1. 3NP4 Projection Tube
2. 3NP4 Tube Socket with Cable
3. Tailpiece
4. Optical Box
5. High Voltage Power Supply

MODEL 160 Protelgram

DESCRIPTION

A 1.4" x 1.66" picture is produced on the face of the 3NP4 cathode-ray tube. The light output of this tube reaches approximately 3,000 foot lamberts.

This light is gathered by a concave mirror, reflected to a plane 45° mirror and projected through an aspherical corrector lens. This optical system which is an adaptation of the "Schmidt" optical principle is essentially a very efficient picture magnifier having a linear magnification of nine times.

The length of the projected beam from the face of the corrector lens to the screen, is shown on this drawing. This beam is usually "folded" one or more times in order to conform to cabinet design. Mirrors used for the purpose of "folding" the beam, which are of necessity placed between the projection unit and the screen, are of the highest quality. Only front surfaced mirrors are used.

A variety of picture sizes can be produced ranging from cabinet-contained screens, from 130 to 234 square inches, e.g.:

- Model 161A
  130 square inches with rounded corners 13-1/3" x 10"
- Model 160A
  192 square inches with square corners 16" x 12"
- Model 160A
  234 square inches with rounded corners 18" x 13-1/2"

and

- Model 162A for movie-type projection on large screens from 32" x 24" (758 square inches) to 48" x 36" (1728 square inches)

The same Protelgram unit is used in all of the above models with the exception of the corrector lens in the optical box which determines the distance from the corrector lens to the screen. (See description of optical box, page 6).

The chassis used with Protelgram is a conventional television chassis with the following probable modifications:

1. A 350 V. - 50 ma D.C. source for the 25 kv high-voltage unit.
2. Wider focus current range to allow for the greater degree of adjustment desired for a projection tube.
3. Provisions for a somewhat higher video output voltage.
4. A protective circuit to prevent screen burns on the projection tube face in the event of sweep failure in the TV chassis.

The aluminum phosphor screen increases the light output and prevents ion sputter on the cathode-ray tube in the no ion-trap is needed. This inside coating, the anode also covers the tube and the greater part of the neck. An outside coating, of "Aquaflow", is ground and used as a static shield. The capacitance between inside and outside coatings serves as the fixed filter capacitor for the 25-kv high-voltage.

The total deflection angle is 47 deg. Grid driving voltage required is about 90 volts peak-to-peak in order to insure adequate modulation of high cut-off tubes. The filament operates at 6.3 volts, 0.80 amp. Average beam current is approximately 50 microamps, but highlights peak reach 500 microamps. On visual-aiding this the spot size remains substantially constant, approximately 0.003 in. The peak brightness on this tube face reaches 5000 foot-lamberts.
The tailpiece includes the focus coil, the deflection yoke and its associated wire-wound shield, the tube clamp assembly and the tube positioning adjustments.

Protelgram, being a "short focus" system, requires precise positioning of the tube in the optical box. These controls are adjusted only when the tube is installed, and they are easy to operate - while their effect can be clearly observed on the viewing screen.

A 1000 ampere-turn coil is used for focusing. Two types of focus coil are used -
- Shunt (Tailpiece 160AT-66) - 11,000 ohms
- Series (Tailpiece 160AT-61) - 290 ohms

While the deflection coils are built to standard electrical specifications, their shape is necessarily different from conventional forms. A molded phenolic form is used for the deflection coils, so shaped that the tube mates firmly in it. The deflection coils are so designed that linear current will produce linear deflection over the full picture area; their design also corrects spot astigmatism near the edge of the tube face at wide angles of deflection.

There are 7 leads attached to the tailpiece which are used to connect the focus coil, ground and deflection coils to the chassis.

**SPECIFICATIONS**

**Wiring Color Code:**
- Horizontal Deflection Coil: *Orange with white tracer*
- Vertical Deflection Coil: *Orange with black tracer*
- Focus Coil: *Blue with white tracer*
- Deflection Yoke: *Black with black tracer*

Polarity determined by the direction of sweep desired.

Tailpiece 160A-60T Shunt Focus Coil, 11,000 ohms Red
Tailpiece 160A-61T Series Focus Coil, 290 ohms Red

Ground: Black - Must be securely fastened to provide slow resistance connection to all other grounded chassis in system. It is imperative that the optical box be electrically connected to the ground side of the H. V. supply.

