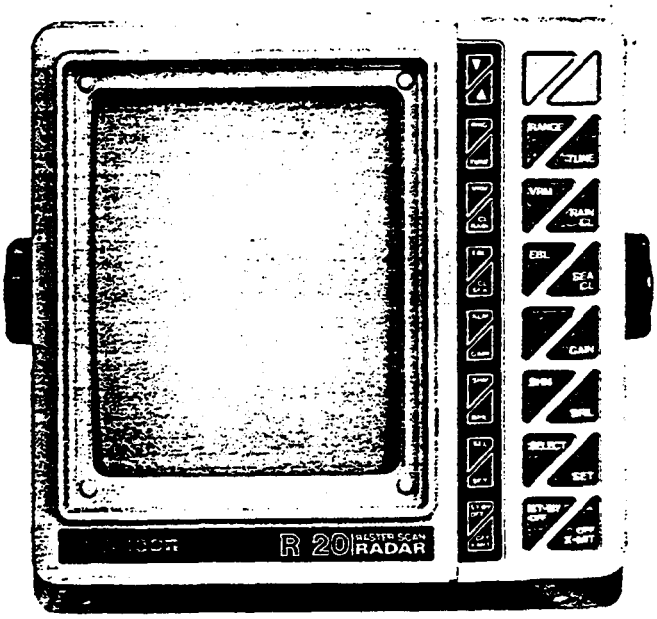
Raytheon

Model R20

Raster Scan Radar System



OPERATION REFERENCE GUIDE

1. To turn set on press STBY/OFF .
   To transmit press XMIT/OFF .
   To turn off press STBY/OFF and XMIT/OFF together.

2. To change:
   : Ranges; Press RANGE and ▲ or ▼ key.
   : Gain Level; Press GAIN and ▲ or ▼ key.
   : Sea Clutter; Press SEA CL and ▲ or ▼ key.
   : Rain Clutter; Press RAIN CL and ▲ or ▼ key.
   : Tune Level; Press TUNE and ▲ or ▼ key.

Brilliance: Hold key depressed for desired brilliance level.

VRM: Hold VRM key depressed for reversed VRM symbol. Use ▲ or ▼ key to set VRM distance. Press VRM key to turn off.

EBL: Hold EBL key depressd for reversed EBL symbol. Use ▲ or ▼ key to set bearing line on target. Press EBL key to turn off.

Target Alarm: Hold ALM key depressed for reversed ALM symbol. Use ▲ or ▼ key to set alarm range. Press ALM key to turn off.

Select Mode: Press SELECT key until desired symbol appears onscreen (F, I, E, H, L, or T). When desired symbol appears, press SET to turn function "ON" or "OFF".

SHM: Press SHM to momentarily remove the ships heading line from display on the CRT.

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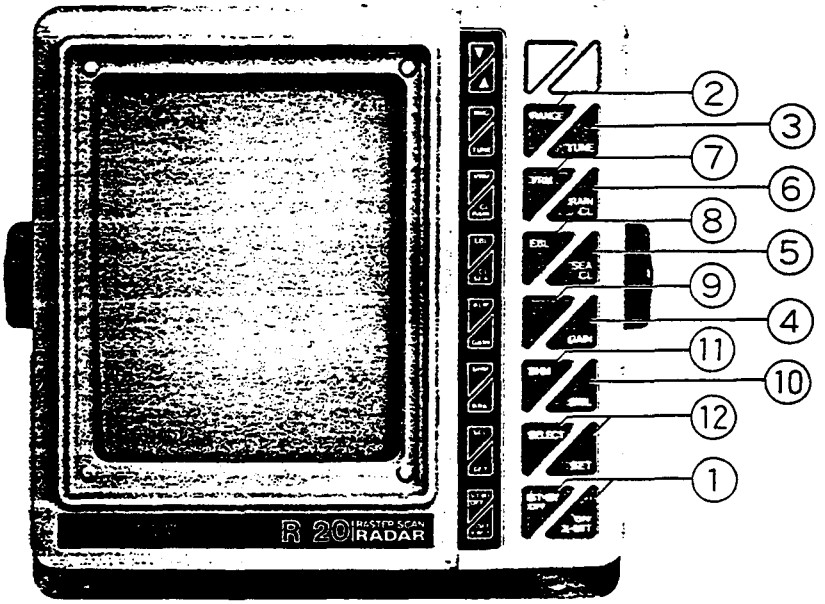
Raster Scan Radar System



CONTROLS

1. POWER ..... Controls power to the radar (OFF, STBY or XMIT).
2. RANGE ..... Decreases/increases operating range scale of radar display.
3. TUNE ..... Adjusts receiver for maximum target reception.
4. GAIN ..... Controls setting of receiver gain.
5. SEA CLUTTER ..... Minimizes sea clutter by reducing nearby gain.
6. RAIN CLUTTER ..... Reduces effects of rain or snow on display.
7. VRM ..... Controls VRM for accurate distance measurements.
8. EBL ..... Controls EBL for accurate bearing measurements.
9. ALM ..... Enables, and sets target guard zone.
10. BRIL ..... Adjusts intensity of the screen.
11. SHM ..... Turns SHM OFF while depressed (momentary).
12. SELECT ..... Selects 6 functions below.
    - F ..... Turns fixed markers "ON" or "OFF".
    - I ..... Eliminates interference from other ship radars.
    - E ..... Expands target echoes for better viewability.
    - H ..... "Freezes" the picture while the "SET" key is held depressed.
    - L ..... Displays LAT/LONG data from Loran
    - T ..... Displays TD data from Loran.

    SET ..... Turns the above functions ON or OFF

SECTION 3

OPERATION

3.1 OPERATING CONTROLS

While the operation of the R20 seems easy and straight forward, the navigator who is familiar with the panel layout and understands the functions of the various controls will be able to obtain the best performance from his equipment. Please take some time to read through this section of the manual to avoid misunderstandings of the radar's capabilities.

3.1.1 Layout of Controls

Layout of controls is shown in Figure 3-1.

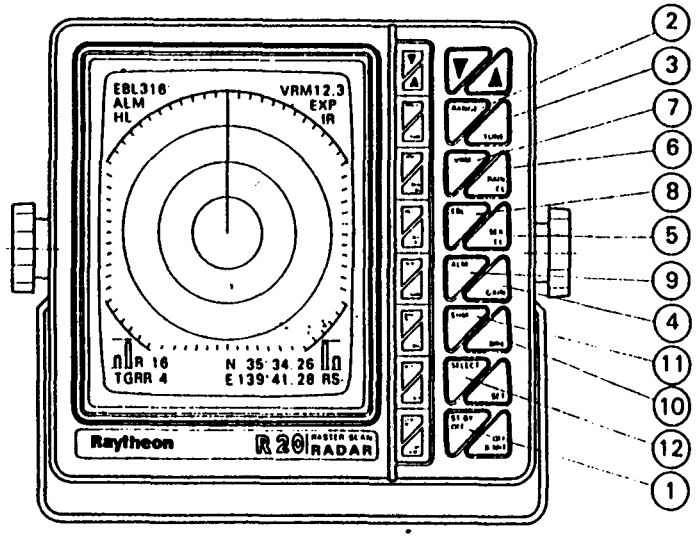


FIG. 3-1 OPERATING CONTROLS

REPRODUCED AT GOVERNMENT EXPENSE

3.1.2 The controls

① POWER [ST-BY/OFF], [X-MIT/OFF] KEYS

In the "OFF" state no power applied to the Radar system.
Upon pressing the [ST-BY/OFF] key, power is supplied to the scanner and Display Unit, and the sign "R20" is displayed in the middle of screen during the warm-up condition. Approximately 90 seconds after the initial switching to ST-BY, the sign "R20" will disappear from the screen and the sign "READY" will be displayed on the screen. The radar is now ready and available for operation.
Pressing the [X-MIT/OFF] key, (with the sign "READY" displayed) puts the radar to transmit and echoes from targets will be received, amplified, and displayed on your screen.
By pressing the [ST-BY/OFF] key, the radar returns to "Standby" condition with the transmitter "OFF" and "STANDBY" appears in the CRT center.
By pressing the [ST-BY/OFF] and [X-MIT/OFF] keys simultaneously, the radar will turn "OFF" and all Alpha-Numeric information will extinguish.

