

TD-2 RADIO SYSTEM

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		<u>1. GENERAL</u>
		1.01 The maintenance methods discussed in this section are those concerning the over-all system and such station maintenance which is not covered elsewhere. Maintenance of system components such as the antenna, the radio transmitter-receiver bay, power plants, FM equipments, switching and monitoring equipments, alarms, order wire, etc., is covered in the maintenance sections of the Practices pertaining to those units respectively and listed at the end of Section R90.305.
		<u>2. TUBE COOLING SYSTEM</u>
		<u>(A) To Replace Motor</u>
		2.01 Disassemble the motor-blower taking care to place identification marks on each impeller, deflector head, etc., since the parts must be <u>reassembled in exactly the same relative positions.</u>
		(1) Remove filter unit from the base angles by first removing the mounting screws and disconnecting the rubber hose coupling and clamps.
		(2) Remove in turn from the blower, the end head, with its felt caulking and including the intake valve, impeller, deflector head, with its felt caulking. Care must be taken not to damage the felt caulking. Then remove the second impeller and so on until all three impellers are removed. The next item is the frame division head which <u>must not</u> be removed.
		(3) Remove bolts from the motor base and then slide the motor straight back, being careful not to injure the packing around the shaft. This packing is mounted to the division head.

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2.02 Reassemble in exactly the reverse order to that given in paragraph 2.01 above, observing the following precautions:

- (1) Be sure to center the motor shaft with center of blower casing division head and see that felt packing is tight and then run the motor to be certain that it runs freely. It may be necessary to shim the motor base to attain proper centering by using suitable washers.
- (2) Place the first impeller on the shaft and be sure that it is spaced midway within its chamber and at the same time see that identification marks coincide. To aid in the spacing use a straight edge set against the deflector head stops, measure the distance between the straight edge and the impeller hub which should be temporarily pushed on until the impeller is definitely against one side of its chamber and then adjust to 1/2 of the measured distance.
- (3) Tighten the impeller hub clamping bolts firmly.
- (4) Next, place deflector head with its felt caulking back tightly against the stops and run the motor to be certain of running freely. If the felt caulking becomes loose it may be necessary to use a screwdriver or similar tool to caulk back into the grooves.
- (5) Proceed with the next impeller and so on.
- (6) When reassembling the end head endeavor to align the holes for the mounting screws because any rotational adjustment will be found difficult to make.

(B) To Lubricate Motor

2.03 Procedure:

- (1) Remove the small set screw located at the top of each bearing.
- (2) Add 3 to 5 drops of oil (supplied with the motor).

Note: The motor has greased sealed ball bearings with an expected 3 to 5 years grease supply. It is only necessary to add a small amount of oil once a year to restore the proper grease consistency.

- (3) Replace set screws.

(C) To Remove and Clean Filters

2.04 Procedure:

- (1) Remove the two holding clips. These clips have a pin that engages a bayonet slot in the filter housing.

- (2) Tap the filter on a hard base.

Note: If the filter becomes permanently clogged to the extent of 50% by visual inspection, it should not be reused.

(D) To Adjust Pressure Switch and Alarm

2.05 The pressure switch is set by the manufacturer to close contact at 1 ounce on decreasing air pressure and remains closed for any less pressure. There is an adjusting screw to vary the contact pressure but since test equipment is not supplied, defective units should be returned for repair and readjustment. The 1/8 inch copper tube connection to the air line need not be replaced whenever the switch is replaced.

3. WAVEGUIDE GAS PRESSURE EQUIPMENT

(A) To Charge with Nitrogen Gas

3.01 Procedure:

- (1) Wheel the hand truck with the gas cylinder to a convenient position.
- (2) Attach the hose by means of its snap-on chuck to the filler valve located in the waveguide pressure window.
- (3) Admit gas to the high pressure gauge of the regulator and then adjust the "T" handle of the regulator to 3 lbs. on the low pressure gauge.

Caution: Care should be exercised not to exceed 3 lbs. because the pressure windows contain a mica sheet subject to damage at higher pressures. An allowable pressure increase of 20% over the 3 lbs. caused by extreme ambient temperatures is allowed for in the mica window design.

- (4) Disconnect the hose and store the truck and gas cylinder.

(B) To Test for Leaks

3.02 Procedure:

- (1) Apply soap and water solution by brush to the gasketed flange joints and threaded pipe fittings or any other suspicious point of the waveguide under pressure.
- (2) Observe for gas bubbles.
- (3) Tighten the bolts or threaded joints to stop any leaks.

Note: It may be necessary to replace the gasket.

(C) To Adjust the Pressure Gauge Alarm3.03 Procedure:

- (1) Remove the rear plate of the pressure gauge by removing the three screws.
- (2) With a screwdriver, adjust the cam (Fig. 1) clockwise to increase the pressure at which contact is made and counterclockwise to decrease the pres-

sure at which contact is made. Depress the valve stem and "bleed" the waveguide and refill as is necessary to provide the desired test pressures.

Note: This is a very sensitive adjustment involving only a slight movement.

Requirement: Contact should be made on decreasing pressure at a pressure of 1 lb.

ADJUSTING SCREW AND CAM.  
TURN CLOCKWISE TO INCREASE  
PRESSURE CONTACT AND  
COUNTER-CLOCKWISE TO  
DECREASE PRESSURE CON-  
TACT.

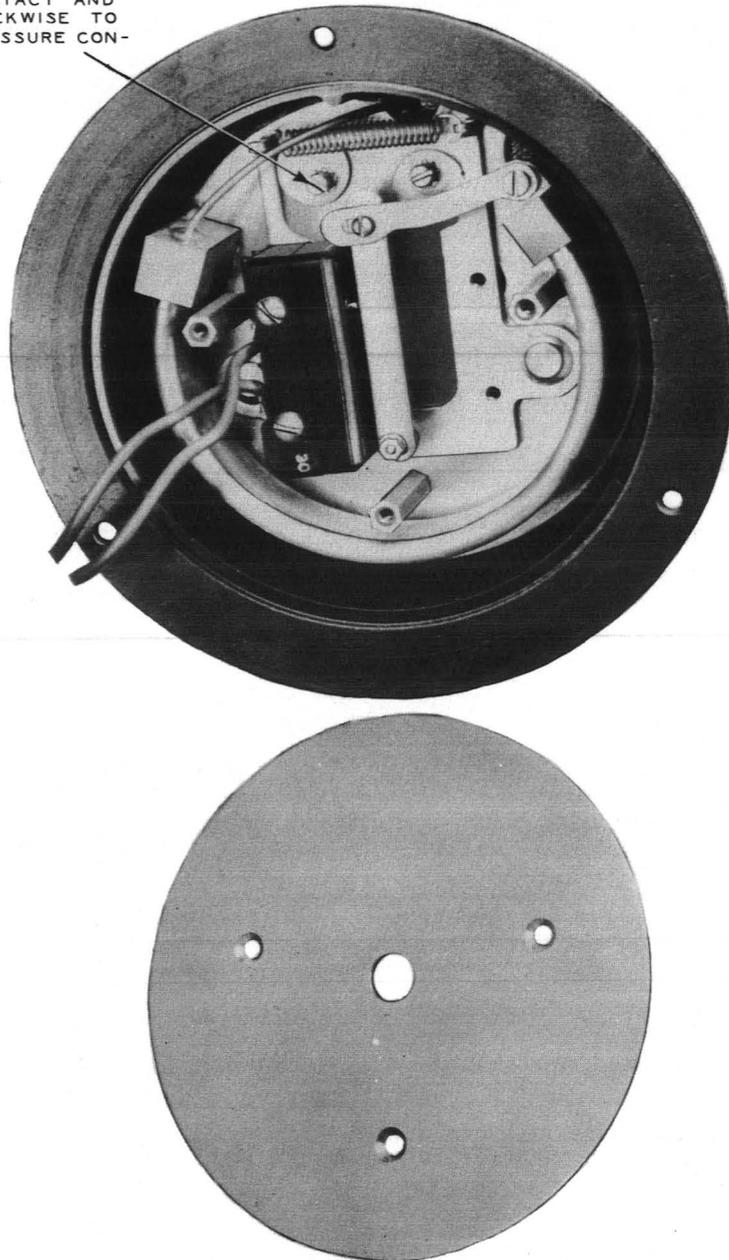


Fig. 1 - Mechanism of Pressure Gauge Alarm

(D) Replacement of the Gas Cylinder

3.04 Replace the gas cylinder when the pressure gauge of the regulator indicates 25 lbs. pressure.

Note: This precludes the chance of moisture entering the cylinder and facilitates the manufacturer's process in refilling.

