Servicing

Leyer

Mk.II SERIES

MAGNETIC TAPE RECORDERS

BYER MARK II SERIES
MAGNETIC TAPE RECORDERS

SERVICE AND MAINTENANCE MANUAL

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PART ONE -- MODEL "66"

SECTION 1. General Description of THE TAPE TRANSPORT MECHANISM.

The Tape Transport is powered by two capacitor induction Spooling Motors and a single Phase synchronous Capstan Motor with inbuilt flywheel providing a smooth, direct wow free drive with no mechanical linkages.

In twin speed units the Capstan Motor is fitted with a special two speed winding.

The Capstan itself is formed by grinding the motor shaft to the requisite size for the respective speeds.

The large precision ground brake drums are moulded on to the spooling motor extension shafts. Brake shoes align automatically and are self-energising in opposite directions. This provides more powerful braking to whichever spool is unwinding tape, and precludes any possibility of "tape throwing" during "shuttling". The brakes are held "ON" by damped springs and are released by a common solenoid taking up two connecting tie-rods.

A second solenoid carries an arm on which is mounted the Pressure Roller and the Tape Lift Arm. When the pressure roller solenoid is de-energised, i.e. the machine is in a condition ready for Shuttling, the Tape Lift Arm holds the tape away from heads and opens the Play head shield.

A cross arm, set in the pressure roller arm, operates a bank of contacts on the right hand side (facing unit). The opposite end of this arm runs on the shuttle monitor control arm.

The two solenoids, (Pressure Roller L1, Brake L2) are operated from a full wave voltage doubler circuit, comprising a selenium rectifier and a dual 250 mfd electrolytic capacitor. This results in a peak voltage of approximately 45 volts no load, dropping to approximately 25 volts when both solenoids are energised, giving an initial surge current through the solenoids to ensure a safe margin for their reliable operation.

The 16 Volts A.C. supply required for the rectifier is obtained from a special winding on the amplifier power transformer through pins 5 and 6 of the amplifier power source socket at the rear left side of the transport mechanism. This supply is also brought out to a jack on the Control Box lid for use with a 16 volts Head De-magnetiser and other ancillary items, but is dropped to 12 volts for the 12AU7 oscillator valve heaters.

PLAY AND RECORD MODES.

When the amplifier is switched to a "RECORD" position i.e. Microphone, 600 ohms, Bridge-In or Radio, number 7 pin of the amplifier power source socket is earthed in the amplifier. When switched to "PLAY", number 8 pin becomes the earth.

With the amplifier set to "PLAY", pressing the play button forms a circuit from both solenoids via the play button contacts and the amplifier input selector switch to ground, (the positive of the voltage doubler is grounded here also) and both solenoids are energised.

When the solenoids are energised, an alternative or holding circuit is made through.....

(a) Pins 1 and 2 of Remote Control Socket. (Bridged in dummy plug)

(b) The "STOP" button.

(c) L1 contacts A and B. (Closed by pressure roller cross arm).

(d) Tape Over-run Switch. (Closed by tape tension).

(e) L2 contacts E and F.....

to pin number 8 of the amplifier power source socket, which is still earthed in the amplifier. Thus when the Play button is released, the solenoids remain energised through their holding circuit.

The contacts L2 are operated when the right hand brake shoe is lifted from the brake drum by its operating solenoid. This forms a relay which also switches on the supply to.....

(a) The spooling motors. (via appropriate resistances)

(b) The capstan motor.

(c) The high tension to the oscillator from No.4 pin of the amplifier power source. In "PLAY" position this is switched off in the amplifier.

When the "STOP" button is pressed, or the tape over-run switch is opened, the holding circuit is broken, the solenoids drop out, brakes are applied and the motors switched off.

With the input selector set to a "RECORD" position, a similar set of conditions exists, but the holding circuit now passes from the tape over-run switch through L2 contacts "G" and "H", L1 contacts "G" and "D" and "PLAY SAFE" switch contacts "A" and "B" to pin No.7 of the amplifier power socket which is now earthed in a record position.

