

FIGURE 1

## INTRODUCTION

1. Although at first glance the tape recorder may appear to be a complicated instrument, closer inspection will show that it is neither as complicated mechanically as an automatic record changer nor as complicated electrically as a superheterodyne receiver.

2. Fundamentally, the art of a magnetic recording is old, dating from the last century. A magnetic recording consists of a varying degree of magnetization of any convenient form of signal carrier which can be magnetized and maintain the magnetized state, as well as being mechanically stable. In the SOUNDMIRROR, this material is a strong paper tape or ribbon, .248 inches wide maximum, on which a magnetic coating has been applied.

3. This paper tape is moved at a fixed rate of speed through a magnetic field which acts on this coating to produce a record in the form of the different amounts of magnetization. In the playback process the tape is moved at the same rate of speed past a pickup coil; a voltage proportional to the magnetization is generated in the pickup coil and is amplified in a conventional amplifier so that it may be reproduced through a speaker.

4. Much as the grid bias is used in a vacuum tube, a bias current is mixed with the signal current when a recording is made. In the BK401, a 30 KC bias having an amplitude of approximately twice that of the peak amplitude of the signal current is used. It is very important that this bias

be present, since its absence will cause a distorted recording which cannot be corrected.

5. A magnetic recording is unique in that the recording material is not physically or mechanically changed in the recording or playback processes. For this reason, the recording may be played back many times, or erased by a demagnetization process so that the tape may be used countless times for recordings. This erasing process is similar to the recording and consists of recording, with the bias only, at such a high level that all previous information on the tape is cancelled out and the average magnetic state of the tape is as it was before any recording was made on it. Anything which interferes with this high power bias will result in incomplete erasing.

6. The erase head is so placed on the recorder that the tape passes through it before the recording head. Erasure takes place automatically as recording occurs so that no special step is necessary. As will be noted in the operating instructions, the procedure for setting the unit for the erase-record processes is such that a recording will not be inadvertently erased.

7. As this unit employs motors and vacuum tubes, a considerable amount of heat is generated within the unit; therefore, in order to provide sufficient ventilation, the unit should be placed no closer than six inches from the nearest wall and should never be operated on top of a radiator or near a warm-air outlet.

Manufactured by THE BRUSH DEVELOPMENT COMPANY, 3405 Perkins Ave., Cleveland 14, Ohio

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## OPERATING INSTRUCTIONS

1. The Brush BK401 SOUNDMIRROR is designed to operate from 105-120 volts, 60 cycle AC. If 50-cycle current is the only power available, the BK 401-1 should be used. The BK401-1 is designed for 50-cycle operation and makes recordings which may be interchanged with those of the BK401. Radio servicemen can supply a converter for operation from DC power, or a transformer for operation from line voltages other than 105-120 volts.

*Do not connect the unit to a DC power source or to other supply voltages unless the unit is adapted as described above.*

### Recording

2. To prepare the SOUNDMIRROR for recording:

- (a) Insert the line cord plug into a convenient wall receptacle of the proper rating.
- (b) Turn the power switch (93) to the "ON" position.
- (c) Place a full reel of tape on the supply reel turntable (128) so that the tape will feed from the reel as indicated by the arrow on the panel.
- (d) Place an empty reel on the take-up reel turntable (137) and feed the end of the tape up through one of the radial slots in the reel. Hold the end of the tape and rotate the reel in a counterclockwise direction four or five revolutions. The tape should now be firmly fastened to the take-up reel. The black coating of the tape should face inward on the supply reel and outward on the take-up reel.
- (e) Hold the take-up reel and pull a sufficient amount of tape from the supply reel to go through the heads (98), around the capstan (144), and past the forward limit switch (96). Follow the arrows on the panel. The black coating of the tape should bear against the pole pieces of the two heads (98).
- (f) Turn the Record-Play switch (94) to the record position.
- (g) If a microphone recording is to be made, connect the Brush model BA-106 crystal microphone which is supplied with the unit, to the microphone jack (138).
- (h) If a recording from a radio receiver is desired, it is recommended that the detector circuit of the radio be connected to the radio input terminals on the back of the SOUNDMIRROR. It is possible to make this connection across the radio speaker voice coil, but this will reflect any audio circuit deficiencies present in the radio.
- (i) Depress the Record pushbutton (97E) and adjust the signal level, by means of the Record Volume Control (41), until the indicating tube (4) almost closes on peak passages.
- (j) Depress both the Record (97E) and the Forward (97A) pushbuttons so that both lock in the depressed position.
- (k) Momentarily depress the Start pushbutton (97C) to start the drive mechanism and begin the recording.
- (l) The Stop pushbutton (97D) is used to stop the recording process.

### To Rewind

3. (a) Fasten the tape to the supply reel (101) by feeding the end of the tape up through one of the radial slots in the reel and holding the end while rotating the reel for four or five revolutions in a counterclockwise direction. The tape should now be firmly fastened to the supply reel, and the black-coated surface should be toward the center of the supply reel.
- (b) Place the tape in the slot of the Reverse Limit switch (95). This switch controls the dynamic braking ap-

plied upon completion of the rewinding or if the tape should break.

- (c) Depress the Reverse pushbutton (97B). The tape will now completely rewind and automatically stop when the rewinding is complete. If desired, the operator may stop at any point by depressing the Stop pushbutton (97D).

*Never attempt to stop fast-moving reels by hand.*

### To Play a Recording

4. (a) Insert the line cord plug into a convenient wall receptacle of the proper rating.
- (b) Turn the power switch (93) to the "ON" position.
- (c) Place the reel containing the desired recording on the supply reel, or left hand, turntable so that the tape will feed from the reel as indicated by the arrow on the panel.
- (d) Place an empty reel on the take-up reel, or right hand, turntable and feed the end of the tape up through one of the radial slots in the take-up reel. Hold the end of the tape and rotate the take-up reel in a counterclockwise direction four or five revolutions. The tape should now be firmly fastened to the take-up reel. The black coating should face inward on the supply reel and outward on the take-up reel.
- (e) Hold the take-up reel and pull a sufficient amount of tape from the supply reel to go through the heads (98), around the capstan (144), and past the Forward switch (96). Follow the arrows on the panel. The black coating of the tape should bear against the pole pieces of the two heads (98).
- (f) Turn the Record-Play switch (94) to the "Play" position.
- (g) Depress the Forward pushbutton (97A).
- (h) Momentarily depress the Start pushbutton (97C) to start the drive mechanism.
- (i) Adjust the volume by means of the Play Volume control (40), and the tone by the tone control (42).
- (j) The Stop pushbutton (97D) is used to stop the SOUNDMIRROR when playing a record; however, the unit will automatically stop upon completion of a record or in case the tape should break.

### To Start Playback at Advanced Position

5. If it is desired to begin to play a recording at an advanced position on the reel, or to skip a portion of a reel, it may be done by allowing the tape to wind directly from the supply reel to the take-up reel. When the heads and capstan are thus bypassed, the tape will wind at a high rate of speed. The Forward pushbutton (97A) is depressed and the Start pushbutton (97C) held down until the approximate position is reached. Braking is provided by pushing the Reverse pushbutton (97B). After the reels have come to a stop, the Stop pushbutton (97D) should be pressed to relieve the brake. Never attempt to stop fast-moving reels by hand.

It is suggested that colored Scotch tape be used to mark the tape to show the desired divisions or passages.

### To Repair or Splice Tape

6. In case the tape is broken accidentally, or it is desired to edit the recording, a splice may be made with Scotch tape. Do not use medical adhesive tape as the adhesive material is not suited for this purpose. The Scotch tape should be applied to the reverse, or uncoated, side of the recording tape. The edges of the splice should be trimmed with a small pair of scissors, or a knife, to bring the width of the splice to that of the rest of the recording tape so it will pass through the heads without interference.



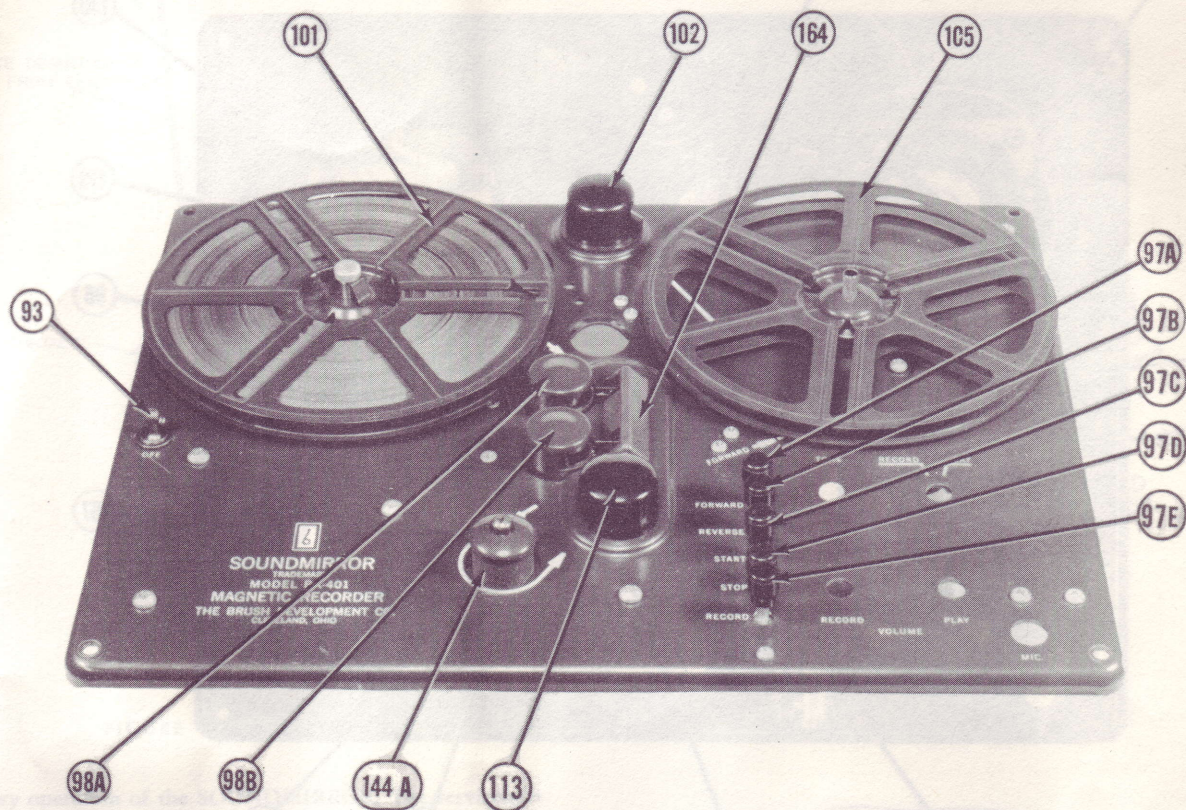


FIGURE 2—PANEL TOP VIEW WITH AMPLIFIER UNIT REMOVED

## MECHANICAL OPERATION AND ADJUSTMENT

1. The function of the mechanical section of the SOUND-MIRROR is to deliver the tape at a uniform rate of speed past the erase and record-reproduce heads. It also provides reels for convenient handling of the lengthy tape and a means of rewinding the tape. In order to insure that the proper rate of speed be maintained, it may be necessary to make some of the adjustments outlined in the following.

### Supply Reel Brake

2. This brake applies friction to the supply turntable so that, during recording or playback, a tension is maintained on the tape between the supply reel and the heads. The tension is necessary to prevent the tape from being supplied faster than it passes through the heads. If it is insufficient, the tape will spill and tangle; if it is excessive, the rate of speed of the tape will be too slow and uneven. The brake pressure is adjusted by bending the body of the spring brake (126). The force necessary to rotate the supply reel should be from .75 to 1.0 inch-ounces. It may be measured by winding from ten to twelve turns of a short length of tape around an empty reel. Place the reel on the supply shaft and use a small scale (spring balance) fastened to the end of the tape to measure the force.

3. If the felt pads become loosened from the metal, it will be necessary to replace the entire brake assembly. These pads are secured with a special cement and are not replaceable in the field.

### Limit Switches

4. The purpose of the Forward Limit switch (96) is to automatically bring the unit to a stop upon the completion of a reel, or accidental breaking of the tape, when recording or playing a record. The Reverse Limit switch (95)

serves to automatically halt the unit when a reel has finished rewinding or if the tape should accidentally break during rewinding. Failure of the Limit switches to function properly will result in tape spillage and may interfere with the tape travel. If either Limit switch is loosened or removed, it will be necessary to check and readjust it when remounting.