4. ANTENNA SYSTEM TESTS(A) General

4.01 Maintenance tests which concern the antenna itself are covered in BSP Section R40.164. The following tests are those which involve the antenna as a system component.

(B) Antenna Orientation - Method I

4.02 The method of orienting the antennas described below consists of transmitting a signal from an adjacent repeater station and orienting the receiving antenna for maximum received signal. The same method is used for the local transmitting antenna by connecting it to the receiving waveguide run and receiving equipment in place of the normal receiving antenna. These tests should be made during periods of no fading.

4.03 Apparatus:

Weston 779 Analyzer  
J68340A Test Bay  
20 foot cable assembly per  
ED-45465-01, G2  
3 ED-45466-01, G1  
Twisted pair (approximately 150' long)  
358A coaxial plug  
3 waveguide gaskets  
Can of Antisize (For use in tapped aluminum holes)  
Wrenches as follows:

1/2" drive ratchet handle  
1/2" drive 6" extension  
1-1/8" socket 1/2" drive  
3/4" socket 1/2" drive  
speed handle 1/2" drive  
1/2" diameter steel bar 1 ft. long  
small 3/8" drive ratchet handle  
7/16" deep socket 3/8" drive  
7/16" - 7/16" box-open end wrench

4.04 Procedure:

At the transmitting station:

(1) Connect the RF sweep oscillator to the receiver input. This will involve disconnecting the receiver from the waveguide.

Note: If an IF Signal Generator is available it will be simpler to use it to drive the Transmitter Modulator.

(2) With the sweep OFF, set the oscillator to the center frequency of the channel and adjust levels to make the PWR OUT meter in the transmitter control unit read 0 db.

At the receiving station:

- (3) Operate the CONT key on the receiver control unit to MAN.
- (4) Patch from IF OUT of the IF main amplifier to AT11.
- (5) Patch from AT11 to the IF DET IN jack.
- (6) Set AT11 to 20 db.
- (7) Connect the negative lead of the analyzer to ground and the positive lead to the center conductor of the IF DET OUT.
- (8) Adjust MAN gain for a midscale reading of RCVR OUTPUT.
- (9) Call the transmitting station and request that he break the circuit at the input of the transmitter modulator.
- (10) Observe the RCVR OUTPUT reading.

Requirement: The reading should be zero.

- (11) Restore the connection at the transmitter.
- (12) With the 779 analyzer on the 100 $\mu$ a scale, reduce the setting of AT11 to give a reading of approximately 40 $\mu$ a.
- (13) Record settings of AT11 and meter readings from about 40 $\mu$ a to full scale and note that fluctuations over the period of a minute are less than 1.0 db. If not, it may be necessary to postpone the tests until the fading is less severe.
- (14) Set AT11 to a value which is 5 db above midscale to account for the loss in the cable assembly.
- (15) Run the twisted pair from the antenna deck to the radio room and patch one end of it to IF DET OUT by means of the coaxial plug.
- (16) Connect the other end to the analyzer on the antenna deck.
- (17) Open the waveguides feeding the two antennas which are to be oriented and install one transducer on each antenna.

(18) Install the other transducer on the receiver waveguide and connect the 20-foot cable assembly between the receiver antenna and the receiver waveguide.

(19) Loosen the elevation lock nuts and adjust the antenna elevation to maximize the meter reading. If the initial orientation was badly out, it may be necessary to increase the setting of AT11 to bring the meter reading down.

Note 1: Antenna orientation may be accomplished only if no rapid or severe fading is present. If, with the antenna stationary, the meter fluctuates more than a few divisions in a minute, accurate orientation will be difficult.

Note 2: An optional procedure is to set the two nuts so that at the upper and lower limits of travel the meter deflection is the same, but a few divisions lower than the maximum. Then lock the antenna at the midpoint between the two limits.

(20) Loosen the antenna pivot bolt, the cap screws at the base of the antenna and the two cap screws at the bottom of the rear support rod to permit the antenna to be rotated in azimuth.

(21) Rotate the antenna in azimuth and adjust for maximum meter reading. The tail rod should be kept approximately vertical during the azimuth alignment.

Note: Swing the entire allowable amount to avoid maximizing on a minor lobe.

(22) Check elevation adjustment.

(23) Tighten all nuts and bolts.

Caution: The two drive bolts which rotate the antenna should be seated firmly but not tightened.

(24) Disconnect the cable from the receiving antenna and connect it to the transmitting antenna.

(25) Repeat (19) through (23).

(26) Make several alternate checks of meter readings on the two antennas to check that the two antennas have approximately the same gain.

(27) If one antenna has lower gain check its orientation again.

#### (C) Antenna Orientation - Method II

4.05 This method should not be used except for transmitting antennas of one-way circuits.

#### 4.06 Apparatus:

Same as 4.03 plus Telephone Head Set at transmitting antenna connected by twisted pair to order wire circuit.

#### 4.07 Procedure:

At the transmitting station:

(1) Connect the microwave sweep oscillator to the receiver input. This will involve disconnecting the receiver from the waveguide.

Note: If an IF Signal Generator is available it will be simpler to use it to drive the transmitter modulator.

(2) With the sweep OFF, set the oscillator to the center frequency of the channel and adjust levels to make THE PWR OUT meter on the transmitter control unit read 0 db.

(3) Open the waveguide connection to the antenna at a convenient point and insert the cable assembly and transducers.

At the receiving station:

(4) Operate the CONT key on the receiver control unit to MAN.

(5) Operate the meter switch to RCVR OUTPUT.

(6) Adjust the MAN gain control for a midscale deflection of the meter.

(7) Call the transmitting station and request that he break the circuit at the input of the transmitter modulator.

Requirement: The RCVR OUTPUT reading shall be zero.

(8) Have the connection at the transmitter restored.

(9) Patch from IF OUT of the IF main amplifier to AT11 and from AT11 to from AT11 to the IF DET IN.

(10) Set AT11 to 20 db.

(11) Connect the negative lead of the analyzer to ground and the positive lead to the center conductor of the IF DET OUT.

(12) With the 779 analyzer on the 100µa scale, reduce the setting of AT11 to give a reading of about 40µa.

(13) Record settings of AT11 and meter readings from about 40pa to full scale and note that fluctuations over a period of a minute are less than one db. If not, it may be necessary to postpone the tests.

(14) Set AT11 to give a convenient meter reading and establish order wire contact with the transmitter antenna deck at the transmitter location.

(15) Orient the transmitter antenna in elevation and azimuth for a maximum meter reading.

Note: The transmitter crew should control the action, with no comments from the receiver end except for meter readings.

#### (D) Received Signal Power

4.08 A measurement of received signal power should be made after the antennas at both ends have been oriented, and subsequently if there is evidence of excessive loss in the circuit.

#### 4.09 Apparatus:

J68340A Test Bay at each end of the circuit.

#### 4.10 Procedure:

At the transmitter:

(1) Using the RF sweep oscillator (or the IF sweep oscillator if available) with sweep OFF, obtain a transmitter output power of +27 dbm.

At the receiver:

(2) Operate the CONT key to MAN.  
 (3) Adjust the MAN gain control to give reading of 1 volt when meter switch is on RCVR OUTPUT.