② RANGE ([RANGE] ▽, △)

By holding the [RANGE] key depressed until the buzzer sounds, the "R" character of RANGE indication located on the left bottom corner of display will be displayed as reversed character. [R]
By pressing the ▽ or △ key, the desired RANGE scale can be selected. At the initial turn-on, the radar will be on the 2 nm range. Upon pressing the key △, the range increments by one step, conversly the range decrements by the key ▽. If the ▽ or △ key is held depressed, the range will continue stepping successively in the desired direction.
The selected range automatically determines the proper number and distance betwteen the range rings.

TABLE 3-1 RELATION OF RANGE, RINGS AND PULSE LENGTH

Range	Rings	Distance Between
0.25 nm	2	0.125 nm
0.5 nm	2	0.25 nm
1 nm	4	0.25 nm
2 nm	4	0.5 nm
4 nm	4	1 nm
8 nm	4	2 nm
16 nm	4	4 nm

③ TUNE ([TUNE] ▽, △)

By holding the [TUNE] key depressed until the buzzer sounds, the "T" character of TUNE indication located on the left bottom corner of display will be displayed as reversed character. [T]
By pressing the ▽ or △ key, the TUNE control will maximize the target echoes. If land targets are not within the radar's range, adjust the control for maximize sea clutter return. An on-screen bar indicates the "TUNE" position in its range.

④ GAIN ([GAIN] ▽, △)

By holding the [GAIN] key depressed until the buzzer sounds, the "G", character of GAIN indication will be displayed as reversed character. [G]
By pressing the ▽ or △ key, the GAIN control is varied and thus controls the strength of echo returns on the radar screen. An on-screen bar indicates the Gain level selected for display.

⑤ SEA CLUTTER ([SEA CL] ▽, △)

By holding the [SEA CLUTTER] key depressed until the buzzer sounds, the "S" character of SEA CLUTTER will be displayed as reversed character. [S]
By pressing the ▽ or △ key, the SEA CLUTTER level varies the near-by gain on short ranges. The echo returns from sea surface. Clutter can be reduced when the STC Gain is increased. There is an on screen bar indication of the STC level in use.

⑥ RAIN CLUTTER ([RAIN CL] ▽, △)

By holding the [RAIN CL] key depressed until the buzzer sounds, the "R" character of RAIN CLUTTER will be displayed as reversed character. [R]
By pressing the ▽ or △ key, the RAIN CLUTTER control can break up the returns from rain or snow thus allowing weaker targets to become visible. As you push the △ key, the echoes will become narrow and the returns from rain or snow will be reduced. An on-screen bar indicates the selected rain clutter level.

⑦ VRM ([VRM] ▽, △)

By holding the VRM key depressed until the buzzer sounds, the "VRM" characters will be displayed as reversed character. [VRM]
By pressing the ▽ or △ key, the VRM position is changed. If the VRM key is depressed for a short time, the VRM can be turned "OFF". The VRM distance is displayed on the CRT after the VRM characters in "nautical miles."

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⑧ EBL ([EBL] ▽, △)

By holding the EBL key depressed until the buzzer sounds, the "EBL" characters will be displayed as reversed character. [EBL] By pressing the ▽ or △ key, the EBL bearing line is rotated.
If the EBL key is depressed again, the EBL display turns "OFF". The EBL position in degrees is displayed on the CRT left top side after the "EBL" characters.

⑨ SEAGUARD ALARM ([ALM] ▽, △)

By holding the [ALM] key depressed until the buzzer sounds, the reversed "ALM" characters are displayed on the CRT. [ALM]
By pressing the ▽ or △ key, the ALARM range can be varied.
If the ALM key depressed again, the ALARM function turns OFF. While the alarm function is Off, "ALM" range characters are not displayed.

⑩ BRILLIANCE ([BRIL] ▽, △)

By depressing the BRIL key, the brightness of the screen and the panel illumination can be varied in intensity. When holding this key continuously until a buzzer sounds, the brilliance will be at its minimum level. The next brilliance step returns the intensity to the lowest level for nighttime use.

⑪ [SHM]

While the [SHM] key is depressed, the SHM will not be displayed on the screen. This feature allows a small target under the ships heading mark to be seen. When the key is released, the SHM reappears.

⑫ [SELECT] and [SET]

The [SELECT] key is used to select one of the following functions:

1. Fixed Rings	ON or OFF
2. Interference Rejection	ON or OFF (on screen indication)
3. Expansion	ON or OFF (on screen indication)
4. Hold	freezes display while "set" key is depressed
5. Loran C Latitude/Longitude	ON or OFF
6. Time differences	ON or OFF

As the SELECT key is pressed, the reversed character of "F", "I", "E", "H", "L", or "T" is displayed in the top right when each function is selected by SELECT key, the [SET] key turns the feature ON or OFF alternatively.
While "IR" is ON, the "IR" characters are displayed on the screen. While "EXP" or "HOLD" is ON, "EXP" or "HLD" is displayed. When "L" or "T" is ON the characters appear at display window below the target video.

3.1.3 A Typical Operation Procedure

1) Press the [STBY/OFF] key.
2) After the sign on screen has changed from "R20" to "READY" (approximately 90 seconds), press the [X-MIT/OFF] key.
3) Set [BRILLIANCE] so as to obtain desired brightness of the screen. [BRIL]
4) Set the [RANGE] to the 4, 8, 16 mile range. Example: [RANGE] △
5) Check the EXP, IR, RAIN CL and SEA CL modes are "off".
6) Set the [GAIN] to produce a light (noise) background speckle on the screen. Example: [GAIN] △
7) Set the Tuning control for maximum echoes on the screen. Example: [TUNE], ▽ or △ as necessary.
8) Set the [RANGE] scale you wish to cover. Example: [RANGE]
9) Set the Rain clutter if necessary; Sea clutter as necessary. Example: [RAIN CL] △ [SEA CL] ▽
10) If necessary, set IR to On to reduce radar interference. Example: Press [SELECT], [I], press [SET]
11) For range and bearing measurements, set EBL and VRM to On.
12) When the radar is no longer required, depress the [STBY/OFF] and [X-MIT/OFF] key together at the same time. The radar will be "OFF". If you wish to keep the radar in a state of immediate readiness, press only the [STBY/OFF] key. The screen will indicate "STANDBY" condition.

3.2 RANGE AND BEARING MEASUREMENT (See Fig. 3-2.)

The picture on the screen shows a view of the position of targets around your vessel. In effect your ship is at the center of the screen and targets are presented in polar coordinates (or map-like) throughout 360 degrees. Your vessel is always "heading" at "0" degrees. The display is referred to as the PPI (Plan Position Indicator).

3.2.1 Range Measurement—Range measurements to targets may be made by estimation or accurately measuring distances with the VRM.

Method 1) (Estimation)

Note the range scale in use and the distance between rings

Count the number of rings between the center of the screen and the target, and visually estimate the distance between the inner edge of the target and inner edge of the nearest ring.

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Method 2) (Accuracy)

Press the [VRM] switch to display the variable range ring, and reversed character [VRM], and press ▽ or △ switch to move the variable range ring to the inner edge of the target. The actual target distance appears on the right top of the screen in "nautical miles".