THE PLAY SAFE SWITCH

When opened, i.e. in "SAFE" position, disconnects the record press button from earth (via pin No.7 of amplifier power socket), thereby making the transport inoperative in any "RECORD" position. As an additional safety measure, the switching to safe also shorts out the record head. The play mode is in no way affected.

REMOTE OPERATION

Remote control of the "RECORD", "PLAY" and "STOP" functions is accomplished in the following manner, after first removing the 4 pin dummy plug at the rear of the Control Box.

(a) REMOTE RECORD

Bridge pins 1 and 3 of remote socket with a Press Switch.

(b) REMOTE PLAY

Bridge pins 1 and 4 with a press switch.

(c) REMOTE STOP

Connect a normally closed switch between pins 1 and 2 of remote socket.

For a remote "START" switch, serving either record or play as set at the Input Selector, connection is made to pins 3 and 4 (Bridged) and pin No.1 on the remote socket.

If non-locking operation is desired, i.e. "Press-to-start" and "Release-to-stop", omit the remote "STOP" switch leaving no connection to pin No.2.

In the Record and Play modes, the supply reel motor is connected in series with a resistance to the mains supply via L2 contacts "A" and "B". The take-up spool motor is similarly treated, but in this instance the resistance in series is lower in value. This provides optimum take-up and hold-back torques for correct tape tension.

TAPE SHUTTLING

When the "TAPE SHUTTLE" control is rotated to either "EDIT" position, contacts "C" and "B" (Tape Shuttle Control contacts) are opened, thereby breaking any circuit through solenoid L1 and cancelling any previous mode of operation.

Contacts "A" and "B" are also broken and at the same time, contacts "A" and "D" / "A" and "E" are made. This has the effect of energising L2 only, via pin No. 8 of the amplifier power socket, and L2 contacts are operated, as is also the Tape Shuttle

control switch. The former (L2) switching AC mains through to the latter and on, via the lower valued resistance, to the two spooling motors.

The spooling motors now have equal torque in opposite directions and remain static, keeping the tape under tension. This condition allows the tape to be rocked over the heads for editing, cueing, etc..

Turning the control to position 1, opens Tape Shuttle Control contacts "A" and "E" but leaves contacts "A" and "D" made. Contacts "B" and "C" remain open.

The L2 solenoid circuit is now through Tape Shuttle Control contacts "A" and "D", L2 contacts "E" and "F" and pin No. 8 of amplifier power socket to ground.

The Tape Shuttle Control switch now also supplies the spooling motor (toward which it has been turned) with power, through series resistances. Through further series resistances power is applied to the opposing spooling motor to provide hold-back tension whilst shuttling. This condition conversely applies when the control is turned in the opposite direction.

In positions 2, 3, and 4, spooling hold-back torque and tape shuttle control contacts remain as in position 1, but the torque is increased on the motor toward which the control has been turned.

Should the "Tape Over-run Switch" be operated, the solenoid L2 becomes de-energised and the machine will stop. The Tape Shuttle Control must then be returned to the "STOP" position before any further operation may be commenced. When the machine is shuttling and the control is returned to "Stop", contacts "A" and "D" open, releasing the solenoid and stopping the machine.

All contacts are now at normal, and ready for further operations.

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SECTION 2. SERVICE AND MAINTENANCE

REMOVAL OF FRONT PANEL

Access to the front of the tape transport mechanism is gained by removing the 16 retaining screws and lifting the front panel clear. This panel forms part of the structural strength of the assembly and the screws should always be tightened securely when replaced.

With the front panel removed, the undermentioned components are accessible for inspection and adjustment.

(a) Brake drums, Brake shoes and Tie Rods.

(b) Contact Sets -

  (1) L1 (Right hand top corner)

  (2) L2 (Operated by right hand brake shoe)

  (3) Tape Shuttle Contacts (Operated by cam on knob of right hand lower control).

  (4) "Record" contacts. (Operated by the Record press button).

