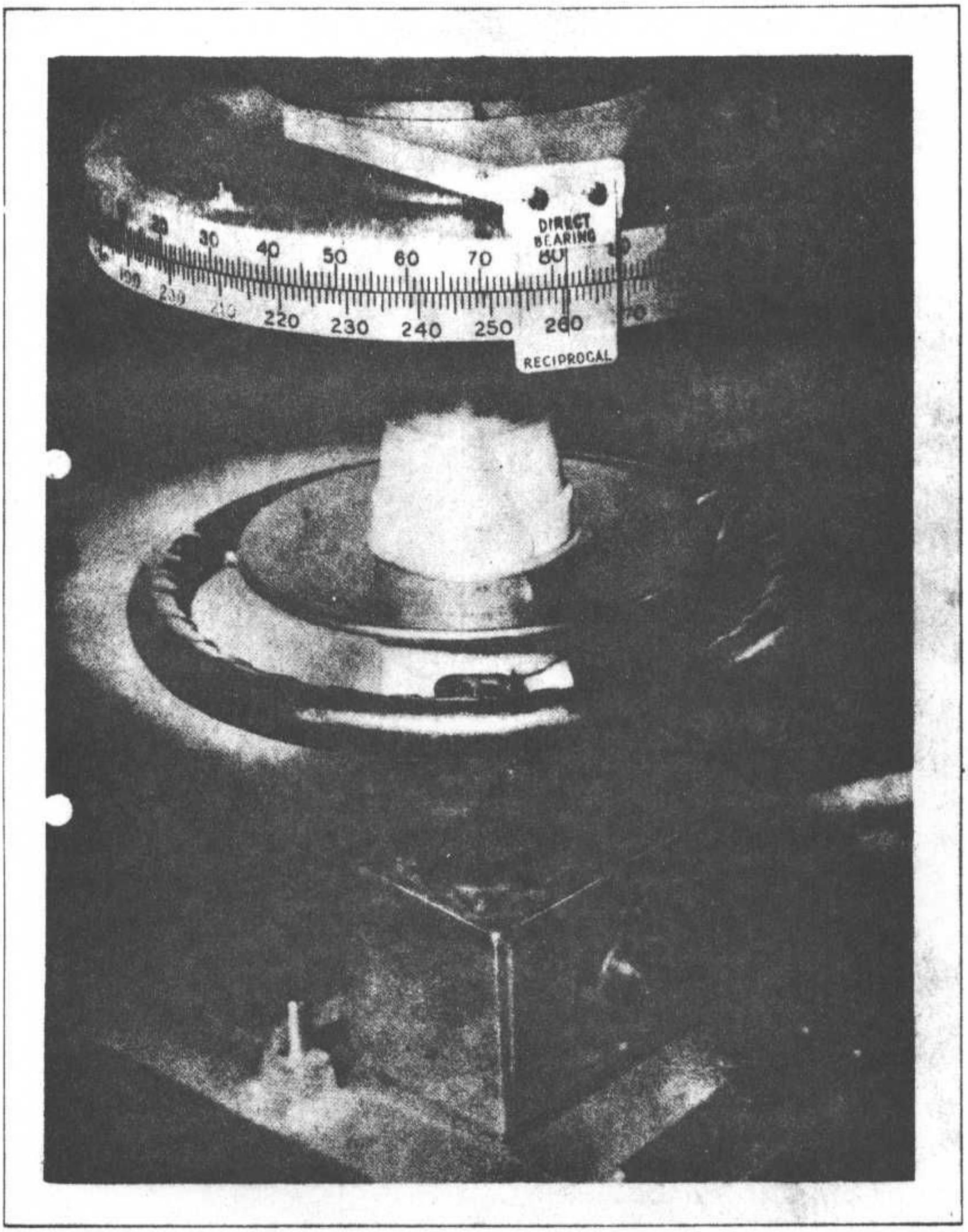
MOBILE D/F

AAFTAC-12/7/43-A852-IM

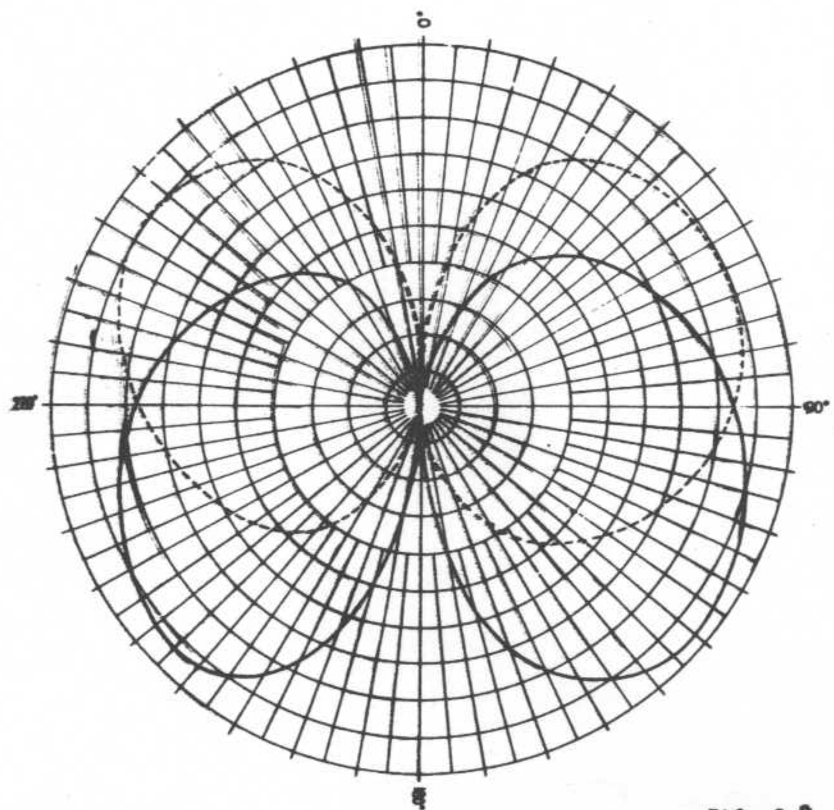
FIG. 1

DECLASSIFIED BY EXECUTIVE ORDER #11652



D/F SCALES AND CONTROLS

AAFTAC-12/7/43-A852-IM FIG. 2



TRUE BEARING OF
TRANSMITTED SIGNAL

f=112 Mc/s

— SENSE CONTROL SWITCH NORMAL (REFLECTOR SWITCHES CLOSED)

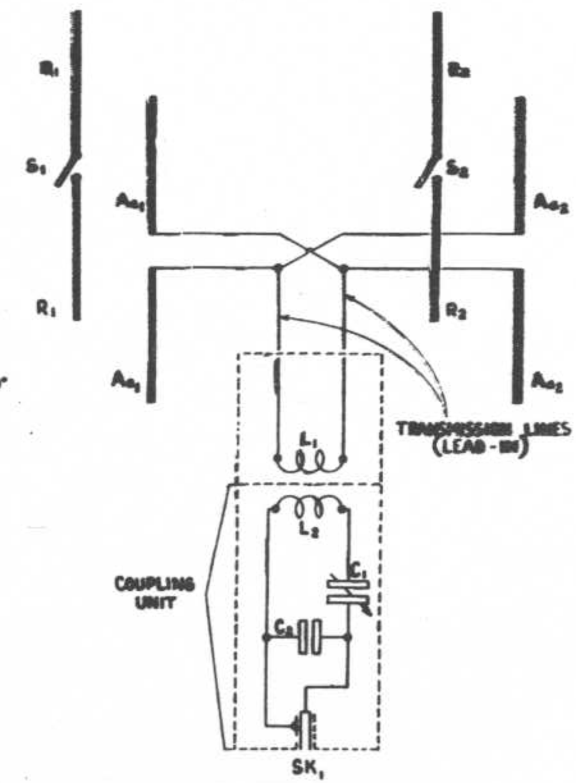
---- SENSE CONTROL SWITCH DOWN (REFLECTOR SWITCHES OPEN)

POLAR DIAGRAM OF D.F. ANTENNA

7-16-42 CMS 69

FIG. 3 0

F'G 3



Ae1 & Ae2 - SIGNAL DIPOLES
R1 & R2 - - - REFLECTOR DIPOLES
S1 & S2 - - - " SWITCHES
L1 & L2 - - - COUPLING LINK
C1 - - - - SERIES TUNING CONDENSOR
C2 - - - - SHUNT CAPACITOR
SK1 - - - - ANTENNA CONNECTOR - TO RECEIVER

CIRCUIT DIAGRAM - D.F. ANTENNA

7-16-42 CMS 70

AAFTAC-12/7/43-A852-IM

otherwise the blanketing signal may induce error up to 40°. Conversely an a/c at 100 miles would require an increase in R/F and an audio gain. The following procedure for receiver operation is mandatory.

a. Audio gain control will be set so that the signal will just be audible with clarity.

b. The R/F gain control will be used to control the volume.

c. If plane is barely audible with R/F gain at maximum, advance audio gain.

7. Method of Reading Bearing Rings. (See Fig. 2) - Every D/F station has two 0-360° scales mounted just above the steering wheel. The upper is the TRUE scale and the lower scale is the MAGNETIC RECIPROCAL. The upper TRUE scale is adjusted so that when a bearing is obtained on a plane sending out its D/F signal which is due North (true) of the station, the reading indicated on the upper scale is zero.

When an aircraft is due North of the station and requests homing he must be given a "steer" which will enable him to fly 180° (true) in order to get back to the station. The compass in the plane does not indicate true, however, but magnetic direction. This difference is compensated for at the station by adjusting the lower MAGNETIC RECIPROCAL scale to read as follows:

> MAGNETIC RECIPROCAL TRUE BEARING (WEST) OR MINUS (EAST) the magnetic declination at that locality. Thus if the magnetic declination is 5°EAST, 0 true would correspond to 180 minus 5 = 174 MAG. REC.

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C. Operation of D/F Station Antennas: - Two vertical di-poles spaced about 44" apart constitute the receiving antenna for the D/F (fixer and homer) station. About 14" directly behind these di-poles are located two similar di-poles which are not electrically connected into the system but which through their ability to reflect these very hich frequencies after the directivity characteristics of the main di-pole antennas.

A tubular H-frame provides a convenient mounting for these two sets of di-poles. Spacing between the legs of the H-frames is approximately 14" and the length of each leg approximately 44". Horizontal mounting of the H-frame atop the rotating shaft provides for symetrical displacement of the antenna system about the center of the rotating shaft.

It is necessary to differentiate between the two sets of di-poles. First are the "Signal Di-Poles", the pair directly connected to the receiver, second are the "Reflectors", the pair which is not electrically connected in any way to the system.

Connections between the signal di-poles are transposed in such a manner that the upper half of each di-pole is connected to the lower half of the opposite di-poles as shown in Fig. 3. Lead-in wires are connected at the center of these inter-connecting leads which run down the inside of the rotating shaft and terminate as the ends of a loop embedded in a circular groove cut in the composition extension-piece at the lower end of the shaft.

When the signal di-poles are lined up so that a horizontal line drawn through them is exactly perpendicular to the "line of sight" direction of the plane sending out its D/F signal, the voltage induced in each di-pole is exactly equal in phase and magnitude, but due to the transposition of the leads connecting the two di-poles, these voltages arrive at the lead-in to the receiver with their electrical polarity opposing each other (180° out of phase) so that complete cancellation of the signal occurs under these conditions.

As the antenna system is rotated, one di-pole becomes closer as the other di-pole becomes farther away from the plane sending out the D/F signal, until a maximum separation of the two di-poles occurs when the two di-poles are directly in line with the plane. This separation of 44" (112 C.M.) corresponds roughly to half wave length at these VHF frequencies.

Under this last condition the signal induced in each di-pole is still equal in magnitude but being displaced one-half wave length apart along the line of the transmitted signal, the voltages are mutually opposite in polarity (180° out of phase) but again because of the transposed connection between the two di-poles the voltages are fed to the lead-in, equal in phase and magnitude so that under this condition a maximum signal is obtained.

How the signal varies from maximum to minimum, as the antenna system is rotated from the position of being approximately lined up with the direction of the signal, to that of the signal di-poles beind exactly perpendicular to the direction of the received signal is shown in the Polar Digram of Fig. 3. The distance from the center "O" to the curve at any specific angle gives a measure of the signal strength in that direction. This is called a "Polar Digram", as it corresponds to a map at the pole.

When taking a bearing on a plane, the antenna system is rotated by the operator until the signal disappears. This point is called a "null" and is very critical and sharp with respect to the actual angular position of the antenna and its corresponding reading on the 360° scale attached at the lower end of the rotating shaft.

By referring to the Polar Diagram of Fig.3, it will be noted that this null occurs at two distinct places, displaced from each other by approximately 180°, therefore, it is necessary to have some means of enabling the operator to identify the proper null (sensing) so that when he calls out the bearing of a plane he knows definitely that the proper bearing is being called in to the D/F plotting board and not one which is 180° from the actual bearing of the plane.

"Sensing" which accomplishes this, is done by means of the "Reflectors" mounted on the opposite side of the H-frame. Reflectors as these have no direct electrical connection with any other part of the system; however, a mechanically operated set of switches provide for connecting and disconnecting the quarter wave sections of each of the reflectors as indicated in the schematic circuit diagram to the reflector switches make it possible for him to have the reflector switches under his direct control at all times.

With half wave reflectors connected, the sensitivity pattern is distorted into shape corresponding to that shown by the dotted lines in the Polar Diagram. Relative signal strength for various angles of rotation is shown for the antenna system with and without reflectors.

When the reflector switches are open the reflectors have practically little or no effect upon the sensitivity pattern of the signal dipoles is distorted, increasing the signal strength if the dipoles are in front of the reflectors and decreasing the signal strength if the dipoles are behind the reflectors.

Accurate bearings are obtained with this system by rotating the antenna array through about 20° to either side of the null and depressing the sense switch. If the signal becomes weaker, the point at which the null occurred is the correct bearing. If the signal becomes stronger, the point at which the null occurred is not the correct bearing, but approximately (not necessarily exactly) the reciprocal of the correct bearing and the operator should then seek out the outer null to obtain the exact bearing of the plane from the D/F station.

CAPABILITIES AND USE OF THE SCR-602

1. GENERAL - The SCR-602 is a light weight (LW) quickly assembled, portable radar set for late warning of approaching a/c. Its maximum satisfactory range is about 40 miles, which precludes its use for G.C.I. However, this set is of interest to GCI controllers, as it is being included in tactical organizations which will employ GCI controllers. Its use in a forward position for early reporting has already been proved, and it is not inconceivable you may be controlling off an operations board with several SCR-602's reporting by radio links, in some of the new offensive uses of control.