3.2.2 Bearing Measurement—Bearing measurements may also be esimated or measured precisely.

Method 1) (Estimation)

Using the bearing scale on the screen, visually estimate the bearing where the radial line of the bearing scale would pass through the center of the target. The bearing you obtain will be the targets relative bearing in degrees.

Method 2) (Accuracy)

Press the [EBL] switch to display the electronic bearing line and reversed character [EBL]. Press ▽ or △ switch to move the electronic bearing line to the center of the target. The targets relative bearing appears on the left top of the screen in "degrees".

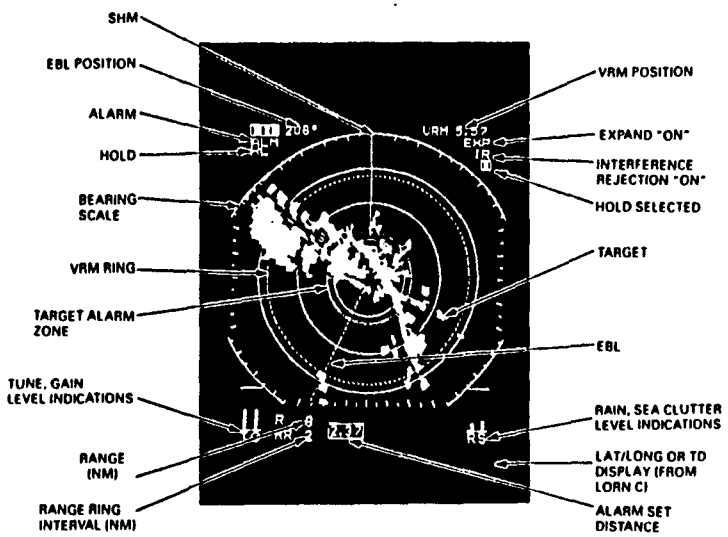

FIG. 3-2 RANGE AND BEARING MEASUREMENTS

3.3 USING THE CONTROLS

3.3.1 TUNE Control

Radar magnetrons, during their aging process, may take several minutes to completely stabilize on frequency. So, after switching to On and tuning initially, the tuning should be rechecked after the first 10 minutes:

Symptom that the equipment may be out of tune are a lack of distant echoes or, sometimes, the appearance of double echoes (one echo behind another). Normally it is possible to "fine-tune" the radar by selecting a comparatively weak echo and then set the TUNE key level where the strongest echoes are displayed.

3.3.2 GAIN Control

The correct setting of the GAIN control is for light background speckle to be just visible on the screen. The equipment is then in its most sensitive condition. Objects will be detected at the greatest possible range. With too little gain, weak targets may be missed and not displayed with a decrease in detection range. With excessive gain the difference between echoes and background noise will be substantially reduced, making target observation more difficult.

In areas around strong targets (buildings, hills, towers, etc.), the gain might be temporarily reduced to clarify the picture. This should be done with care so important targets will not be missed. With the gain at its normal setting, clutter from rain or snow may obscure the echo from a ship inside a squall or storm. A temporary reduction in gain along with the proper RAIN CL/SEA CL settings may usually permit the stronger and more distinct ship's echo to be distinguished.

Detection of targets beyond the storm may, however, require slightly higher gain than normal, since the storm may have attenuated, but not completely obscured the echoes from the targets. The GAIN control should be always be reset to the optimum level following the range scale changes. In addition, when environmental conditions change, readjustment of the gain may be required.

3.3.3 SEA CLUTTER Control

Whereas the GAIN control affects the strength of echo returns at all ranges, the effect of SEA CLUTTER control is greatest on near by returns, becoming progressively less as range increases. The SEA CLUTTER control is effective up to a maximum of about three miles.

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In particular, the SEA CLUTTER control reduces the strength of the mass of random signals received from waves at short range. The STC level used should be sufficient to reduce the strength of sea clutter while still allowing small near by targets to be distinguished. The level should never be set so high so as to blank out all near-by returns.

The sensitivity of the SEA CLUTTER control is variable in 32 steps, thus enabling an optimum picture to be obtained under adverse weather conditions.

Maximum reduction in the strength of close-range clutter takes place when the control is set the maximum. When it is set to the minimum there is no reduction in the strength of near-by clutter.

The SEA CLUTTER control may be useful to reduce effects from rain or snow clutter in the immediate vicinity of the vessel. A temporary increase in the setting may permit stronger echoes from ships, and some navigational marks inside storms or squalls, to be distinguished.

At close range in crowded regions the control may be temporarily advanced to clear the picture. This should be done with care, so as to avoid missing important target returns.

The SEA CLUTTER control should be always checked and reset to the minimum required level position after any temporary alteration or when environmental conditions improve.

It is important to remember that both GAIN and SEA CLUTTER levels should be checked and adjusted each time a new range scale is selected. This is important to assure that excessive sea clutter or insufficient gain will not cause important targets to be missed or not displayed.

3.3.4 RAIN CLUTTER Control

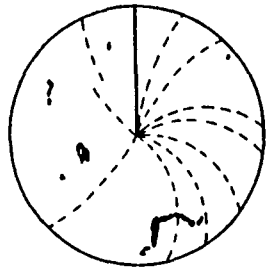
During heavy rain or snow storms the RAIN CLUTTER control may be used to improve the detection between echoes and the storm clutter. When operating the RAIN CLUTTER, you will notice the reduction of background returns from land and large targets. This is normal. The rain storm should be minimized and allow targets to be seen within the storm.

3.3.5 [IR] Interference Rejection

When other radars are using the same frequency band as that of your own radar, interference typically appears arranged in curled spokes as shown in Fig. 3-3. The radar interference is most noticeable on longer range scales.

Activating the [IR] feature will eliminate this type of interference as well as affecting reduction of the background noise.

In general, the IR should be set to "ON" for normal operation to allow maximum target presentations on the radar display.



The IR feature is activated by the [SELECT] and [SET] keys.

FIG. 3-3 RADAR INTERFERENCE

3.3.6 EXPANSION MODE

From time to time, targets may appear too small in size on the display. In this situation, activating the "expansion" mode will allow the displayed targets to be enlarged on the display, providing greater visibility to the operator.

The expansion mode is activated by the [SELECT] and [SET] keys.

3.4 NAVIGATION WITH THE RADAR

3.4.1 Obtaining a Position Fix

The Model R20 Radar is an accurate and reliable navigational aid for determining your ship's position. Figure 3-4 shows examples of alternative methods of using radar sitings from prominent navigational points which can be identified on a chart. A position fix based on two or more navigational points will furnish an accurate fix, especially when the points approach 90 degrees are separated by more than 90° from each other relative to your ship.

3.4.2 Avoidance Techniques Collision

The moment a new target appears on the screen, its range and relative bearing should be noted. This is best done by putting the target information directly onto plotting sheet or chart.

As in visual observation, "a constant bearing indicates a collision course."

As soon as a series of plots taken at intervals of 3 minutes indicates a closing range with no significant change in successive bearings, positive course change action should be considered and "The Regulations for Preventing Collisions at Sea" should be observed.

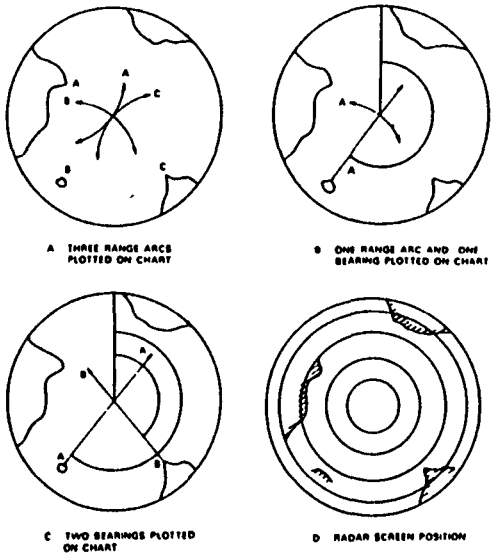


FIG. 3-4 POSITION FIX METHODS

3.4.3 Determining Your Radar Line-of-Sight Range (Target Detection Range)

When searching for distant targets, your radar line-of-sight range to the target can be a limiting factor. Radar waves behave like light waves but they are refracted slightly more, increasing the distance to the radar horizon slightly more than that to the optical horizon (however, displayed range is correct). As Fig. 3-5 shows, the radar line-of-sight range is a combination of the radar horizon of your ship's radar scanner and the radar horizon of the target.