Note: If the meter fluctuations are large, the measurement will be subject to some error due to fading.

(4) Connect the RF power meter to the output of AT4 and set AT3 and AT4 to zero.

(5) Set the frequency of the RF sweep oscillator to the center frequency of the receiver with sweep OFF.

(6) Adjust AT1 to give a power meter reading of .0 dbm.

(7) Connect the output of AT4 through AT5 to the input of the receiver, using the 726 Cable-Transducer if available or flexible wave guide if not.

(8) Set AT5 to 10 db.

(9) Adjust AT3 and AT4 as required to obtain a 1 volt reading at RCVR OUTPUT.

(10) The received signal power is then:

$$-(AT3 + AT4 + AT5 + \text{RF patch cord loss}) \text{ dbm.}$$

#### 4.11 Computation of Expected Received Signal Power.

(1) Referring to figure 2, obtain the received signal corresponding to the path length.

(2) Apply the correction for frequency shown on the lower curve of figure 2.

(3) Apply the correction for wave guide and filter loss. (About 0.02 db per foot of wave guide and about 0.2 db per channel filter.)

Requirement: The measured signal power should be within 2 db of the expected signal power.

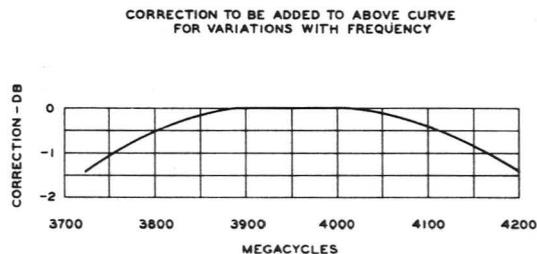
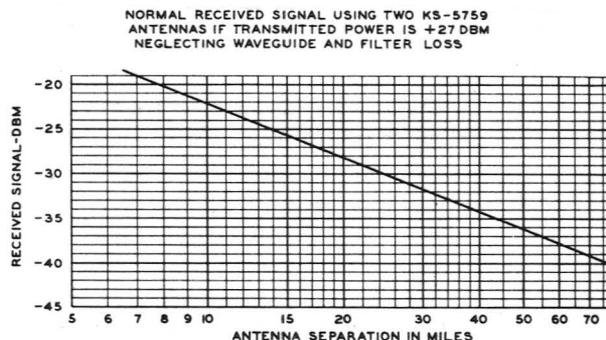


Fig. 2 - Received Signal Power

5. SYSTEM CONTINUITY TESTS(A) General

5.01 The simplest method of making continuity tests of the radio system may be to connect the output of a 70 mc signal generator to the input of the radio transmitter and observe the operation along the route to the distant terminal. This will not check the operation of the FM terminal equipments, and the FM transmitter may be used instead of the signal generator and the FM receiver may be used to observe the signal at the distant terminal. From television operating center to television operating center, a test pattern may be transmitted. Regardless of the type of the input signal, the observations along the route will be the same.

(B) Continuity Test With KS-5782 Signal Generator5.02 Apparatus:

KS-5782 Signal Generator

5.03 Procedure:

(1) Patch the KS-5782 Signal Generator on the FM test console to the RADIO TRANS IN jack on the patching bay.

(2) Set the frequency to 70 mc and the output to 0 dbm.

Note: Although this is the maximum output of the generator, it is 3 db less than the normal input to the transmitter.

(3) Operate the reset button on the transmitter control panel and observe the PWR OUT meter.

Requirement: The meter shall read between -3 db and 0 db.

(4) Have the alarm centers observe the clearing out of the alarms along the route.

(5) Have the attended stations observe the RCVR OUTPUT and the AUTO BIAS on the receiver control unit and the PWR OUT on the transmitter control panel.

Requirements: AUTO-GC BIAS - Normal  
RCVR OUTPUT - Normal  
PWR OUT - 0 dbm

(C) Continuity Test with FM Terminal Equipment5.04 Procedure:

(1) Place the FM transmitter in operation and, at the patching bay, connect to the RADIO TRANS IN.

(2) Observe the PWR OUT meter on the transmitter control panel.

Requirement: 0 db

(3) Have the alarm center observe the clearing out of the alarms along the route.

(4) Have the attended stations observe the RCVR OUTPUT and the AUTO-GC BIAS on the receiver control panel and the PWR OUT on the transmitter control panel.

Requirements: AUTO-GC BIAS - Normal  
RCVR OUTPUT - Normal  
PWR OUT - 0 dbm

(5) Have distant terminal observe signal on the FM receiver.

(D) Continuity Test With Test Pattern5.05 Procedure:

(1) Procedure is similar to that in Par. 5.04 except that a test pattern from the television operating center is connected to the FM transmitter input and the pattern at the distant terminal is viewed on a picture monitor either at the radio terminal or at the television operating center.

6. SYSTEM GAIN-FREQUENCY CHARACTERISTIC AT VIDEO FREQUENCIES6.01 Apparatus:

61B Signal Generator  
70A Power Meter

6.02 Procedure:

(1) Connect a short P2BJ patch cord between the 75-ohm UNBAL SINE WAVE OUTPUT jack on the signal generator and the FM TR IN jack on the monitoring bay.

(2) The following switches should be operated:

CLAMP	switch to TEL
FREQ ADJ	switch to TEL
AFC	switch to TEL
TUNE	switch to TEL
AFC	Switch to ON

(3) Set the frequency of the signal generator to 50 kc and its output to -20 dbv.

(4) At the distant terminal, connect a P3AB balanced patch cord between the VIDEO output jack of the receiver of the channel under test and the MEAS IN - 110 OHM BAL jacks on the power meter.

- (5) Use two 341C Plugs to connect the PROT PAD OUT and the 110 OHM - 1MW IN jacks on the power meter.
- (6) Calibrate the power meter to read dbv.
- (7) Set the receiver GAIN control for a power meter reading of 0 dbv.
- (8) Set the signal generator in turn to each of the frequencies listed in the table below. At each frequency check the adjustment of the REF VOLTS ADJ, 0 CAL ADJ and the LEVEL ZERO ADJ controls on the signal generator.

Requirements:

FREQ. KC	POWER METER READING DBV	
	MAX.	MIN.
50	0	
100	+0.1	-0.1
400	+0.1	-0.1
700	+0.1	-0.1
1000	+0.1	-0.1
2000	+0.1	-0.1
4000	+0.2	-0.2
6000	+0.3	-0.3
8000	+0.4	-0.4

7. TROUBLE LOCATION TESTS(A) General

7.01 Almost any trouble condition which affects system performance will have a direct and observable effect upon the video signal. The observation of a television picture or a standard television test pattern will enable certain transmission difficulties to be diagnosed if proper precautions are taken to compare it with the input picture. The evaluation of transmission impairment thus becomes a question of comparison among different observers over the order wire. Impairments other than gross defects are therefore difficult to determine and require close cooperation and considerable observer experience. The most satisfactory signal for quality observations is the standard test pattern. Other program material may be used if the impairment consists of poor high- or low-frequency transmission, noise or CW interference. The judgment of resolution impairment by observation of a picture other than a test pattern is almost hopeless. Too much stress cannot be laid upon comparison with the input as all the defects are frequently noted in signals from television studios. A television picture, particularly one of movement, is generally not suited for trouble shooting. The simple repetitive wave form of the 63A Signal Generator is much to be preferred since a single line may be examined in detail with an oscilloscope and the exact character of the signal may be

measured and evaluated. Figs. 3 and 4 show characteristics of various types of normal test signals from the 63A Signal Generator. Fig. 5 shows a picture and sync pulse signal from the 61B Signal Generator.

(B) Lack of Resolution

7.02 The ability to resolve the converging lines of the vertical wedge of a test pattern is impaired if a transmission system attenuates the higher frequency components of the picture signal. Loss of resolution within the TD-2 system is a definite indication that the high frequency response of the system is deficient.