5. Fig. 4 shows the proper adjustment of either Limit switch with the small roller spring removed. Note that the main reed is not straight, but angles slightly from the body of the switch. The contacts should be barely touching, as shown, and will be held open when the roller spring is in place. The Forward Limit switch should act when the reed is  $\frac{1}{8}$ " from the end of its travel in either opening or closing directions. The Reverse Limit switch should be adjusted to act as the point shown in Fig. 6. A maximum pressure of 14 grams (approximately  $\frac{1}{2}$  ounce) should be required to bring the switch over its null point, and a minimum of 4 grams (approximately  $\frac{1}{7}$  ounce) to hold, as measured at point where the actuator contacts the reed. Adjustment of either Limit switch is accomplished by loosening the screws which hold the switch to the panel and repositioning on the panel. All adjustments should be made when the switches are cool to minimize temperature effects. If the roller spring is removed, it should be replaced in exactly the same position as it was, on the mounting bracket side of the switch and with the convex side of the spring away from the reed and toward the mounting bracket. The amount of overtravel should be checked to see that it is not great enough to reopen the switch contacts.

6. The Limit switch actuators should be carefully adjusted so that the tape rides on the Limit switch cover when in motion. The tape should carry the actuator until, at the end of the actuator travel, the actuator is inside the cover and prevented from coming out by the tape. In some cases, it may



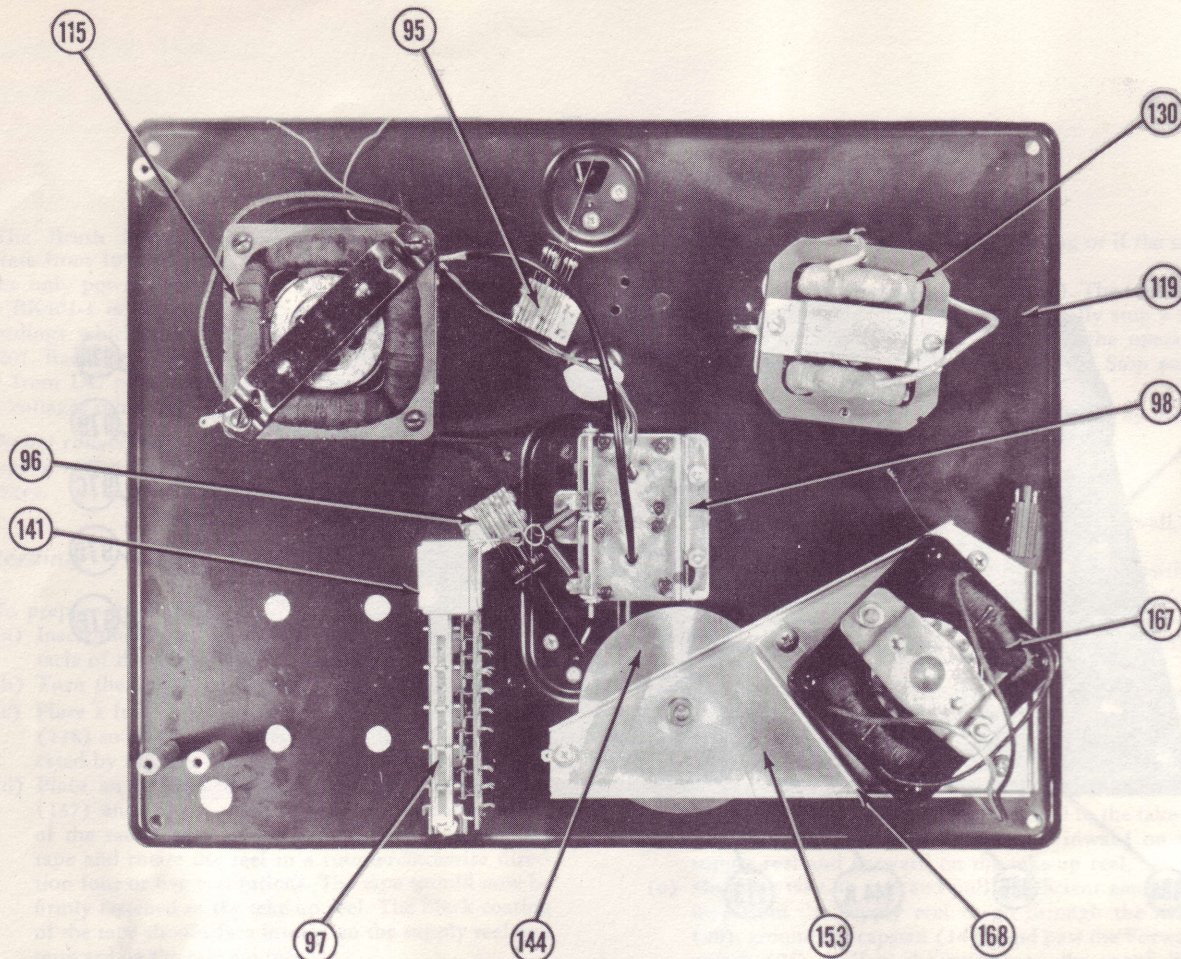


FIGURE 3—PANEL BOTTOM VIEW WITH AMPLIFIER UNIT REMOVED

be necessary to clear the paint from the actuator pivot holes to allow the actuator to move freely. If the Forward switch actuator is not properly adjusted, it may cause flutter and distortion. This is caused as the actuator chatters and repeatedly pushes against the tape, causing speed variation. In extreme cases the switch may chatter enough to interrupt the motor circuits. Proper adjustment of the actuator is such that it contacts the tape at enough of an angle to insure rapid and sure action. If the actuator meets the tape at an angle too near  $90^\circ$ , it may cause chatter.

7. If the tape does not freely enter the Reverse Limit switch guide, when rewinding, it may be necessary to remove burrs from the edge of the guide. The Limit switch covers are not interchangeable and if the covers are removed, they should be replaced in their proper position. If the Forward cover is used in the reverse position, the tape will not enter the reverse guide.

### Head Brakes

8. The erase and record-reproduce head brakes (133, 134) have a two-fold purpose. They keep the tape in proper contact with the heads and also keep a constant pressure against the tape to aid in maintaining the constant rate of tape travel. If the head brake pressure is insufficient, poor recording or playback will result because the tape will not be in proper contact with the head pole pieces. The speed of the tape will be uneven and too rapid. If the pressure is excessive, the tape speed will be slow and uneven. The head brake adjustment is illustrated in Fig. 5. The total pressure is adjusted by bending the actuating lug which extends from the bell crank assembly (141) and receives the pressure from the staff of the Forward pushbutton. Bending the lug away from the pushbutton staff decreases the pressure, and toward it increases the pressure. It is important to note that this regulates the *total* pressure applied to both heads. The portion of this total that is applied to either head is adjusted by carefully

bending the bell crank arm. Bending the bell crank arm toward the erase head increases the erase head brake pressure and vice versa. The proper adjustment is such that each head brake receives exactly one-half of the total pressure. If additional adjustment is necessary, it may be obtained by bending the lower arm of either head brake toward or away from the bell crank. Bending it away from the bell crank will increase pressure. The total head brake pressure should be from 1.5 to 2.0 ounces and may be measured with a small scale (spring balance) fastened to the end of a short section of tape pulled through the heads.

9. If the felt brake pad of either head brake becomes loose, it will be necessary to replace the complete brake shoe assembly (133 or 134). The felt pads are fastened with a special cement and are not replaceable in the field.

10. The most common cause of the head brakes failing to retract when the stop pushbutton (97D) is depressed, is interference with the underpanel wiring. This is easily corrected by rearrangement of the wiring. This same condition may not allow the brakes to properly contact the heads. Other causes of poor head brake operation are: Interference with the edge of the panel, which is corrected by repositioning the head assembly (98); interference with the head cover (98A or 98B), which is corrected by changing the angle of the shoe; and binding at the pivot, which is remedied by adjusting the end play in the bracket. If the angle of the shoe is to be changed, the brake assembly must be removed from the bracket before bending. After bending and replacing, the assembly must be adjusted for proper pressure. The end play in the bracket is controlled by the end play washer (127A) which may be removed or replaced with a washer of different thickness if necessary.

### Drive Assembly

11. The drive assembly is illustrated in Fig. 7. The proper operation of this mechanism is extremely important to satis-



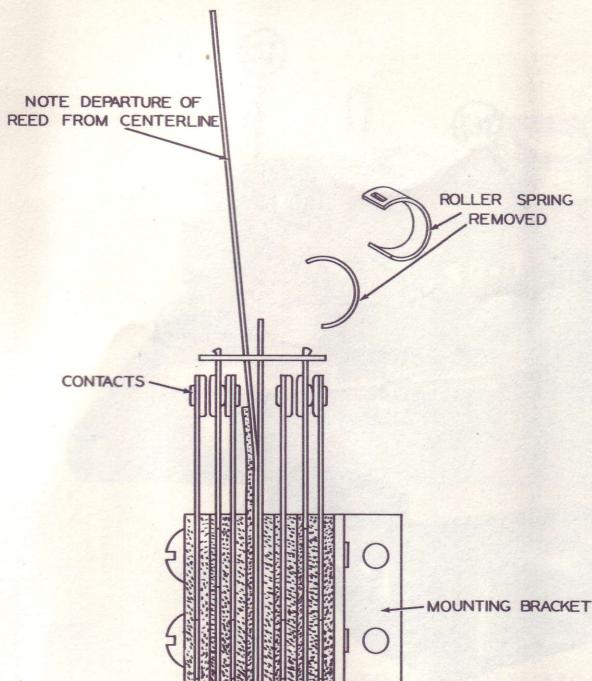


FIGURE 4—LIMIT SWITCH

factory operation of the SOUNDMIRROR. The serviceman is advised not to attempt any major repair of this assembly, but to replace it as a unit. This is because of the many points in the assembly which might cause speed variation in the SOUNDMIRROR and result in distortion. Correct tape speed is 7.5 inches  $\pm$  2% per second.

12. The bearing felts of the drive motor (167) should be lubricated with light oil. The idler wheel (147) bearing should be lubricated sparingly with Lubriplate No. 105, as should the interface of the idler wheel adjustment washer (146). The upper surface of the capstan felt washer (156) should be coated with Beacon No. 285 grease. Extreme care should be taken to prevent oil or grease from contacting any of the drive surfaces, which include the drive motor (167) shaft, sometimes covered with a drive spring (161); the rubber tire of the idler wheel; the outer circumference of the capstan flywheel (144); and the Corprene surface (144A) of the capstan. These surfaces should not be touched after cleaning to prevent finger printing. Carbon tetrachloride is recommended as a cleaning solvent. The Corprene surface of the capstan is best cleaned when it is in motion without tape. This may be done by depressing the forward and start pushbuttons at the same time and allowing the capstan to rotate as the cleaning cloth is applied. In extreme cases, crocus cloth may be used to smooth the surface.

13. The idler wheel tension adjustment nut (158) should be adjusted so that there is barely perceptible friction between the idler wheel mounting bracket (155) and the drive assembly plate (153). The idler wheel tension adjustment spring position is critical since misplacement will cause it to interfere with the idler wheel. When replacing this spring, it should be connected to the hook on the idler wheel mounting bracket (155) first and given one turn clockwise before connecting to the lug (157A). The tension on the idler wheel should be 3 ounces.

14. If the SOUNDMIRROR has been out of operation for some time, the rubber tire of the idler wheel (147) may acquire a permanent set, or flat spot, at the point of contact with the drive motor and capstan. This condition may usually be relieved by running the unit for one-half hour or more. If this is not effective, the idler wheel should be replaced.

