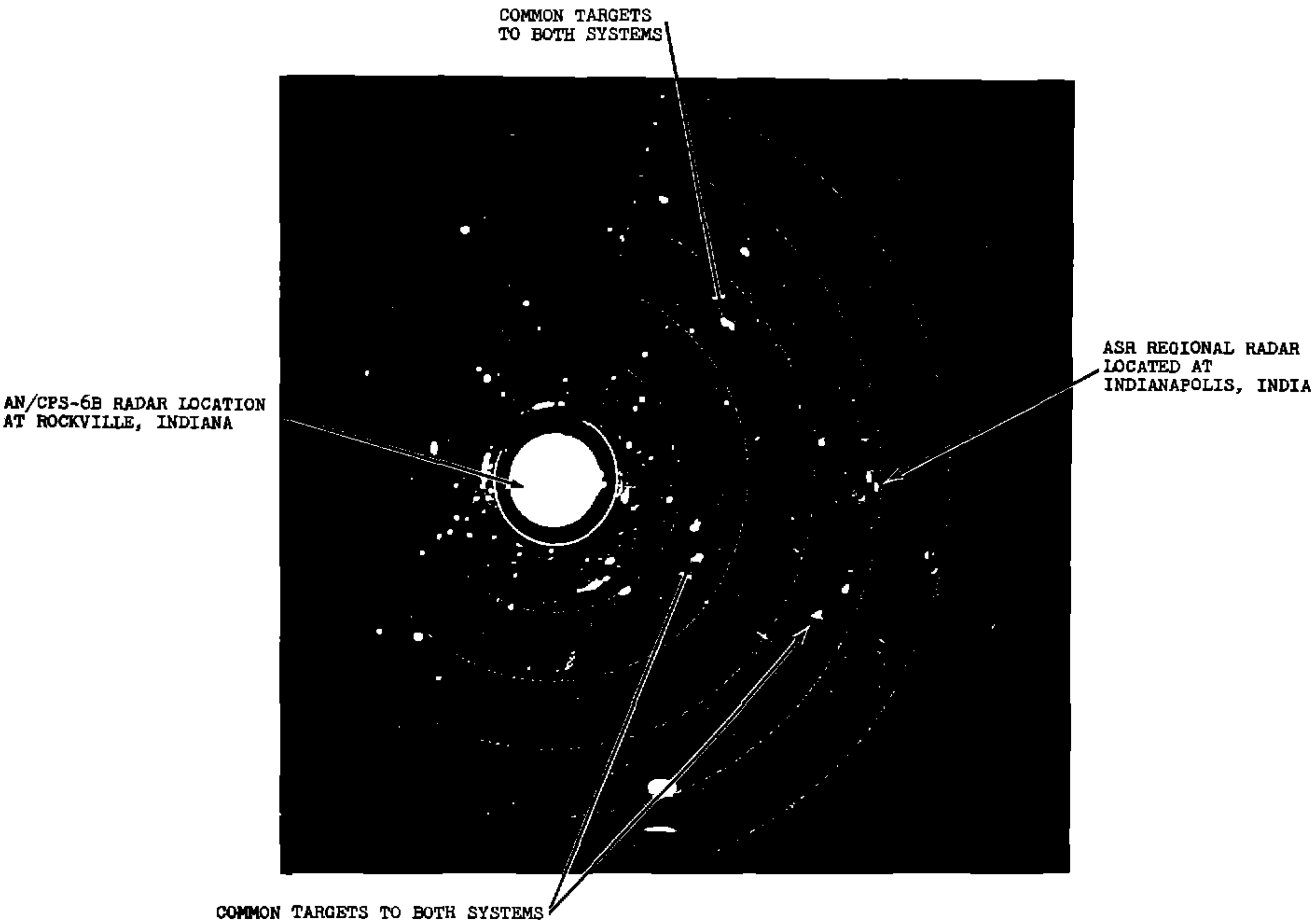
NOTE: COUNTDOWN FOR THE AN/CPS-6B RADAR IN THE "OFF" POSITION AND THE ASR RADAR FREE RUNNING.

SWEEP INTENSITY OF THE AN/CPS-6B RADAR TURNED DOWN SO AS NOT TO BE VISIBLE.

FIG. 5d PPI PATTERN OF ASR-2 RADAR

NOTE: AN/CPS-6B TRIGGER
INPUT DISCONNECTED.