The distance to the radar horizon from radar scanner of height "h" meters, under standard conditions, may be calculated from the formula

$$\text{Distance (nm)} = 2.23\sqrt{h}$$

For example, a scanner at height of 5 meters has a radar horizon of 5 nm.

A 5 meters cliff has a radar horizon of 5 nm. Therefore, under standard conditions, the cliff should begin to appear on the screen when the ship comes nearer than 5+5=10 nm.

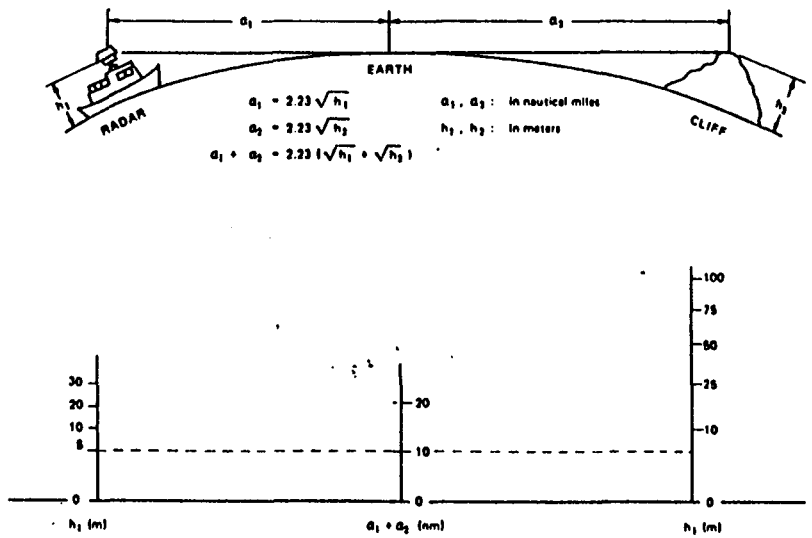


FIG. 3-5 RADAR HORIZON

3.5 FALSE ECHOES

Occasionally, signals appear on the screen at positions where there is no visual target. These targets could be false echoes.
The following conditions are the most common cause of false echoes.

3.5.1 SIDE ECHOES

In your antenna some of the radiation escapes on each side of the main beam of energy and is known as "side lobes". If a large target is very close to your ship, may be reflected by the target and they will be displayed on the screen as an echo. (See Fig. 3-6)
These echoes sometimes appear as arcs form echoes at each side of the true echo. Sometimes joined together if the side echoes are strong.

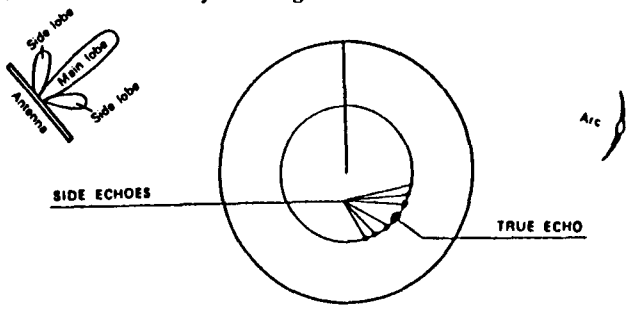


FIG. 3-6 SIDE ECHOES

3.5.2 Indirect Echoes

Indirect echoes may appear when there is a large target, such as a passing ship, at a short range and a reflecting surface, such as a funnel, on your own ship in line with the antenna. The signal on first striking the smooth side of the large target, will be reflected, and the echo returns to the antenna and is shown on the display. However, the same reflection hits other masts or obstacles and then gets picked up by the radar antenna with enough strength to appear as a target on the radar screen.

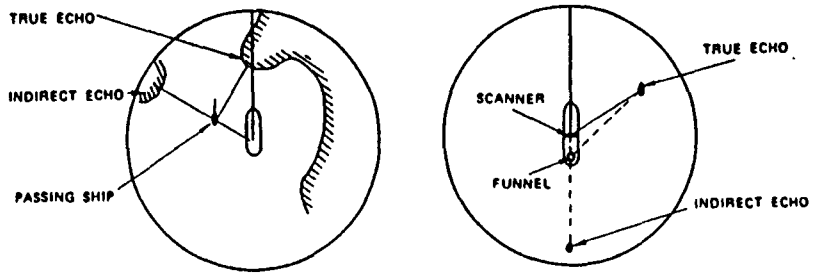


FIG. 3-7 INDIRECT ECHOES

3.5.3 Multiple Echoes

Multiple echoes could appear if there is a large target having a wide vertical surface parallel to your own ship at comparatively short ranges. The signal will be reflected by the wide vertical surface, then the reflected signal strikes your own ship, and it will return along the same paths to the target. This will be repeated.
Thus, the multiple echoes will appear beyond the true target's echo on the same bearing as shown in Fig. 3-8. This is not very common.

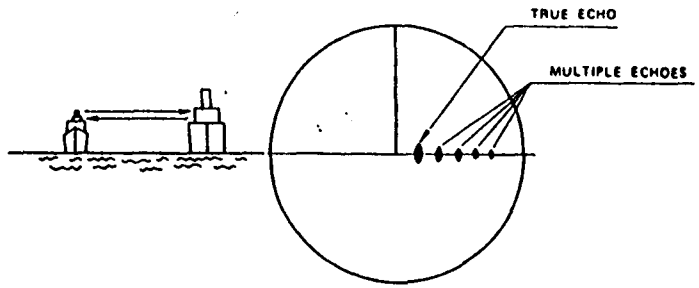


FIG. 3-8 MULTIPLE ECHOES

3.5.4 Ghost Echoes

The ghost echoes may appear if there is a target having a wide smooth surface near your own ship. As shown in Fig. 3-9, the cause of the ghost echoes is similar to that of the indirect echoes.
The ghost echoes appear on the screen as if you saw the target reflected in a mirror.

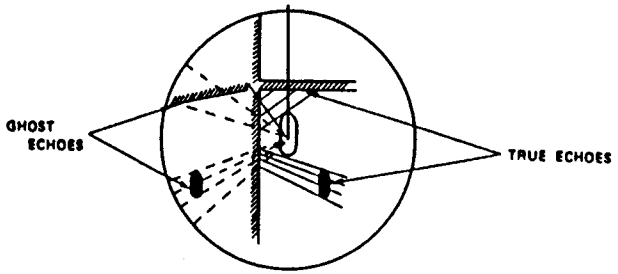


FIG. 3-9 GHOST ECHOES

3.5.5 Shadows

Although the scanner unit should be ideally placed where there is a good all-around view, as far away as possible from any part of the ship's superstructure or rigging to reflect the beam, there may be some obstructions. An obstruction will throw either a complete or partial shadow as shown in Fig. 3-10.

If there are targets in such shadow sector, target's echoes may not be displayed on the screen. Thus, it is important to know the bearings and width of all shadow sectors, and it can be checked by turning the SEA CLUTTER control to zero when light rain clutter covers much of the screen and the sea is calm.

Any shadow will then be shown as dark sectors in the clutter.