2. Description: - The SCR-602 has been delivered in models from 602-T1 to 602-T8. (See Fig. 1). The present T8 model includes new IFF Interrogation equipment, built in a separate case. The SCR-602 is rack mounted in two adjoining steel frame racks. The receiver rack houses power equipment in the bottom, the main PPI and ASV receiver in the central portion, with the PPI power unit and indicator unit at the top. This rack stands about 4' - 6" high, 2' - 6" wide, and 1' - 6" deep. The adjoining transmitter rack continues up in a tapered tower through the tent top to support the rotatable Yagi antenna. The lower part of this rack houses the transmitter, T. and R switching unit, inductive coupling unit to antenna, and the antenna rotating gear box. All units of the set are connected with lock-plug connector cables, which provide quick assembly or servicing.

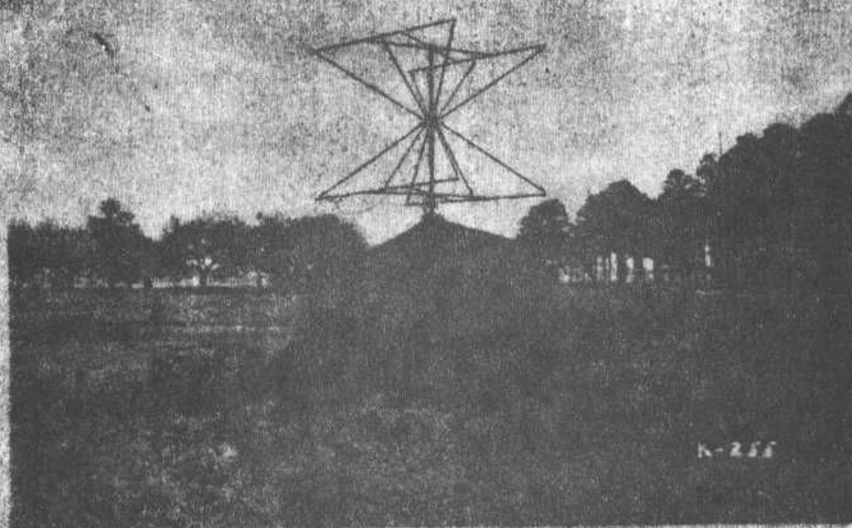
3. Frequency: - The operating frequency (212 megacycles) was chosen as about the highest frequency at which good receiver sensitivity could be obtained. Earlier models of British equipment operated on 176 megacycles, and the A.S.V. receiver was found to require some modifications before satisfactory efficiency could be obtained on 212 m.c.

4. Display: - A 9" PPI tube is used with a rotating time base mechanism coupled to the antenna indicating true azimuth in a scale over the front of the tube. Signals from the receiver intensity modulates the cathode ray tube beam, thus showing up as bright spots on the time base, at a distance from the center of the tube corresponding to range. Calibrator spots represent mile intervals, and may be varied from 15 miles to 60 miles, or changed in linearity. A/C signals appear as small arcs trailing off at either end. The tube is painted with a phosphorescent coating so that the signals will persist for several seconds. Since the unit is designed for mobile operations no provision was made on the early models, for a grid corresponding to a fixed location. A lucite disc, graduated in 10° sectors has been provided on the front panel, moulded to fit closely to the contour of the PPI Cathode-Ray tube. This requires plotting of readings on a polar diagram, or sector grid in corresponding degrees to lucite disc, and their transformation to a grid map of the area. The new TS model is provided with a lucite front panel which may be gridded if desired.

SECRET

[redacted]

SCR 602 T-6



[redacted]

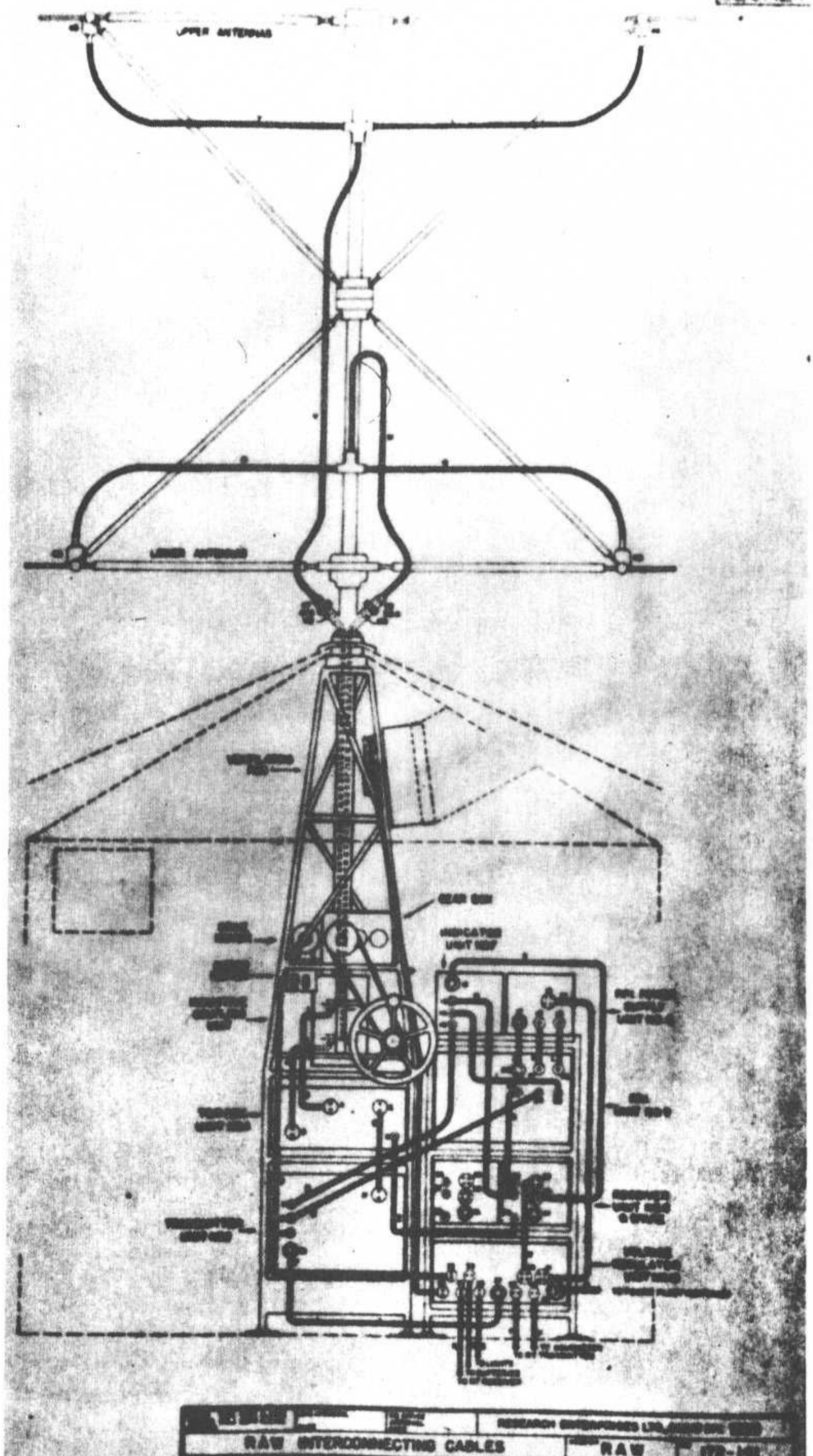
COMPLETE UNIT INSTALLED

FIG. 1

SECRET

DECLASSIFIED BY EXECUTIVE ORDER #11652

SECRET



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The indicator unit uses a Cathode-ray tube to display information obtained from the receiver, by a sweep circuit which moves a spot of light from bottom to top on screen. Three different sweep velocities create corresponding 10-mile, 40-mile and 100-mile ranges respectively. A vertical scale on a square lucite plate in front of the tube inticates range at a glance.

There is an indicated height display unit called an "A" Scan, in which the signal appears as a hump up above a horizontal base line, the height of the hump being directly proportional to the signal strength. Height determination depends on ground reflections of a known order. Therefore it is possible to clear the ground around the station for several hundred yards to simulate charted conditions and find heights by means of a chart of signal intensities. Even under favorable conditions the determination is rough, and can only be made at a few points of the plane's course.

5. Antenna System: - The antenna system consists of four horizontally polarised Yagi antennas, rotating continuously at about 6 RPM. The lower pair set a minimum of 8'-10" above the ground and the upper pair 6'-6" above. The antennas thus stacked are set 6'-0" apart horizontally. The lower pair of antennas can be switched either in phase or anti-phase with the upper pair by pressing a switch at the control position. Thus we have an ambiguity check in determining heights. Considerable practice will be necessary for the operator to get heights inas much as some balancing of signal strengths will have to be done be-

forc consulting the signal characteristic chart. On an average flat site, planes flying 15,000 to 25,000 feet altitude are generally picked up about 40 to 50 miles away, and planes flying at 5,000 to 15,000 feet about 30 to 40 miles away. Thus from the initial pick-up in range a rough estimation of height can be made.

SPECIFICATION SUMMARY

1. MAXIMUM RANGE on flat site: 40 to 50 miles at 15,000 to 25,000 feet alt.
2. MINIMUM RANGE on flat site for low flying a/c 10 to 15 mi.
3. CEILING: About 25,000 feet altitude.
4. RANGE ACCURACY: Range to nearest mile. Azimuth accuracy -2 degrees.
5. OPERATING FREQUENCY: 212 megacycles.
6. TRANSMITTER OUTPUT: 100 K.W.
7. PULSE WIDTH: Two (2) microseconds.
8. RECURRENCE FREQUENCY: 400 CPS.
9. ANTENNAS: 4 Yagi-type, horizontally polarized lower pair can be switched in phase or anti-phase with upper pair.
   Antenna mounting collapsable.
   Antenna Rotation - 6 rpm.
   Common T/R system . . . . i.e. same antenna for transmitting and receiving.
10. POWER SUPPLY: 6 h.p. gasoline engine drives two 700-watt, 80-volt, 1,000-cycle alternators, and one (1) 500-watt, 24-volt d.c. generator. The d.c. generator supplies the alternator fields, blowers, lights and charges batteries. One (1) alternator supplies the transmitter only.

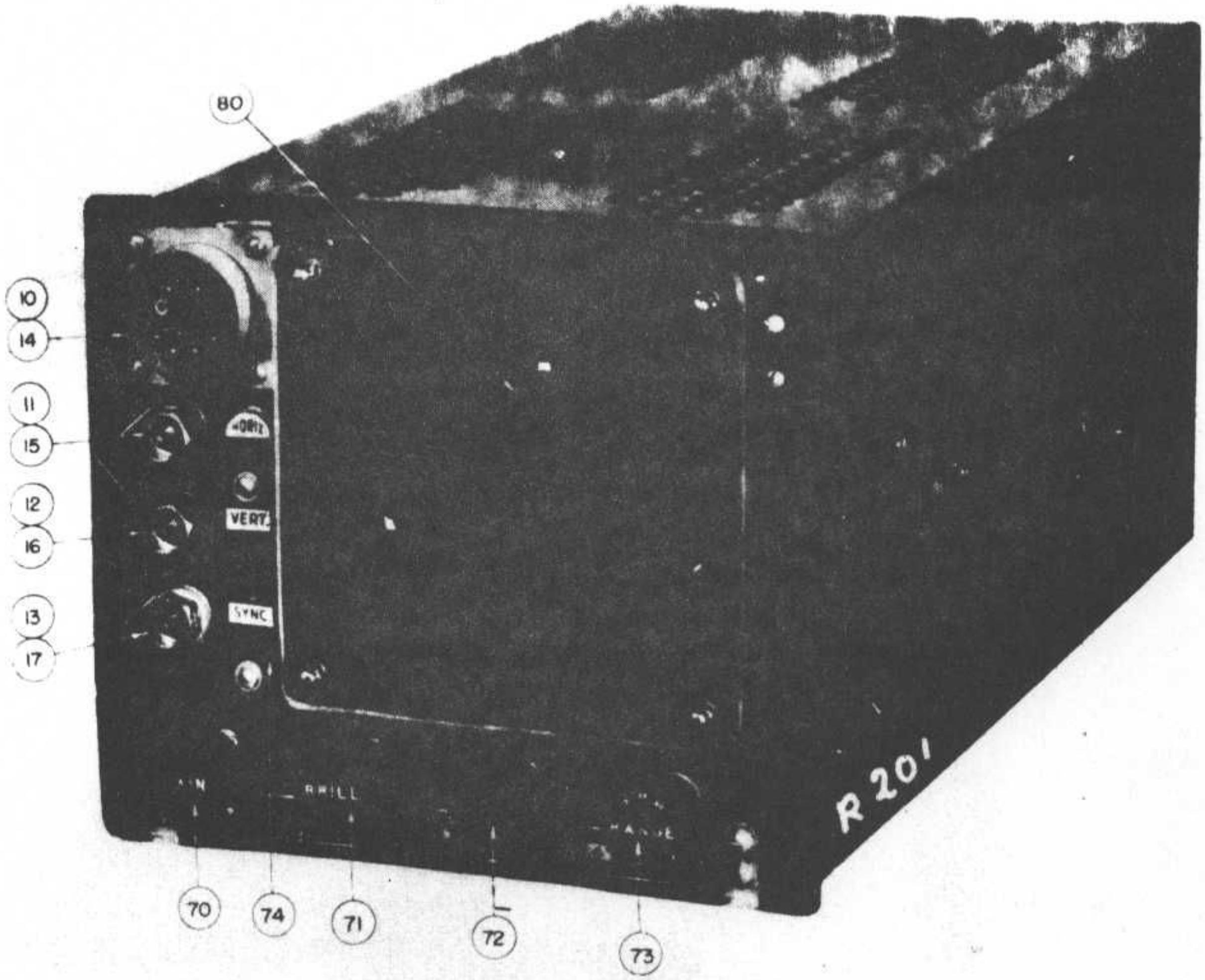

FIG. 2

"A" SCAN UNIT

AAFTAC-12/21/43-A896-1M

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11. RECEIVER: A.S.V. type, modified and retuned for 212 megacycle operation.

12. DISPLAYS: A.S.V. display indicator (CRT) for range. "A" Scan for elevation.
9" PPI CRT synchronous with antenna.

13. TENT: 8'-0" tent with 5'-6" walls built to fit around the antenna mast.
O.D. outside, painted black inside.
Ventilation blower in top and fly entrance.

CONCLUSION: This Radar is definitely not to be considered for GCI operation, Its probable uses, are:

a. Early warning against a/c at air fields not equipped with more elaborate equipment.

b. A means of locating and informing returning bombers their location.

c. Spot reporting in Tactical areas where radar coverage depends on mobility.

d. Early warning to gun crews and infantry of approach of enemy planes.

e. Detecting ships. (Not tried)

f. Detecting tanks in open country. (Not tried)

CHAPTER IX

CAPABILITIES AND USE OF THE SCR-540-A

1. The SCR-540 airborne radar for the detection of other a/c, is the American equivalent of the British MK. IV. Set. Undoubtedly, night fighter squadrons going into combat will be equipped with the SCR-520 - 720 Sets, but all basic training for R.O., and night fighter pilots is still being conducted in ships equipped with SCR-540.