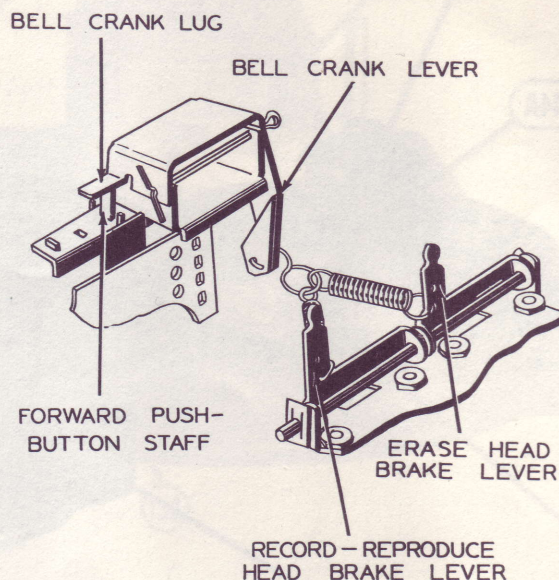


FIGURE 5—HEAD BRAKE

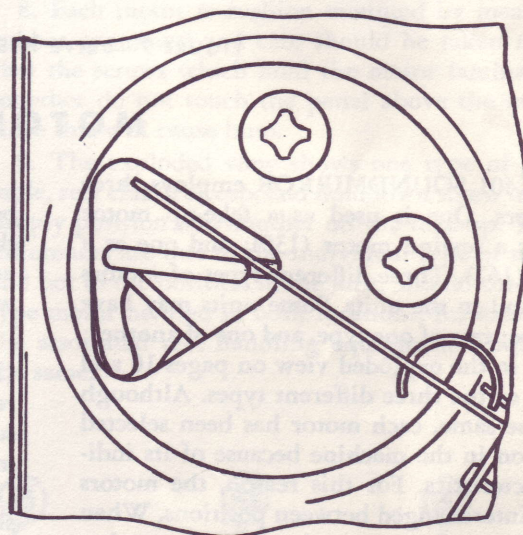


FIGURE 6—REVERSE LIMIT SWITCH

15. In removing the drive assembly for servicing or replacement, it will be found that it is more convenient to remove the plate mounting screws (160) on the underside of the assembly than it is to remove those holding it to the main panel.

#### Pushbutton Assembly

16. A standard latching type five-station pushbutton switch (97) is used. Care must be taken to see that the connecting leads do not place the terminal strip of the switch in a strain because this will cause poor contact and may even allow a contact to drop from the switch. All stations except the Start (97C) latch when depressed. If they fail to do so, it may be necessary to file the latching cam of the offending station so that it will engage the latching bar. If the switch is in poor condition, it should be replaced as a unit.



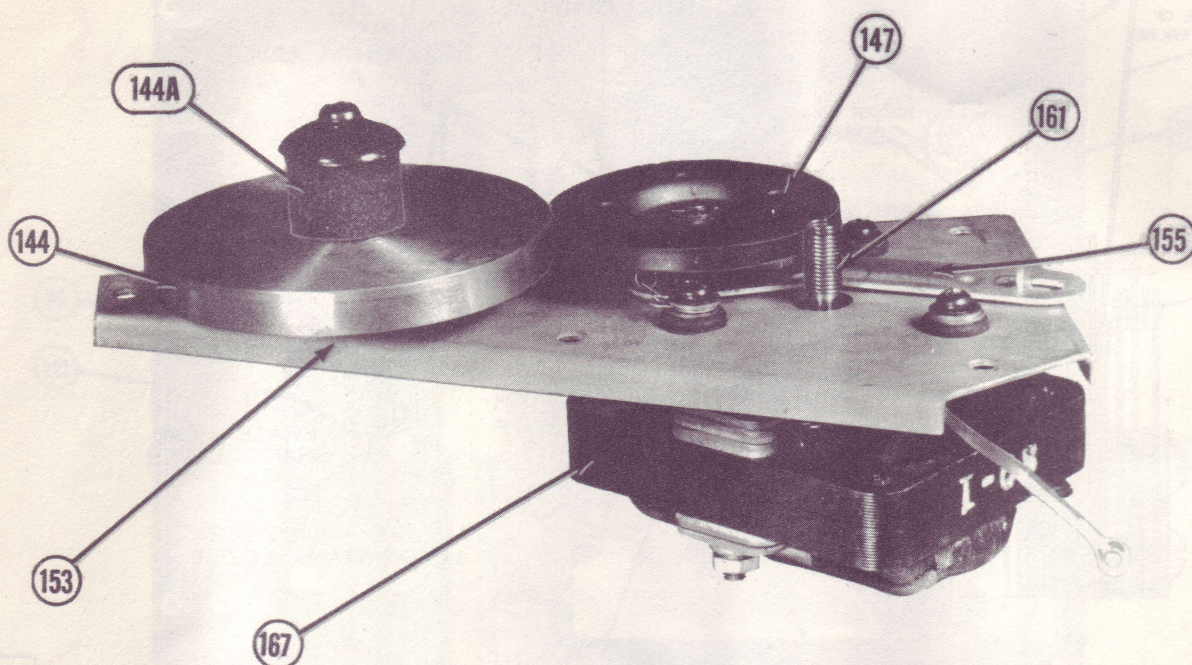


FIGURE 7—DRIVE ASSEMBLY UNIT

## MOTORS

1. The BK401 SOUNDMIRROR employs three electric motors. One is used as a take-up motor (115); one as a rewind motor (130); and one as a drive motor (167). Three different types of motors are to be found in the units. Some units may have all of one type; two of one type, and one of another; or, as shown in the exploded view on pages 10 and 11, one each of the three different types. Although nominally the same, each motor has been selected for its position in the machine because of its individual characteristics. For this reason, the motors must not be interchanged between positions. When ordering replacement motors give the part number of the motor as identified from the exploded view (Fig. 12) as well as the position of the motor in the machine. The motor shown in the exploded view as a take-up motor (115), is a part No. 300345; the one shown as a rewind motor (130) is a part No. 204927; and the one shown as a drive motor (167) is a part No. 201404. Remember that they may appear in different positions in other units.

2. The bearing felts of each motor should be lubricated with light oil, being careful not to get oil on the drive or brake surfaces of the unit. In some cases the motor bearings become misaligned in shipping or due to rough handling. They may usually be realigned by grasping the motor shaft and turning it while pulling upward. In extreme cases, it may be necessary to run the motor without a load for five or six hours to free up the bearings.

3. If a motor is found whose shaft has become bent because of rough handling, it is recommended that the entire motor be replaced. This condition usually causes the rotor to drag on the stator and will cause speed variation.

4. Some drive motors (167) have a drive spring (161) on their shaft. This spring should not be removed since it is not readily replaceable and is supplied when necessary as an integral part of the motor. Some drive motors require a hum shield (168). When replacing these motors be sure that the shield does not touch the motor laminations, and position the shield for lowest hum level in the amplifier. It may be found that the take-up motor touches the pre-amplifier chassis and causes severe hum. In this case the offending corner of the motor frame or oil retainer bar should be cut or filed to clear.

5. Misadjustment of the unit's several friction brakes, accumulation of dirt or tape coating on the capstan or limit switch, or oil or grease on the drive surfaces will all tend to make the operator think that he has one or more weak or defective motors. All these points should be checked before passing judgment on a motor.

6. Since the take-up motor (115) runs at greatly reduced speed during the recording and playback processes, it is normal that this motor become very warm. It is of a type designed to operate at high



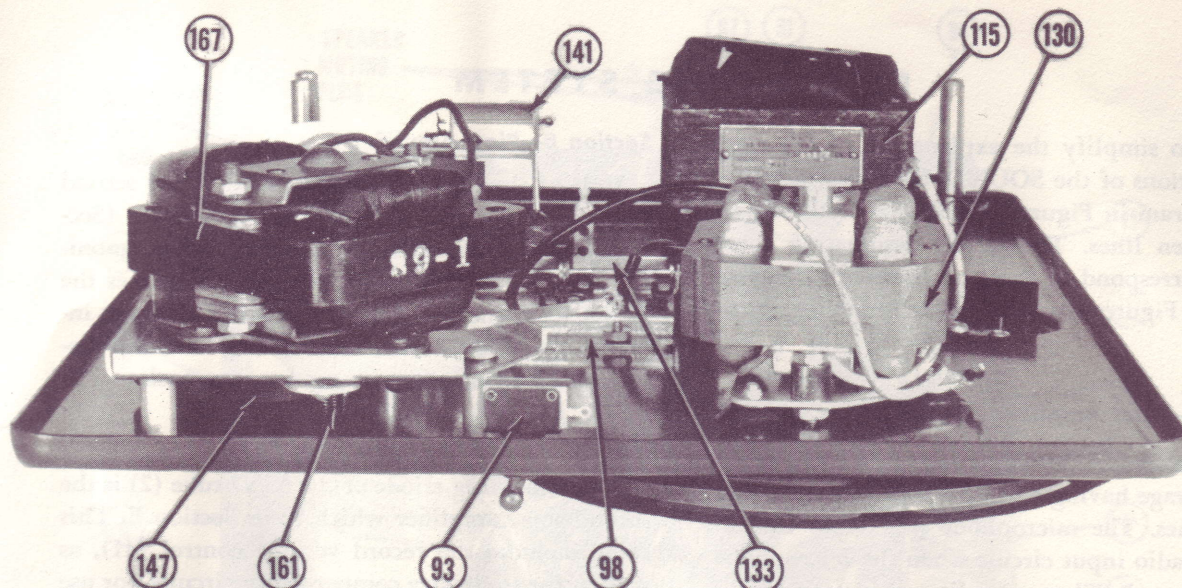


FIGURE 8—BOTTOM VIEW FROM LEFT SIDE AMPLIFIER UNIT REMOVAL

temperatures and will suffer no ill effects. The take-up reel (105) is mounted directly on the shaft of the take-up motor and will become quite warm for that reason during extended operation of the SOUND-MIRROR. This will in no way injure the tape or the reel.

7. Distortion may be caused by irregular torque of the take-up motor (115). This effect is generally caused by insufficient skew in the rotor laminations and appears only at the low speed at which this motor operates during the recording and playback processes. It may be detected by grasping the motor shaft, turning the motor on by depressing both the forward (97A) and start (97C) pushbuttons, and feeling the force needed to slowly turn the motor against its torque. This necessary force should be

smooth and regular. If a "cogging" effect, or regular variation in force, is noted, the motor must be replaced.

8. Each motor is cushion mounted by means of rubber grommets and care should be taken to see that the screws which hold the motor laminations together do not touch the panel above the motor, since this will cause hum.

9. The exploded view shows one type of turntable, reel clamp or cap, and holddown screw on the supply position and another on the take-up. These differences are due to the individual type of motor and not to the position in the unit. Should the same type motor be used in both locations, for example, the associated reel handling equipment would be the same.

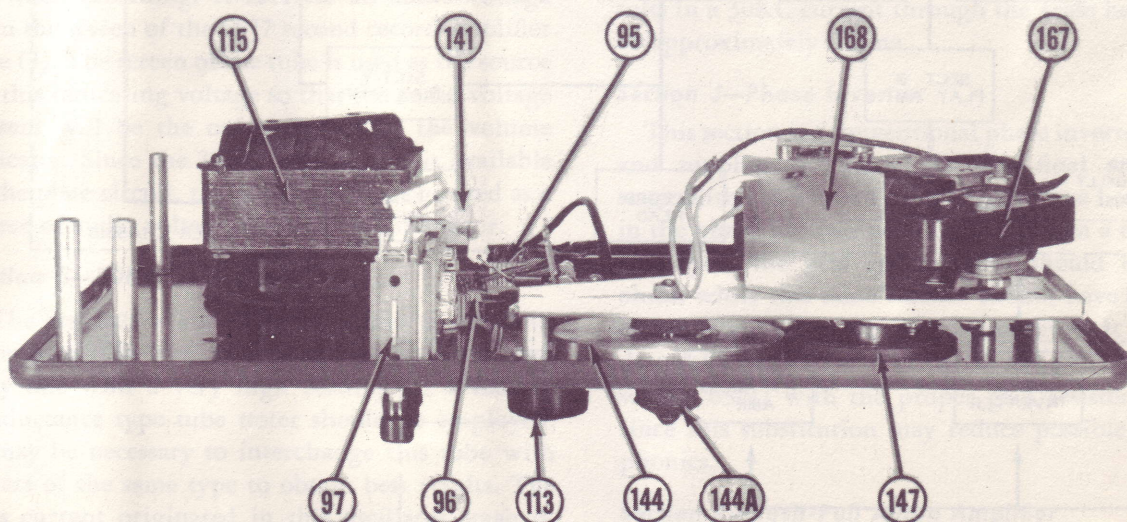


FIGURE 9—BOTTOM VIEW FROM FRONT AMPLIFIER UNIT REMOVAL



## ELECTRONIC SYSTEM

In order to simplify the explanation of the electronic portions of the SOUNDMIRROR, the schematic diagram in Figure 13 has been sectionalized with broken lines. The letters designating these sections correspond to those on the block diagram shown in Figure 10 and to the following paragraphs.