**Focus Coil:**
- Two types available:
  1) P9.205.11 M Shunt D.C. resistance 190 ohms ± 10%
     
  2) P9.205.12 M Series D.C. resistance 11,100 ohms ± 10%

**Deflection Yoke:**
- Horizontal: Inductance 1.3 millihenrys ± 10% @ 1000 c/s, D.C. Resistance approx. 15 ohms
- Vertical: Inductance 45 millihenrys ± 1000 c/s, D.C. Resistance 68 ohms ± 10%

The optical box is 8-1/2 x 8-1/2 x 9 in. and weighs 18-1/2 lbs. It contains the Schmidt optical elements - a concave mirror 6.7" in diameter having a curvature of 7-7/8" (200 mm), a plane mirror and a spherically corrector lens 4.5 inches in diameter. The plane mirror, which is mounted at a 45° angle to the concave mirror and a corrector lens fold the light beam, hence the description "folded Schmidt" system. There are no obstructions in the light path (with the obvious exception of the tube face itself) that intercept useful light. Clearance for the tube face is obtained by an elliptical hole in the 45° plane mirror. The light emitted from the tube face is gathered by the spherical corrector, reflected to the plane mirror and from there projected upwards through the spherical corrector lens.

The throw distance from the corrector lens to the viewing screen varies in accordance with the particular corrector lens used. These distances are as follows:

<table>
<thead>
<tr>
<th>Model</th>
<th>Picture Size</th>
<th>Throw Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>160A</td>
<td>16&quot; x 12&quot; square corners</td>
<td>32&quot; - 33&quot;</td>
</tr>
<tr>
<td>161A</td>
<td>18&quot; x 13 1/2&quot; rounded corners</td>
<td>23 1/8&quot; - 23 7/8&quot;</td>
</tr>
<tr>
<td>162A</td>
<td>32&quot; x 24&quot; to 48&quot; x 30&quot;</td>
<td>88 3/4&quot; - 91 1/4&quot;</td>
</tr>
</tbody>
</table>

The same Protelgram unit is used for the three Models, with the exception of the corrector lens in the optical box.

This light throw forms an elongated projected beam with a circular base of 4.5 in. diameter at the corrector lens and a rectangular base at the viewing screen. It can be "folded" in this path with another (larger) 45° plane mirror, near the top of the cabinet, or horizontal projection. The spherical corrector, the 45° plane mirror and the spherical corrector lens inside the optical box, are adjusted in the factory and remain in adjustment under normal use. No adjustments of the elements or of the corrector lens should be attempted.

The optical unit is dust-proof. Only the upper face of the corrector lens is exposed. This corrector lens is made from a special gelatin-in-water solution molded to a flat glass plate. This solution is shrunk, by controlled density and evaporation, to the correct shape. The lens is treated against fungus growth and atmospheric influences and then is chemically hardened. The corrector plate is covered with another glass plate so that it can be dusted with an ordinary cloth without being scratched. The linear magnification of the picture is 90. A numerical aperture of 3.62 is obtained with the "folded Schmidt" system.
HIGH VOLTAGE POWER SUPPLY (160B OR 160B-1)

This unit supplies the 25-kV required for the second-anode of the 3NP4 tube. It is small in size (8-1/2 in. high, 4-1/2 in. wide and 7 in. long); light in weight (5 lbs.), has great stability for optimum picture quality and causes no radio interference with its associated television receiver or with nearby television or radio receivers.

It consists of the following parts:

a) Cover
b) 2 tubes - 6966G 69ST
c) Sealed Can with 4 leads and H.V. lead and anode connector for 3NP4 tube
d) Chassis and circuit components (see drawing on page 10)

Two types of this unit are used; 160B or 160B-1. The performance characteristics are identical. However, in the model 160B-1, the negative side of the plate power input has been insulated from the chassis.

The sealed can contains 3 rectifier diodes, type EY51, a specially designed transformer using a new low-loss magnetic core material (Ferrosilicon) and high-voltage capacitors. Replacement of this can, if necessary, is a simple service operation.