  (5) Tape Over-run Switch. (Operated by Nylon moulding beneath the guide roller.)

(c) Pressure Roller Arm, Tape Lift Arm and Head Shield opening mechanism. For further access the pressure roller may be removed by....

  (1) Removing the retaining screw in the centre.

  (2) Withdrawing the pressure roller.

NOTE:- Carefully note the location of shim washers, if any, that they may be replaced in proper sequence.

The two bakelite mouldings which surround the pressure roller mounting stud and the head shield arm may also be removed if greater accessibility is desired.

Servicing the front face of the tape transport consists, in the main, of contact cleaning and adjustment, brake setting and pressure roller tensioning. For the latter, complete removal of the transport from the case is necessary.

BRAKE SERVICING

Inefficient braking is usually evidenced by a prolonged period of tape travel after shuttling. In more serious instances, the tape may even "throw a loop" and become entangled round the spool. This fault could result from.....

(a) Oil on brake drums and brake shoes.

(b) Displacement of spooling motor.

NOTE:- Later models are fitted with a locating spigot and trouble (b) should not be encountered.

Remedy (a)

Lift brake shoe away from panel where it may be detached from its return spring and removed.

Brake drum may now be removed by loosening the set screw which locks it to the motor shaft. A 5/32" hexagonal spanner is provided for this purpose and the screw should be slackened off a few turns to ensure complete clearance from its recess in the shaft.

If it is found that the brake drum cannot be withdrawn easily, two screwdrivers may be used gently as levers against the chassis, using an even pressure 180 degrees apart. Failure to observe this 180° placement could result in a bent motor shaft.

With brake drum removed, it will be seen that the felt seal on the motor shaft has become oil saturated. It should be replaced with a new seal.

Clean all oil from the chassis, brake drum and brake shoe with Carbon-tetrachloride or similar cleaning fluid. Methylated spirits has been found successful. Acetone or Lacquer thinners should be avoided as they could possibly act on the adhesive which secures the brake lining to the shoe.

An excessive amount of oil on the brake shoe may necessitate the replacement of the part.

On re-fitting, the brake drum must be re-set with the front face .805" from the chassis, (with motor shaft end play taken up on ball at rear of motor).

A smear of light grease should be applied to the brake shoe bearing post, the hole which engages the tie rod, and in the case of the right hand shoe, a light touch of grease on the boss which operates the contacts.

Remedy (b)

Where it is seen that the brake shoe is not seating correctly on the brake drum, and a check shows that motors without spigots are fitted, the brake drum must be removed as described in the preceding section. i.e. under heading "Remedy (a)."

The motor shaft should then be centered in the 1" diameter hole in the chassis and locked into place, making sure that the motor screws are not tightened to the point where distortion of the motor rear end-bell occurs.

Replace brake drum as described previously, and lock in place.

BRAKE ADJUSTMENT

By turning the shuttle control to either "EDIT" position the brakes will be released. Clearance between the heel of the shoe and the brake drum should be approximately .015". Adjustment is made by twisting the cranked section situated half way along the brake tie rod. Special tool No. 3008 ST should be used for this purpose. Twisting clockwise increases, and anti-clockwise decreases the gap between shoe and drum.

Contacts L2 should now be checked. To do this, manually close solenoid L2 to actuate brake, and check that the contacts make firmly and break cleanly. If adjustment is necessary, slacken the two screws securing the contact bank to the chassis and move the bank bodily in the direction required to achieve the desired setting. Tighten securing screws firmly.

When brakes are operating correctly, the differential braking action is quite obvious if the spools are turned by hand.

UNRELIABLE OR NON-RELEASE OF BRAKES

Apart from electrical faults, this trouble is usually due to the brake actuating solenoid being mechanically overloaded. Causes of this are.....

(1) Brake shoes opening too far. (i.e. more than .015")

(2) Excessive friction in solenoid bearings or in linkages.

Remedy (1) Is discussed under heading "BRAKE ADJUSTMENT"

Remedy (2) Clean and lubricate the relevant moving parts.