2. The Original MK. IV A.I. equipment was developed for use in interceptor aircraft in conjunction with GCI. Under operating conditions it was found GCI could plot the course and speed of the target and position the interceptor successfully 2 miles behind the target, on course, thereby positioning the interceptor to close to a point of visual contact. Maximum range of the SCR-540 for A.I. interception is equal to the fighter height above the ground.

The minimum range varies from 300 to 800 feet. At ranges exceeding 6,000 feet, the blip tends to fade. During these momentary fadings, the fighter may lose the target.

At close ranges, 400 to 2,000 feet, the blip may change rapidly from one side to the other of the azimuth tube, creating the impression that the target is weaving. This is thought to be due to the fact that the echoes returned from various parts of the target alternately add and cancel out, thus giving a rapidly fluctuating effect.

3. Component Parts. (See Fig.1)

a. Antenna

b. Panel Control Unit

c. Modulator

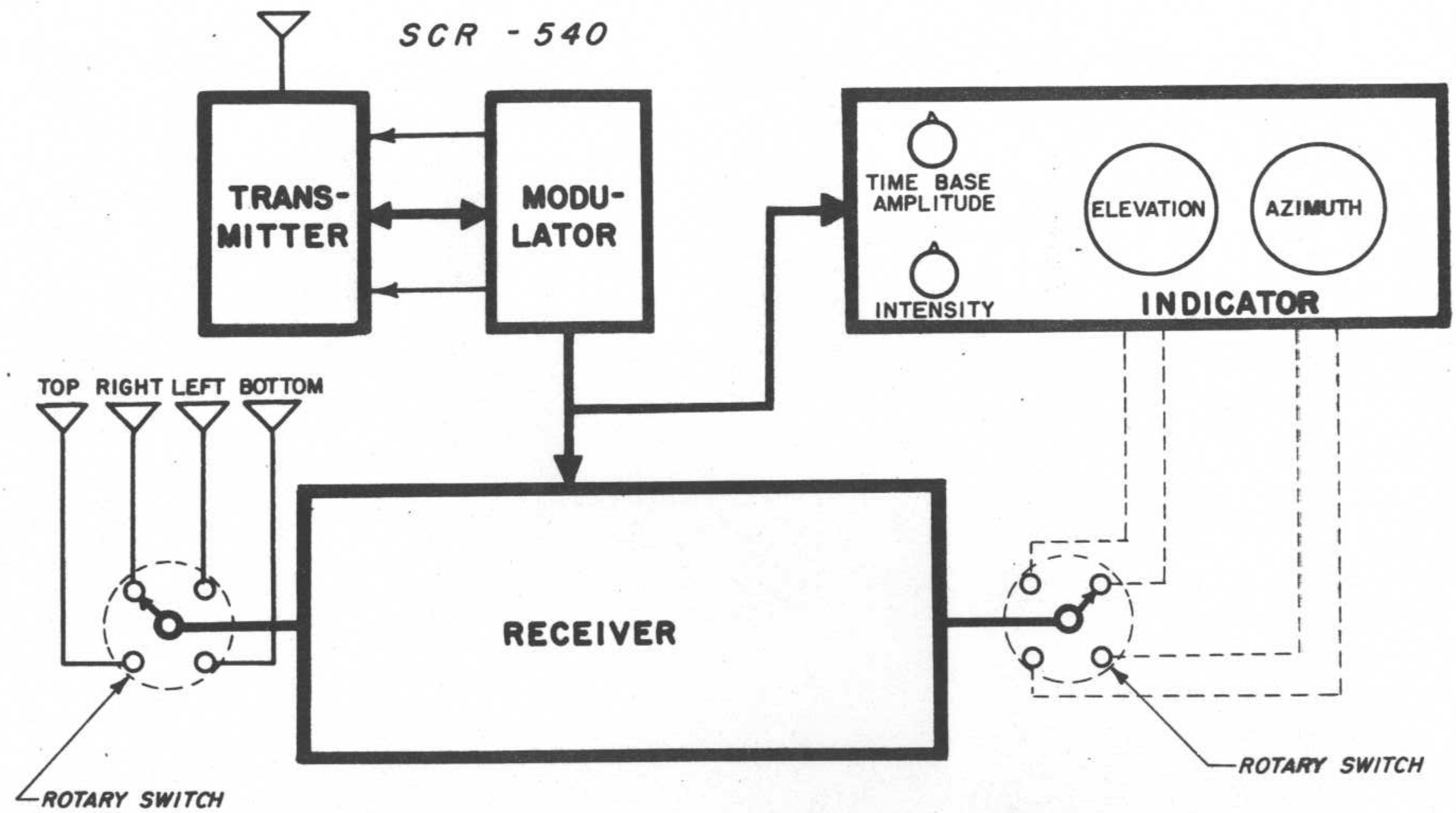
d. Transmitter

e. Receiver

f. Indicator Unit

4. Antennas. (See Fig. 2) - All antennas are made directional forward by proper placement and combination with a director. Coverage is provided by an antenna switching device which selects the antennas in the following sequence: bottom elevation, top elevation, right azimuth and left azimuth. Each antenna is connected to the receiver for an equal period of time, and conversely, an input switching device puts the impulse from the receiver on the C.R.T. of the indicator unit at the same instant. The antenna combination provides a forward coverage of 40° either side of Vertical axis of plane and 30° above and 15° below the horizontal axis of the plane. (See Fig.4)

5. Indications. (See Fig. 3) - The indicator unit houses a pair of 5 "CRT's" placed side by side which provide the visual display of echoes. The logarithimic sweep on both the elevation and azimuth tubes indicate range. Ground echoes blanket out any echoes which may be produced by aircraft which are at a greater range than the altitude. However, any target which is between zero range and a range which is equal to the altitude will produce an echo which appears between the transmitted pulse and the ground echoes.



BLOCK DIAGRAM .... SCR - 540

FIG. I

AAFTAC-12/7/43-A852-1M

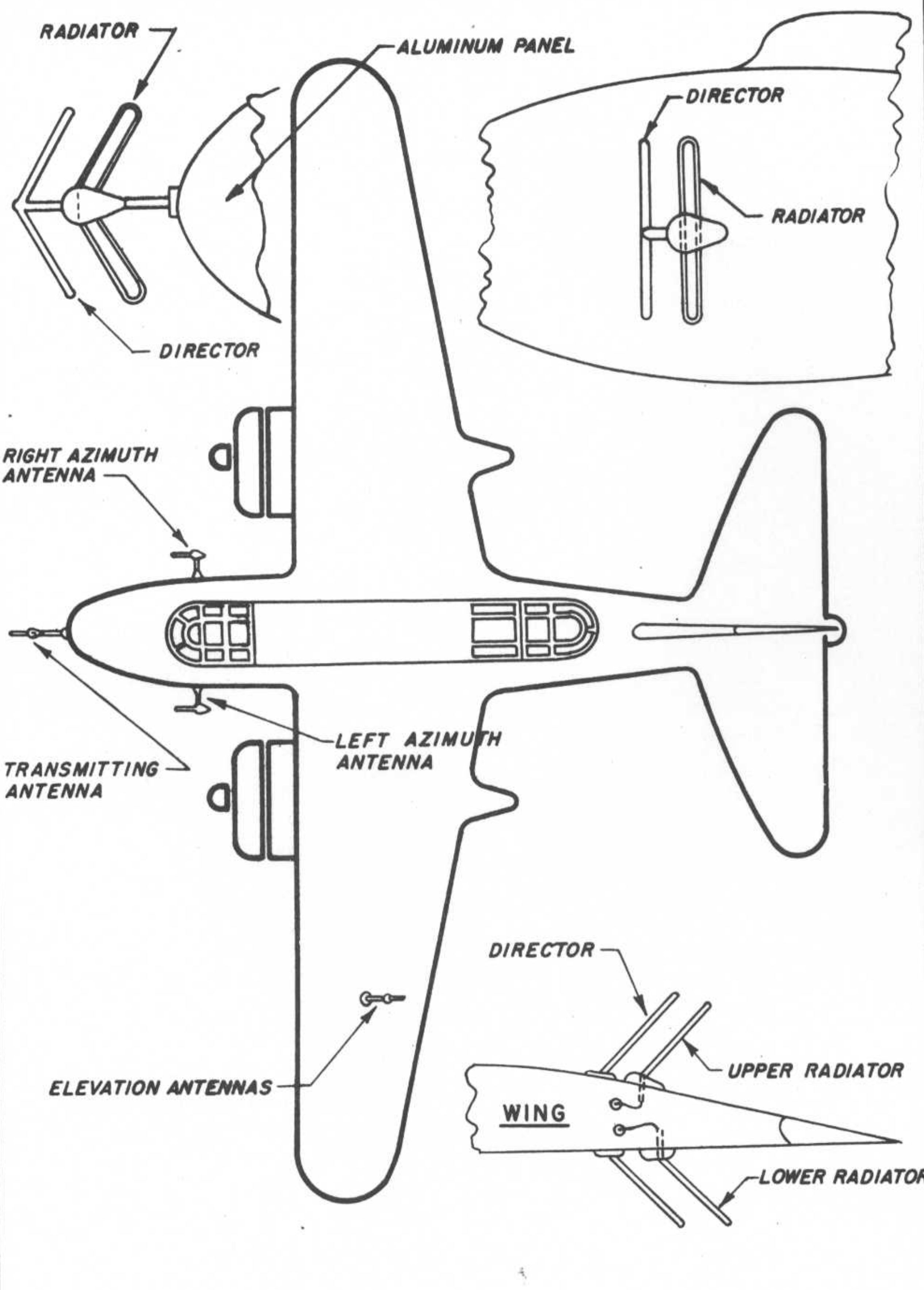
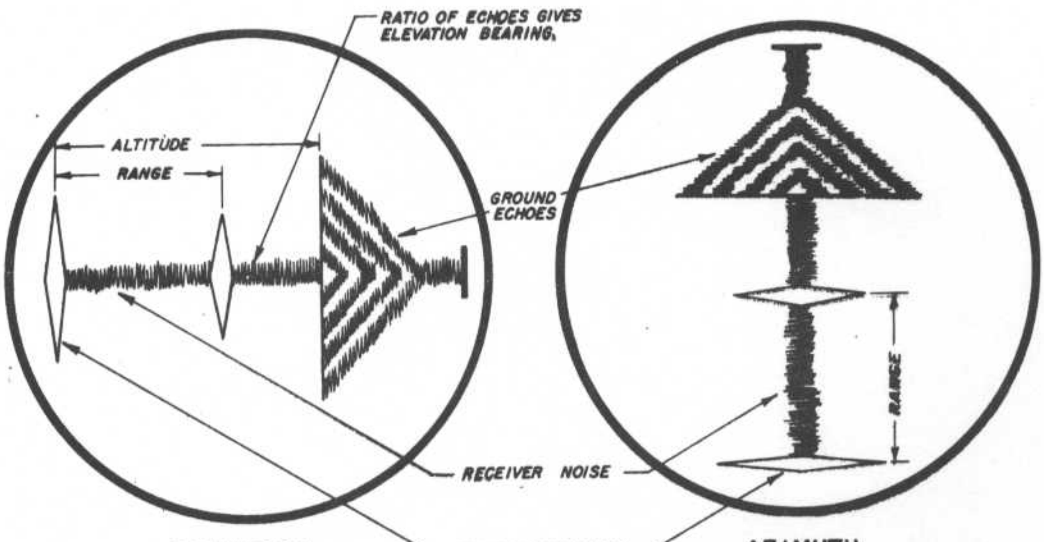