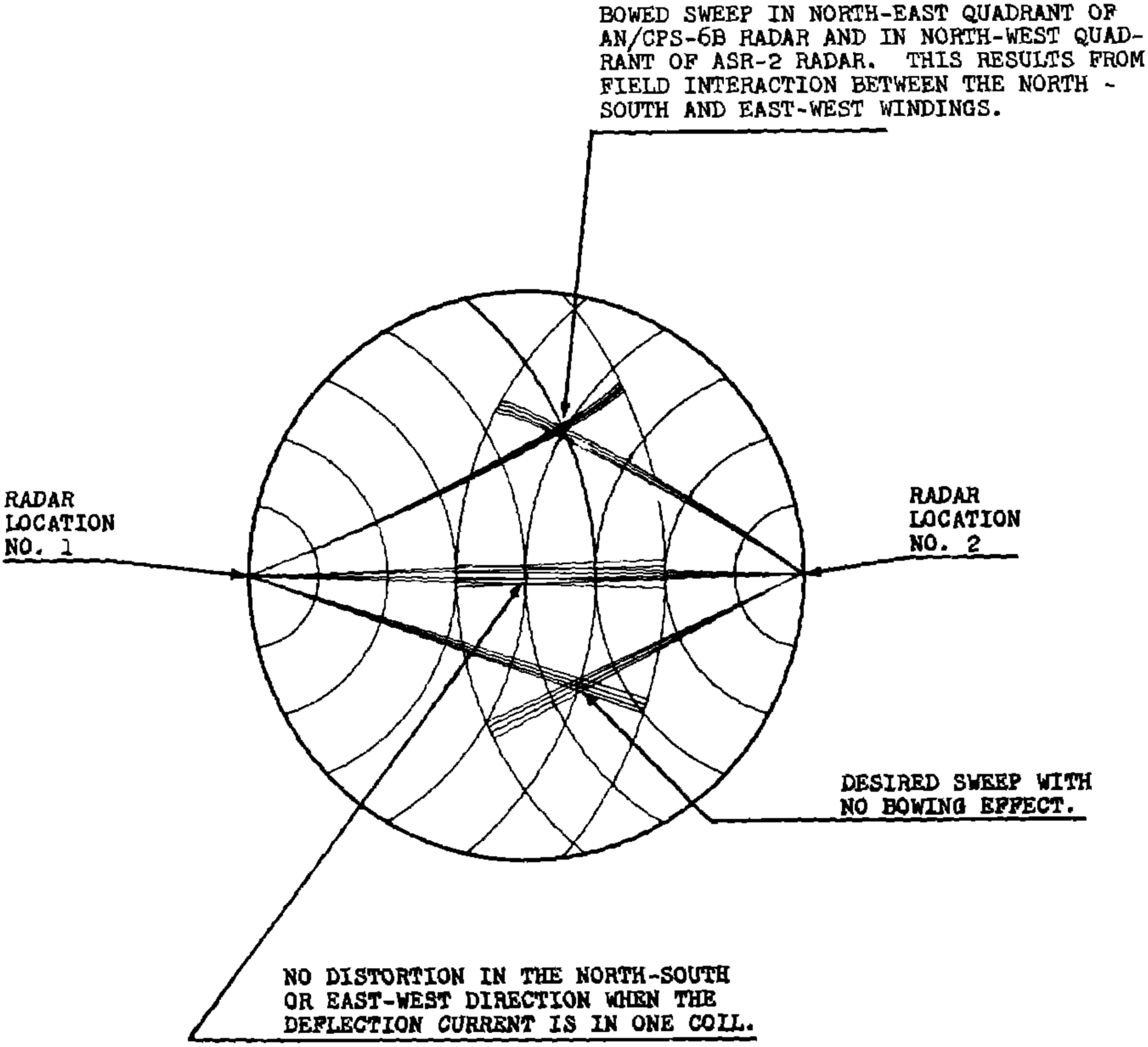
FIG. 5e PPI PATTERN OF ASR-2 RADAR



NOTE COUNTDOWN CIRCUIT FOR THE AN/CPS-6B RADAR IN THE "OFF" POSITION

REGISTRATION BETWEEN COMMON TARGETS TO THE TWO DIFFERENT RADAR SYSTEMS DISPLAYED

FIG. 6 PPI PATTERN OF AN/CPS-6B AND ASR-2 RADARS WITH VIDEOS TIME-SHARED



10-INCH CATHODE-RAY TUBE SHOWING THE POSSIBLE EFFECT OF BOWING IN THE NE, SE, SW, OR NW QUADRANTS THIS DRAWING DEMONSTRATES THE POSSIBLE EFFECT OF BOWING ON AZIMUTH REGISTRATION AND DOES NOT PERTAIN TO THE AN/SPA-8A

FIG 7 EFFECTS OF SWEEP BOWING ON CATHODE-RAY TUBE PATTERN