7.03 Apparatus:

Test Pattern Signal  
KS-5799 Video Monitor

7.04 Procedure:

- (1) Apply a standard test pattern signal to the input of the FM transmitter.
- (2) At the distant terminal, connect the KS-5799 Video Monitor to the FM receiver output and observe the received pattern.

Requirement: Individual lines of the vertical wedge should be clear and distinct all the way to the inner circle.

(C) Transients

7.05 Presence of transients indicate improper alignment and adjustment of the TD-2 system. Transients are most readily observed near the center of the picture area where the focus is optimum.

7.06 Apparatus and procedure as in (B).

Requirements: Transients after sharp transitions from white to black in the picture should not be present.

(D) Streamers to the Right of Large White Areas

7.07 Streamers to the right of large white areas of the picture are due to low-frequency transmission distortion. In the TD-2 system, such distortion could occur through trouble conditions in the video amplifiers of the FM terminal equipment.

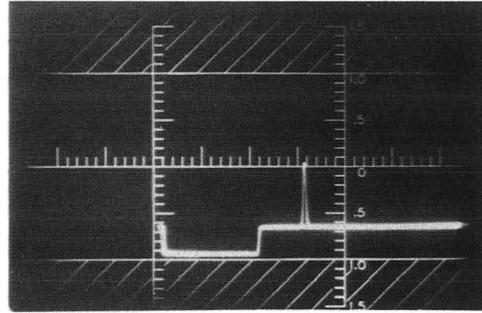
7.08 Apparatus and procedure as in (B).

Requirements: Streamers should not be present.

(a)

Output of 63A Signal Generator showing the negative sync pulse and NARROW picture pulse.

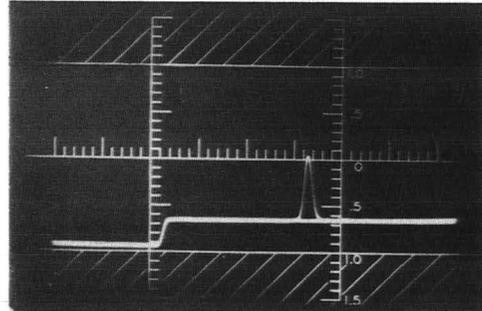
amplitude 1.0 v P-P  
20 divisions = 10 microseconds



(b)

Back edge of sync pulse and NARROW pulse on expanded time scale.

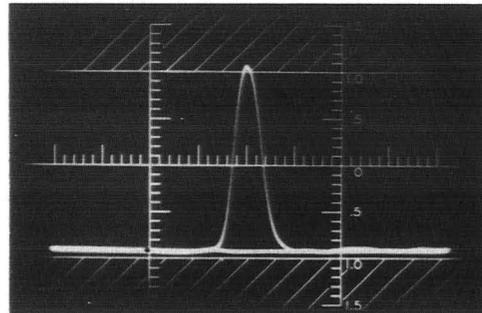
amplitude 1.0 v P-P  
20 divisions = 3 microseconds



(c)

Expansion of NARROW pulse only in scale and amplitude.

amplitude 0.7 v  
20 divisions = 1 microsecond



(d)

Back edge of sync pulse on expanded scale.

amplitude 0.3 v  
20 divisions = 1 microsecond

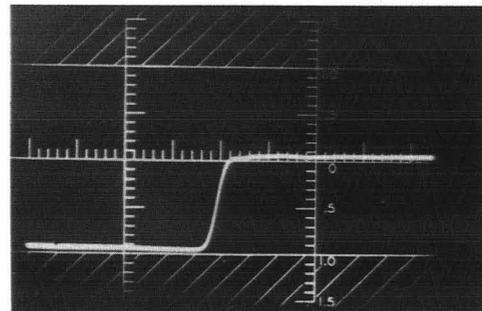
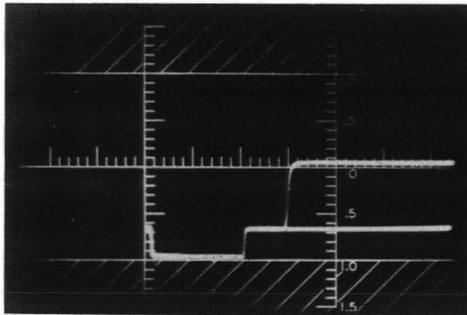


Fig. 3 - 63A Signal Generator Waveforms

(a)

Output of 63A Signal Generator showing sync pulse and leading edge of WIDE picture pulse.

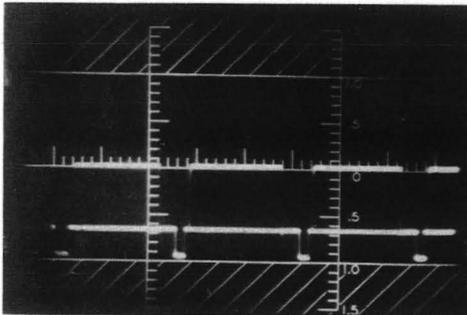
amplitude 1.0 v P-P  
20 divisions = 10 microseconds



(b)

Three lines of composite signal with WIDE picture pulse. Note the presence of both front and back "porch".

amplitude 1.0 v P-P  
20 divisions = 100 microseconds



(c)

Two cycles (two frames) of modulated WIDE pulse showing 60 cycle gating of picture component.

amplitude 1.0 v P-P  
20 divisions = 1/60 second

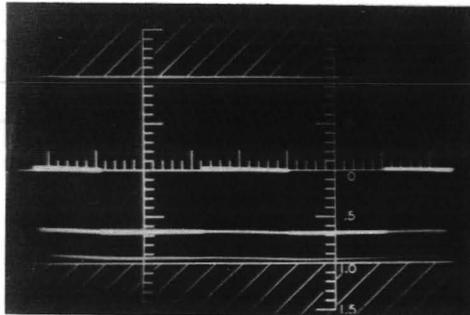


Fig. 4 - 63A Signal Generator Waveforms

Output of 61B Signal Generator showing three lines of composite signal without 60 cycle modulation. Note that the trailing edge "picture" pulse runs directly into the sync pulse.

amplitude 1.0 volt P-P  
20 divisions = 100 microseconds

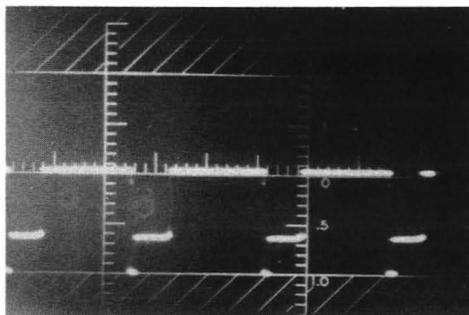


Fig. 5 - 61B Signal Generator Waveform

(E) Scintillations in the Picture

7.09 Sparkling or scintillations in the picture are due to random "noise". It should be noted that certain types of studio equipment give fairly noisy pictures and are unsuitable for determining quality.

7.10 Apparatus:

Any Television Picture Signal  
KS-5799 Video Monitor

7.11 Procedure:

- (1) Apply any television picture signal to the input of the FM transmitter.
- (2) At the distant terminal, connect the KS-5799 Video Monitor to the FM receiver output and observe the gray area of the test pattern or picture for sparkling or scintillations.

Requirements: Picture should be free from noise.

(F) Bars Across the Picture

7.12 Vertical, horizontal or diagonal bars across a picture which may be either stationary or moving are caused by sine wave interference or crosstalk. Interference which is at a frequency higher than the line scanning rate of the picture produces diagonal or vertical bars or a "heringbone" pattern. Interfering signals of lower than line rate produce horizontal bars which may or may not move vertically across the picture. A special case of interference is power line crosstalk. This will appear as a horizontal bar if the interfering system is synchronous with the power frequency at the program originating point. If the interfering signal originates in a power network which is not synchronous with that at the originating studio, the bar will move slowly across the field in a vertical direction.