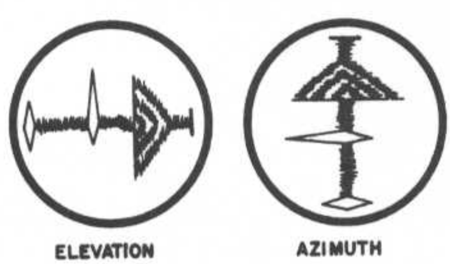
FIG. 2

AAFTAC-12/7/43-A852-1M

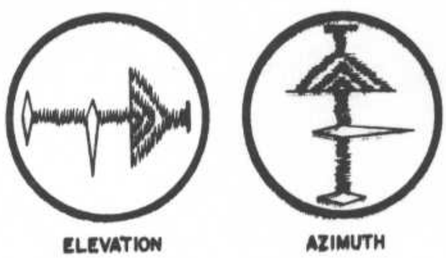
SCR - 540



TARGET DEAD AHEAD



TARGET IS TO THE LEFT & ABOVE

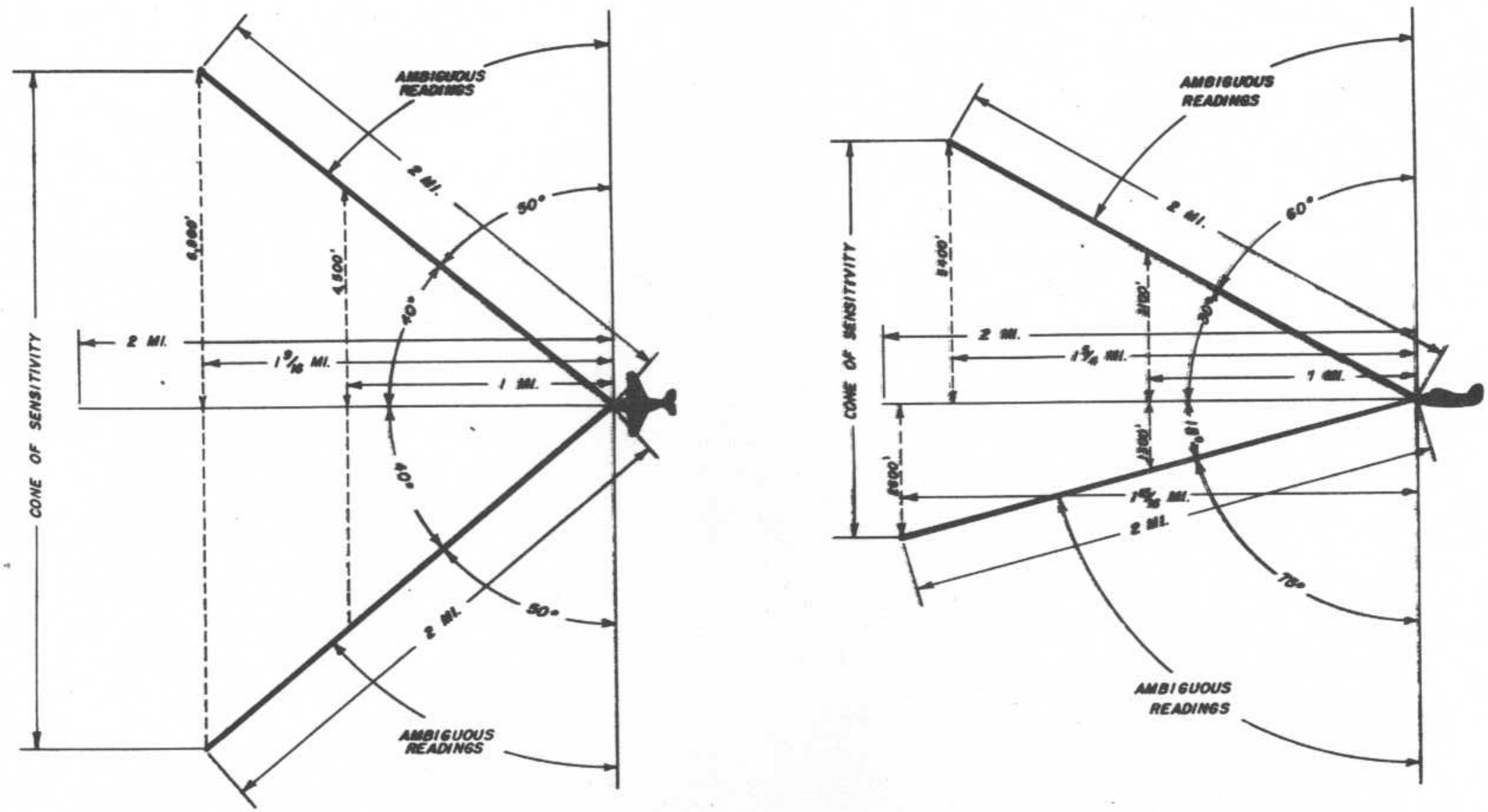


TARGET IS TO THE RIGHT & BELOW

TYPE OF DISPLAY ON INDICATOR SCOPES

FIG. 3

AAFTAC-12/7/43-A852-1M



IN HORIZONTAL PLANE

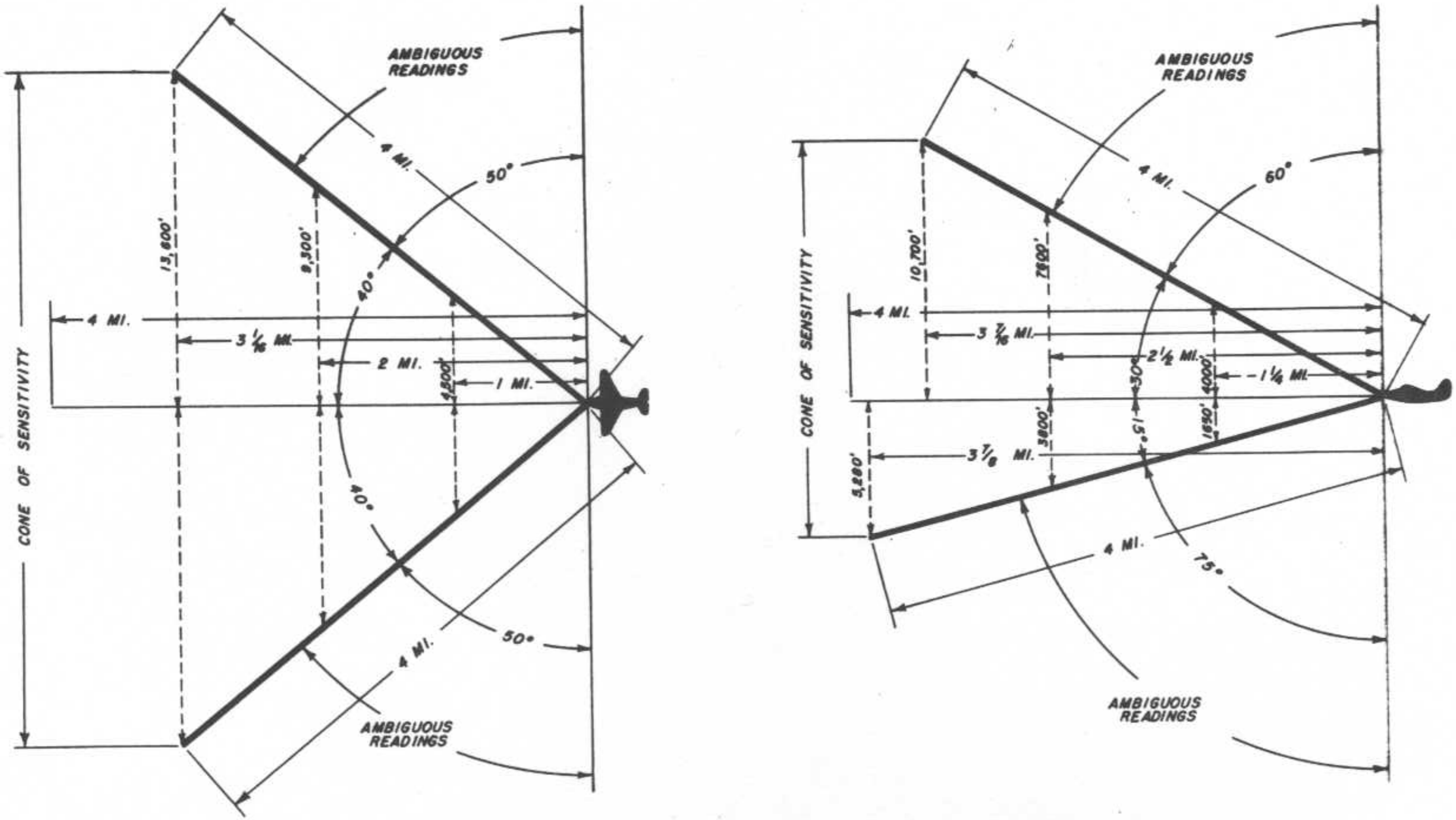
IN VERTICAL PLANE

RANGE & COVERAGE OF SCR-540 AT 10,500 FT.

FIG. 4

AAFTAC-12/7/43-A852-1M

SECRET



IN HORIZONTAL PLANE

IN VERTICAL PLANE

RANGE & COVERAGE OF SCR-540 AT 20,000 FT.

FIG. 5

AAFTAC-12/7/43-A842-1M

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CHAPTER X

CAPABILITIES AND USE
OF
THE SCR-520 - SCR-720

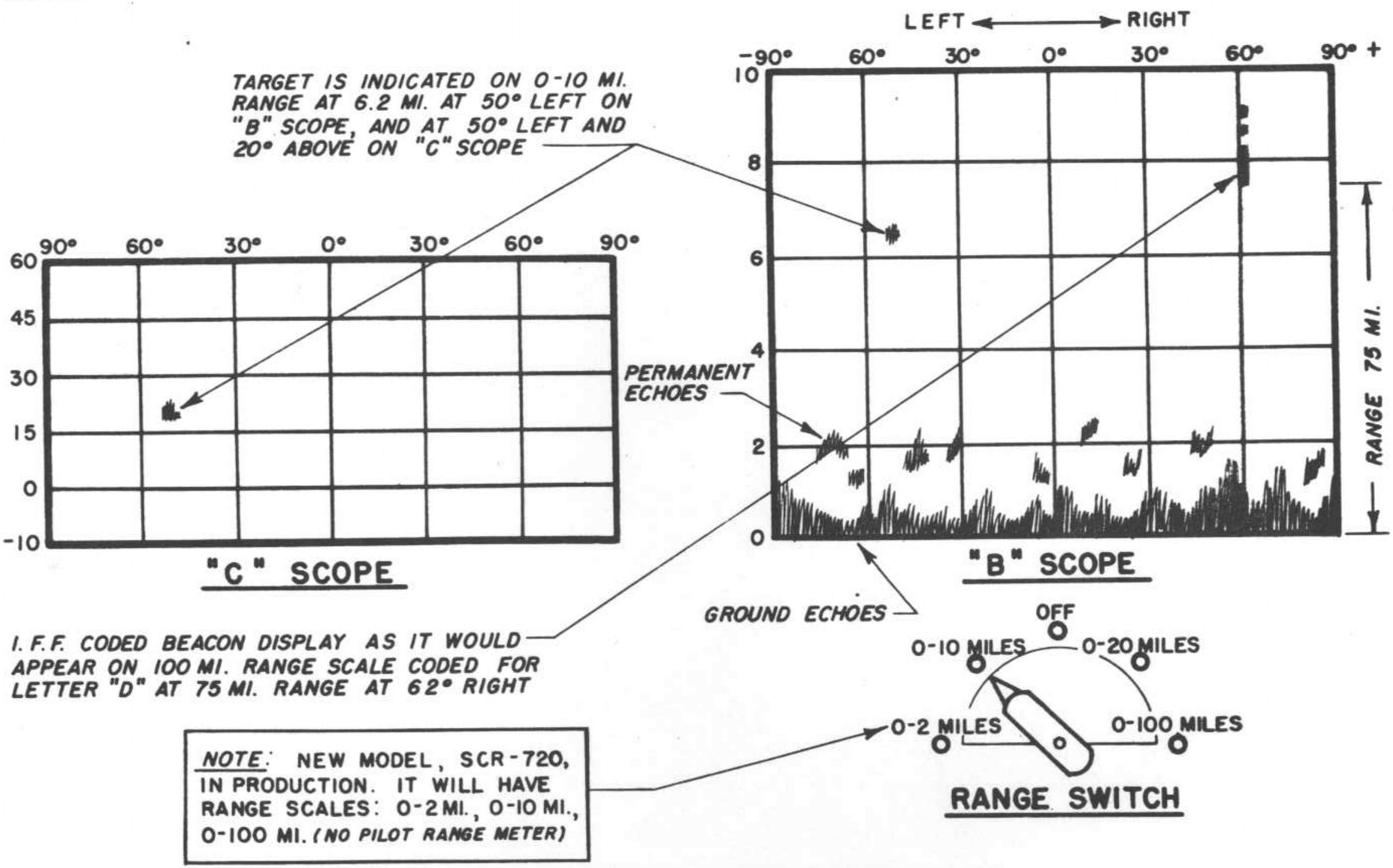
1. GENERAL DESCRIPTION: - Radio set SCR-520-B is designed for use aboard aircraft for the detection of other aircraft. It is equipped to provide RADAR operation on ranges of 1, 10 and 100 nautical miles. It is also equipped to provide BEACON operation for homing and navigating on ranges of 10 and 100 miles. It covers an azimuth range of 180° (90° to the left and right of the plane's horizontal center line) and a vertical tilt range (elevation) of from -10° to + 65° from the plane's horizontal axis. The antenna is mounted in the nose of the ship. It consists of an antenna with a parabolic reflector, mounted on a turntable which rotates 360 r.p.m. In addition to rotation, the antenna moves up and down to sweep the v ertical range. The equipment is designed to operate day and night under temperature ranges of from -40 to + 50° centigrade with relative humidities as high as 90°, up to 30,000 feet above sea level. The apparatus provides a visual indication to the operator which gives location of a target in terms of azimuth and elevation angles (in degrees) and range (in nautical miles) (Fig. 1) The pilot also has a visible indication of the azimuth and elevation angles in degrees and an approximate indication of the azimuth and elevation angles in degrees and approximate indication of the range in nautical miles. (Fig. 2)

2. INDICATORS: - The pilot's and operator's indicators(See Fig.1,

2 and 4) (oscillioscopes) are of two types: a type "B" scope and a type "C" scope. Since the operator is interested in both the range and bearing of a target, the operator's indicator is provided with oscilloscopes of both types. Since the pilot is mainly interested in the bearing of the target, the pilot's indicator is provided only with a class "C" oscilloscope. A range meter which is controlled by the radar operator and provides a rough indication of distance, is however, provided for the pilot's use. These scopes are described in greater detail below.

3. DEFINITIONS: - a. "B" Scope. (See Fig. 1) The horizontal axis of this scope is marked off in degrees to show the antenna azimuthal bearing (that is, the bearing of the antenna to the right or left of the line of flight). The zero in the center of this scale indicates the "DEAD AHEAD" position of the antenna. The -90° marking at the left indicates an antenna bearing 90° to the left of the "DEAD AHEAD" position as shown in Fig. 1. The vertical axis of the "B" scope has a scale calibrated in nautical miles. In the SCR-520-B there are three ranges of 0 to 1, 0 to 10 and 0 to 100 nautical miles respectively. The distance of an image above the horizontal zero line indicates the range of the target.

b. "C" Scope. (See Fig. 1 and 2) - The horizontal axis of this scope is calibrated in degrees to show the azimuthal bearing of the antenna the same as for the "B" Scope. The vertical scale, however, is calibrated in degrees to indicate the vertical angle of inclination of the antenna to the line of flight and hence of the target. This



A. I. DISPLAY OF THE SCR-720

FIG. I

AAFTAC-12/7/43-A852-1M

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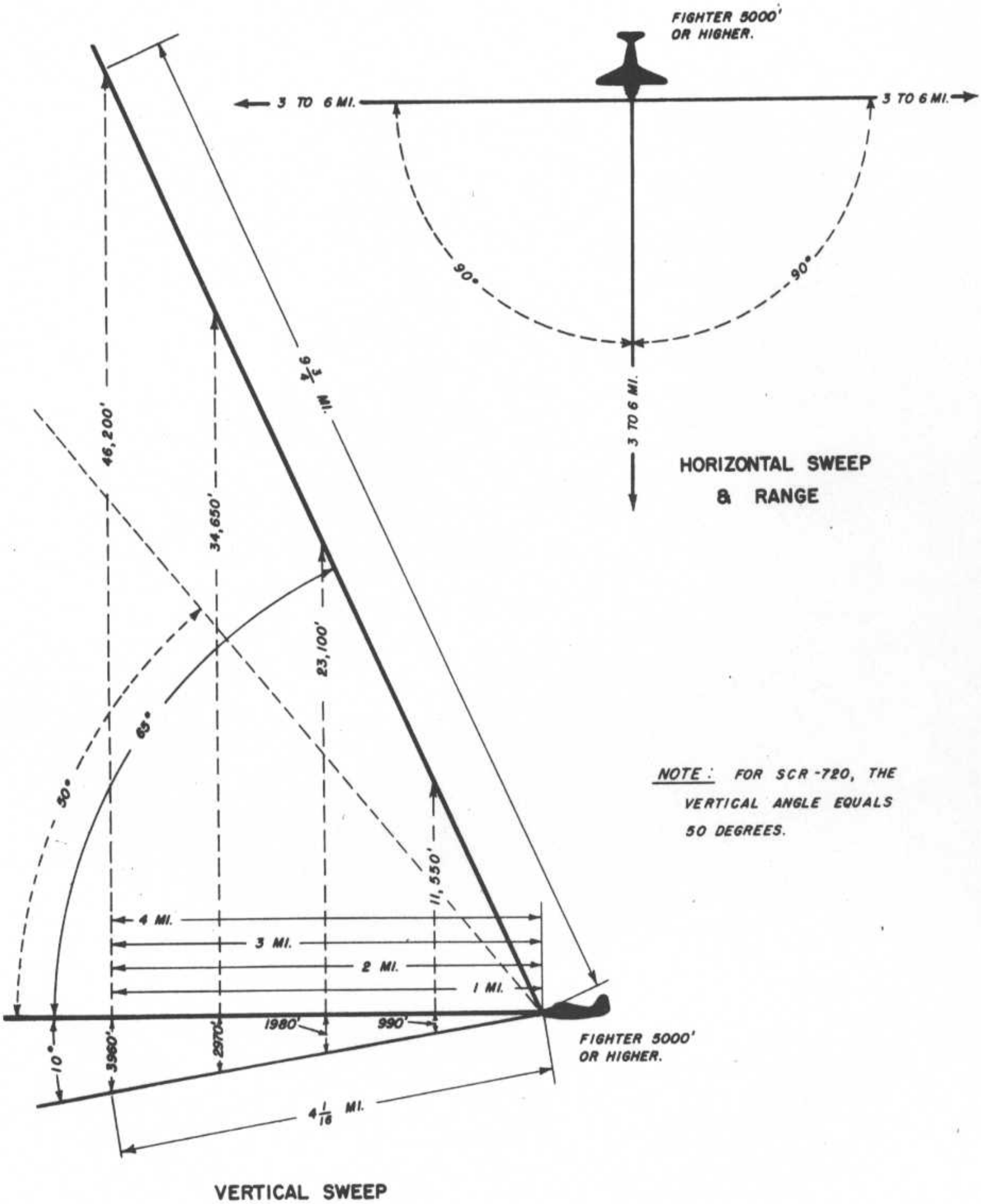

SCR - 520B

FIG. 3

AAFTAC-12/7/43-A852-1M

DECLASSIFIED BY EXECUTIVE ORDER #11652

scale goes from -10° to $+65^\circ$; the -10° indicating an antenna elevation of 10° below the level of the airplane and the $+65^\circ$ above the line of flight.