DESCRIPTION OF THE CIRCUIT

The triode section of the 69ST tube operates as a conventional blocking oscillator, with frequency is 1000 ± 40 cycles. The saw-tooth voltage, which it generates, is applied between the control grid and cathode of the 6966G driver tube, which is beyond cutoff. The driver tube plate-current flows through a portion of the primary of the high-voltage transformer, in pulses corresponding to the saw-tooth peaks of the input signal. The top end of the primary is connected to the voltage tripler circuit. The peak voltage across the high-voltage winding is approximately 8.5 kV. Three indirectly heated rectifier tubes, which have been developed for pulse operation, are used in the voltage tripler circuit. The heat power is derived from individual windings on the high-voltage transformer. Because the transformer is self-resonant to approximately 25 k/µs, each 6000 cycle pulse will start a damped train of high voltage transient oscillations whose frequency is 25 k/µs and whose initial peak amplitude is approximately 8.5 kV. The amount of power supplied to the heaters of the rectifier tubes is determined by the frequency of the transformer. Therefore, in order to maintain the proper operating temperature on the rectifier heaters, the blocking oscillator frequency must be held to 1000 ± 40 cycles. A thinner condenser C1 which is accessible through a hole in the side of the chassis serves to adjust this frequency. This adjustment has no effect on H.V. amplitude, and should not be touched except when a frequency determining element requires replacing and then only with the proper equipment.

Automatic control of the driver tube bias, by means of a control voltage derived from the voltage peaks across the resonant circuit provides a most effective method of obtaining high power efficiency and good regulation. The control voltage is obtained from a separate winding on the high-voltage tripler transformer, and is rectified by the diode sections of the 69ST tube. The rectified control voltage is filtered by an network consisting of C6, C8, and R6, and then applied to the driver grid circuit across resistor R6. The use of this method of automatic voltage control of the driver tube provides a regulation characteristic which is substantially flat within the desired operating range.

The output voltage falls off very rapidly beyond this range. This is a very desirable feature for the viewpoint of protection against external short circuits. It also reduces the accidental shock hazard. Despite this, use extreme care when working on the high voltage circuits.

PROTEGGRAM TUBE INSTALLATION AND ADJUSTMENTS

ELECTRICAL ADJUSTMENTS

1. Properly tube test receiver to transmitted tube pattern. Look down into tube at pattern reflected from 45° mirror.
2. Adjust electrical controls of receiver to obtain normal and properly focused pattern on tube face as described in service notes.
3. Adjust size of pattern and center so that each corner just touches edge of tube face.
4. Look at viewing screen while making these adjustments.
5. Slightly loosen 6 "thumb-nuts" this is internal focus "O".
6. This is horizontal focus "H" look at edges of tube only and bring both sides into focus simultaneously.
7. This is vertical focus "V" look at top and bottom and bring both focus vertically.
8. Re-check "O" after adjusting "N" and "V".
9. Repeat 2, 3, and 5 if necessary.
10. Tighten 5 "nuts".
11. Adjust grid and vertical deflection with soft coat.
HOW TO INSTALL OR REPLACE THE 3NP4 PROJECTION TUBE

TUBE POSITIONING ADJUSTMENTS

The face of the 3NP4 tube is the first lens in the projection system. It must be positioned accurately to obtain satisfactory resolution.

Three thumbwheel adjustments "P", "H" and "R" are used for this purpose.

"P" moves the tube towards and away from the concave mirror.

"H" tilts the tube horizontally.

"R" tilts the tube vertically.

The chart above shows the recommended procedure for installing the tube and adjusting the positions of the tube in the optical box. Adequate accuracy can be obtained by following the steps shown.

1. Loosen the four nuts "P" which hold the tailpiece to the optical box.
2. Rotate the tailpiece to the left and right.
3. Pull-out the tailpiece.

Note: This operation should be done with care to prevent the tube from hitting the 45° plate mirror.

As a rule, it is essential to clear the anode cable.

1. Loosen the screws on the tube clamp and the screws which secure the tube in the triangular endplate.
2. A light shield and wingnut head are secured with the tube. Place the light shield over the top of the tube and place it in the top projection of the tube and hold it in place with the thumbwheel adjustment "P". The screw "D" must make good contact with the anode plug (black rubber) on the right side of the tube. Therefore, the spring must be kept clear of the light shield or placed under it.
3. Insert the tube through the deflection yoke, keeping the anode end "down".
4. Push the tube as far as it will go into the deflection yoke and tighten the screws in the tube clamp. To avoid breaking the neck of the tube, do not tighten the anode cable head or the deflection yoke.
5. Then tighten the screws in the tailpiece assembly keeping the neck of the tube in the center of the tube.