ADJUSTMENT OF CONTACTS

Should adjustment become necessary, the use of a contact adjusting tool is advised.

Dirty and pitted contacts may be cleaned by the use of a small square of very fine emery paper folded double and inserted between the two contact faces. Gentle finger pressure of the contacts onto the emery surface will facilitate the removal of all pitting and dirt.

Contact "Banks" may be re-positioned by loosening the two screws securing the contact mounting bracket to the chassis, and re-tightening in the new position.

A definite amount of contact pressure is vital for reliable operation. This pressure is best defined as that which will produce a positive wiping action between the contact surfaces in either the "make" or "break" actions.

TAPE SHUTTLE CONTACTS

The tape shuttle contacts are double-acting. With the control set at "STOP" it will be seen that the contacts are at rest.

Turning the control to "EDIT" breaks the lowest pair, changes over the adjacent set, and makes the remaining pair.

Rotating to positions 1, 2, 3 and 4 re-opens the final pair but retains the "change-over" and "break" sets in their operated condition. Care must be taken that the "change-over" set is non-shorting, i.e. "break" before "make", and that contacts cannot make connection to adjacent spring sets or to the spring actuating arm which bears on the operating cam.

TAPE OVER-RUN SWITCH

The tape over-run switch contacts should be set as lightly as is consistent with reliable operation and should not open more than approximately 0.01" before reaching the limit stop.

Spring tension on the nylon tape tension arm should be no more than is necessary to operate these contacts. If free movement of the tape tension arm is impaired, it will probably be due to oil being present in the centre bearing causing the nylon to swell and introducing friction.

NOTE:- In later machines a metal sleeve bearing is fitted into the nylon moulding to obviate any trouble in this direction.

To remove the tape tension or actuating arm the "PLAY" press button, the power switch knob and the guide roller must first be dismantled, as one spindle is common to all.

First step in dismantling is to unscrew the "Play" button. This consists of a disc attached to a spindle which is threaded at the opposite end. The threaded section is forcibly screwed

into a nylon retainer which in turn bears on the return spring. This spring operates the "Play" contact set.

(1) Unscrew the play button by pressing with the thumb on the face of the button and turning anti-clockwise until it can be withdrawn.

(2) Loosen the grub screws in the power switch knob using the hexagonal key spanner provided, and lift the knob clear.

(3) Remove retaining circlip, the guide roller and tape tension arm.

All traces of oil must be removed from the tension arm and its spindle. Before replacing, it will be advisable to open out the bore of the tape tension arm with an expanding reamer (7/16") until there is suitable clearance to preclude any further stickiness in the bearing.

Re-assembly is quite straight-forward. The "Play" button should be screwed down until its height, in relation to the knob, matches the other press buttons.

MAL-ADJUSTMENT OF PRESSURE ROLLER & ASSOCIATED MOVEMENTS.

The tension of the pressure roller against the capstan is most important and irregularities may result from a number of causes. In most cases of mal-adjustment, the effect is partial loss of control by the capstan of the tape motion - particularly at the beginning and/or end of a reel - with the audible evidence in the form of a random wow.

Pressure roller tension can be readily checked in the following manner, by means of a suspendable type spring balance with a full scale reading of approximately 8 lbs.

(a) With a reel of tape almost fully spooled onto the take-up spool, (approximately 30 to 40 turns should remain on the supply reel) remove the pressure roller cover disc and replace the pressure roller retaining screw.

NOTE: It will be necessary to fit a 3/16" washer under the screw when the cover disc is not present - pressure roller will otherwise run off the spindle over the retaining screw head.

(b) Loop a short length of cord over the end of the screw and attach the spring balance.

(c) Pull on the spring balance so that the cord lies directly over the centre of, and as close as possible to the take-up spool.

(d) Start the machine - preferably in "Play" operation.

(e) A reading of 5 to 5½ lbs should be reached before the pressure roller tension is reduced to the point where the tape motion becomes irregular.