4. BEACON INTERROGATION: - Beacon service is obtained by transmitting R/F pulses with a time duration approximately $2\frac{1}{2}$ times, and a repetition rate 1/5 that of the radar pulses used on the 1-MILE and 10-MILE range settings. These pulses cause the "home" transmitter to transmit coded pulses. These pulses, when picked up on the indicator, reveal the location of the "home" station in the same manner as an echo reveals the location of a target. (Radar pulses with 100 MILE range setting have the same repetition rate as beacon pulses but have a time duration the same as radar pulses with 1-MILE and 10-MILE range settings).

The SCR-520-B Radio Set provides means to supply trigger pulses to, and receive video pulses from, identification equipment. The video pulses are placed on the oscilloscopes of the Operator's and Pilot's Indicator.

5. COMPONENTS, DIMENSIONS, AND WEIGHTS: - The SCR-520-B Radio Set consists of the units shown on the isometric drawing Fig. 5. In addition to the power and control units, the SCR-520-B Radio Set is composed of two synchronizers, and Operator's Indicator, a Pilot's Indicator, a radio receiver and transmitter (consisting of a transmitter, a TR box and a converter), an antenna unit and three junction boxes. The total weight of the complete installation including cables

and connectors for interconnecting the component parts of the system, and mounting racks for holding the various units in place, is approximately 530 lbs.

6. POWER REQUIREMENTS: - The power required to operate the equipment is about 100 amperes at 26 volts and is obtained from the 24-volt storage battery of the airplane, charged by the airplane's engine-driven d-c generator.

7. COMPARATIVE DATA

Type	SCR-520-B	SCR-720
AI Range	3½ to 5 mi. above 5000 ft.	8 mi. at 10,000 to 20,000 ft.
Beacon Range	Approx. 90 mi.	100 miles
Antenna Type	Rotating Parabolic type in nose of ship 360 RPM	Rotating Parabolic Type in Nose of Ship with 360 and 100 RPM
Scopes	"B" Scope and "C" Scope.	Same
Range Meter	In pilots cockpit	Same Scope for 2 and 10 mile range.
Combined "B" and "C" Scope Indicator	In pilots cockpit	"C" and "B" Scope for 20 and 100 mile ranges.
Pulse Recurring	2,000 cycles for AI	1600 cycles for AI
Rate	400 cycles for Beacons.	400 cycles for Beacons.
Range Control Scales	0-1 mi. 0-10 mi. 0-100 mi.	0-2 mi. 0-10 mi. 0-20 mi. 0-100 mi.

April 1, 1944 SECT. B. - CHAP. XI.

IFF AND THE MARK III IDENTIFICATION SYSTEM

1. Definition: - Identification is the process of determining by means other than visual if a plane is "friend or foe". With the advent of night time and inclement weather interception, the British found it highly necessary to bring out an efficient system for the positive identification of aircraft in their vicinity. Many systems of flight plans, light displays and such, were tried and found wanting. Finally though, equipment was developed that tied in very closely with radar and then the first all-round practical system of identification was launched. This early system was called the Mk.II System and since it identified "friend or foe" it soon came to be known by its initials of IFF.

a. Mk.II IFF - In brief the Mk.II IFF consisted of equipping a plane with an SCR-535. When that plane entered the radar beam and was challenged by the ground its airborne IFF equipment sent back an answer. It showed on the scope as a pulse following, after a short delay, the regular radar echo. The Mk.II System was an automatic device and once turned on required no further attention. The pilot was not even aware of the challenge to his plane or the reply that instantly followed.

The above system though, soon developed outstanding flaws. First the SCR-535 airborne set was designed to sweep through all the frequencies used by various types of radar, thus allowing transmission on any one frequency only once every six seconds. If the antenna is revolved very slowly, as in tracking missions, the incoming IFF can be seen only if the azimuth of the PPI time base, the moment of IFF transmission and the azimuth of the aircraft all approximately coincided. The big difficulty then was the time lag that this equipment produced. Secondly, the set was too easily duplicated and was used to advantage by the enemy. Many instances arose in which enemy planes flew through the radar beams emitting the IFF and went along unmolested. The answer seemed to be in the direction of a coded, standardized frequency IFF system. Thus we find the Mark III System making its appearance.

b. MARK III IFF: - It is better though, before going further into the Mark III to first understand the main termonology of our system. The Mark III system is made up of three main units.

(1) The "Interrogator" is the part of the ground equipment used in challenging unknown planes. It is simply a transmitter which sends out an interrogating pulse once every 2½ seconds.

(2) The "Transponder" which is the airborne unit of the system is designated as SCR-695. Its purpose is to receive the challenge of the ground unit and transmit a suitable reply. The SCR-695 covers the frequency spectrum from 157-187 megacycles in cycles of one every 2½ seconds. The same as that of the Interrogator.

(3) The third unit necessary to complete the identification is the ground equipment known as the "Responser". Its job is to receive the reply from the "Transponder" and throw it onto the scope in a visual form.

We now have identified our units. In practice it would work in the following sequence:

a. Plane enters radar field.

b. The challenge is transmitted by the "Interrogator".

c. The "Transponder receives the chall nge and emits the reply.

d. The "Transponders" reply is received by the "Responser, the Responser throws the reply on the scope, and the identification is complete.

The airborne transponder is comprised of a receiver, a transmitter, a power supply and a single 14-inch rod antenna. This transponder is normally quiet, but becomes active on being challenged.

The airborne radio control equipment is made up of the Selector Control Box and the Power Control Box. The Selector Control Box has a six position coding switch, and contains six coding circuits which are tied in to the transmitter-coder. The Power Control Box supplies the energy for transponder operation through the medium of the ON-OFF switch on the panel.

2. Frequency Bands: - There are two frequency bands, the "I" and "G", to which the SCR-695 transponder responds. In so far as the "G" band is the more direct, we will discuss that band first.

a. "G" Band: - The "G" band is a controller's band and is used in conjunction with GCI night fighter operations. In the event that the controller is not definite as to the exact position of his aircraft, with respect to other aircraft in the vicinity, he will call his fighter pilot through the radio-telephone and tell him to make his "cockerel crow", or "canary," please. The pilot will comply by pushing the "G" band switch-button located on the "G" band control box. This will activate a timing circuit and the transponder will transmit for about fourteen seconds. Note well that the "G" band is not automatic, but requires pilot attention to be activated. Once turned on though, the "G" band will transmit a pulse each time it receives one. The response is therefore a series of pulses whose repetition rate is equal to that of the interrogators pulse. On the PPI tube of the SCR-588 the "G" band signal will show as a series of vertical lines approximately ½-inch long, appearing at right angles on the outer edge of the "blip": A normal display will give an indication of approximately five or six pulses appearing.

b. "I" Band: - The second of the two bands to which the SCR-695 responds is the "I" band. The "I" band range in the frequency spectrum is between 157 and 187 megacycles, and it is in this range that the transponder sweeps. When the aircraft is challenged, the transponder answers all calls falling in this range. A challenge picked up by the antenna is applied to the transponder-receiver. The receiver then triggers the associated transmitter which sends out its pulse. The answer thrown on the scope of the RC-188 by the responser will show as an echo at right angles to the time base.

3. IFF Display: - The identification signal received by the responser may be displayed either on the display unit of the primary radar equipment or on a separate display unit.

In the simplest case of display on the primary radar indicator, the Mark III signal is displayed on the range scope on the opposite side of the time base to the normal echoes. (i.e. downward) . In certain cases, where it is particularly desirable to present the information on the primary display scope, but at the same time necessary to avoid any risk of interference with detection information, the IFF signals are displayed as a second trace on the same tube.

The other form of display uses a separate range tube for display of IFF information, as in the RC-188 for the SCR-588.

a. RC-188: - The RC-188, which is the ground unit of the Mark III system, resembles the SCR-588 sans the H/R console. The cathode ray tube contained within has a rotating time base with a hundred mile diameter. The pulses appear on the face of the scope (once every $2\frac{1}{2}$ seconds) in answer to the challenge. In appearance they will show as narrow, wide or very wide pulses. The narrow and wide pulses are normal coding, while the very wide are the pilot's emergency signals.

You will recall one of the deficiencies of the Mark II system was its inability to give off a simple, practical coded reply. This made it relatively easy for the enemy to duplicate our IFF and masquerade as a friendly ship. The Mark III system corrected this deficiency by incorporating a coded reply, thus making it almost impossible for the enemy to employ such tactics. The following material will attempt to throw some light on the matter of "I" band coding.

4. "I" Band Coding: - Control of the transponder through a code selecting device makes possible the transmission of definite width signals. The transponder has six different code positions (shown below) which, when thrown on the face of the tube, will appear as narrow, wide or very wide pulses.

POSITIONS	1ST SWEEP	2ND SWEEP	3RD SWEEP	4TH SWEEP
1	N	N	N	N
2	N	-	N	-
3	N	N	N	-
4	N	N	W	W
5	N	-	W	-
6	N	N	W	-
EMERGENCY	VW	VW	VW	VW

The Code-Selector controls the width of the signal or the omission of the signal, thus setting up a definite arrangement of pulse. The pulses that do appear may be narrow or wide. The narrow flash being a result of a narrow, 7-microsecond pulse covering 1.3 miles of time base on the range scope. The wide flash, the result of a wide, 21-microsecond pulse and covers 4 miles of the time base on the range scope.

In the event that a flight is challenged by an interrogator, the code selector unit may use any of the six possible combinations mentioned previously to identify itself. Let us say that the code position selected is number five, the four part answer will then return as follows:

a. A flash of narrow pulses, 1.4 miles in width.

b. A quiet period of no re-transmission.

c. A flash of wide pulses, 4 miles in width.

d. A quiet period of no transmission.

Thus a responser receiving this signal immediately identifies the plane as "friend".

Pilots Distress Signal: - Besides the six codes made up of wide and narrow pulses, plus quiet periods, there is a very wide pulse which is used for emergency. This pulse is activated by the pilot throwing the Emergency Switch on the Power Control Box. Then, in reply to a challenge from the interrogator, a distress signal will appear. This distress signal is a very wide pulse, each one being 80 microseconds long and covering 8 miles of time base on the range scope. It is a non-coded, distinctive flash, so different from the usual coded answer that it can be recognized immediately.

5. Simultaneous Triggering: - Now having covered the operation of both the "G" band and "I" band, a natural question would be "when both bands are in operation, how are the two kept separate?" The answer is simple; while both bands may operate at the same time, through the medium of an electronic switch, they will retransmit alternately.

The "G" and "I" bands do not pulse simultaneously. The "G" band is on and the "I" band off for 1/15th of a second. Then the "G" band is off and the "I" band on, for 2/15ths of a second. This on and off sequence is continuous, occurring five times per second as long as the "G" band remains on.

The following chart illustrates the radar units and associated IFF equipment:

RADAR UNIT CODE NUMBER	PULSE RECURRANCE FREQUENCY C/S	IFF GROUND EQUIPMENT USED WITH RADAR	I BAND FLASH SCOPE USED	PULSE RECURRENCE FREQUENCY C/S
SCR-588	400	RC-188	Separate	80
SCR-270	621	RC-150	Same	155
SCR-271	621	RC-151	"	155
SCR-516	1366	RC-316	"	273
SCR-268	4098	RC-148	"	273

Chapter XII

AI CONTROL BEACONS AND AI BLIND APPROACH

1. DEFINITION: - The AI Beacon is one application of IFF transmission to provide aircraft with bearing indication, by which it may navigate, or Home. Early in 1940 it was discovered IFF transmission was sensitive up to ranges of 90 miles or more, and work was begun to utilize these obvious benefits.

a. Uses of AI Beacons:

(1) As a navigational aid for fixing

(2) As a Homing device

(3) As a blind approach system

(4) As a point for orbit or patrol.

2. Method of Operation: - Beacon equipment is designed to provide a coded signal for identification purposes to a/c equipped with proper interrogation equipment. When such a/c is headed in the approximate direction of the beacon, the pulsed signals from the plane's transmitter are received by the beacon receiver. This receiver amplifies the signals, detects them and amplifies the pulses. The pulses then activate a coding device. This device keys the beacon transmitter into operation and signals are returned to the a/c. The returning signals inform the a/c operator of the bearing, distance and identity of the beacon station.

3. CHARACTERISTICS: - There are two types of Beacons in operation at the present time. The SCR-621-T2 beacon is designed to work in con-

conjunction with the AI SCR-520-B - 720, while the smaller YH-1 beacons only responds to the SCR-540-A. Due to the difference in frequency and pulsing of the SCR-540-A and SCR-520 sets, it is electrically impossible to build a combined beacon, which will respond to both sets. Either of these sets may be installed in a one-half ton panel truck for mobile operation, where the tactical situation requires periodic movement, or they may be permanently installed. These beacons are housed in weather protecting cases, with collapsable antennas which permit ease and rapidity of installation.