CAUTION: In this operation or in any subsequent operation, do not move the tailpiece assembly by grasping the deflection yoke.

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1. Now look at viewing screen. Loosen the two nuts "C" which hold the overall adjustment "D". Bring the center of the pattern to focus on the viewing screen by adjusting the head "P".
2. Adjust the electrical controls of the receiver as described in the service manual. Place the screen properly focused in the center of the tube so that each corner of the pattern just touches the edge of the tube face.
3. If the pattern is not level on the screen, it may be adjusted by a slight rotation of the tailpiece. Tilt the screen from nuts "R" and tighten after proper positioning of the tailpiece.
4. If the pattern is not properly centered in the viewing screen, then adjust the three tilt screws "R" after lowering the leveling screws, which should be re-tightened after adjustments have been made.

WARNING: Breakdown of the face plate of the tube by a 25 kv electron beam produces soft X-rays which are well shielded by the plastic optical box when the tube is in its normal operating position. Without this shielding, free radiation will result, prolonged exposure to which could prove harmful. Therefore, it is recommended that the tube be operated only inside the optical box.

(F) Look at the viewing screen while making the following adjustments. (Turn down contrast control on the receiver and look at the lines on a medium-bright raster).

1. Slightly loosen 2 nuts "L" and 3 screws "N".
2. Adjust the overall focus "H" and focus the center of the raster only.
3. Adjust the horizontal focus "R" so that both sides of the raster focus equally well.
4. Adjust the vertical focus "T" so that the top and bottom of the raster focus equally well.
5. Re-check overall adjustment. "P".
6. Repeat steps 2, 3, 4 and 5 if necessary.
7. Hand-tighten 2 nuts "L" and 3 screws "N".
8. Wipe-off any dust accumulation on the corrector lens with a soft rag.

Note: If a dust-shroud is used around the optical box, be sure that the shroud is fitted securely around the optical box and does not interfere with the light rays from the corrector lens.

SERVICING THE TAILPIECE (160AT-60) (160AT-61)

REPLACEMENT OF FOCUS COIL ASSEMBLY

1. Disconnect tube socket "A".
2. Disconnect anode connector "B" from tube cup.
3. Loosen 3 screws "C".
4. Gently remove 3NP4 tube.
5. Remove triangular plate "D" by unscrewing 3 screws "E".
6. Loosen cable clamp "F".
7. Loosen 2 mechanical centering adjustment screws "G".
8. Remove 2 snap washers "H" and spring "I".
9. Remove focus coil and replace with new one.
10. Adjust 2 screws "G" as follows:
   a) Completely assemble Proctelgram unit in the receiver. (See Tube Installation)
   b) Switch the receiver "ON" and tune to a transmitted pattern.
   c) Set both the horizontal and vertical centering controls on the receiver in the middle position of the total travel.
   d) Adjust the 2 screws "G" until the 4 corners of the transmitted pattern just touch the edge of the tube face.
   e) Make the total positioning adjustments as explained.

REPLACEMENT OF DEFLECTION YOKE

1. Remove 3NP4 tube and focus coil as described
2. Carefully note the mounting position of the yoke to be removed.
3. Unscrew 4 screws "F".
4. From opposite side of mounting plate remove the ground lug screw "IP".
5. Remove the plastic insulating disc "C".
6. Remove the deflection yoke and replace with a new one. The yoke must be positioned exactly as it was found.
7. Install the tube and make the tube positioning adjustments.

SERVICING THE OPTICAL BOX (160A-0) (161A-0) (162A-0)
The optical box contains the concave mirror, the 45° plane mirror and the aspherical corrector lens. These are optically aligned at the factory and adjustments should be attempted under any circumstances. Optical parts must be replaced at the factory.

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This is a dust-proof unit and the side plates should not be removed except in those cases when there is a need for cleaning. At a rule, this is not required. However, the unit may be used in places where dust or grease accumulation may be unusually severe. If, in such cases, the mirrors require cleaning, first remove dust and a can of the can's hair brush and then polish with lens tissue, such as is used for polishing eyeglasses. Where discoloration or dirt is excessive, apply a spray such as "Windex".