7.13 Apparatus:

Any Television Picture Signal  
KS-5799 Video Monitor

7.14 Procedure:

- (1) Apply any television picture signal to the input of the FM transmitter.
- (2) At the distant terminal, connect the KS-5799 Video Monitor to the output of the FM receiver and observe the received picture.

Note: Bars indicate the presence of interference.

(G) Secondary Images (Echoes) - Overshoot of Sync or Narrow 63A Signal Generator Test Pulses

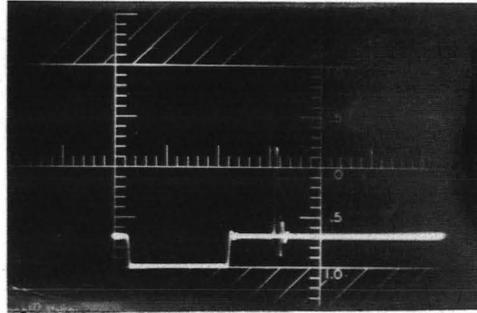
7.15 The relation between gain and phase at the upper video frequencies is such that transmission problems in that range are likely to be complex and to include distortion other than that attributable to attenuation alone. Misalignment or other failure in the feedback amplifiers may cause distortion. Another possible source of this trouble is in the IF channel. A non-symmetrical or badly distorted transmission characteristic will distort the signal side bands and cause picture irregularities similar to those produced by poor transmission in the video amplifiers. There will generally be overshoots at the pulse edges such as shown in Fig. 6 and these may be followed by one or more ripples or echoes. The phase problem in the IF portions of the system may sometimes be difficult to analyze. Any appreciable deviation from normal will usually be accompanied by a change in the gain characteristic which will be seen in a sweep frequency test. In a limiter, however, it is possible to obtain a typically flat transmission characteristic while introducing phase distortion which seriously degrades the upper frequencies. Whenever it is necessary to repair or maintain the limiter, the special procedures given in Sections R10.304 and R20.364 should be closely followed. The low-pass filters at the discriminator outputs in the FM receiver are passive devices which should require no attention. Should a failure occur, though, the response may be altered. Still another possible source of high frequency distortion is an impedance irregularity anywhere in the IF or RF portion of the system. Impedance is most important where the connecting cable is long. An open center conductor in the cable will result in loss or reduction of signal level and will distort the transmission characteristic of the amplifier. There may also be a substantial increase in interference pick-up if the receiver is subject to strong radiation fields.

7.16 A plurality of images may be due to reflections and echoes in the radio path and not the result of improper equipment performance. They are caused by radio signals reaching the receiver through multiple paths having different transit times and generally can be improved only by relocating transmitter or receiver or both. Reflections are most likely to occur in urban locations where there are many buildings and structures along the path. In extreme cases, for example when the path is directly between two rows of buildings, the signal may be reflected back and forth many times and produce multiple echoes of substantial magnitude. Because transmission reflections are similar to the effects of certain equipment troubles, they may not be recognized immediately.

(a)

Effect of high frequency distortion. (Sharp cut-off above 4 mc) Narrow pulse amplitude is increased and overshoots are produced at pulse edges because of phase distortion beyond cut-off.

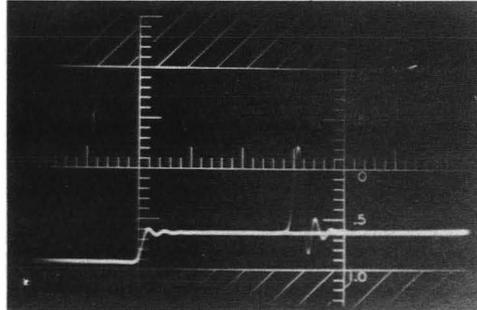
amplitude approx. = 1.2 v P-P  
20 divisions = 10 microseconds



(b)

Expansion of (a) above to show details of transients following sync and narrow picture pulses. (Compare with photo 2b)

amplitude approx. = 1.2 v P-P  
20 divisions = 3 microseconds



(c)

Same high frequency distortion as (a) above, but narrow pulse expanded in amplitude and time scale. (Compare with photo 2c)

amplitude approx. = 0.6 v P-P  
20 divisions = 1 microsecond

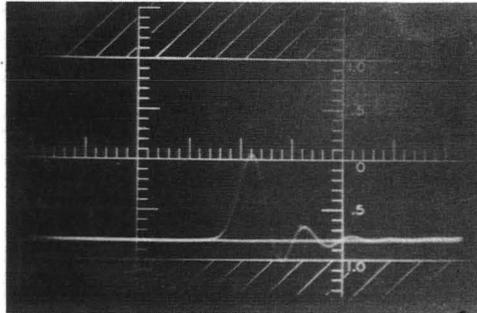


Fig. 6 - High Frequency Distortion

## 7.17 Apparatus:

KS-5799 Video Monitor  
63A Signal Generator  
J68337A FM Test Console  
368A Plug

(3) Adjust the Signal Generator for the NARROW pulse as outlined in the general instructions of BSP Section R10.304 FM Terminal Transmitter.

## 7.18 Procedure:

- (1) Connect the 63A Signal Generator through a variable attenuator on the FM test set, set to about 14 db, to the FMT IN jack on the monitoring bay.
- (2) At the distant terminal, connect the SCOPE IN 1 on the FM test console to the FMR OUT jack on the monitoring bay; insert a 368A plug in the SCOPE IN 2 jack.

(4) Observe the test signal at the distant terminal.

(5) If radio reflections are suspected, operate the FM transmitter with the AFC off and change the transmitter frequency slowly over a range of about 5 mc. As the frequency changes, the changing phase relations of the spurious paths will usually cause the echoes to vary in position and amplitude.

(H) Envelope of Tips of 63A Sync Pulses Not in a Straight Line

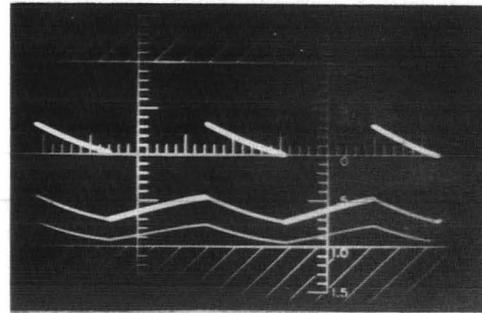
7.19 This condition generally represents poor low frequency response in one of the video amplifiers. In the case of the FM transmitter, it will usually be found that the clamp circuit is not operating normally. The video signal will show envelope distortion corresponding to the variation in average d-c level from line to line and since the standard television pattern is based upon a 60-cycle frame rate, the fundamental frequency of such distortion will be 60 cycles. In a true picture signal, where picture content in each line has approximately the same average amplitude, the distortion will appear primarily in the

region of the vertical synchronizing group where the average d-c becomes that of the sync pulses alone. The base line or envelope of the bottom of the horizontal sync pulses will therefore bulge downward following the last line of a frame group and will rise with distortion in the first lines of the next frame. (See Figs. 7a and 7b.) If the signal has a very large 60-cycle component, as does the WIDE pulses produced by the 63A Signal Generator, distortion will be much more pronounced and the base line may have an envelope amplitude as great as 50% or more of the maximum signal amplitude. In a milder form, the distortion appears as slope across the group of pulses and gives the signal an envelope which is roughly a symmetrical saw tooth wave. Generally

(a)

Distortion produced in the transmitting amplifier clamp circuit by disabling the 6AL5 diode. Note that the signal envelope follows the 60 cycle component of the composite signal.