4. SCR-621-T2 Beacon: (See Fig. 1-2) The SCR-621-T2 - T3 model is the latest coded IFF Beacon for interrogation by the SCR-520 - 720. It is housed in a weather proof case with locking snaps and padlocks on front and rear access doors. The transmitter is of rack construction of the following components:

a. Power supply and voltage regulator

b. Coder and monitor chassis

c. Receiver and transmitter chassis.

The Antenna is a turnstile type, phased and fed for maximum transmitting and receiving characteristics with a sharp lack of directivity. Power input may be commercial or gas engine driven, AC generator of 115-volt, 60-cycle alternating current at 3 amperes.

The Monitor unit is a 2" CRT which may be turned on to check the receiver, coder and transmitter for proper wave form.

The Receiver is a superhetrodyne type employing wide band IFF section, video amplifier and follower output.

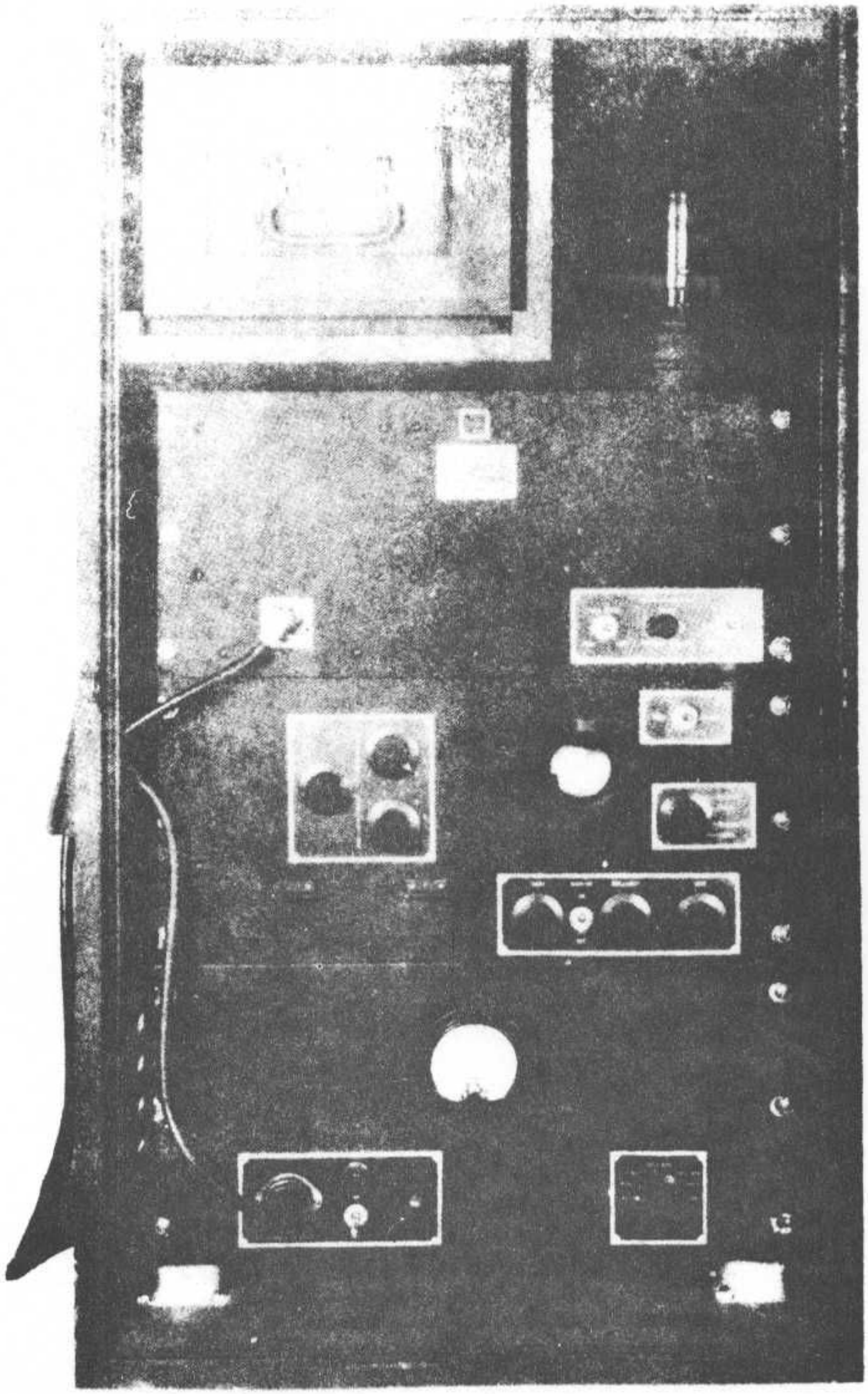

Figure 1 - FRONT VIEW OF SCR-621-T2.

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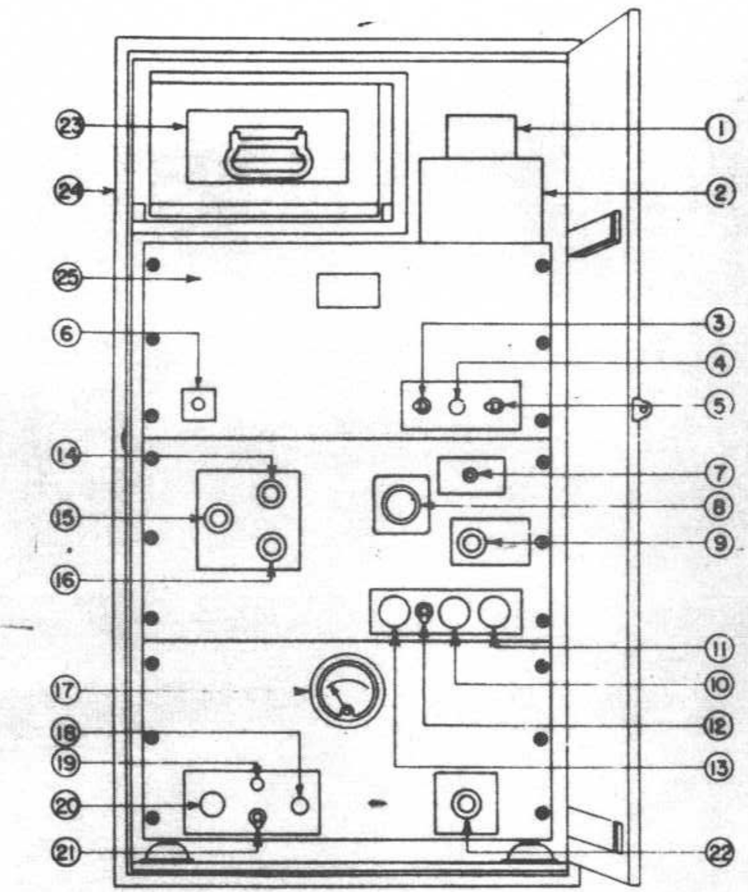

FRONT VIEW SHOWING DOOR OF WEATHERPROOF HOUSING OPEN

(CONTROLS (3) AND (5) DO NOT APPEAR ON SCR-621-T3)

1. BLOWER MOTOR
2. AUXILARY POWER TRANSFORMER ARL-131-18
3. FREQUENCY METER SELECTOR SWITCH
4. FREQUENCY ADJUST CONTROL
5. TRANSMISSION SELECTOR SWITCH
6. ANTENNA PLUG
7. "TEST-NORMAL" SWITCH
8. MONITOR TUBE
9. MONITOR SELECTOR SWITCH
10. BRILLIANCE CONTROL
11. GAIN CONTROL
12. MONITOP "ON-OFF" SWITCH
13. FOCUS CONTROL
14. CONSTANT CODE SELECTOR SWITCH
15. CONSTANT-PULSATING SELECTOR SWITCH
16. PULSATING CODE SELECTOR SWITCH
17. METER
18. FUSE
19. PILOT LAMP
20. POWER INPUT PLUG
21. POWER INPUT "ON-OFF" SWITCH
22. METER SELECTOR SWITCH
23. SPARE TUBE KIT ARL-131-15
24. WEATHERPROOF HOUSING ARL-131-14
25. RADIO SET, INCLUDES TRANSMITTER, RECEIVER, CODER, POWER SUPPLY ARL-131-13

FIG. 2

621-22	
AAFTS BOCA RATON, FLA. SCR-621-T2 RADIO SET	
DRAWN BY: TRACED BY: [signature] CHECKED BY: [signature] APPROVED BY:	COMPLETED 3-31-43

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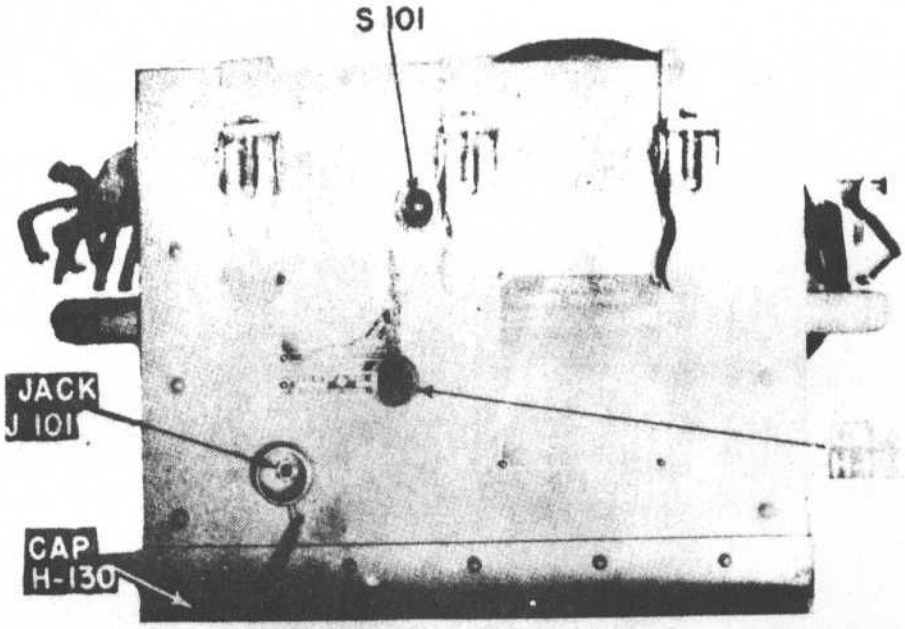
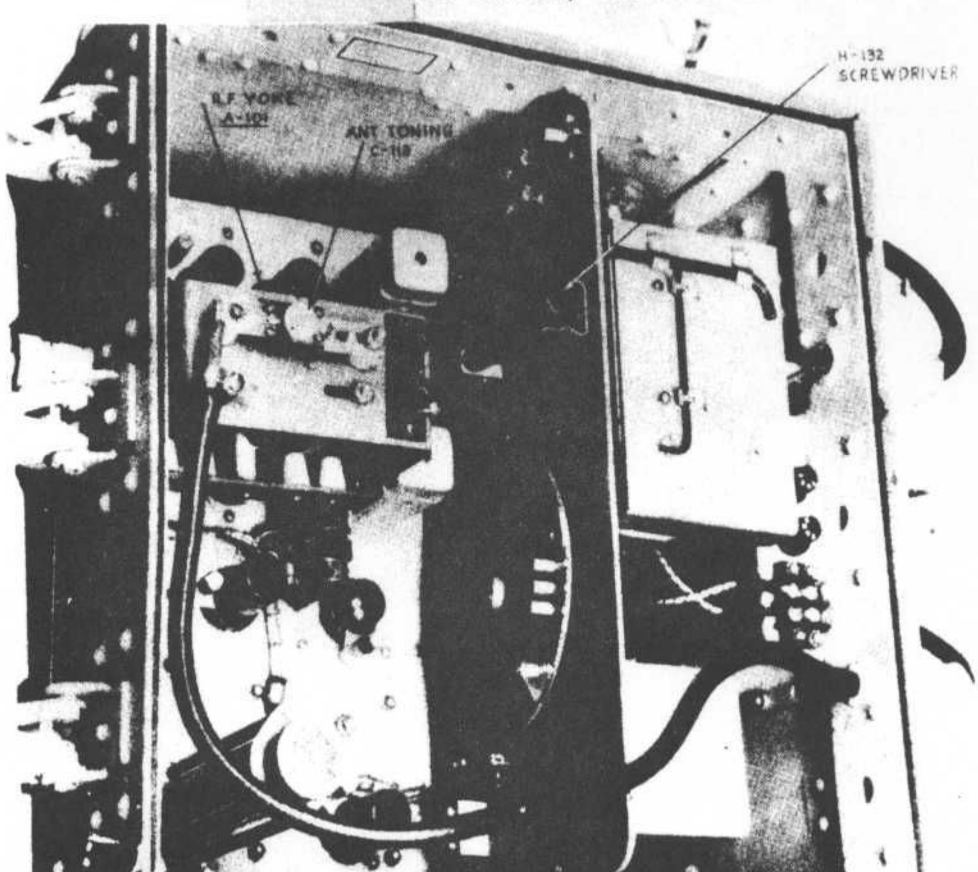


YH BEACON, OUTSIDE VIEW



YH BEACON, TOP VIEW

FIGURE 3

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The Transmitter may be adjusted to operate on one frequency or sweep back and forth across a band of frequencies. Sweep operation is seldom used.

The Coder unit controls the transmitter. There are two types of codes, constant and pulsating; and six codes of either type may be used.

5. YH-I Beacon: (See Fig. 3) - Little technical information could be gotten on the YH-I Beacon: It is a mobile, compact IFF Beacon approved jointly by Air Corps and Navy to work in conjunction with the SCR-540-A, Mk. II - AI Interrogator. The YH-I Beacon is housed in a weather-proof case. The Beacon consists of two chassis mounted in a metal box 17" square 11" deep. The entire unit weighs 46 pounds and is provided with a power input cable to take commercial or portable generator 110-volt 60-cycle alternating current. It comes supplied with signal generator I-98 and frequency meter BC-906-A for alignment and checking of Beacons operation. The antenna is a collapsable turnstile type which is 16 feet above the ground when erected. A coding wheel may be set up to transmit pulses in any one of six codes.

6. Tactical Employment:

a. Fixing: - The AI Beacon manifests itself to the AI operator as a powerful echo which is sensitive to bearing and gives range within plus or minus one mile under average to good conditions. Bearing is also very accurate and is usually within plus one or two degrees. When used in conjunction with American SCR-540 and 540-A, the beacon has a theoretical range of some one hundred and twenty miles although the guaranteed service area extends to a radius of sixty miles from the station when the aircraft in use is flying at an altitude of ten thousand feet. Thus an AI operator after a suitable amount of practice is enabled to fix the position of his aircraft to within one or two square miles.

b. Homing: - In addition to the fixing facilities it provides, the AI Beacon makes an excellent homing device. The accuracy of the AI equipment is such that an operator after practice can bring his machine back to its base and vector it immediately over the beacon location with an accuracy of plus or minus two hundred feet at a height of one thousand feet. With a decrease in altitude, this two hundred feet accuracy progressively improves until at an altitude of one hundred feet an operator can check his position as the ship passes over the instrument to within plus or minus twenty feet.