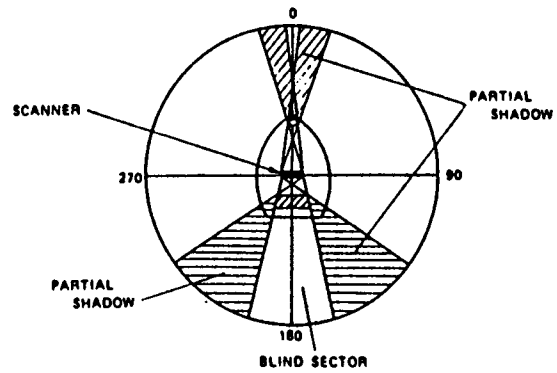


FIG. 3-10 SHADOWS

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SECTION 4

MAINTENANCE

4.1 USER PREVENTIVE MAINTENANCE

Continuous satisfactory operation of the radar can depend on how well you take care of your equipment. These simple maintenance tips can save you time and money, and help you avoid premature equipment failure.

1) Always keep the equipment as clean as possible. Remove dirt, dust, or water-spray during the boat clean up.
2) During routine ships maintenance, make a thorough inspection of the radar system including the following points:
   a. Check all hardware for tightness.
   b. Check for evidence of any corrosion on the scanner unit, display unit, or its cable and connectors. Clean as required.
   c. Check the cable connections and terminal strip connections for cleanliness and tightness. Make sure the wiring is free from chafing or abrasions.

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4.2 SCANNER UNIT

Set the safety switch (S101) of the Scanner Unit to OFF before working on the radar Scanner.

> CAUTION:
> The safety switch of this radar only stops antenna rotation. The transmitter will operate when the radar is turned to ON. Avoid allowing the array to point towards anyones' eye level during service work.

4.2.1 Radome

Wipe the surface of the Radome with a clean, soft cloth. Remove any paint, dirt, or caked salts. Heavy deposits of dirt or caked salt on the surface of the Radome can cause a considerable drop in the radar's performance. Avoid using chemical cleaners of solvents. Alcohol is preferred or light detergents as a cleaning agent.

4.2.2 Lubrication

Periodic replacement of lubricants is recommended.

Locate the main drive gear, clean away old lubrication residue and dirt. Using an appropriate applicator apply a light coating of grease (MOBILUX Grease No. 2 Mobil Oil Company or equivalent) on the gear of the main shaft and the drive motor.

Cleaning and lubrication should be done approximately every six months.

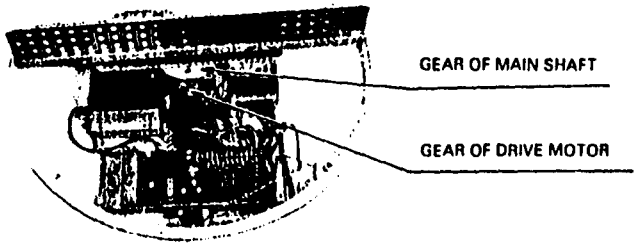

FIG. 4-1 LUBRICATION

4.2.3 Mounting

Check the mounting bolts of the Scanner Unit and tighten if necessary.

4.3 DISPLAY UNIT

The face of the cathode-ray tube may, in time, accumulate a film of contaminants which tends to dim the picture.

Be sure Radar is "OFF", use glass cleaner and soft cloth or towels to clean CRT glass, key board, and radar cabinet.

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SECTION 5

ADJUSTMENT AND FAULT FINDING

5.1 ADJUSTMENT

5.1.1 Adjustment for Replacing Components

Although the radar is delivered adjusted for optimum performance, it may be necessary to make adjustments after a major component has been replaced or if a fault is suspected during operation.

NOTE

REPLACEMENT ITEM	ADJUSTMENT REQUIRED	See Sect. #
Magnetron V1	Tuning	5.3
MIC Frontend E301	Tuning	5.3
Cathode-ray tube V501 Display PCB	Adjusting centering magnet Adjusting intensity Adjusting focus	5.3
SHM Unit S102	Bearing Alignment	

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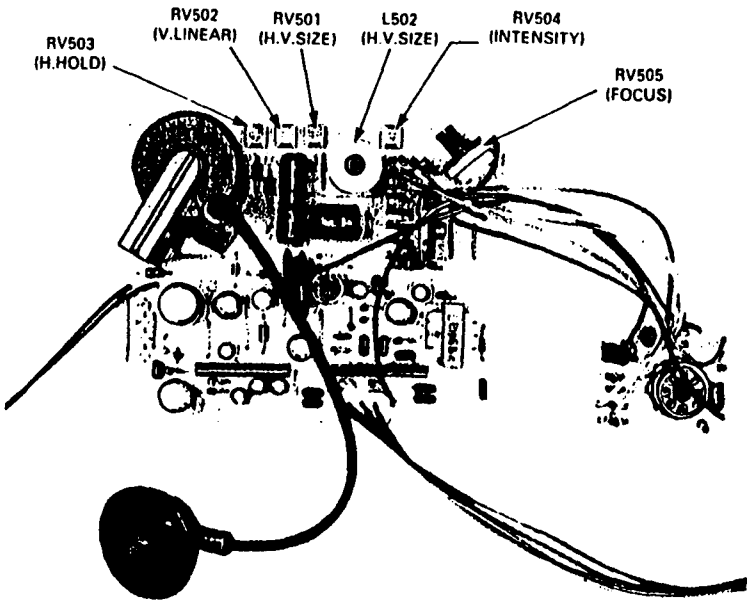

FIG. 5-1 DISPLAY PCB

1) Intensity adjustment (See Fig. 5-1)
   a. Remove the cover from Display Unit.
   b. Set BRILLIANCE for maximum level.
   c. Adjust RV504 on Display PCB, so that PPI is of suitable brightness.
2) Focus adjustment (See Fig. 5-1)
   a. Remove the cover from Display Unit.
   b. Adjust RV505 on Display PCB so that the sweep line, rings, and targets on the screen are as small and clear as possible.
3) H. HOLD
   Adjust RV503 on Display PCB so that horizontal screen is kept in sync.
4) H. SIZE and V. SIZE
   Adjust L502 and RV501 on Display PCB so that the rings are found.
   Note: With a ruler, adjust for equal diameters N/S E/W.
5) V-LINEAR
   Adjust RV502 on Display PCB so that the rings are found.
6) Main Board PCB Adjustment (See Fig. 5-2)
   a. Remove the hole cover for adjustment.
   b. Proceed with adjustment as required on the Main PCB (PC1 and PC2) as follows.

   6.1) Interlace adjustment (PC1)
   Adjust RV1 so that the TV horizontal lines are finely interlaced.

   6.2) Relative Bearing Alignment (PC1)
   Adjust RV2 (BRC) and RV3 (BRF). (See Section 2.4.3)

   6.3) GAIN adjustment (Comparator set: PC2)
   a. Set GAIN control at the maximum, turn IR "ON".
   b. Adjust RV1 until some back ground speckle is present on the screen.

   6.4) 0 nm Adjustment (PC2)
   Adjust RV2. (See Section 2.4.4)

   6.5) Tuning Adjustment (PC2)
   a. Set the Tune control at the center.
   b. Adjust RV3 until the strongest echoes are displayed.

   6.6) Alarm (PC2)
   a. Set the RANGE to 0.25 nm
   b. Press ALARM key and set alarm zone within 0.25 nm.
   c. Set GAIN control until the echoes are displayed in the alarm zone.
   d. Adjust RV4 until to obtain desired loudness.

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6.7) Polarity Setting of Loran C data output (PC2)
You can set the polarity of Loran C data output by changing the jumper plug of J8.

7) Power Supply voltage adjustment on PC503 (See Fig. 5-3)
   a. Connect the Test Metter to TP1 (+) and ground (−)
   b. Adjust RV1 until the voltage of T.M. is 12.0V.