If the pressure roller tension is too low, check the following possible causes:-

(a) Pressure Roller Solenoid.

(1) Looseness of screw and spacer securing solenoid frame to chassis panel.

(2) Looseness of screws or rivets securing the armature spring plate.

(3) Fouling of magnet face by foreign matter, magnetic or otherwise, preventing the armature spring plate from seating properly.

(b) Pressure Roller and Capstan.

(1) Presence of oil, tape debris or any foreign matter on the capstan and/or pressure roller.

(2) Deep grooving or wear on the pressure surface of the pressure roller.

(c) "Bottoming" of Tape Lift Pin within its recess in the head block when the pressure roller solenoid is energised.

The following is the action to be taken, respectively, should any of the foregoing faults be present.

(a) (1) Fully tighten screw and spacer, at the same time turning solenoid frame fully anti-clockwise against the securing screw.

(2) Remove spring plate assembly from its mounting spindle and tighten or replace screws or rivets.

(3) Clean magnet face of foreign matter.

(b) (1) Clean pressure roller and/or capstan with a dust free cloth moistened with Carbon-tetra-chloride.

(2) Fit new pressure roller and check for correct tension. (New rollers can sometimes cause excessive tension).

(c) When pressure roller solenoid is energised and the pressure roller is engaged against the capstan, the tape lift pin should be evenly positioned in its recess in the head block, and must be clear of the bottom of the recess and of the tape itself. Should the pin foul the bottom or sides of the recess, gently bend the arm until correct positioning is achieved.

In extreme cases of a bent tape lift arm, it may be necessary to loosen the pressure roller mounting stud and move the tape lift arm in or out of its mounting hole. Unless absolutely necessary, it is recommended that this should be left locked, and adjustment be concentrated on the tape lift arm.

At the point where the tape is in contact with the tape lift arm, an angle of approximately 90 degrees between the chassis and the tape lift arm will ensure correct layering of the tape on the spool. If, when spooling, the tape does not "layer" in the same place as when the pressure roller is engaged, a slight alteration to the angle of the tape lift arm, at the point where the tape makes contact, will remedy the position. (Bending the top of the arm away from the head block will cause the tape to "layer" closer to the panel, and vice versa).

In later machines a Stop has been incorporated to limit the return travel of the pressure roller arm. Fitted to one leg of the pressure roller surround, this stop prevents the tape lift arm from being bent by pressure against the front cover panel in the event of any excess movement of the pressure roller arm.

If pressure roller tension needs to be varied further after the abovementioned remedies have been carried out, remove the spring plate assembly from its mounting spindle, place it in a small bench vice and slightly "set" the spring in the appropriate direction.

PRESSURE ROLLER CLEANING

Drive of tape through the machine can be affected by dirty or greasy pressure roller surface. A brush is useful for removal of dust particles, but oil, grease or wax must be removed with the aid of a cleaning fluid, preferably Carbon-tetrachloride. This should be applied sparingly, using a moistened cloth. After cleaning, correct drive surface is obtained by applying a fine film of powdered graphite evenly over the pressure roller driving surface.

PRESSURE ROLLER LUBRICATION

The pressure roller and guide roller are both fitted with oilite bearings and require no attention in this respect.

THE MOTORS

Normally the three motors of the Tape Transport Mechanism require no attention - bearings are of phosphor-bronze with an oil pad reservoir. However, should unforseen circumstances necessitate the removal of a motor from the transport, the following sequences should be observed.

CAPSTAN MOTOR REMOVAL

(1) Disconnect unit from mains (A.C.) supply.

(2) Disconnect "head" outlet cables and Power Supply cable at rear of tape transport.

(3) Remove tape transport from case by slackening the four socket head screws (two each end on front of transport) and lifting unit out by means of the "U" handles provided at top right and left corners.

(4) Place transport upside down on a bench or table with rear of unit facing operator.

(5) Loosen the three screws securing the Control Box lid, and open lid to full extent.