7. Procedure:

a. Fixing Procedure: - To obtain a fix upon a single beacon the operator will instruct his pilot to climb until he is able to read the chosen beacon with ease. The operator would then order the ship to orbit at a convenient rate. The observer will then inform the pilot when his tubes indicate that the marker is dead ahead. Due to the accuracy of the equipment the period during which such an indication can be observed is very short and operators must be careful not to be "caught out". It remains for the pilot to note his heading and pass it back to the operator when the latter individual can plot his position upon a suitable map if necessary.

b. AI Homing Procedure is Self-Evident: - The usual height precautions in relation to the height of ground will of course be borne in mind. Upon approaching the base it may be necessary to reduce altitude to something less than three thousand feet above ground level. This step is customary because AI beacons are not sensitive when viewed from above. It is this drop in sensitivity which enables AI operators to tell the precise moment at which they are immediately over the marker.

c. The Procedure for Blind Approach follows the standard blind landing regulations for other types of equipment such as the Lorenz installation. It is as well for the pilot to know the QDM of the run-way on which he is to make his run. He will traverse it in the opposite direction, i.e. on the reciprocal QDM, following this immediately by a turn of some ten degrees to the right. This new course will be held for a number of minutes calculated previously for each individual installation. The pilot will then commence a rate one turn to the left until he is satisfied that he is once again flying on the QDM proper. From this moment until the pilot is satisfied that he can see the run-way clearly, it is the duty of the operator to give him corrections based on the AI beacon indications appearing on the screen. The operator can give the pilot lateral correction and three definite fixes:

a. The point at which they cross the outer marker beacon.

b. The point at which they are exactly half way between the outer and inner beacon.

c. The point at which they cross the inner marker beacon, i.e. the beginning of the run-way.

NIGHT FIGHTER AIR CRAFT

1. GENERAL: - The P-70, a modified version of the Douglas A-20 is a high wing monoplane weighing eleven (11) tons. It is powered by two 1600 horse power radial engines.

Identification features are :

a. A recractable, tri-cycle landing gear
b. An extremely long nose
c. Engine housings that protrude well back of the wings
d. A high tail assembly.

2. Speed - True air speed of an aircraft, in relation to its indicated air speed, is influenced by temperature, barometric pressure and altitude. The following table shows average speeds for various altitudes and temperatures assuming a constant barometric pressure of 30.02".

Indicated Air Speed	Temp. - Alt. -	True Air Speed 20c 5,000	12c 10,000	2.5c 15,000	-6c 20,000
180		200	218	235	258
200		220	240	260	283
220		245	268	290	315
250		273	300	325	
275		300	327		
300		328	355		

3. Fuel: - When fully loaded, the P-70 carries a total of 600 gallons of gasoline. One tank holding 200 gallons is located in the upper part of the bomb bay directly behind the pilot. In the wings adjacent to the fusilage are two tanks known as the right and left inboard tanks. These hold 140 gallons.

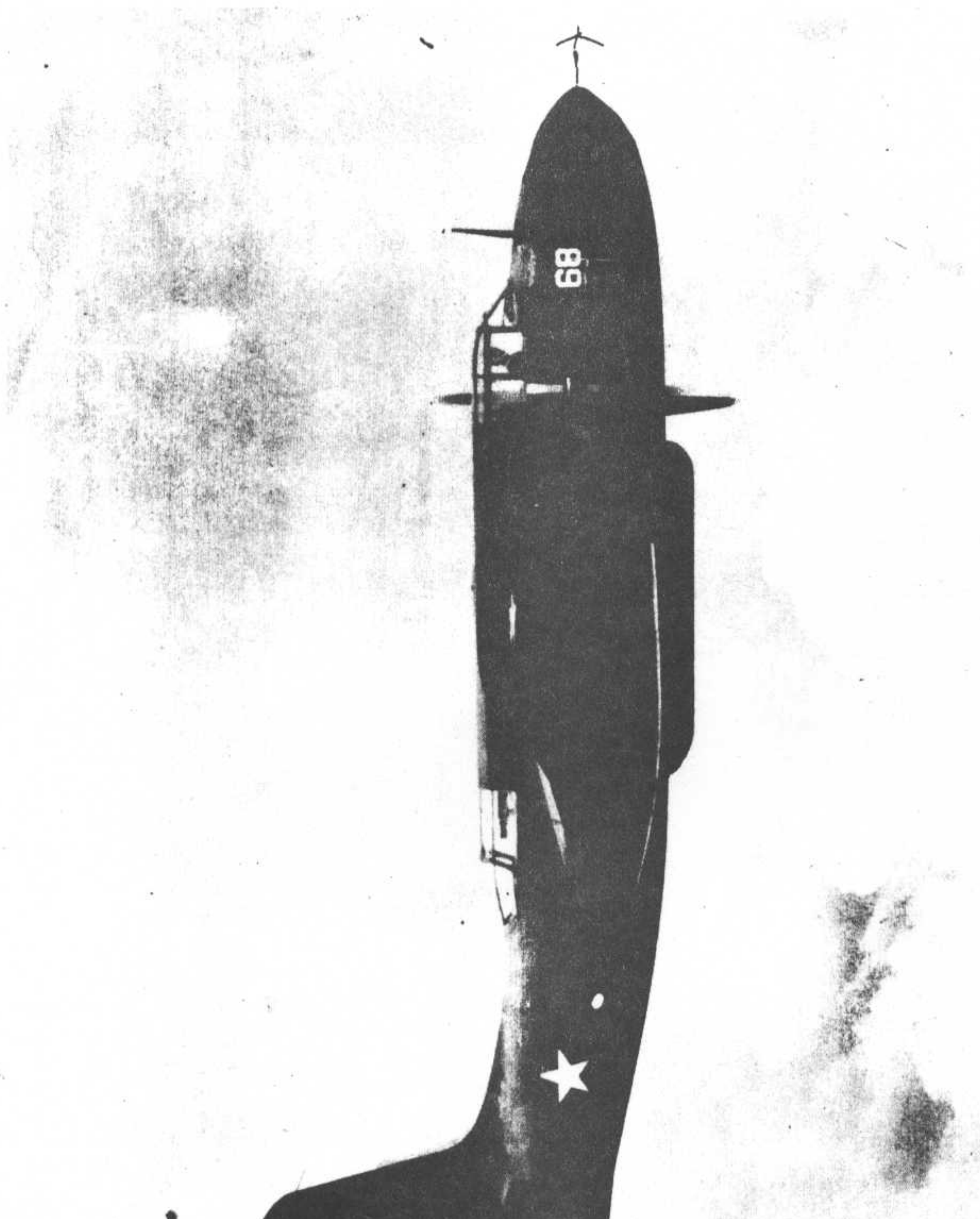
each. Also in the wings and beside the inboard tanks are the right and left outboard tanks holding 60 gallons each.

Rate of fuel consumption is extremely variable. The following table shows average rates of consumption at 10,000 feet. These figures should not be taken as absolute, due to the large number of influencing factors.

Ind. Speed	Fuel Consumption per Hour
180	120 gals
200	150 "
220	200 "
250	300 "

4. Oxygen Supply: - The P-70 carries two oxygen cylinders containing 400 pounds pressure of oxygen. They provide a four hour oxygen supply for each member of the two-man crew when flying at an altitude of 20,000 feet. On night interceptions the oxygen is turned on immediately upon take off as an ample oxygen supply is an aid to night vision.

5. Armament: - Armament of the P-70 consists of four 20 mm. cannons placed in and protruding from the lower part of the belly "bath tub". Sixty rounds of ammunition per gun, or a total of two hundred fourty rounds, are carried. The rate of fire is 600 rounds per minute. The guns are bore-sighted to fire straight ahead, when the ship is flying true. The fire pattern does not converge to form a cone.



P-70

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6. Radio and AI Equipment: - The control panel for the VHF radio set is located on the right side of the pilot's cockpit. The AI observer has a receiver and transmitter and can hear ground to air conversation but cannot communicate with the ground unless the pilot holds his transmitter key down. He can hear the pilot at all times but can only talk to him when the pilot switches on the inter-communication phone. The AI equipment is located in the rear cock-pit directly in front of the observer and at eye-level.

7. Emergency Operation of Undercarriage and Flaps: - When the hydraulic system designed to lower the wheels fails, the landing gear control lever should be placed in the down position. This will release the latch holding the nose wheel and it will descend and lock. The emergency landing gear release, located on the right side of the cockpit near the floor, is then pulled. This releases the pin holding the undercarriage up and by series of jerky maneuvers the pilot can force the landing gear to descend and lock.

If the hydraulic system is a complete failure, the flaps cannot be operated. In case the main hydraulic pump fails, the hand operated hydraulic pump, located on the floor at the pilot's left, will force enough fluid into the system to raise or lower the flaps.

8. Ceiling: - In local test flights, the P-70 has been flown to an altitude of 30,000 feet. Under average operating conditions, however, its maximum ceiling is around 22,000 feet. Its most effective operating

range is between 12,000 and 16,000 feet.

9. Rate of Climb: - The normal climbing speed of the P-70 is 165 miles per hour. This varies according to the angle of climb, wind velocity, direction, etc. A conservative rate of climb is 1500 feet per minute up to 20,000 feet. This figure is conservative as shown by actual test data tabulated below:

Altitude			
From	To	Time Required	Rate of Climb
Take-off	5,000 ft.	3½ min.	1428 ft. per min.
5,000 ft.	10,000 ft.	3 min.	1667 ft. per min.
10,000 ft.	15,000 ft.	3½ min.	1428 ft. per min.
15,000 ft.	20,000 ft.	4½ min.	1111 ft. per min.
20,000 ft.	25,000 ft.	8½ min.	588 ft. per min.

The angle of glide is about one to one. This means that at an altitude of 10,000 feet the aircraft would glide about two miles.

THE P-70-1

1. GENERAL: - The P-70-1, night fighter, is the latest conversion of the A-20 Line. It is a modified A-20-G twin-engine, mid-wing, two-seat monoplane, with tricycle landing gear.

The two power plants are 14-cylinder, 1,650 horse power, Wright double-row cyclones. These are equipped with Hamilton Standard hydromatic propellers. The engines are designed to operate on 100-octane gasoline. The P-70-1 is of all metal construction except for the control surfaces. The dimensions are as follows:

Length - 47 ft. - 4 in.
Height - 17 ft. - 5 in.
Span - 61 ft. - 4 in.

2. Fuel Capacity: - The normal fuel capacity is 400 gallons, but this can be increased by 146 gallons with the addition of a bomb bay tank. Since the normal fuel consumption is 100 gallons per hour it has a four hour crusing range. On a GCI mission this range will be cut to three hours because part of the time is devoted to combat which very sharply increases gasoline consumption. The armament consists of six (6) 50-caliber machine guns which are mounted in the nose. The pilot will operate the guns; the other position to be occupied by the R.O., inflamable 50-caliber M.G. will be furnished for rear compartment. The P-70-1 has a normal cruising speed of from 200 to 220 miles per hour (I.A.S.). It is red-lined at 425 miles per hour (I.A.S.) The maximum ceiling is 28,000 feet and the maximum service ceiling is 25,000 ft. The best service ceiling is 20,000 feet.

This plane has a 2,500 feet per minute rate of climb for the first minute, then 1,500 feet per minute up to 15,000 feet, then 1,000 feet per minute up to 18,000 feet. Above 18,000 feet the rate of climb drops to 600 feet per minute up to its ceiling.

According to the latest available reports, the P-70-1 is to be equipped with the SCR-540 or a similar set.

1. THE BEAUFIGHTER: - For all practical purposes the Beaufighter is essentially the same as the P-70-1 in performance, having a slightly higher ceiling (2,000 feet greater) and a little faster rate of climb; this being true because it is a lighter plane.

It has a conventional landing gear, all metal construction (except control surfaces), two 1,400 to 1,600 horse power engines, air brakes, fuel capacity of 700 gallons, cruising speed of 200 to 220 miles per hour (I.A.S.), and is about the same over-all size as the A-20.

The Beaufighter has four (4) 20-mm. cannon mounted in its belly and in some cases it is equipped with six (6) .303-caliber machine guns, mounted three in the leading edge of each wing.

THE MOSQUITO: - The Mosquito is a mid-wing, in-line engine, plywood monoplane. This plane has many unique features.

1. Two Merlin 21's - 1275 h.p. each
2. Two Merlin 23's - 1275 h.p. each
3. Two Merlin 31's - 1275 h.p. each
4. Two Merlin 61's - 1650 h.p. each

The first three installations ... le the Mosquito to attain a cruising speed of 240 to 260 miles per hour (I.A.S.). With the Merlin 61 installation at an altitude of 20,000 to 25,000 feet it can attain a T.A.S. of 420 to 430 miles per hour. Using this same installation and a pressure cabin, an altitude of 45,000 feet has been attained.