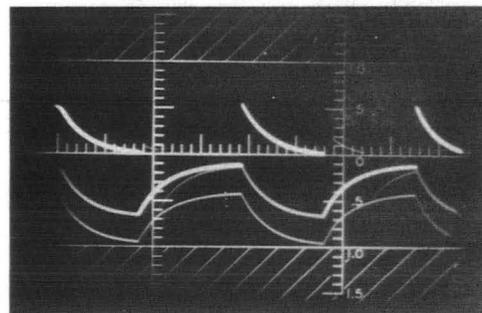
amplitude 1.0 v P-P  
20 divisions = 1/60 second



(b)

Distortion produced by introducing the composite signal into a 197A repeat coil. This wave form is observed at terminal 8 (cathode) of V6 using the high impedance probe.

amplitude approx. 10.0 v P-P  
20 divisions = 1/60 second



(c)

Signal at CLAMP MON jack of the transmitter showing the effect of the clamp circuit upon the distortion introduced by the coil as shown in (b) above. The thickening of the black level line is due to small overshoots which are caused by improper termination of the repeat coil as used in this test.

amplitude 0.8 v P-P  
20 divisions = 1/60 second

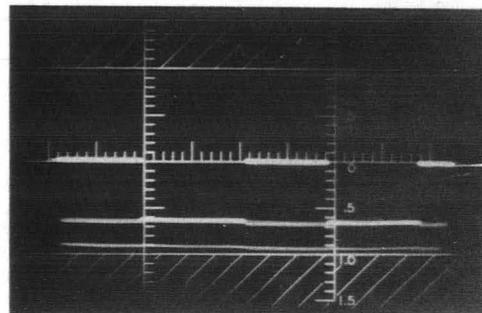


Fig. 7 - Low Frequency Distortion

speaking, a clamp failure will produce a more violent distortion than is likely in the video amplifier of the FM Receiver because the latter is designed to pass the video band without the aid of the periodic d-c reinsertion of the clamp. Examination of the signal at the CLAMP MON jack of the FM Transmitter, or monitoring at IF with the FM Test Console should quickly determine whether or not the trouble is in the transmitter. If it is found to be in the receiver, it may be traced by bridging the oscilloscope in the test console at the video input.

#### 7.20 Apparatus:

63A Signal Generator  
J68337A FM Test Console  
368A Plug

#### 7.21 Procedure:

- (1) Connect the 63A Signal Generator through a 14 db attenuator to the FMT IN jack on the monitoring bay.
- (2) At the distant terminal connect the SCOPE IN 1 on the FM test console to the FMR OUT jack on the monitoring bay; insert a 368A plug in the SCOPE IN 2 jack.
- (3) Adjust the 63A Signal Generator for the WIDE pulse as outlined in the general instructions of BSP R10.304 FM Terminal Transmitter.
- (4) Observe the test signal at the distant end.

Requirement: Envelope of the tips of the sync pulses should be in a straight line (Fig. 7c).

#### (I) Distortion of 63A Sync Pulse and in the Picture Signal Within a Single Line

7.22 Distortion in the sync pulse and in the "picture" signal within a single line is generally due to distortion in the band extending roughly from line rate (15.75 kc) to about 500 kc. If the frequency distortion is in the region of the line rate, a pulse having a width which is a substantial fraction of the horizontal period will be sloped in much the same manner as poor 60-cycle transmission affects the frame period. Distortion occurring within a line period is not corrected by the clamp. Another condition within this group is distortion in the region of 500 kc. In this case the corners of the sync and signal pulses appear quite rounded or may appear to be clipped off giving the effect of a "sawed off" corner. This trouble is often

in combination with attenuation or phase distortion at the higher frequencies and may have transient effects at the pulse edges. This trouble is likely to occur in the video amplifiers of either the transmitter or receiver.

#### 7.23 Apparatus:

63A Signal Generator  
J68337A FM Test Console  
368A Plug

#### 7.24 Procedure:

- (1) to (3) As in Par. 7.21.
- (4) Observe the test signal at distant terminal.

Note: Effect of mid-frequency distortion is shown in Fig. 8.

- (5) Check the video wave forms at the FM transmitter VID MON jack and if questionable, measure transmitter response as described in BSP Section R10.304.
- (6) Check response of the FM receiver video amplifier as described in BSP Section R20.364.

#### (J) Rounding Off of Sharp Edges of 63A Signal Generator Pulse

7.25 Rounding off of the sharp pulse edges accompanied with a reduction in amplitude and spreading of the narrow spike in the test signal and general lack of definition in a test pattern as viewed on a picture monitor, is caused by attenuation of the high frequencies. If the condition is simply one of smooth roll-off as in Fig. 9 without other complications such as phase distortion, the effect may be scarcely noticeable on a picture. However, an impairment of two or three db at 4 mc will be easily seen on the narrow spike test signal and if more than one link in a long circuit has such distortion, the final transmission soon becomes intolerable.

#### 7.26 Apparatus:

63A Signal Generator  
J68337A FM Test Console  
368A Plug

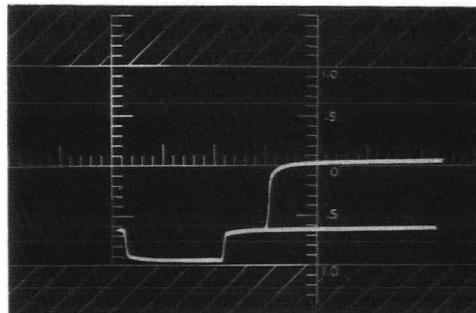
#### 7.27 Procedure:

- (1) Connect the 63A Signal Generator through a variable attenuator on the FM test set, set to about 14 db, to the FMT IN jack on the monitoring bay.

(a)

Effect of mid frequency distortion. Note rounded corners of the sync and picture pulses.

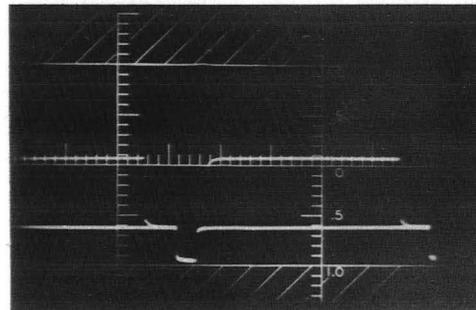
amplitude = 1.0 v P-P  
20 divisions = 10 microseconds



(b)

Same as (a) above, except that sweep speed is somewhat slower to show the "sawed-off" effect at the corners of the wide picture pulse.

amplitude = 1.0 v P-P  
20 divisions = 50 microseconds



(c)

Effect of same distortion as (a) and (b) above on the narrow picture pulse. Note that the narrow pulse is substantially unchanged and that the effect of the distortion is principally on the sync pulse.

amplitude = 1.0 v P-P  
20 divisions = 10 microseconds

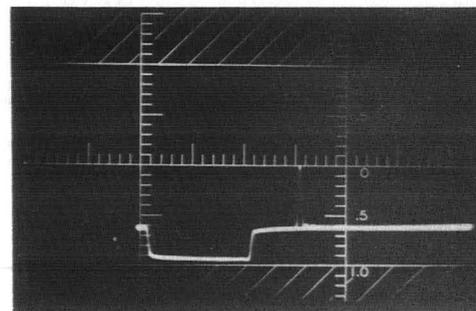


Fig. 8 - Mid Frequency Distortion

(2) At the distant terminal, connect the SCOPE IN 1 on the FM test console to the FMR OUT jack on the monitoring bay; insert a 368A plug in the SCOPE IN 2 jack.

(3) Adjust the 63A Signal Generator for the NARROW pulse as outlined in the general instructions of BSP R10.304 FM Terminal Transmitter.

(4) Observe the test signal at the distant terminal.