(6) Disconnect leads from "Mains" switch (single speed units have three leads, two speed units have six), carefully noting colour coding of leads for re-assembly.

(7) Slacken the four studs on rear end-bell of capstan motor until free of thread in chassis panel.

(8) Support motor with both hands and ease out gently. Careful handling is necessary to avoid possible damage to the capstan.

NOTE:- If motor is to be forwarded for repair, fit four 5/32" Whitworth nuts to the motor studs to hold end-bells in place during transit.

CAPSTAN MOTOR RE-FITTING

In re-fitting the capstan motor, the foregoing procedure is reversed. Utmost care should be taken that the capstan does not at any time foul the capstan shield, and it is also important that the weight of the motor should not be taken by the motor shaft or capstan.

SPOOLING MOTORS REMOVAL

(1) Remove front cover panel as described in Para.1 Section 2.

(2) From front of unit disconnect two leads to condensor and two leads to terminal panel. (Note and code tag the leads for re-assembly).

(3) Remove brake shoe and brake drum as described under heading "Brake Servicing".

(4) Slacken four securing studs on rear end-bell of motor until motor is free.

NOTE:- The four aluminium posts surrounding the brake drum serve also as securing nuts for the studs holding the motor to the chassis, and may drop free.

When replacing, it is important that the small diameter post be placed at the lower position, toward the center of the machine. (This forms the brake shoe pivot.)

SPOOLING MOTORS - REFITTING

Re-fitting is a reversal of the foregoing procedure but the remarks relating to brake servicing and adjustment should be noted.

THE TRIPLE HEAD ASSEMBLY

The Triple Head Assembly is attached to the 1/8" aluminium chassis by a 5/32" Whitworth screw through the body of the head block moulding, which has a spigot to prevent rotation.

HEAD BLOCK REMOVAL

(1) Disconnect the four leads from the three-way "tag strip", and the two wires from the earth lug under the tag strip mounting screw.

(2) Disconnect the twin shielded lead from the "Head Outlet" socket.

(3) Free the shielded lead from under the holding clip.

(4) Unscrew the 5/32" screw holding the head block to chassis and lift the head block clear.

CLEANING OF HEADS

Dust and ferrous powder is best removed by a denture, or similar stiff bristle brush. Where caked accumulations occur, they are usually caused by the particles adhering to smears of adhesive from cellulose tape. For this reason it is not good policy to use other than a correct splicing tape when making joints.

Accumulations not readily removable by brushing, can usually be cleared by the use of acetone, lacquer thinners or similar solvent on a piece of clean rag or absorbent cotton. Solvents of this nature should be used very sparingly and NEVER in the vicinity of a naked flame or spark of any nature.

HEAD BLOCK REPLACEMENT

Before fitting, make sure that the tape tracks are clean and that the heads are locked in line. Screw head block down, making sure that the locating spigot is properly seated in its receiving hole in the 1/8" base plate or chassis.

Connect leads, check operation and adjust azimuth setting of record and play heads. (See section 3)

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PART ONE -- MODEL "66"

SECTION 3. Azimuth Adjustment. (all models)

In normal circumstances it should not be necessary to perform any adjustments to the "Record" head, but if at any time the record head alignment becomes suspect, it must be remembered that on machines fitted with separate "Record" and "Play" heads - such as the Byer Mk.II Series units - it is necessary to set the Play head to a Standard Azimuth Alignment Tape before adjusting the Record head.

Following is the procedure recommended with the various models in the Byer Mk.II Series - all adjustments being carried out at a tape speed of 7½ IPS. where possible.

In the instance of a machine operating at a lower speed than 7½ IPS., adjustment of the Play head can still be made with the Standard Alignment Tape - at 3¾ IPS. the frequency of the tone will be halved, but adjustment procedure is identical with that described in the following paragraphs.

For "Record" head adjustment in slower speed units, a lower frequency tone should be fed from the oscillator; e.g. 3¾ IPS., use 5 Kc. tone; 1⅞ IPS., use 2500 cycle tone.