8) Beam centering adjustment on CRT (See Fig. 5-3)
Rotate the two knobs simultaneously or individually so that the beam center coincides with the center of CRT.

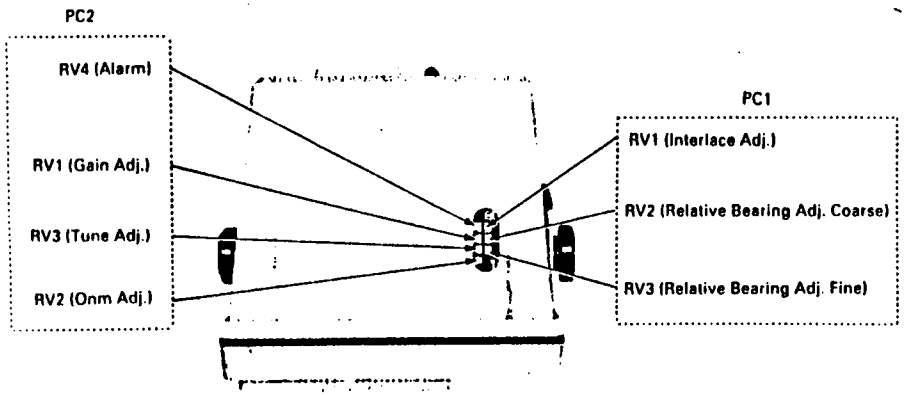

FIG. 5-2 MAIN BOARD PCB ADJUSTMENT

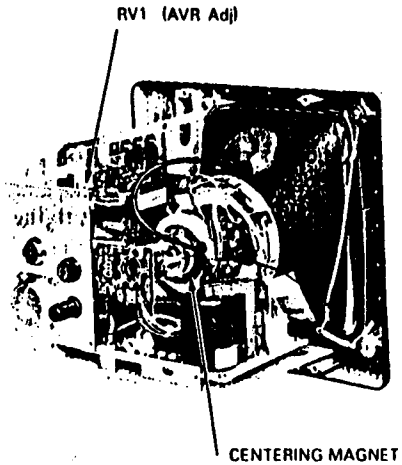

FIG. 5-3 POWER SUPPLY ADJUSTMENT, CENTERING ADJUSTMENT

5.2 TROUBLE-SHOOTING

5.2.1 General

While the R20 Radar is a highly reliable system, early detection of component fatigue can be spotted during regular operational checks.

When a problem is observed, corrective service should be arranged to avoid failure at critical times at sea.

5.2.2 Fault Finding

(1) Regular operational checks (preventative maintenance)

The electrical performance of the equipment should be evaluated at periodic intervals by qualified Raytheon Technicians and the results recorded. Changes in test results may indicate an aging or failing component. Table 5.1 provides a check list of items.

Whenever an abnormal result is obtained from a test, appropriate corrective maintenance should be employed to prevent serious damage or failure modes.

CAUTION: In making checks, be alert to the high voltage points existing throughout the equipment.

(2) Fuse

A fuse seldom blowns out without some cause. Even if a fuse is merely replaced and does not blow again, it still may be necessary to make further checks of the circuits associated with the fuse.

Table 5.2 shows a table of fuses employed in the equipment.

(3) Fault finding procedure

Often the display on the CRT can help indicate which major circuit is at fault. The next step is study the block diagram (Fig. 104) to obtain an idea as to obtain an idea as to which stages require checking, in what order, and what additional tests such as controladjustments may be necessary. It may be found quicker to check-out the equipment according to the trouble shooting guide (Table 5.3).

In general, the causes of troubles frequently encountered include abnormal resistances, intermittent variable resistors, switches, and relays and shorted crystal diodes.

In the following fault finding procedure, it is assumed that only a VOM is available; the use of an oscilloscope simplifies the procedure, and may prove necessary in some cases.

Table 5-3 is the trouble shooting guide and check-out procedure, Table 5-4 shows typical voltages and resistances at significant points throughout the equipment. Fig. 5-4 shows typical waveforms at significant points throughout the equipment. The internal resistance of the tester used in measurements was 20 kΩ/V dc, 8 kΩ/V ac.

TABLE 5-1 OPERATION CHECK LIST

Unit to be checked	Check item	Correct condition	Remarks	Measuring point
Scanner Unit	a. Input voltage	Refer to Note		TB1 1A~2A
	b. AVR output voltage	6.8V		PC101 CD6-K ground
	c. Mag. current	12 V		PC101-TP1 ~ground
Display Unit	a. Input voltage	Refer to Note		J401-1~2
	b. AVR output voltage	12 V		TP1~ground
	c. Observation of screen sensitivity, sweep length, sweep linearity, sweep center, ring and illumination.			
	d. Check of the operating controls			

Note: Allowable variation of input voltage.
DC11V~42V

TABLE 5-2 FUSES USED

Location	Part No.	Rating current	Protective circuit	Type	Remarks
Display unit	F401 F401	6.3A 3A	All circuit All circuit	Glass tube 6.3A Glass tube 3A	dc 12V dc 24V, 32V

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TABLE 5-3 TROUBLE SHOOTING GUIDE

Trouble	Remedy
1. Does not start at OPERATE switch to STBY.	Check: o Blown fuse F401. o Check input power circuits. o Fault of contact on S401. o Fault of power supply circuit on PC503. o Fault of contact on connector of PC503. o Fault of rectifier diodes on PC503.
2. Scanner fails to rotate.	Check: o Fault of S101. (Safety Switch OFF) o Fault of contact on terminal boards. o Fault of M101 (Commutator and brushes.) o Fault of drive mechanism.
3. Scanner rotates but rotation of sweep is abnormal	Rotation of M101 or fault of connection between M101 Check: o Fault of motor encoder (DP). o Fault of M101. o Fault of main circuit for the Display Unit.
4. No picture on the screen.	Fault of CRT display unit or its supply voltages. Check: o Open heater of CRT or blown fuse F501 on display PCB. o Fault of contact on CRT socket. o Fault of contact on CRT cap. o fault of video circuit
5. Only horizontal line screen.	There may be fault in vertical sweep generator, amplifier circuits and deflection coil. Check: o Fault in vertical sweep generator, amplifier circuit
6. Incorrect sweep o Start of sweep is not centered on the screen. o Markers are oval.	o Adjust MT401 o Adjust horizontal or vertical hold. o Adjust vertical length and linearity. o Adjust height as necessary.

Trouble	Remedy
7. Range rings on the screen but no noise and no echoes:	Faulty circuit between IF amplifier of receiver unit and input circuit of display unit video amplifier. Check: o Fault of GAIN, STC control settings. o Fault of receiver unit. o Fault of contact on terminal boards and connector. o Fault of GAIN, STC circuit on PC2.
8. Noise and range rings on the screen but no echoes.	If no transmission is present, check the modulator and magnetron. Check: If transmission appears to be present as indicated by the correct MAG. I reading on Tester. PC101 TP1 = 12 VDC o Failure of Local Oscillator tuning. If transmission appears to be present, carry out the Local Oscillator tuning procedures and check the MIC o Fault of MIC Mixer. If no transmission is present, o Whether the lead wire to magnetron is contacted to chassis. o Fault of magnetron.
9. Poor sensitivity. Dim echoes.	Check: o Reduction of transmitting output power. o Fault of magnetron. → Check of MAG. I reading on PC101-TP1. o Fault of MIC Frontend. o Fault of CRT. o Failure of Local Oscillator tuning. o Failure of FOCUS adjustment. o Failure of INTENSITY ADJ. o Fault of video amplifier circuit on PC2. o Fault of receiver unit.

Trouble	Remedy
10. NO VRM or VRM cannot be controlled.	Check: o Fault of S401. o Fault of main circuit.
13. NO EBL or EBL cannot be controlled.	Check: o Fault of S401. o Fault of main circuit.
14. No alarm zone marker, cannot be controlled or no alarm sound.	Check: o Fault of S401. o Fault of main circuit. o Fault of Buzzer BZ1.