### Section A—Input Amplifier

This section uses the 6SJ7 tube (1) as a high-gain amplifier stage having a grid-to-plate gain in excess of 100 times. The microphone jack (138) disconnects the radio input circuit when the microphone plug is inserted. When recording, this stage amplifies the signal from microphone or radio inputs, and when playing back it amplifies the signal from the play head.

It is possible that the high-gain of this stage may cause it to rectify a signal from a near-by powerful broadcast station, mixing it with the desired audio signal. If this condition should exist, it may be corrected by connecting a 500 mmf. mica capacitor between the grid and the cathode terminals on the 6SJ7 (1). This connection must be made directly at the tube socket terminals. Also, connect a 500 mmf. mica capacitor between the cathode terminal of the 6SJ7 and the chassis ground. This connection should be made as close as possible to the tube socket terminal.

### Section B—Play Amplifier

Half of the 6SN7 tube (2) is used as the second stage amplifier and feeds the phase inverter (Section J). When recording, this stage serves as a monitor amplifier. When playing back, it amplifies the signal from the recording medium. This stage includes the play volume control (40) and the frequency compensating circuits for play back

### Section C—First Record Amplifier

The remaining triode of the 6SN7 tube (2) is the second stage amplifier which feeds Section E. This stage includes the record volume control (41), as well as the frequency compensating circuits, for use in the recording action.

### Section E—Second Record Amplifier

This is the final stage used during recording and employs a 6SJ7 tube (3). During recording, it supplies the audio signal to the record-reproduce head through the audio coupling capacitor (25). The 30KC bias current is introduced in this stage. It is impressed across the plate circuit of the 6SJ7 through the coupling capacitor (22), and results in a current through the recording head coil, which is a mixture (not a modulation) of the 30KC bias current and the audio frequency which is being recorded.

The 30KC potential across the recording head

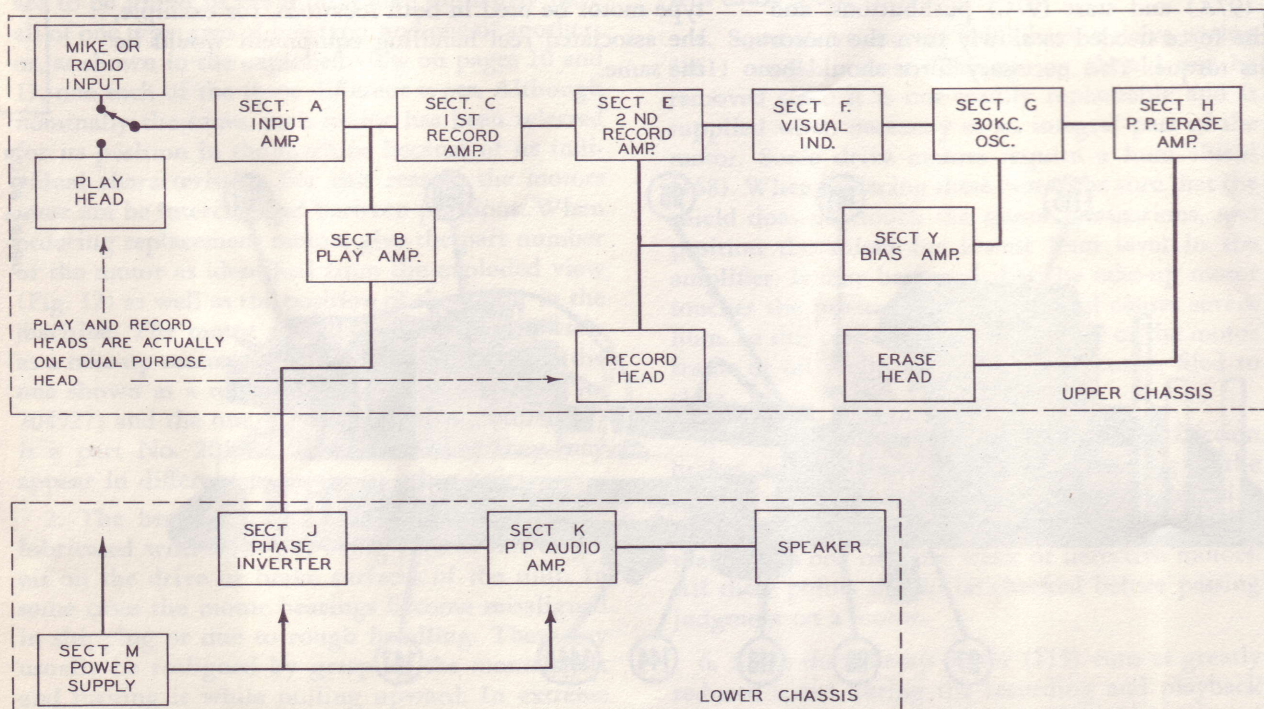


FIGURE 10—BLOCK DIAGRAM ELECTRICAL SYSTEM



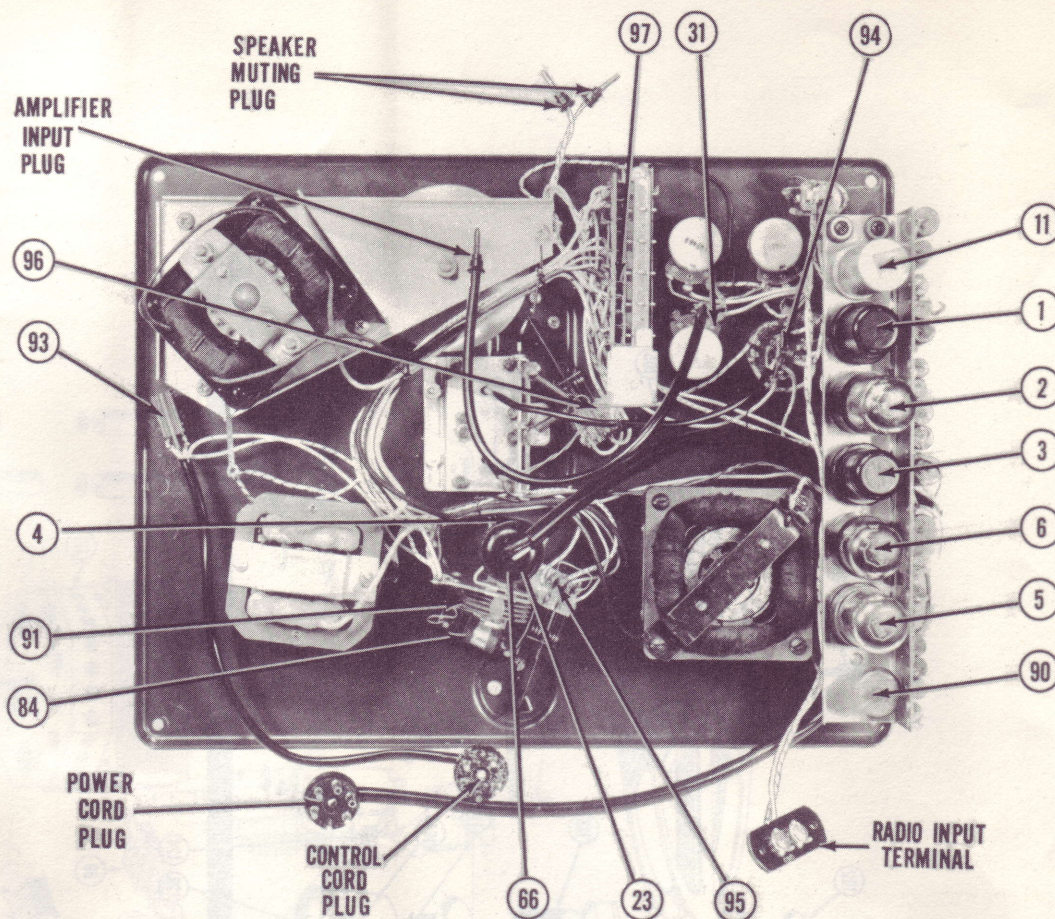


FIGURE 11—PANEL BOTTOM VIEW

should range from 60 to 100 volts, as measured with an AC vacuum-tube voltmeter having a minimum input impedance of 10 megohms.

#### Section F—Visual Recording Indicator

A type 6E5 tube (4) is used as the volume indicator when recording. It receives an audio voltage from the screen of the 6SJ7 second record amplifier tube (3). The screen of the tube is used as the source for this indicating voltage so that the audio voltage present will be the only actuator of the volume indicator. Since the 30KC bias current is available in the plate circuit, the plate could not be used as a source of audio voltage alone for the indicator.

#### Section G—30KC Oscillator

The first half of the 6SN7 (5) is used as the oscillator tube. The quality of this tube is critical and only one with a very high reading on a mutual conductance type tube tester should be employed. It may be necessary to interchange this tube with others of the same type to obtain best results. The bias current originated in this oscillator stage is, after proper amplification, used for the erasure as well as the recording bias.

#### Section H—Push-Pull Erase Amplifier

The two triodes of the type 6SN7 tube (6) are connected to form a push-pull amplifier which receives its driving signal from Section G. During the recording operation, the plate-to-plate potential in this stage ranges between 80 and 100 volts and results in a 30KC current through the erase head coil of approximately 20 ma.

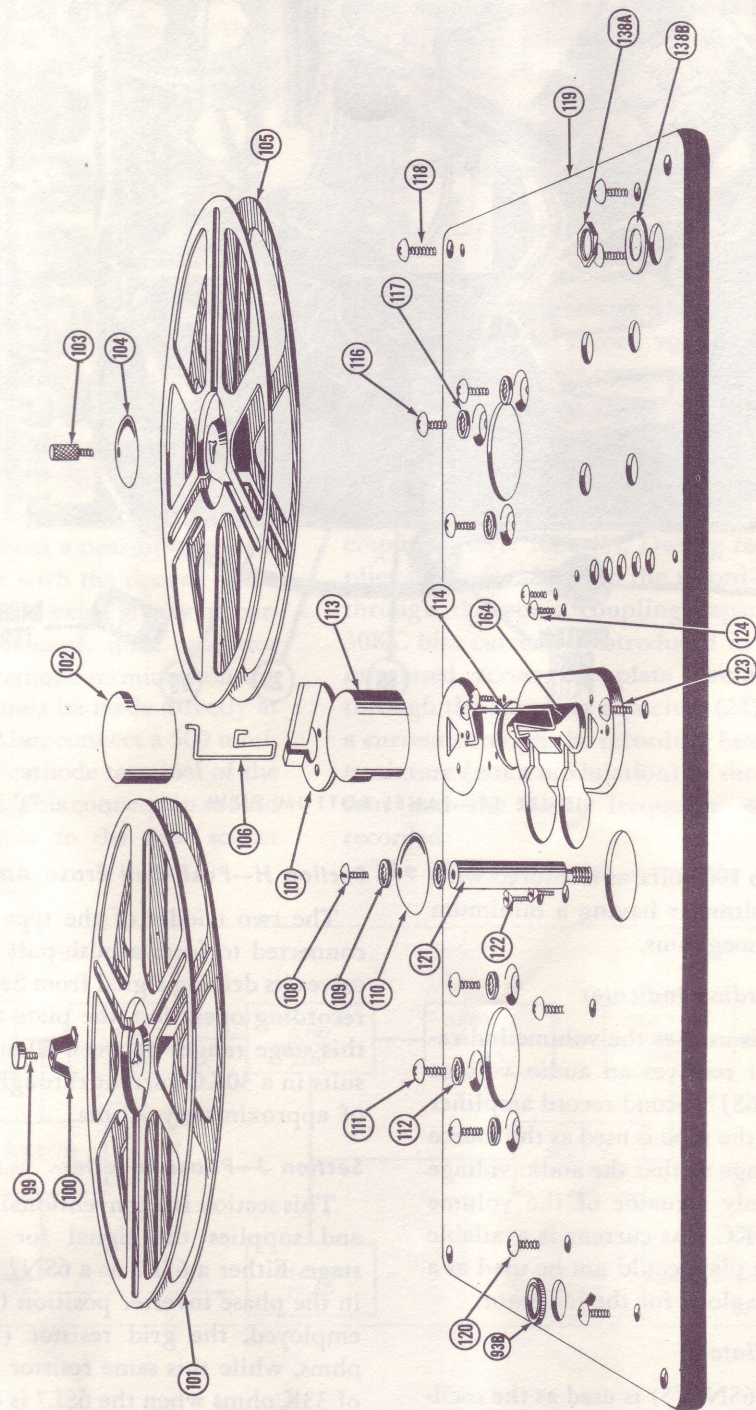
#### Section J—Phase Inverter

This section is a conventional phase inverter stage and supplies the signal for the final amplifier stage. Either a 6SL7 or a 6SN7 may have been used in the phase inverter position (7). When a 6SN7 is employed, the grid resistor (80) should be 22K ohms, while this same resistor should have a value of 33K ohms when the 6SL7 is employed. It may be desirable in equipment using the 6SL7 to replace it with a 6SN7 with the proper grid resistor value, since this substitution may reduce possible microphonics.