(K) Change in Ratio of Sync Pulse to Signal

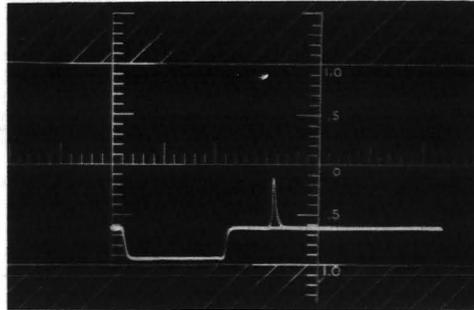
7.28 Nonlinear distortion causes the signal to be transmitted with nonuniform

amplitude, resulting in stretching or compression of the video wave form. A pattern having a triangular or saw tooth wave form or one in which the envelope has such a wave form, such as a special test pattern having steps of uniformly increasing brightness levels, will make a quite small degree of nonlinearity observable on an oscilloscope. When nonlinearity is more severe, it may be seen on any test signal, usually as a measurable change in the sync to signal proportions. One possible cause is clipping or compression in the video amplifiers of either the FM transmitter or receiver. This may be due to tube failure, overloading, or excessive grid current in a stage which causes a rectified bias voltage to be built up on the input coupling capacitor. Curva-

(a)

Effect of high frequency distortion (smooth cut-off above 2 mc) Note slight rounding of sync pulse corners and loss of amplitude and spreading of narrow picture pulse.

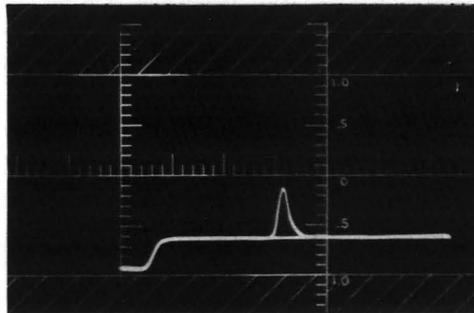
amplitude = 1.0 v P-P  
20 divisions = 10 microseconds



(b)

Same high frequency distortion as (a) above, but expanded time scale. (compare with photo 2b)

amplitude = 1.0 v P-P  
20 divisions = 3 microseconds



(c)

Same high frequency distortion as (a) above, but narrow pulse expanded in amplitude and time scale. Note spreading of the pulse at the baseline. (compare with photo 2c)

amplitude approx. = 0.6 v P-P  
20 divisions = 1.0 microseconds

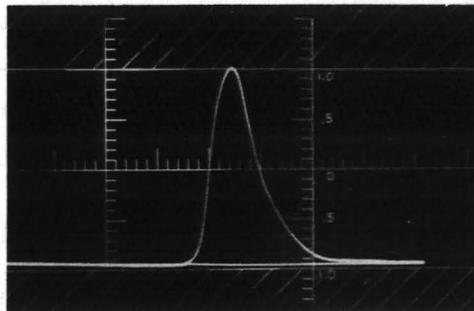


Fig. 9 - High Frequency Distortion

ture in the FM generator or in the FM receiver discriminator characteristic will produce nonlinearity in the detected FM signal. This may be readily measured and adjusted by using the FM test console. Improper transmitter AFC operation will place the middle of the IF band above or below the normal frequency. In addition to clipping off the FM side bands by operating at the side of the IF pass band, the operating point on the discriminator may be well away from the linear portion of the curve.

#### 7.29 Procedure:

- (1) Examine frequency deviation and determine that signal is at the correct IF frequency.

- (2) Check video wave form at FM transmitter VID MON jack at normal level.
- (3) Check linearity of transmitter, receiver and over-all system.

#### (L) Miscellaneous Abnormal Transmission

7.30 The effects of excessive unequalized and improperly terminated cable are shown in Fig. 10.

### 8. MAINTENANCE TOOLS

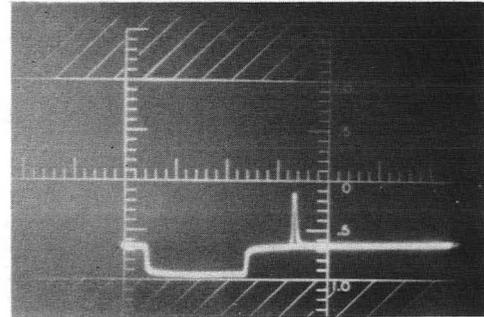
#### (A) Tools Required for Radio Equipment

8.01 The tools required for maintaining the radio equipment at the various locations are listed in Fig. 11.

(a)

Signal at VID MON jack of FM transmitter, showing the effect of excessive length of un-equalized input cable. (500 ft. of KS-8086 cable) Note rounding of corners of sync pulse and decreased amplitude of the narrow picture pulse.

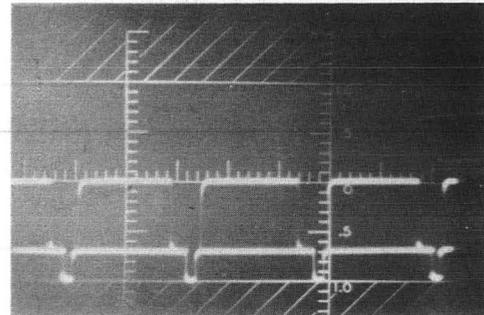
amplitude approx. = 0.8 v P-P  
20 divisions = 10 microseconds



(b)

Same as (a) above, but with wide picture pulse.

amplitude approx. = 0.8 v P-P  
20 divisions = 100 microseconds



(c)

Distortion of sync pulse and narrow picture pulse caused by 500 feet of unequalized KS-8086 cable improperly terminated at FM transmitter. Termination is improper due to open resistance (R1) in transmitter video amplifier.

amplitude approx. = 0.8 v P-P  
20 divisions = 10 microseconds

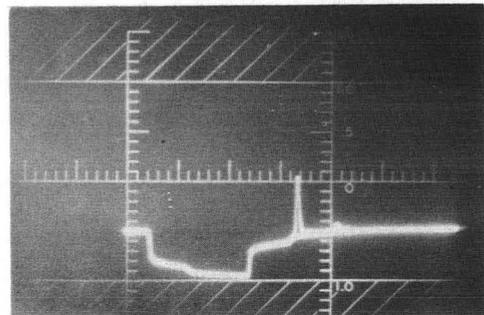


Fig. 10 - Effects of Excessive Unequalized and Improperly Terminated Cable

TD-2 RADIO SYSTEM MAINTENANCE TOOLS					
TOOL	DESCRIPTION	LOCATION REQUIRED AT			
		MAIN- TENANCE CENTER	TERMINAL STATION	MAIN REPEATER STATION	AUXILIARY REPEATER STATION
<b>SPECIAL TOOLS</b>					
P-288625 TUNING TOOL	SLEEVED SCREWDRIVER FOR ADJUSTING CAE & SIMILAR COILS	X	X	X	X
P-257207 TOOL ASSEMBLY	FOR CAVITY TUNING	X	X	X	X
P-257211 V.T. WRENCH	FOR REMOVING 416 TYPE TUBE	X	X	X	X
8" HOLD-E-ZEE SCREWDRIVER TYPE TH-B	FOR REMOVING PANELS FROM BAY	X	X	X	X
8" HOLD-E-ZEE SCREWDRIVER TYPE TR-B	FOR REMOVING PANELS FROM BAY	X	X	X	X
NO. 700 REED & PRINCE SCREWDRIVER		X	X	X	X
ALLEN WRENCH (NON-MAG.) 3/64" ACROSS FLATS	FOR NO. 4 SCREW	X	X	X	X
ALLEN WRENCH (NON-MAG.) 1/16" ACROSS FLATS	FOR NO. 6 SCREW	X	X	X	X
ALLEN WRENCH (NON-MAG.) 5/64" ACROSS FLATS	FOR NO. 8 SCREW	X	X	X	X
ALLEN WRENCH (NON-MAG.) 3/32" ACROSS FLATS	FOR NO. 10 SCREW	X	X	X	X
ALLEN WRENCH (NON-MAG.) 1/8" ACROSS FLATS		X	X	X	X
J.H. WILLIAMS NO. 1116 1/4" END WRENCH		X	X	X	X
BURNDY ENG. CO. Y10Q HAND PRESS WITH R-20PV & R-20V DIES	FOR CRIMPING SLEEVES ON COAXIAL CABLES	X			
STARRETT NO. 559A POCKET SCREWDRIVER	FOR ADJUSTING KS-13998 CONDENSERS	X			
STARRETT NO. 555C JEWELERS SCREWDRIVER	FOR ADJUSTING AFC STOPS ON FM TERM XMTR	X	X		
J.H. WILLIAMS NO. NM-1214 SOCKET WRENCH WITH NM-42 HANDLE	RT. ANGLE SOCKET WRENCH FOR FASTENING WAVEGUIDE COMPONENTS ON BAY		X	X	X