Two methods of head locking have been employed on the Mk.II Series recorders.

(1) A socket headed locking screw for each head at the rear of the head block, which must be slackened slightly before turning the head with the Azimuth Adjustment Tool.

(2) A spring loaded screw for each head which does not require any attention before or after the adjustment is made.

For purposes of instruction it will be assumed that the earlier type of locking screw is fitted.

MODEL "66" - GENERAL PURPOSE PORTABLE

Since the amplifier of this model is dual purpose and serves both "Record" and "Play" functions, it is not possible to record and play simultaneously.

Consequently, if the Record head azimuth is to be adjusted, an additional "Play" amplifier must be available. The Byer, Miniature Transistorised Simultaneous Monitor Replay Amplifier would be suitable for this purpose.

The "Play" head

Equipment Required

(a) Standard Azimuth Alignment Tape.
(b) Azimuth Adjustment Tool.
(c) 5/64" hexagon key for locking screws.

Adjustment Procedure

(1) Load Azimuth Alignment Tape onto machine and press Play button.

(2) Slacken slightly the head locking screw.

(3) Insert Azimuth Alignment Tool into socket provided on head face and turn the head slightly in either direction to achieve maximum output meter reading from the 7Kc. tone on the tape.

(4) When maximum reading has been obtained, re-tighten the locking screw, being careful not to alter the azimuth setting whilst so doing. Observe meter reading as a check on this.

(5) Rewind Alignment Tape and remove from machine.

The Record Head

Equipment Required

(a) Reel of tape.
(b) Azimuth Adjustment Tool.
(c) 5/64" Hexagon spanner for locking screws.
(d) An Audio Oscillator capable of feeding the "66" Input with a 10Kc. signal. (5Kc. in the case of 3¾ IPS.)
(e) An additional "Play" amplifier.

Adjustment Procedure

(1) Load reel of tape onto machine.

(2) Substitute "Play" plug on rear of Tape Transport with plug or leads from additional amplifier.
NOTE:- If using the Byer Simultaneous Replay Monitor Amplifier, insert four pin plug as above, and connect the 'phone plug on the cable into the jack socket on rear of control box marked "Head Demagnetiser".

(3) Connect oscillator to appropriate input jack of recorder amplifier, and with amplifier in the corresponding "Record" condition (e.g. if the oscillator is feeding to Bridge-In, Input Selector must be set to Bridge-In, etc.) feed in a 10Kc. signal.

(4) Adjust meter reading on Record Amplifier to -6 and press Record button.

(5) Using same procedure as with Play head, adjust Record head azimuth until maximum output is obtained from the amplifier connected to the Play head.

Note:- If no output meter is available on the additional amplifier, maximum output will have to be judged aurally. If using the Byer Simultaneous Replay Monitor Amplifier, it will be necessary to use a pair of high impedance magnetic headphones.

MODEL "77" - PROFESSIONAL RECORDER

The "Play" head.

Equipment and procedure is identical with that described under Model "66" "General Purpose Portable" heading.

The "Record" Head.

Equipment required is the same as with the Model "66", with one exception - no additional amplifier is required as the "77" has separate Record and Play facilities.

Adjustment Procedure

(1) Load the machine with a normal tape.

(2) Connect oscillator to appropriate input of the "77" and feed in a 10Kc. signal.

(3) Set the "METER/600 OHMS" switch to "Record" and press Record button.

(4) Adjust "RECORD GAIN" to give a meter reading of -6 vU.

(5) With unit running in this condition, set "METER/600 OHMS" switch to Play.

(6) Slightly slacken locking screw of Record head, insert Azimuth Adjustment Tool in sockets on head face and turn in either direction for a maximum output reading on the meter.

(7) Re-tighten locking screw.

NOTE:- No provision is made for adjustment of Erase heads as this is not necessary.

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MAGNETIC TAPE RECORDERS

SERVICE AND MAINTENANCE MANUAL

PART ONE -- MODEL "66"

SECTION 4. Electronic Assembly.