#### Section K—Push-Pull Audio Amplifier

A type 6SN7 tube (8) is used in a conventional Class "A" push-pull audio amplifier output stage.

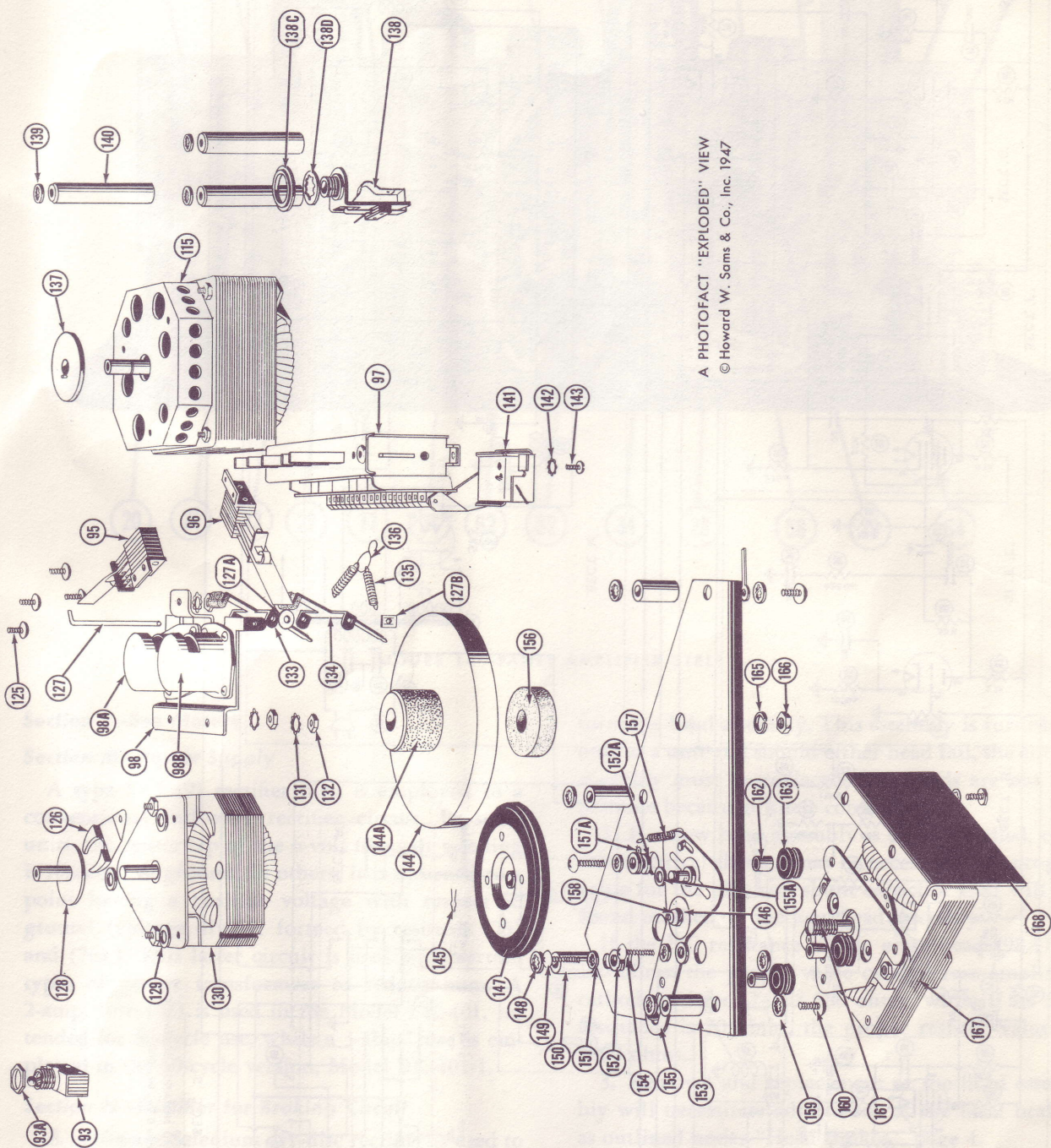




Class "A" push-pull audio amplifier output stage. A type 6SN7 tube (8) is used in a conventional Section K—Push-Pull Audio Amplifier

The first half of the 6SN7 is used as the push-pull tube. The quality of the tube is critical and only one with a very high reading on a vacuum tube tester should be employed. It may be necessary to interchange the tube with others of the same type to obtain best results. The bias current originated in this oscillator stage is first proper amplification, used for the entire as well as the recording bias.





A PHOTOFACT "EXPLODED" VIEW  
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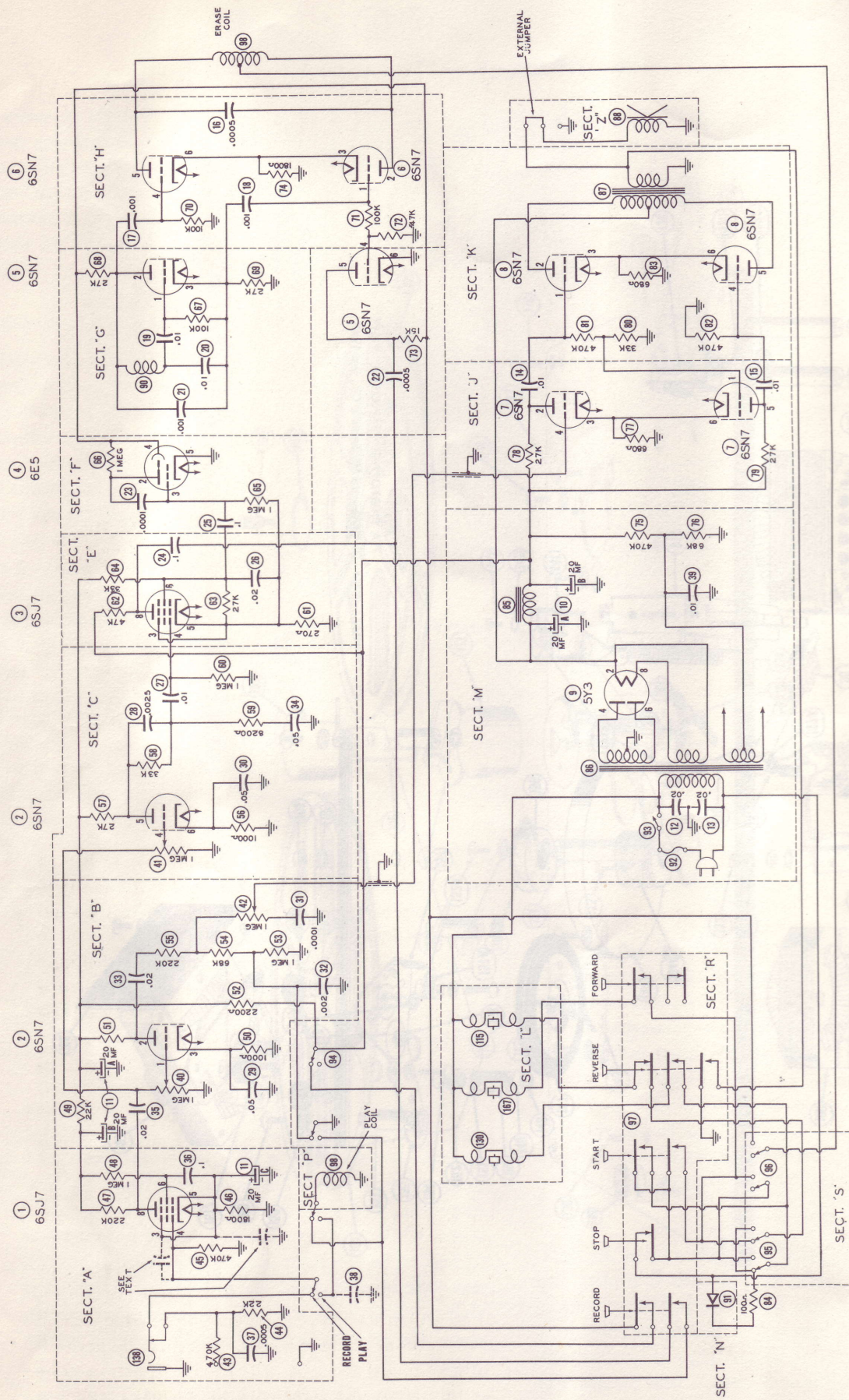


FIGURE 13

A PHOTOFACT STANDARD NOTATION SCHEMATIC  
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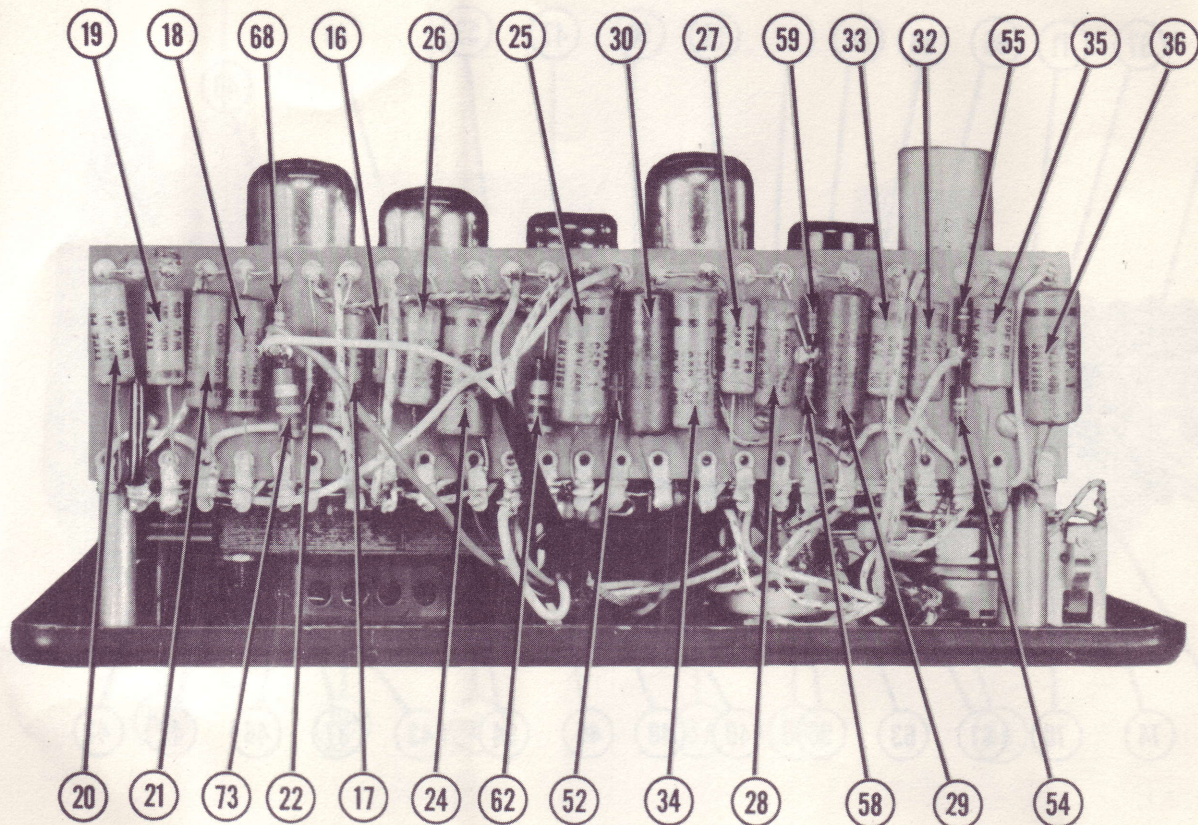


FIGURE 14—PANEL AMPLIFIER STRIP

#### Section L—See Motors

#### Section M—Power Supply

A type 5Y3 (9) rectifier tube is employed in a conventional full-wave rectifier circuit. In some units, the center tap of the 6-volt filament winding is returned to ground; in others, it is returned to a point having a positive voltage with respect to ground (voltage divider formed by resistors (75) and (76)). This latter circuit is used with certain types of power transformers to reduce hum. A 2-amp. fuse (92) is used in the Model BK-401, intended for 60-cycle use, while a 3-amp. fuse is employed in the 50-cycle version, Model BK-401-1.