Table 5.4 shows typical voltage and resistances at significant points throughout the equipment. Fig. 5-4 shows typical wave forms at significant points throughout the equipment.

TABLE 5.4 TYPICAL VOLTAGES AND RESISTANCES

(A) Inter-unit terminal board

Note: Resistance measurements shall be made under the following conditions:
POWER switch-OFF S101-ON.
Resistance value shall be measured between measuring point and ground unless otherwise specified, and negative terminal of the tester is grounded as a rule.
The tester used for this measurement is 20 kΩ/V dc, 8 kΩ/V ac.
Voltage measurement shall be made under the following conditions:
POWER switch-ON, RAIN CLUTTER-min, GAIN-max, SEA CLUTTER-min.
Ship's power supply is dc 12V.

Measuring Point	Resistance (Ω)	Voltage (V) 0.25 ~ 2 (nm)	Voltage (V) 4 ~ 16 (nm)	Remarks
TB1 1A~2A	4.5×10	10~42	10~42	DC120 V
1B~2A	6×10	9.6	9.5	DC 12 V
BZ	110×10	5.1	5.1	DC 30 V
GS	19×10	6.0	6.0	DC 12 V
33	7.5×10	22.2	22.2	DC120 V
VD~VDR	5.5×10	−0.135	−0.135	DC0.3 V
BP	26×10	2.6	2.6	DC 30 V
TI	10×10	0.03	0.03	DC0.3 V
PI	6.5×10	13	13	DC 30 V

(B) Resistances at inter-unit connector without connection of cables.

Note: Refer to Note given in item (A).

SCANNER UNIT			DISPLAY UNIT		
Measuring Point		Resistance (Ω)	Measuring Point		Resistance (Ω)
TB101	1A	∞ × 10K	J402	1	∞ × 10K
	2A	∞ × 10K		2	∞ × 10K
	1B	∞ × 10K		3	12 × 10
	BZ	∞ × 10K		4	0 × 10
	GSR	0 × 10		5	0 × 10
	GS	500 × 10		6	5 × 10
	33	∞ × 10K		7	100 × 10
	VD	∞ × 10K		8	∞ × 10K
	VDR	0 × 10		9	∞ × 10K
	BPR	0 × 10		10	100 × 10
	BP	24 × 10		11	18 × 10
	TIR	0 × 10		12	0 × 10
	TI	30 × 10		13	1K × 10
	PI	40 × 10		14	0 × 10
				15	∞ × 10K
				16	6 × 10

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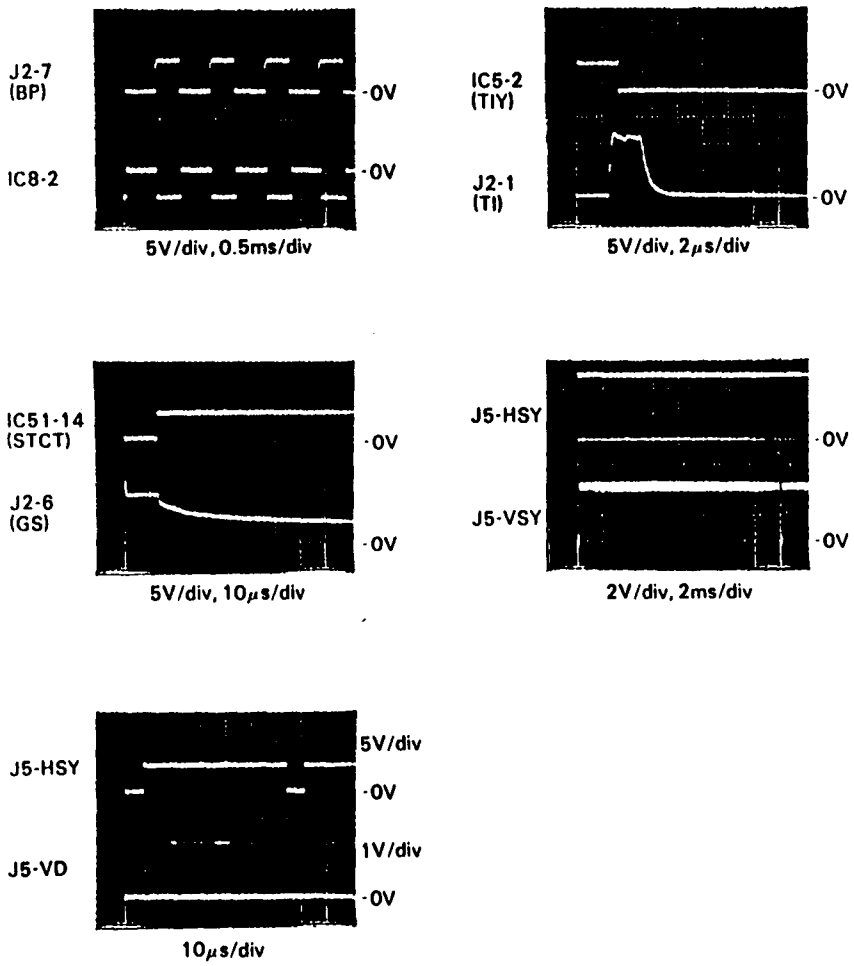

FIG. 5-4 TYPICAL WAVEFORMS

5.3 REPLACEMENT OF MAJOR COMPONENTS

5.3.1 Replacement

(1) Magnetron V201

a. Remove screws holding the transmitter unit.
b. Remove the cover from chassis.
c. Disconnect magnetron leads from the pulse transformer.
d. Remove 4 screws holding the magnetron.
e. Remove the magnetron away from the mounting plate and withdraw.
f. To reassemble, reverse the above procedure.

CAUTION: Keep the magnetron away from ferrous metals.

(2) Diode Limiter A 102

a. Remove screws holding the transmitter Unit.
b. Remove screws holding the receiver unit.
c. Remove 4 screws holding the magnetron plate that the circulator and the diode limiter are mounted.
d. Withdraw the diode limiter.
e. To reassemble, reverse the above procedure.

(3) MIC Frontend E 301

a. Remove screws holding the receiver.
b. Remove the cover from chasis.
c. Disconnect leads from PC301.
d. Remove the diode limiter from the receiver chasis.
e. Remove the frontend cover and withdraw the diode limiter.
f. To reassemble, reverse the above procedure.

(4) Cathode-ray tube V'401 (See Fig. 5-5)

a. Remove the cover from the Display Unit.
b. Remove the socket from CRT base.
c. Remove the HV cap from CRT.
d. Remove 4 screws holding the CRT.
e. Loosen the screw holding the deflection yoke and withdraw it.
f. Remove the CRT.

– To replace the CRT proceed as follows:

g. Insert the CRT in position and orientate it so that HV cap is at 12 o'clock.
h. Place the CRT front panel on the tube face and tighten screws.
i. Place the deflection yoke and tighten the screw.
j. Place HV cap and socket.
k. Then reverse above procedure c→b→a.