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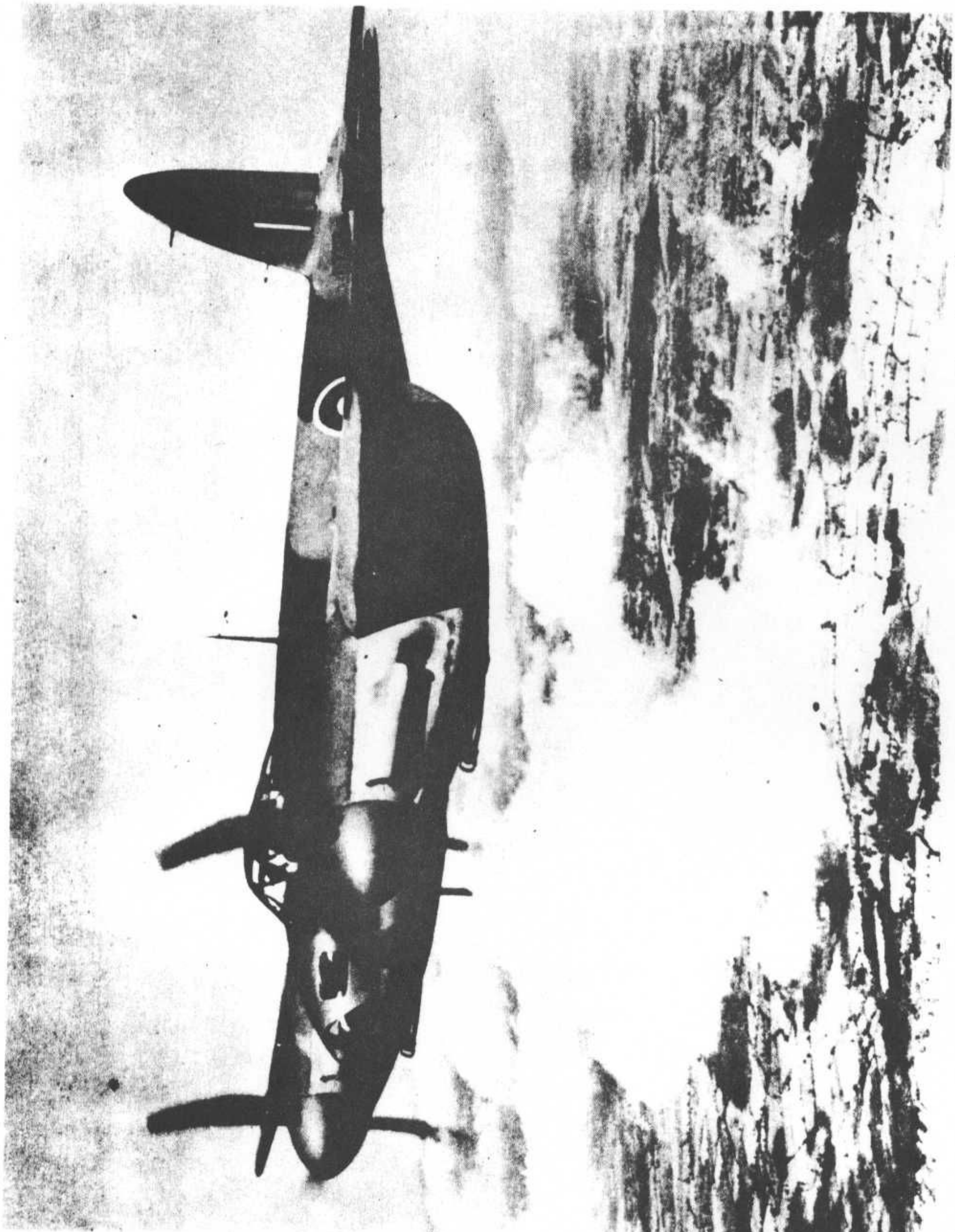

DeHavilland "Mosquito"

SECRET

S E C R E T

The fuselage and wings are constructed of plywood which is composed of 1/16" birch, 1/2" balsa and another 1/16" of birch. It is all covered with canvass and then painted like a canoe. The wing spread is five feet less than the A-20.

The navigator or R.O. sits to the right and slightly behind the pilot. Actually he sits on the main wing spar.

The Mosquito has a 600-gallon fuel capacity which will give it a range of 1,500 miles, 6 hours on patrol or approximately 4½ hours flying time on a control mission.

This plane is equipped with the British Mark VII, Mark VIII and the American SCR-540 or SCR-720 AI equipment.

If the SCR-540 is used, the armament consists of four 20-mm cannon in the belly plus four .303-caliber machine guns in the wings, while if the Mark VII, VIII or SCR-720 is used, the four machine guns are left out of the nose leaving the four 20-mm cannon as the sole armament. There is a piece of armor plate behind the seats of the pilot and R.O.

The Mosquito is well streamlined and affords the pilot very good visibility in all directions. This plane relies upon speed and maneuverability for its own protection, rather than armor plate.

S E C R E T

P-61

The P-61 is the new night fighter that is being manufactured by Northrup.

The aircraft is of the twin boom and twin tail design. It has an exceptionally long glass enclosed nose which is divided into two compartments. The pilot occupies the front section and the gunner the rear section. The latter's compartment is elevated so that he has a much larger angle of vision. It is a three-place ship, the personnel consisting of pilot, gunner, and AI operator.

This new fighter is powered by two Pratt and Whitney air cooled radial engines, each having 2000 horse power.

The plane has an extremely long cruising range for a fighter. It can stay in the air between six and seven hours without the use of external fuel tanks. The craft is equipped with a rack which can be used for either extra gas tanks or bombs. In the event no bombs are carried and extra fuel tanks are used, this new fighter will have a range of 3000 miles. The plane has a very high rate of speed, being red lined at 420 mph. The normal and most economical cruising speed will probably be about 260 mph. The most efficient operating altitude (critical altitude) is between 20,000 and 25,000 feet with a ceiling of about 35,000 feet. The maximum rate of climb is 2500 feet per minute up to an altitude of 25,000 feet.

As to armament, the plane has 4 - 20 mm cannons placed in the

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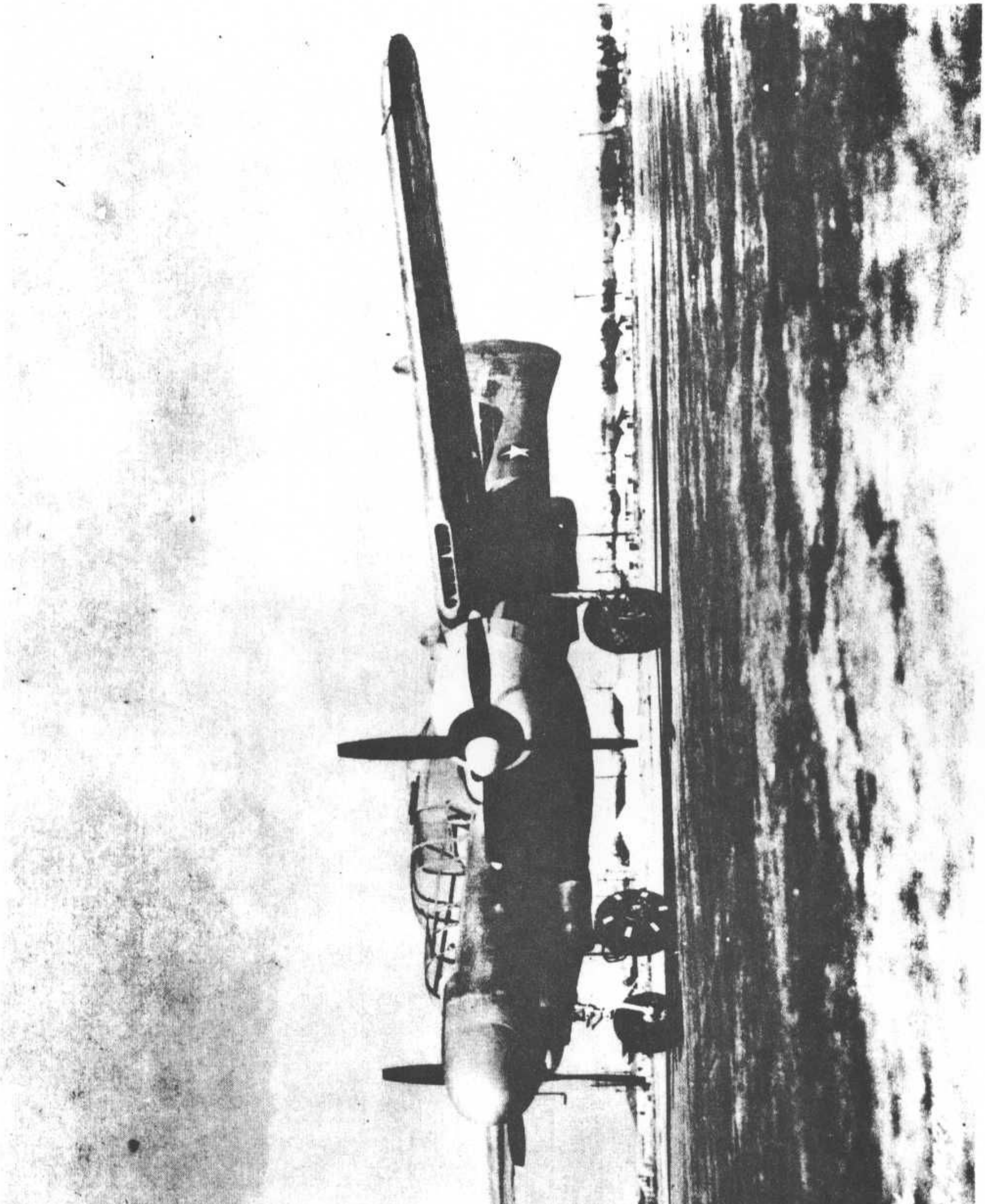

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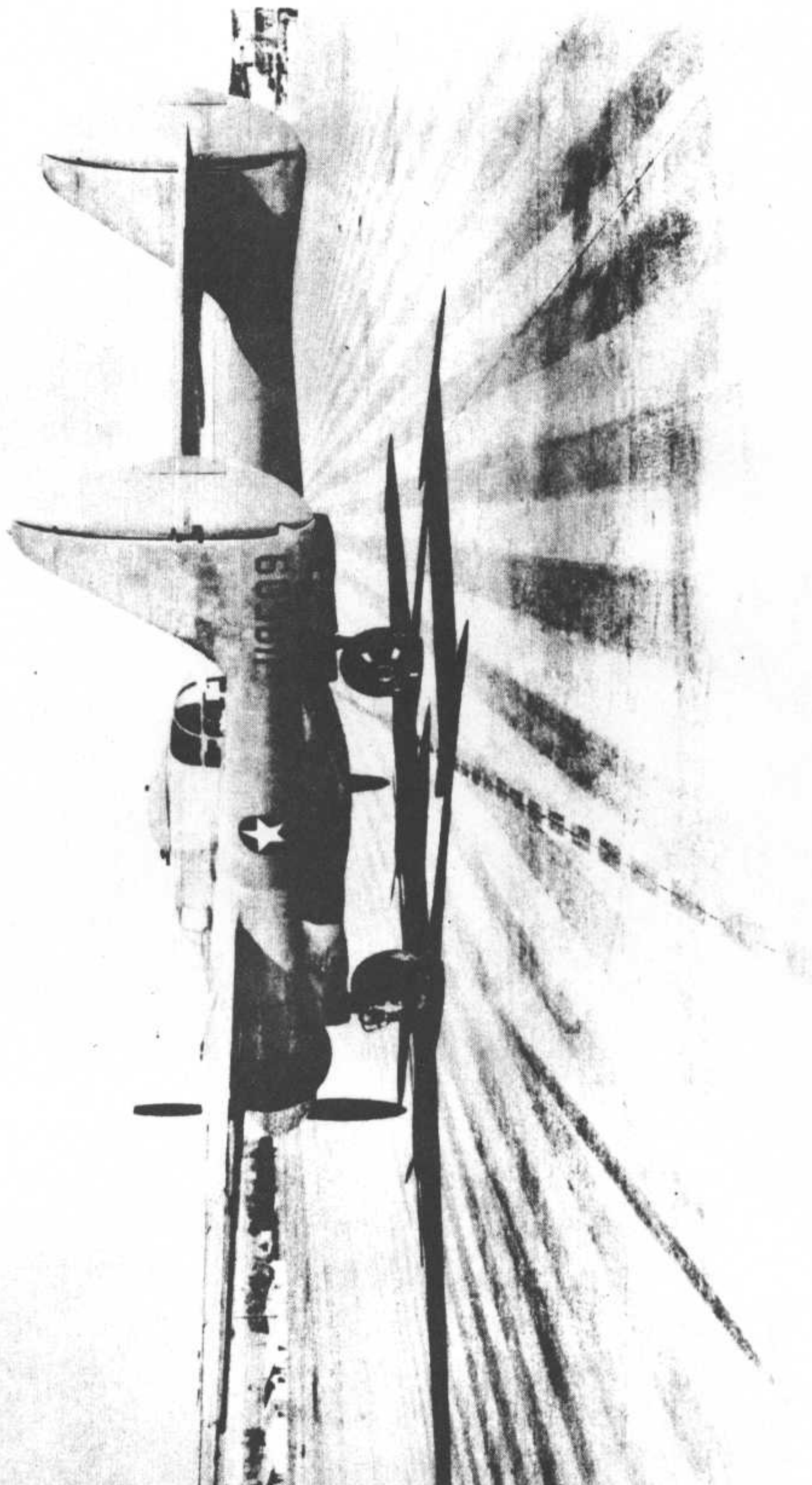

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lower belly of the ship and 4 - 50-cal. flexible machine guns mounted in a turret on the top of the ship and to the rear of the gunner. The 20 mm. cannons are forward firing only, but the turret guns can be fired 360° laterly and 180° over head. An unusually large reserve of ammunition can be carried. It will consist of 200 rounds per 20 mm cannon and 600 rounds per 50 cal. guns. The rate of fire is 400 to 600 rounds per minute for the 20's and approximately 650 rounds per minute for the 50's.

The pilot fires the forward firing 20's. All three members of the crew can fire the turret guns. The gunner is the master controller as far as the guns are concerned and will do most of the firing because obviously the AI operator will usually be occupied with his own equipment.

The ship is well armored with bullet proof glass in front of the gunner compartment and also in front of the pilot compartment. Additional armor is between the two compartments. There is also heavy armor in front of the AI operator.

An oxygen drum is carried in one of the booms. Four hours for each man is the normal quantity carried, although the amount will vary, depending upon the mission.

While the plane is not as maneuverable as some of the light and smaller fighters, it has good maneuverability considering its weight of 27,000 pounds.

COMMUNICATION FACILITIES FOR GCI

1. COMMUNICATION REQUIREMENTS. Communication facilities between the GCI operations room and other centers will vary according to the requirements of each Area. Primary telephone and VHF facilities will be necessary to conduct operation. These facilities may be divided into external and internal in relation to the operations room, with as many lines and channels as necessary to provide satisfactory operation. (See Fig. 1) Termination of all lines should be in the switchboard as requirements for GCI and reporting often necessitate cross patching. This also provides the necessary switching between inter lines, as well as a quick change over panel if accidental failure requires a cross patch. (See Fig. 2)

2. External Lines

a. Area Operations Room
(Four hot lines if possible)

b. Adjoining GCI Stations
(One hot line into switchboard)

c. Night Fighter Airdrome
(one hot line into switchboard)

d. Wing Radar Filter Room
(One hot line into switchboard)

e. VHF Vans
(Provide two operating lines and one for field phone to crews)

f. Administrative Lines to:

(1) Orderly Room
(2) Guard Tent
(3) Administrative Unit

g. D/F Unit
(One line for field phone and spare line for selsyn control unit for D/F indicator)

h. Adjacent CHL Stations
(one line for each station)

i. "Y" Service
(May be line from Area if "Y" information is supplied through liaison in Area)

3. INTERNAL LINES OF COMMUNICATION All Internal lines interconnect through the switchboard. (Fig. 1)

a. Senior Controller: Interconnected with:

(1) Controller positions No. 1, 2, and 3 (VHF)
(2) Line to PBX for connection with Area.
(3) Loop to Liaison Operator)

b. Liaison Operator:

(1) GCI Liaison at Area
(2) "Y" Service
(3) Adjoining CHL
(4) Night Fighter Airdrome
(5) Through PBX to D/F Unit
(6) Statis Board Operator

c. Positions No. 1, 2, and 3. (In multiple Set-up)
(Similar hookup as Senior Controller)

d. PPI Reader, Plotter-Computer, Recorder Loops
(Lines looped through switchboard to as many positions as desired)

e. General Situation Board Plotter
(Through switchboard) (to any position)