#### Section N—Rectifier for Braking Circuit

A half-wave Selenium dry-disc rectifier is used to supply pulsating direct current for the dynamic braking operation. Some units have used the type 117Z6 rectifier tube for this purpose. When the 117Z6 is employed, the series resistor (84) value is changed from 100 to 50 ohms.

#### Sections P and Q—Head Assembly

1. The erase head (98A) and the record-reproduce head (98B) are mounted on the head bracket to

form the head assembly. This assembly is furnished only as a unit and should either head fail, the entire assembly must be replaced. The heads are not repairable because of their construction.

2. If a new head assembly is to be installed, certain electrical changes may be necessary. The proper value for the play coil shunt capacitor (38) will be found marked on the new head assembly.

If the DC resistance of the erase head (98A) is 100 ohms, the proper value of the erase amplifier cathode resistor (74) is 680 ohms; while if its DC resistance is 70 ohms, the proper resistor value is 1800 ohms.

3. Removal and replacement of the head assembly will necessitate adjustment of the head brakes as outlined under "Head Brakes," page 4.

4. The surface of the heads upon which the tape rides and which contain the pole pieces are subject to an accumulation of tape coating residue, which is worn off as the tape passes. This must be periodically removed since it will cause distortion. The accumulation interferes with the proper passage of the tape and causes speed variation. It also prevents the tape from contacting the pole pieces.

5. This accumulation may be removed with car-



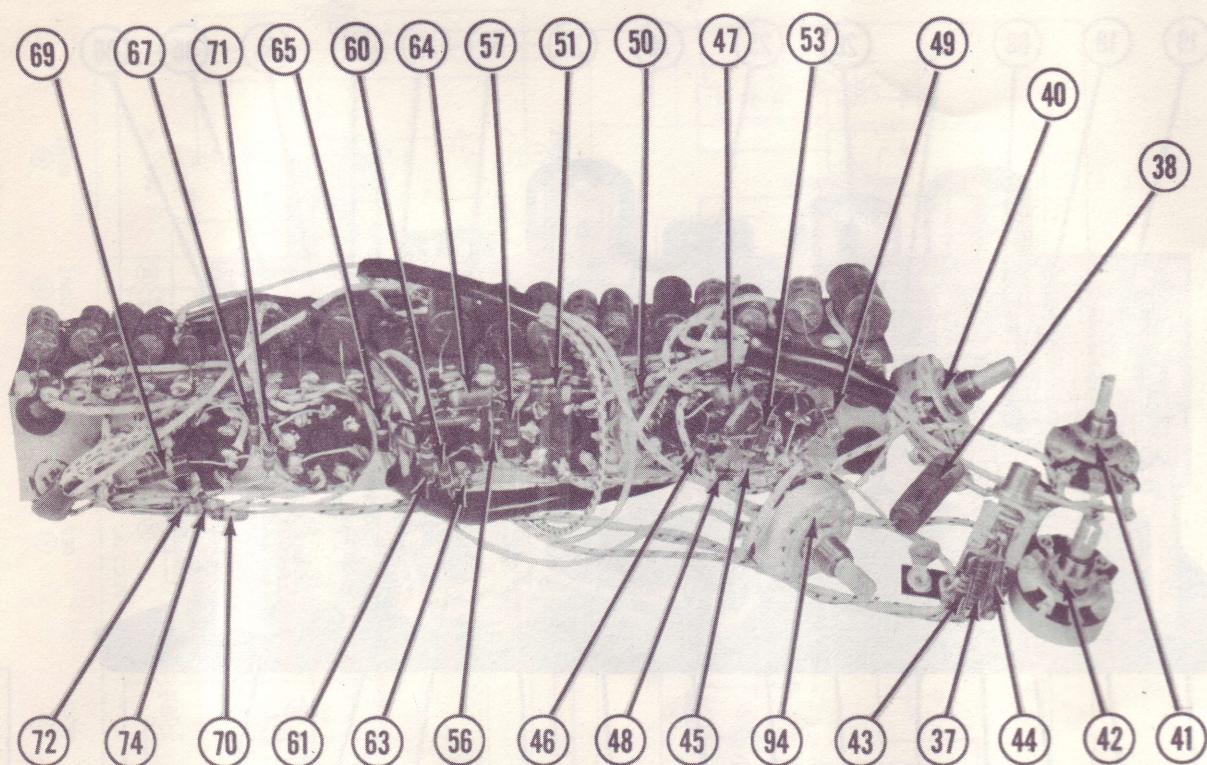


FIGURE 15—PANEL AMPLIFIER STRIP

bon tetrachloride and a small cotton swab on the end of a toothpick. Care should be taken to prevent damage to the panel from the solvent. It may be necessary to use the end of a good toothpick or cuticle stick to apply pressure as an aid in removing the coating. Be careful not to mar the exposed metal pole pieces.

#### Section R—See Pushbutton

Paragraph 16, Mechanical Operation and Adjustment.

#### Section S—See Limit Switches

Paragraphs 4-7, Mechanical Operation and Ad-

justment.

#### Section Y—Bias Amplifier

The 30 KC signal generated in Section G is here amplified in the second half of the 6SN7 (5) and fed to the plate circuit of Section E, where it mixes with the audio signal being recorded.

#### Section Z—Loudspeaker

A permanent magnet dynamic speaker (88) is used. Two voice coil impedances, 3.2 ohms and 8 ohms, are used; therefore, two types of output transformers will be found. The speaker cone (89) is not replaceable.

## FREQUENCY RESPONSE

1. The frequency response specifications for the Brush BK401 SOUNDMIRROR are as follows:

100 cycles 0 to - 7 db

300 cycles  $\pm$  2 db

1000 cycles REFERENCE LEVEL

3000 cycles - 3 to + 5 db

5000 cycles - 12 to + 5 db

The difference in response between 3000 and

5000 cycles should not be greater than  $\pm 3$  to - 10 db.

2. The frequency response may be checked as follows: Insert not more than one volt audio signal through microphone jack (138). Adjust record level control (41) to set the indicating eye (4) to within 1/16" of complete closure at 1000 cycles. Without change of record level control, make a recording of