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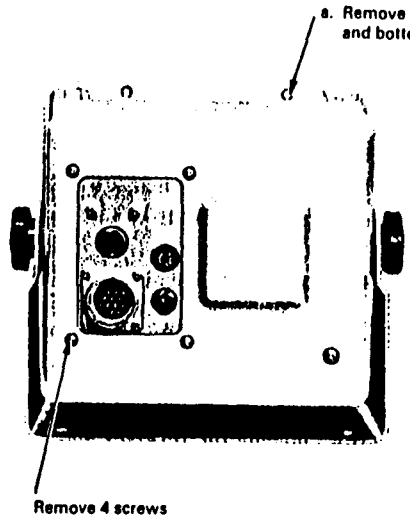

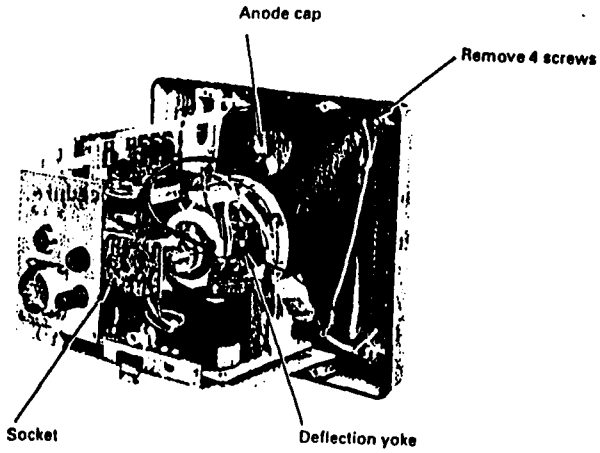

FIG. 5-5

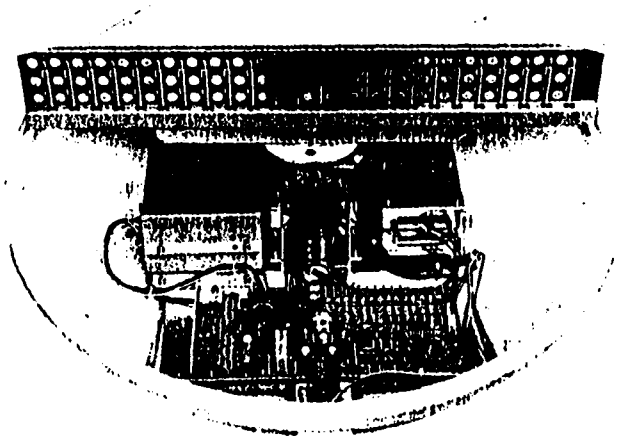

FIG. 5-6 REPLACEMNT OF DRIVE MOTOR

(6) Drive motor M 101 (See Fig. 5-6)
   a. Remove 4 screws holding the drive motor.
   b. Remove the drive motor from turning mechanism plate.
   c. To replace, reverse the above procedure.

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radar

2.4 INITIAL OPERATION AND CHECKOUT

2.4.1 Inspection After the Installation

After completing the installation and prior to energizing the equipment, it's a good idea to recheck that all the steps of the installation are completed in accordance with the instructions.

In particular, inspect to insure that the cables were not accidently crimped or damaged and that the ships input voltage is connected correctly; that the mounting bolts of the scanner unit are tight; the cable gland is tightly sealed at the Scanner Unit, that the antenna connections are correct, and the cable shield is connected properly to RF ground.

2.4.2 Operational Checkout

Activate the power circuits to the radar and switch the radar into standby (STBY). After approximately 90 seconds the "READY" will be displayed on the CRT.

If you are unfamiliar with the operating controls of this radar, please take a few moments to familiarize yourself by reviewing the instructions in Chapter 3 Operation.

Press the X-MIT switch to "ON" and observe presence of radar targets on the screen. Check the operation of the Range, selection keys for each range scale. Observe that the sweep is the correct length and has the proper number of range rings. Observe that the range markers are focused properly.

Operate the [BRIL] key. Check for multiple picture intensity level operation.

After approximately 10 minutes of operation, check the TUNE, ∇, or $\triangle$ keys for maximum target returns occur at the center of the TUNE level range.

If readjustment of the Display Unit is required follow the instructions for alignment in section 5 (pages 1 to 5) adjustment and faultfinding.

POST INSTALLATION SET UP ADJUSTMENTS

2.4.3 Relative Bearing Alignment (RV2 and RV3 on PC1)

This alignment should be carried out for safety once the installation is completed. If the ship is moored, proceed as follows:

(1) Identify a suitable target (e.g., ship or buoy, etc.) preferably between 1 and 2 nm range on the screen.

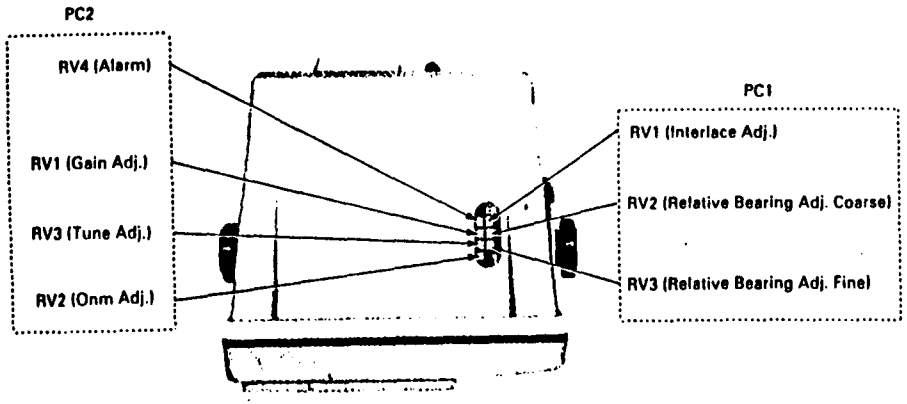


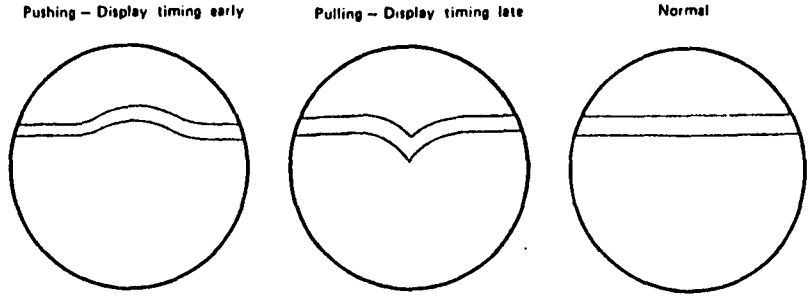
FIG. 2-10 SETUP ADJUSTMENT LOCATIONS

(2) Remove the rubber seal covering the display adjustments (top of display cabinet).
(3) Set the EBL marker on the known target.
(4) Set RV3 (BRF) at its mid position (BRF=Bearing, Fine Adj).
(5) Press the [SET] key until the buzzer sounds and the on-screen words "BEARING ADJUST" appear.
(6) Rotate the coarse bearing adjustment RV2 (BRC) as necessary until the EBL marker matches the observed bearing to the target to within ±10° and the beeper sounds continuously.
(7) Use the fine adjust RV3 to set the bearing to within ±1° on the radar display.
(8) Upon completion, press the [SET] key until the words "BEARING ADJUST" disappear, to restore the normal display mode.

2.4.4 0 nm (Zero nm) Adjustment (see Fig. 2-10.)

This is a radar system timing adjustment. Incorrect timing is most noticeable on the 1/4 NM scale. It can be checked and set in the following manner.

(1) Locate a straight dock, seawall or bridge on the radar display at 1/4 NM scale.
(2) Adjust RV2 (0 nm Adj) in the internal adjustment panel so that the object is straight on the display.



2.4.5 Radar Gain Adjustment

The radar gain can be checked to be sure that "full gain" is available for proper display in the following manner:

A. Set radar gain to maximum level as indicated by the bar graph.
B. Set radar onto maximum range scale.
C. Make sure "FTC" and "STC" are at minimum level.
D. Turn "ON" the "IR" control.
E. Set RV1 (gain preset) for background noise speckle on the CRT.

ALARM VOLUME

Turn on Alarm with [ALM] key. Hold [ALM] key depressed until ALM character in upper left of display reverses to block form. Use △ or ▽ key to move ring to contact targets.

Adjust RV4 alarm volume for desired sound level.