The top of the corrector lens should be cleaned with a soft cloth.

SERVICING THE HIGH VOLTAGE POWER SUPPLY (160B or 160B-1)

a) Cover
b) Tubes - 6BG6G
   6BH7
b) Seal with 4 leads and H.V. lead and Anode connector for 3NP4 tube
   d) Chassis and circuit components

WARNING:
This unit supplies the 25 kv required for the operation of the 3NP4 cathode-ray tube. Although it is a reduced-hazard, pulse type power supply, whose power -output capabilities are limited to the requirements of the 3NP4 tube, nevertheless, extreme care should be exercised while working on this unit.

REPLACEMENT OF SEALED CAN
1) Disconnect 4C line from socket.
2) Remove plate cap from 6BG6G tube.
3) Un solder 4 lead terminals at top of the can. Do not hold soldering iron to terminals any longer than necessary. Pin or unscrew gland "G" at top of can.
4) Remove bottom of chassis by removing 4 screws "S".

5) Loosen 2 nuts "N" on underside of chassis thus releasing 2 clamps "C".

6) Replace with new can.

7) Tighten nuts on underside of chassis holding 2 clamps "C".

8) Replace botton of chassis.

9) Solder 4 leads to terminals at top of can. Do not hold soldering irons to terminals any longer than necessary. (Note: Color Coding of leads - Components layout)

10) Place plate cap on 6B6G6 tube. (See Precaution #1 following).

SERVICING THE H.V. POWER SUPPLY

SERVICE PRECAUTIONS

1) When replacing the 6B6G6 tube, care must be taken to dress the 6B6G6 plate lead away from other connections and grounds. This should clear all objects by at least 1/4" to prevent corona discharge, as some radio interference may result.

2) When placing the cover on the high-voltage unit, make certain that it is not reversed. The 25-kv lead must go directly up through the cover and not cross over inside the box. Severe arcing and sparking may result if the cover is reversed.

HIGH-VOLTAGE SUPPLY SERVICE HINTS

In the interest of safety, testing of this unit should be conducted, as much as possible, with the power supply turned off. If the defective component cannot be located in this manner, operating voltage check should prove helpful. The high voltage supply schematics show the normal operating voltages obtained with a vacuum tube voltmeter. These check points are all accessible by removing the bottom cover of the unit, with slight care taken.

If failure occurs, first check the 6SN7 and the 6B6G6 tubes by replacing them. If this does not correct the difficulty, check to see that the blocking oscillator is functioning as evidenced by a bias of approximately 50 volts on the grid of the 6SN7 tube.

The following conditions could indicate failure of the sealed can:

- Reduced picture brightness
- Excessive sweep width and height
- No picture

"No picture" might also indicate action of the picture tube protection circuit.

As a check for can operation, the high-voltage output may be measured using a high-voltage probe such as the RCA-WG-268 30,000 volt probe and a "Voltoimyst" (Note: Use caution in this measurement).

SERVICING THE H.V. POWER SUPPLY

ADJUSTMENT OF THE HIGH-VOLTAGE SUPPLY OSCILLATOR

The frequency of the blocking oscillator in the high-voltage supply must be maintained at 1000 ± 70 cycles. Adjustment should not be necessary unless a frequency determining element such as the blocking oscillator transformer has been replaced or altered. The 1000 cycle adjustment has negligible effect on either the output voltage or current regulation and should not be tampered with in an attempt to rectify failure. Its only function is to provide the proper frequency which determines just the proper amount of power to the heater of the three high-voltage rectifier tubes inside the sealed can, to assure maximum life of these tubes.

Adjust C-1 with an oscilloscope and a dependable 1000 cycle generator. Sufficient blocking oscillator voltage can usually be obtained from the "B" + red lead to operate the vertical amplifier of the oscilloscope. If sufficient voltage cannot be obtained from the red lead to produce a signal on the oscilloscope, a resistor of about 10 ohms should be soldered in series with the red lead. An increased oscillator signal can be obtained from the H.V. supply side of the resistor. Be sure to remove this resistor after the frequency is set. With the 1000 cycle signal from the generator applied to the horizontal sweep amplifier of the oscilloscope, adjust C-1 until a single stable Lissajou figure is obtained.

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