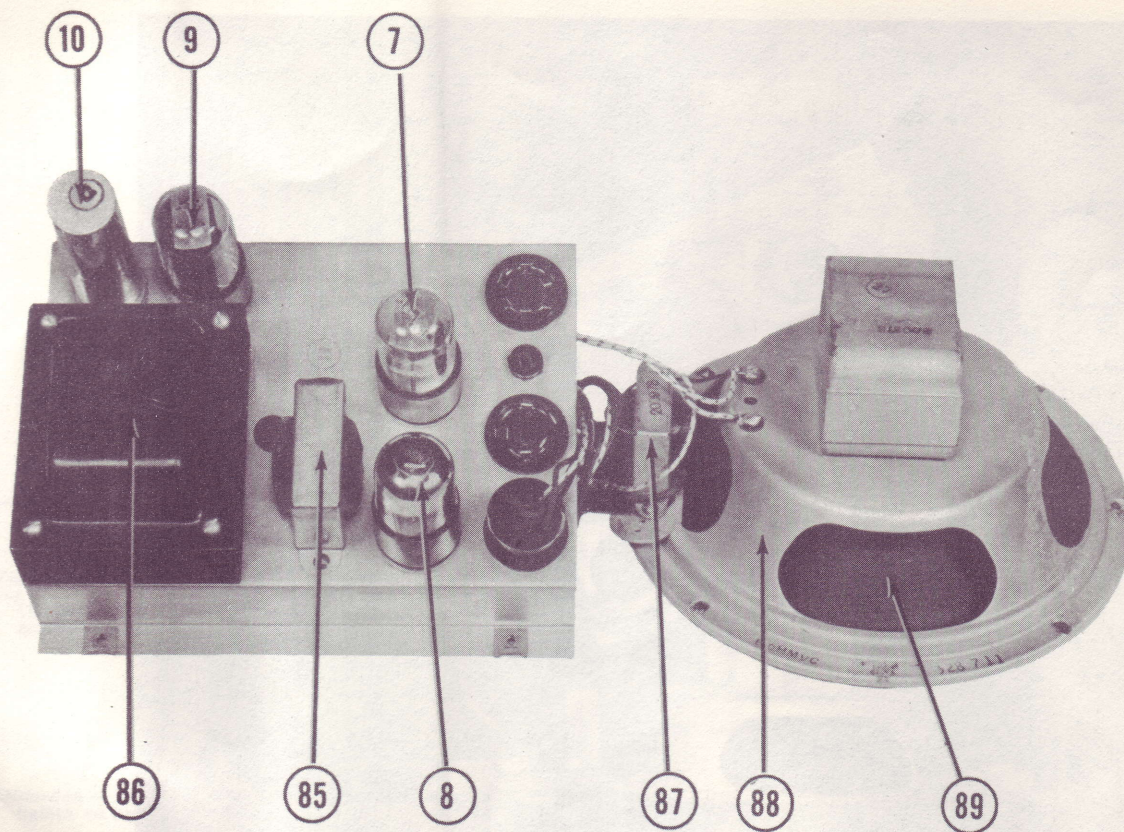


FIGURE 16—AMPLIFIER CHASSIS TOP VIEW

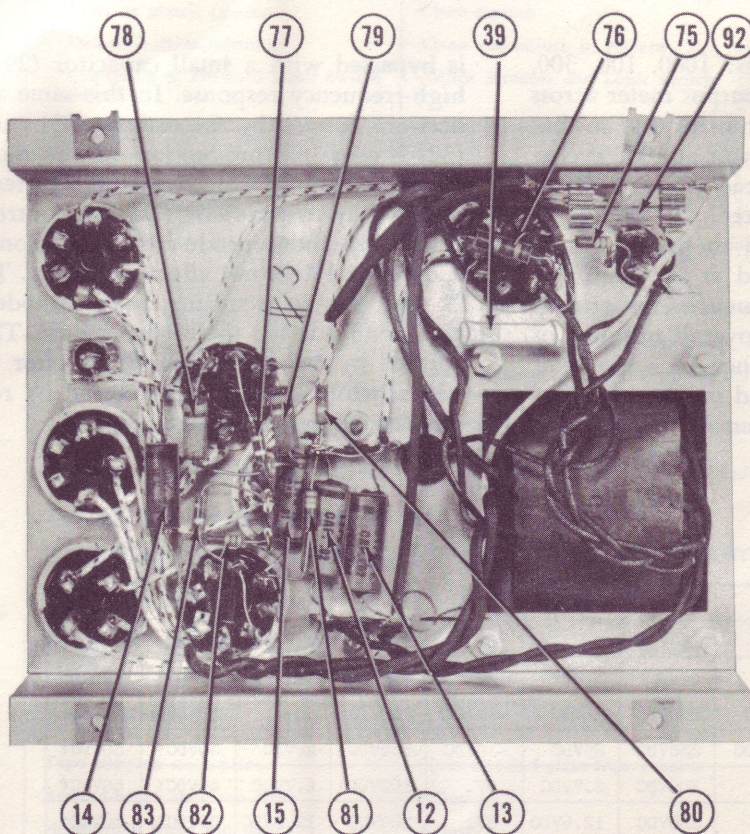


FIGURE 17—AMPLIFIER CHASSIS BOTTOM VIEW



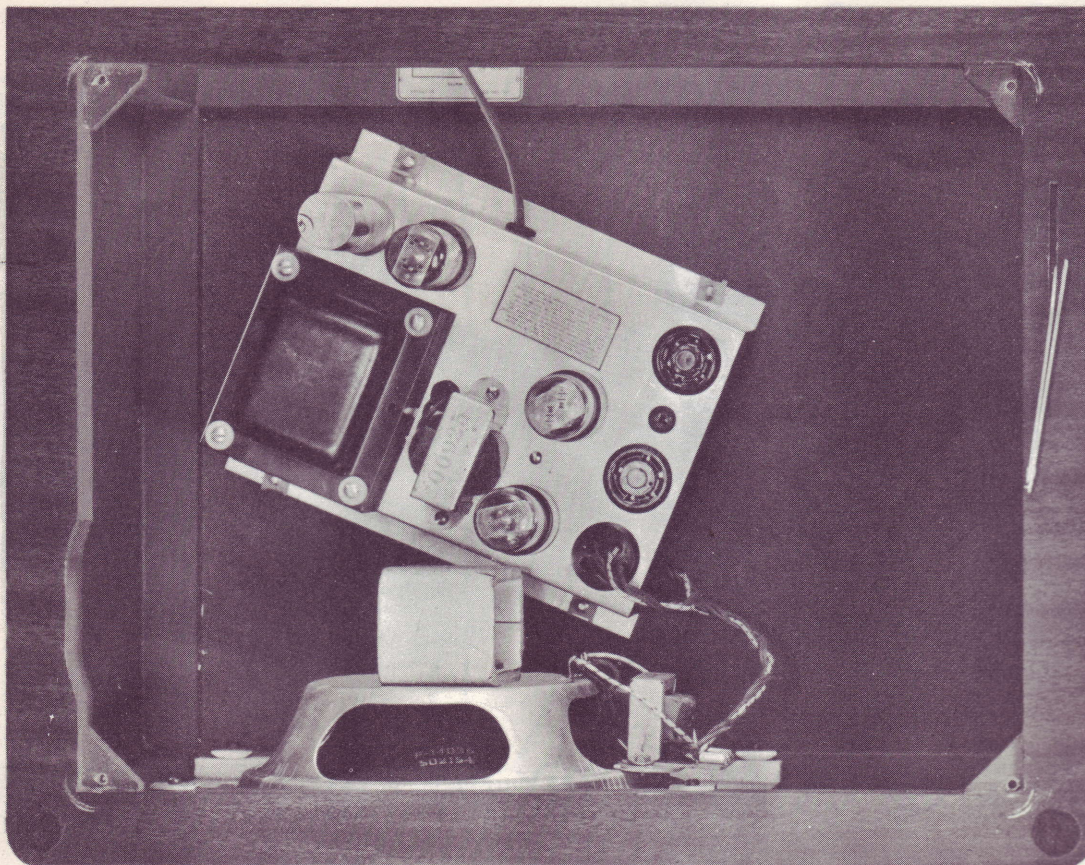


FIGURE 18—AMPLIFIER CHASSIS POSITION

the following audio frequencies: 1000, 100, 300, 3000, and 5000 cycles. Connect output meter across voice coil. Adjust play volume control (40) so that meter reads approximately one volt at 1000 cycles. Use this as reference level and read output as listed in table above on db scale of meter.

3. The amplifier is equalized to provide more gain at the low frequencies and at the high frequencies, while the middle frequencies are attenuated. This is done to make the overall response of the recorder as flat as possible, since the response of the tape is down on the low and on the high frequencies. In Section B of the schematic, the cathode

is bypassed with a small capacitor (29) to aid in high-frequency response. In this same section, the network formed by the resistor (53) and capacitor (32) is used in reproduction only to increase lows. It is shorted out during recording by a section of the record-play switch (94). The tone control (42) controls only the reproduction and monitoring responses and does not affect recording. The Section C, used only in recording, has a cathode bypass capacitor (30) to aid the high response. The network formed by resistor (58) and capacitor (28) boosts highs, while the network formed by resistor (59) and capacitor (34) boosts lows.

VOLTAGE READINGS

Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
1	6SJ7	0V.	50VDC†	2VDC	0V.	2VDC	55VDC	50VDC†	85VDC
2	6SN7GT	0V.	180VDC	5.2VDC	0V.	170VDC	4.9VDC	50VDC†	50VDC†
3	6SJ7	0V.	50VDC†	2.8VDC	0V.	2.8VDC	115VDC	50VDC†	145VDC
* 5	6SN7GT	30VDC	280VDC	72VDC	-10VDC	210VDC	0V.	50VDC†	50VDC†
* 6	6SN7GT	-19VDC	335VDC	20VDC	-10VDC	335VDC	20VDC	50VDC†	50VDC†
7	6SL7GT	0V.	300VDC	2.7VDC	0V.	300VDC	2.7VDC	50VDC†	50VDC†
8	6SN7GT	0V.	350VDC	12.5VDC	0V.	350VDC	12.5VDC	50VDC†	50VDC†
9	5Y3GT	0V.	350VDC	0V.	300VAC	50VDC	300VAC	0V.	350VDC



## RESISTANCE READINGS

Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
1	6SJ7	0Ω	70KΩ	1800Ω	500KΩ	1800Ω	1.1 Meg.	70KΩ	300KΩ
2	6SN7GT	500KΩ	90KΩ	1000Ω	500KΩ	50KΩ	1000Ω	70KΩ	70KΩ
3	6SJ7	0Ω	70KΩ	290Ω	1.1 Meg.	290Ω	26KΩ	70KΩ	110KΩ
* 5	6SN7GT	130KΩ	90KΩ	30KΩ	45KΩ	75KΩ	0Ω	70KΩ	70KΩ
* 6	6SN7GT	150KΩ	60KΩ	700Ω	100KΩ	60KΩ	700Ω	70KΩ	70KΩ
7	6SL7GT	1.1 Meg.	90KΩ	700Ω	22KΩ	90KΩ	700Ω	70KΩ	70KΩ
8	6SN7GT	400KΩ	60KΩ	680Ω	450KΩ	60KΩ	680Ω	70KΩ	70KΩ
9	5Y3GT	0Ω	60KΩ	INF.	95Ω	70KΩ	90Ω	INF.	60KΩ

\*TAKEN IN RECORD POSITION.

† 6.3VAC BETWEEN FILAMENT PINS.

SYMPTOM	CAUSE	REMEDY	TEXT REFERENCE
<i>Insufficient or no erasing</i> (Undesired background noise)	Defective Forward Limit Switch	Contact adjustment	Mech. Adj. Paragraph 5
	Overheating of resistor (74) reduces erase current	Reposition resistor away from takeup motor	Section "H." Figures 11 and 15
	Defective erase head	Replacement	Sections "P" and "Q"
	Defective tubes (5) or (6)	Replacement	Sections "G" and "H"
<i>Distortion — Unintelligible, no bass</i>  <i>Muffled, low output</i>	Accumulation of tape coating residue, dirt, etc., on erase head	Cleaning of pole pieces of head	Sections "P" and "Q"
	No recording bias	Check components in oscillator and oscillator amplifier	Introduction: Pars. 4 and 5. Sections "G" and "Y"
	Accumulation of tape coating residue, dirt, etc., on Record-Reproduce head	Cleaning of pole pieces of head	Sections "P" and "Q"
<i>Undue wavering of sustained note ("Wow" or "Flutter"). Apparent harmonic distortion or roughness</i>	High freq. variation of tape speed (flutter):		
	Head pole piece accumulation	Clean pole pieces	Sections "P" and "Q"
	Dirty or glazed capstan	Clean capstan	Mech. Adj. Par. 12
	Defective drive assembly	Clean and adjust, or replace	Mech. Adj. Par. 11-15
	Chattering of Forward Limit Switch Actuator	Adjust actuator and Limit Switch	Mech. Adj. Par. 4-6
	Irregular torque of takeup motor	Replace motor	Motors, Par. 1, 7
	Low freq. variation of tape speed (Wow):		
	Slippage of tape on capstan	Clean capstan surface (144A)	Mech. Adj. Par. 12
	Binding of tape in any part of drive system	Check and adjust or replace the following: Oversize tape Head brake shoes pressure excessive Warped reel Supply brake pressure excessive	Introduction Par. 3 Mech. Adj. Par. 8 Mech. Adj. Par. 2, 3
	Binding of motor shafts	Realign motor bearings or replace motor	Motors Par. 2, 3, 5
	Binding of rotor against stator in any motor	Replace motor	Motors Par. 3
	Slippage or binding within drive assembly	Proper cleaning, lubrication and adjustment of drive assembly	Mech. Adj. Par. 11-15
	Warped reel dragging on panel	Straightening or replacing reel	
	Flat spot on idler wheel	Run for 1/2 hr. or more to relieve permanent set, or replace	Mech. Adj. Par. 14
<i>Inoperative motor or motors</i>	Faulty limit switch	Clean, adjust, or replace	"Limit Switches"—Mech. Adj. Par. 4-7
	Misplaced or lost contact in pushbutton switch	Replace contact or entire switch	Mech. Adj. Par. 16
	Dragging of rotor against stator or burned-out motor	Replace motor	Motors, Par. 3
<i>Apparently weak take-up motor</i>	Tape slipping on capstan	Clean dirt and glaze from capstan	Mech. Adj. Par. 12
	Rewind-brake shoe too tight	Adjust	Mech. Adj. Par. 2, 3
	Head-brake shoes too tight	Adjust	Mech. Adj. 8, 9
	Misaligned bearings on any motor	Adjust bearings	Motors, Par. 2



SYMPTOM	CAUSE	REMEDY	TEXT REFERENCE
<i>Apparently weak re-wind motor</i>	Excessive friction in takeup motor	Adjust	Motors, Par. 2, 5
	Misaligned bearings	Remove brake; not necessary or desirable	
	Brake friction on takeup motor (early units only)	Straighten or replace warped reel	
	Reel dragging on panel	Adjust	
	Misaligned bearing in rewind motor	Adjust	
<i>Drive motor apparently weak or inoperative</i>	Supply brake shoe—too tight	Clean Limit Switch Guide	Motors, Par. 2, 5 Mech. Adj. Par. 2, 3 Mech. Adj. Par. 6, 7
	Accumulation of dirt and tape residue in Reverse Limit Switch	Adjust or replace Limit Switch	Mech. Adj. Par. 5, 6, 7
	Limit Switch Actuator pressure against tape too great	Adjust	Motors, Par. 2, 5
	Misaligned bearing	Clean dirt and glaze from capstan	Mech. Adj. Par. 12
	Tape slipping on capstan	Be sure idler is free of grease	Mech. Adj. Par. 12
<i>Takeup motor apparently runs excessively hot</i>	Improper contact of idler against capstan or motor shaft	Adjust idler tension spring	Mech. Adj. Par. 13
		Be sure idler bracket is free	Mech. Adj. Par. 13
	Excessive pressure on supply motor or head brakes	Adjust	Mech. Adj. Par. 2, 8
	Normal operation		Introduction, Par. 7 Motors, Par. 6
<i>Tape stalls during operation</i>	Excessive pressure on supply reel or head brakes	Adjust	Mech. Adj. Par. 2, 8
	Capstan dirty or glazed	Clean capstan	Mech. Adj. Par. 12
<i>Failure of head brake shoe to retract under cover or return to braking position</i>	Interference with wiring	Dress wiring away from moving parts	Mech. Adj. Par. 10 Mech. Adj. Par. 10 Mech. Adj. Par. 10
	Binding at pivot	Adjust bracket for end play	
	Interference with edge of panel	Reposition head assembly bracket	
	Interference with head cover	Adjust shoe angle to clear and readjust pressure	
<i>Picks up radio station</i>	Signal rectification by high-gain amplifier	Add bypass capacitors	Sect. "A"
<i>Microphonics (when unit is jarred)</i>	Microphonic tube	Replace tubes	Sections "A," "B"
	Microphonic head	Replace head	Sections "P," "Q"
<i>Forward and reverse pushbuttons fail to remain depressed</i>	Misadjustment of head-brake shoe	Adjust	Mech. Adj. Par. 8
<i>Excessive accumulation of residue on Reverse Limit Switch</i>	Misalignment of actuator	Realignment or replacement, and cleaning of actuator	Mech. Adj. Par. 6
	Roughness of cover	Removal of roughness	
<i>Excessive hum</i>	Magnetic field of motors	Adjustment of shield (168) on drive assembly	Motors, Par. 4
	Magnetic field of power transformer	Positioning of power supply chassis in cabinet—critical	Figure 18
	Takeup motor touching high-gain amplifier chassis	File corner of oil-retainer bar of motor	Motors, Par. 4
	Grounding of record head lead shield within head to form ground loop	Replace head	Sections "P," "Q"
	Screw holding bakelite panel to panel amplifier strip touches amplifier mounting assembly	Reposition washer on mounting assembly	
<i>Incorrect constant speed of tape (correct speed is 7 1/2" per second)</i>	Incorrect friction braking pressures	Readjust	Mech. Adj. Par. 2, 3, 8, 9
	Improper constant speed of drive assembly	Replace entire drive assembly	Mech. Adj. Par. 11-15
<i>Poor frequency response</i>	Accumulation of dirt and tape residue on record head	Clean head pole pieces	Sections "P," "Q"
	Defective compensating component	Replace	Frequency response
	Insufficient bias in record head	Replace defective component	Sections "G," "Y"
	Magnetically defective record head	Replace head	Sections "P," "Q"
<i>Spilling of tape during rewinding</i>	Lack of dynamic brake on takeup motor when stop button is depressed:		
	Defective or misadjusted Limit Switch	Adjust or replace	Mech. Adj. Par. 4-7
	Defective Selenium Rectifier (117Z6 tube used in some units)	Replace	Section "N"
<i>Tape refuses to enter or remain in guide of Reverse Limit Switch</i>	Wrong Limit Switch cover	Replace	Mech. Adj. Par. 7
	Tape catches on burr	Remove burr	Mech. Adj. Par. 7
	Misadjustment of Limit Switch	Adjust or replace	Mech. Adj. Par. 4-7