TD-2 RADIO SYSTEM MAINTENANCE TOOLS (CONTINUED)					
TOOL	DESCRIPTION	LOCATION REQUIRED AT			
		MAIN- TENANCE CENTER	TERMINAL STATION	MAIN REPEATER STATION	AUXILIARY REPEATER STATION
P-378159 HANDLE	FOR REMOVING IF SW. & DIST. AMP. FROM MTG.		X	X	X
WESTON NO. 226L-007 THERMOMETER	FOR MEASURING OVEN TEMP. IN MICROWAVE GENERATORS	X	X	X	X
COMMON TOOLS NO. 168 WIREMAN'S KIT INCLUDING DIAGONAL CUTTERS LONG NOSE PLIERS SHORT NOSE PLIERS 3" CABINET SCREWDRIVER SPUDGER		X	X	X	X
603A TOOL	FOR REMOVING 276 TYPE RELAYS.	X	X	X	X
366 TOOL	1/4" HEX. SOCKET WRENCH	X	X	X	X
553A TOOL	FOR REMOVING NO. 2 TYPE LAMPS		X	X	X
319B TOOL	FOR REMOVING NO. 2 TYPE LAMP CAPS		X	X	X
KS-8740, L7 SOLDERING IRON WITH L30 & L31A TIPS AND IRON HOLDER		X	X	X	X

Fig. 11 - List of Tools Required for Radio Equipment

(B) Tools Required for Power Equipment

## 8.02 Tool supplied with engine alternator

	<u>Hercules Motor Corp. No.</u>
Ratchet Handle, 3/4" Service	3100-B
Socket Wrench Extension, 3/4" Service	3101-A
Socket - Adapter 3/4" Female 1/2" Male	3107-A
Socket, 7/16"	3108-A
Socket, 9/16"	3170-A
Socket, 5/8"	3171-A
Socket, 3/4"	3109-A
Socket, 7/8"	3103-A
Socket, 1"	3112-A
	(30-, 40-, 50-, 60-kw set)
Socket, 1-1/16"	3113-A
	(30-, 40-, 50-, 60-kw set)
Socket, 1-1/8"	3114-A
Socket, 1-5/16"	3115-A
	(30-, 40-, 50-, 60-kw set)
Tappet Wrench, 7/16" x 1/2"	3777-A
	(30-kw set)
Tappet Wrench, 3/4" x 3/4"	3118-A
	(20-, 40-, 50-, 60-kw set)
Tappet Wrench (2) 1/2" x 10"	3256-A
	(20-kw set)
Tappet Wrench (2) 1/2" x 12"	11916-A
	(20-kw set)
Open-end Wrench, 3/4"	13089-A
	(30-, 40-, 50-, 60-kw set)
Open-end Wrench, 7/8" x 13/16"	11917-A
Lady-foot Pry Bar	11920-A
Bronze and Fiber Hammer	13737-A
	(30-, 40-, 50-, 60-kw set)
Bronze and Fiber Hammer	11922-A
	(20-kw set)
Pin Punch Kit	11923-A
Ring Compressor	13171-A
	(30-kw set)
Ring Compressor	11924-A
	(20-, 40-, 50-, 60-kw set)
Screwdriver	11925-A
	(20-kw set)
Screwdriver	11926-A
	(30-, 40-, 50-, 60-kw set)
Flexible Handle Radiator Fan Ad- justing Wrench	11927-A
Tool Roll contain- ing the following items:	-
Screwdriver, off- set, for magneto	D-2919

Wrench, Allen  
set screw,  
10-32, for  
governor switch  
Angle Wrench 8"  
Spark Plug Wrench  
End Wrench,  
1/4" x 5/16"  
End Wrench,  
5/16" x 3/8"  
End Wrench,  
3/8" x 7/16"  
End Wrench,  
7/16" x 1/2"  
End Wrench,  
1/2" x 5/8"  
5" Sq. Shank  
Screwdriver  
12 Oz. Ball  
Peen Hammer  
6" Combina-  
tion Pliers  
1/2" Cold Chisel  
1/8" Punch  
10" Mill File  
Fuel Pump Repair Kit -  
AC Spark Plug Co. #752  
Gauge Feeler - Sears  
Roebuck Co. #4058

## 8.03 Additional tools, instruments, and materials recommended for gas-engine-alternator maintenance:

Bellows, Hand 10"  
Brush, Typewriter, Toothbrush Type  
File, Flat, Pillar, No. 2 cut, 6"  
R-1051  
File, Jeweler's, No. 6 cut, 5-3/8"  
long, KS-2663  
Gun, Grease, Lincoln No. 5950  
Oiler, Hand  
Screwdriver, 5", regular  
Balance, Spring, John Chatillion &  
Sons, No. 06, 0-6 lbs. by 2 oz.  
graduations  
Gauge, Nest, Thickness KS-6909  
Indicator, Speed, Jones No. 5B  
Manometer, 4", Consolidated Ash-  
croft Hancock Company Model 1370  
(Mercury)  
Scale, 6", steel, R-8550  
Thermometer, 0°C-200C R-1032  
Voltmeter, Weston Model 280, d-c,  
range 3-60-150  
Watch, Stop, KS-3008  
Casite, (1 quart), The Casite Corp.,  
Hastings, Mich.  
Cloth, Cleaning, twill jean, D-98063  
Detector, carbon monoxide, AT-6791  
Glycerine  
Grease, 260-300P,  
KAR-B-OUT (8 oz.) The Shaler Company  
Waupun, Wisc.  
Lead, Red.  
Litharge  
Oil, see lubrication chart in 2.01  
Oil, Flushing  
Oil, Switch, 54-57 S 100, if avail-  
able. If not, order Westinghouse  
#8009-1 oil in one ounce bottle

Oil, Watch, 95-100 S 100  
Packing, asbestos, 1/16" thick, width and length as required.  
Packing, Johns Manville #C293, 3/16" twisted, one pound coil (approx. 40 ft.)  
Packing, "Garlock" No. 605 or Pyroid, 1/16" thick, width and length as required.  
Packing, U.S. Rubber Company, type "CBS" Rubber, 1/16" thick, width and length as required.  
Packing, "Vellumoid", 1/32" thick, width and length as required.  
Pad, felt  
Pail, Galvanized (for waste oil)  
Petrolatum  
Sandpaper, 4/0, or Cloth, abrasive 150 Grade  
Shellac  
Soda, Table, (bicarbonate)  
Spirits, Petroleum

8.04 Additional tools and instruments recommended for maintenance of A-C line voltage regulator not elsewhere specified:

File, round 6"  
Pliers, duckbill, KS-6015, 6"

Screwdriver, KS-6854, 3-1/2"  
Screwdriver, regular, 4"  
Screwdriver, regular, 5"  
Screwdriver, offset, 563A or 564A  
Wrench, Allen set screw, R-2670  
Wrench, adjustable, single end, 8", R2512  
Ammeter, a-c Weston 528, 1 ampere with 539 Current Transformer  
Gauge, push-pull, tension, 79B, 0-1000 grams.

8.05 Additional tools and materials recommended for maintenance of engine control circuits, relays, contactors and transfer switches not elsewhere specified:

Burnisher No. 265C  
Cord, No. 1W13A  
Balance, Spring, R-2481, 0-30 lbs.  
Gauge, No. 68B 70-0-70 grams  
Clip, No. 365 (2)  
Scriber No. 240  
Test Set, 81A  
Wrench, Open-end, 3/8" opening, 417A Tool (2)  
Wrench Socket, 3/8" hex. opening, No. 46 Tool  
Bond Paper, KS-7187  
Cloth, abrasive, 150 grade

Bell Telephone Laboratories, Inc.