# PARTS LIST

Ref. No.	Part No.	DESCRIPTION	Ref. No.	Part No.	DESCRIPTION
1	105205	6SJ7 A.F. amplifier	51	RC20AE273K	Play A.F. amp. plate load—27K ohms ½ watt
2	103185	6SN7GT A.F. amplifier	52	RC20AE222K	Voltage dropping—2200 ohms ½ watt
3	105205	6SJ7 A.F. amplifier	53	RC20AE105K	Tone compensation—1 megohm ½ watt
4	105206	6E5 record level indicator	54	RC20AE683K	Tone compensation—68K ohms ½ watt
5	103185	6SN7GT oscillator and bias amplifier	55	RC20AE224K	Tone compensation—220K ohms ½ watt
6	103185	6SN7GT erase amplifier	56	RC20AE102K	Second A.F. Cathode—1000 ohms ½ watt
7	103185	6SN7GT A.F. phase inverter—NOTE: Some models use 6SL7GT	57	RC20AE273K	Second A.F. plate load—27K ohms ½ watt
8	103185	6SN7GT power output	58	RC20AE333K	Tone compensation—33K ohms ½ watt
9	102705	5Y3GT rectifier	59	RC20AE822K	Tone compensation—8200 ohms ½ watt
10A, B	102711	Filter capacitor (electrolytic) 20-20 mfd. @ 450 volts	60	RC20AE105K	A.F. grid—1 megohm ½ watt
11A, B, C	103253	Filter capacitor (electrolytic) 20-20-20 mfd. @ 450/450/25 volts	61	RC20AE271K	A.F. cathode—270 ohms ½ watt
12	103382	Line filter—.02 mfd. @ 400 volts	62	RC30AE473K	A.F. plate load—47K ohms 1 watt
13	103382	Line filter—.02 mfd. @ 400 volts	63	RC20AE273K	Bleeder—27K ohms ½ watt
14	103256	Audio coupling—.01 mfd. @ 600 volts	64	RC20AE333K	A.F. screen dropping—33K ohms ½ watt
15	103256	Audio coupling—.01 mfd. @ 600 volts	65	RC20AE105K	Record tuning eye grid—1 megohm ½ watt
16	CM20AE501M	Erase head 30 K.C. Tuning Capacitor—.0005 mfd. @ 600 volts	66	RC20AE105K	Record tuning eye plate load—1 megohm ½ watt
17	103383	Erase coupling—.001 mfd. @ 600 volts	67	RC20AE104K	Oscillator grid—100K ohms ½ watt
18	103383	Erase coupling—.001 mfd. @ 600 volts	68	RC20AE273K	Oscillator plate load—27K ohms ½ watt
19	103256	Oscillator grid capacitor—.01 mfd. @ 600 volts	69	RC20AE273K	Phasing resistor—27K ohms ½ watt
20	103256	Oscillator feedback—.01 mfd. @ 600 volts	70	RC20AE104K	Erase amplifier grid—100K ohms ½ watt
21	103383	Tuning Capacitor—.001 mfd. @ 600 volts	71	RC20AE104K	Erase amplifier grid—100K ohms ½ watt
22	CM20AE501M	30 K.C. coupling—.0005 mfd. @ 600 volts	72	RC20AE473K	Bias amplifier grid—47K ohms ½ watt
23	CM20AE101M	30 K.C. coupling—.0001 mfd. @ 600 volts	73	RC30AE153K	Bias amplifier plate load—15K ohms 1 watt
24	103252	Audio coupling—.1 mfd. @ 400 volts	74	RC30AE182K	Erase amp. cathode note 3—1800 ohms 1 watt
25	103252	Audio coupling—.1 mfd. @ 400 volts	75	RC20AE474K	Voltage divider note 1—470K ohms ½ watt
26	103382	Screen bypass—.02 mfd. @ 400 volts	76	RC20AE683K	Voltage divider note 1—68K ohms ½ watt
27	103256	Audio coupling—.01 mfd. @ 600 volts	77	RC20AE681K	A.F. cathode—680 ohms ½ watt
28	103380	Treble boost—.0025 mfd. @ 400 volts	78	RC30AE273K	A.F. plate load—27K ohms 1 watt
29	103254	Treble boost—.05 mfd. @ 400 volts	79	RC30AE273K	Phase inverter plate load—27K ohms 1 watt
30	103254	Treble boost—.05 mfd. @ 400 volts	80	RC20AE333K	Phase inverter grid note 4—33K ohms ½ watt
31	CM20AE101M	Treble attenuator—.0001 mfd. @ 600 volts	81	RC20AE474K	Output grid—470K ohms ½ watt
32	103255	Bass boost—.002 mfd. @ 600 volts	82	RC20AE474K	Output grid—470K ohms ½ watt
33	103382	Audio coupling—.02 mfd. @ 400 volts	83	RC20AE681K	Output cathode—680 ohms ½ watt
34	103254	Bass boost—.05 mfd. @ 400 volts	84	103808-3	Voltage dropping note 2—100 ohms 10 watts
35	103382	Audio coupling—.02 mfd. @ 400 volts	NOTE: 1—Not used in all models 2—Models using 117Z6 rectifier use 50 ohms—10 watts in this application 3—Some models use 680 ohms in this application 4—Models using 6SL7 use 22K ohms in this application		
36	103252	Screen bypass—.1 mfd. @ 400 volts			
37	CM20AE501M	Radio input bypass—.0005 mfd. @ 600 volts			
38A	103380	Play coil shunt—.0025 mfd. @ 400 volts			
B	103255	Play coil shunt—.002 mfd. @ 400 volts	85	200925	Filter choke
C	103636	Play coil shunt—.004 mfd. @ 400 volts	86	200924	Power transformer
		Correct value for play coil shun determined by marking on individual heads.	87A	200978	Output transformer for 8 ohms voice coil
39	103256	Filament bypass—Not used in all Models .01 mfd. @ 600 volts	B	200923	Output transformer for 3.2 ohms voice coil
40	103469	Play volume control—1 megohm	88A	300450	Speaker (8 ohms voice coil)
41	103469	Record volume control—1 megohm	B	300373	Speaker (3.2 ohms voice coil)
42	103469	Tone control—1 megohm	89	None	Cone not supplied separately
43	RC20AE474K	Series external A.F.—470K ohms ½ watt	90	103293	Oscillator coil
44	RC20AE223K	External A.F. load—22K ohms ½ watt	91	103820	Selenium rectifier (117Z6 used in some models)
45	RC20AE474K	1st A.F. Grid—470K ohms ½ watt	92	102625	Fuse AGC-2 (AGC-3 used in BK-401-1)
46	RC20AE182K	1st A.F. cathode—1800 ohms ½ watt	93	103258	On-off toggle switch
47	RC20AE224K	1st A.F. plate load—220K ohms ½ watt	93A	103258	Switch nut (hex) accessory
48	RC20AE105K	1st A.F. screen dropping—1 megohm ½ watt	93B	103258	Switch nut (knurled) accessory (Part of 93)
49	RC20AE223K	Decoupling—22K ohms ½ watt	94	201364-4	Record-play switch
50	RC20AE102K	Play A.F. amp. cathode—1000 ohms ½ watt	95	103144	Reverse limit switch
			96	103144	Forward limit switch
			97	200847	Pushbutton switch assembly
			97A		Forward pushbutton



## PARTS LIST (Cont.)

Ref. No.	Part No.	DESCRIPTION	Ref. No.	Part No.	DESCRIPTION
97B		Reverse pushbutton	135	103880	Head brake shoe spring
97C		Start pushbutton	136	104525	S-hook, head brake
97D		Stop pushbutton	137	103013	Turntable (300345 motor)
97E		Record pushbutton	138	21421	Microphone jack
98	300496	Record-reproduce and erase head assembly	138A		Microphone jack hex nut
98A		Erase head cover	138B		Microphone jack insulating washer
98B		Record-reproducer head cover	138C		Microphone jack insulating washer
99	104820	Reel hold-down screw (used with 204927 motor)	138D		Microphone jack lock washer
100	104821	Reel hold-down clamp (used with 204927 motor)	139	ILW-8	Lock washer
101	BK-921	Reel empty (supply)	140	103584	Stud—amplifier suspension
102	104154	Reverse limit switch cover	141	200470	Bell crank assembly
103	104202	Reel hold-down screw (used with 300345 motor)	142	ELW-6	Lock washer (bell crank mounting)
104	103011	Reel hold-down cap	143		4-40 x 5/16, R.H. machine screw (bell crank mounting)
105	BK-921	Reel empty (take up)	144	103213-501	Drive capstan
106	103156	Actuator, reverse limit switch	144A		Drive capstan corprene surface
107	104086	Reverse limit switch guide	145	103142	Clip, idler wheel
108		10-32 x 5/16, R.H. Phillips capstan cover screw	146	103067	Washer, idler adj. nut
109	ILW-10	Lock washer	147	103048	Idler wheel
110	103011	Capstan cover	148	ILW-10	Lock washer drive assembly mounting
111		8-32 x 5/16, R.H. Phillips motor mounting screw	149		8-32 x 1/2, R.H. Phillips screw, drive motor mounting
112	ILW-10	Lock washer	150	103582	Stud, drive assembly mounting
113	103149	Forward limit switch cover	151	ILW-8	Lock washer
114	103156	Actuator, forward limit switch	152	W-8	Washer
115	300345	Take-up motor	152A	W-8	Washer
116		8-32 x 5/16, R.H. Phillips motor mounting screw	153	200846	Drive assembly plate
117	ILW-8	Lock washer	154		8-32 x 1/2, R.H. Phillips screw, motor mounting
118		8-32 x 3/8, R.H. Phillips screw (pre-amp. to panel)	155	103250	Idler wheel bracket
119	300392	Panel	155A	103148	Idler thrust washer
120		10-32 x 5/16, R.H. Phillips screw (drive assembly to panel)	156	103153	Felt cushion
121	103010	Spindle (capstan)	157	103032	Idler wheel tension spring
122		Screw, head assembly to panel	157A	L-71	Idler wheel tension spring lug
123		10-32 x 5/16, R.H. Phillips screw (drive assembly to panel)	158		6-32 Elastic stop nut, Idler bracket adj. nut
124		6-32 x 1/4, R.H. Phillips screw (forward limit switch mounting)	159	ILW-10	Lock washer, plate mounting
125		8-32 x 3/8, "Z" R.H. machine screw (limit switch cover)	160		8-32 x 5/16, R.H. Phillips screw, plate mounting
126	103564-501	Brake shoe (supply)	161		Drive spring (not used on some motors, not supplied separately)
127	103568	Head shoe mounting rod	162	103226	Spacer, motor mounting
127A	W-6	End play washer	163	103428	Motor mounting grommet
127B		Tinnerman nut	164	200988	Brake shoe cover (heads)
128	104822	Turntable (204297 motor only)	165		Lock washer, capstan spindle, 1/4" Cantlink
129	W-8	Thick spacing washer (used only with 204297 motor)	166		Nut, hex, 1/4 x 20
129A	103047	Thin spacing washer	167	201404	Drive motor
130	204927	Rewind motor	168	104784	Hum shield, drive motor (used only with certain type motors)
131	ELW-6	Lock washer	169	400334-501	Cabinet assembly
132		Nut, 6-32 large hex	170	200999	Speaker mounting board and grille
133	103567-501	Erase head brake shoe assembly (with pad)	171	300376-501	Drive assembly, complete
134	103567-501	Record-reproduce head brake shoe assembly (with pad)	172	201154	Microphone, Brush BA-102
			173	103468	Control knob
			174	103556	Pushbutton knob