The electronic assembly consists of a pre-amplifier, (Microphone and Play Head) an equalised stage for "Play" incorporating a Tone Control, an Ultra-linear Power Amplifier, an equalised Recording stage to drive the Record head and a Power Supply - all mounted on a single chassis.

A bias and erase oscillator is built into the Tape Transport Mechanism.

A study of the relevant circuit diagrams in conjunction with the following will be helpful.

MICROPHONE CHANNEL

The microphone input is selected in the extreme anti-clockwise position of the "Input Selector" switch and is connected to the grid of the EF86 valve. From the anode of this stage, signal is taken via the Input Selector switch through the "Gain Adjustment" control to the input grid of the Power amplifier (second half of 12AU7) and thence to the grid of the Phase splitting stage (first half of 12AU7).

From the phase splitter anode and cathode loads, signal is fed to the two push-pull N78 grids and thence to the output transformer. Two secondary windings are provided.

(1) Driving the Level Meter and producing the necessary output, via a pad, for the 600 ohms line output.

(2) To drive the Monitor Speaker, External Speaker and Headphones. (from which negative feed-back loop is derived).

Volume level to the internal Monitor Speaker and extension speaker jack is variable by means of the "Monitor Gain" control, but the headphones jack is not affected.

The Record head equaliser stage (second half of 12AU7) which is driven from the cathode load of the phase splitter, is the source for driving the "Record" head.

Record characteristic equalisation is also accomplished within this stage by the series resonant or capacitative circuit, depending on the tape speed, in shunt with the 3.3K ohm cathode load resistor.

RADIO CHANNEL

This is the second position of the Input Selector moving in a clock-wise direction. It connects internal radio tuner (if installed) to the "Gain Adjustment" control from whence the signal follows the same course as discussed under the heading "Microphone Channel".

PLAY CHANNEL

The central position of the "Input Selector" - it connects the "Play" head to the EF86 input grid, the EF86 Anode to the input of the Play equaliser stage, and the output of this stage to the Gain Adjustment control, thereby inserting an extra stage into the circuit.

600 OHMS AND BRIDGE IN

With the "Input Selector" set in either position, the inputs are connected directly to the Gain Adjustment control.

In all positions of the selector switch, the remaining inputs are shorted to ground to prevent cross talk and eliminating the need to remove all jack plugs not in use.

In ALL "Record" positions of the Input Selector, the High Tension to the record equalising stage and the oscillator (Pin No.4 on Power Plug) are connected, but in Play position these are open circuited.

"Radio" position connects High Tension to the Tuner socket.

The heavy duty switch bank of the Input Selector, (i.e. the bank closest to the front panel) is used for interlocking with the tape transport press button circuitry.

POWER SUPPLY

Power supply for the amplifier consists of a normal full wave rectifier-transformer combination with resistance capacity filtering.

As an additional safeguard, a high tension fuse of 250 mA. rating is mounted on the terminal strip and wired into the centre tap of the power transformer.

A 16 Volts winding on the mains transformer supplies power for the tape transport solenoid system, bias oscillator heaters and also appears at the de-magnetiser jack located on the Control Box lid at the rear of the tape transport.

OSCILLATOR

The bias and erase oscillator consists of a push-pull balanced generator producing a frequency of approximately 55Kc.

An output link on the oscillator transformer drives the dual gapped erase head through a series capacitor. The voltage across the capacitor provides a clean bias voltage that is applied through an isolating network to the Record Head.

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PART ONE -- SECTION 5

ELECTRONIC MAINTENANCE

Electronic maintenance should consist of a periodic check of voltages as indicated on the circuit diagrams and other routine checks of valves etc., as normally applied to all electronic units.

All faults in the electronic assembly will be found to be of a conventional nature, and should be treated as such, subject to a performance check of the circuit or circuits involved with the faulty component.

Faults in the electrical system of the Tape Transport will be normally confined to.....

(a) Dirty or poorly operating contacts.

(b) Faulty motor windings

(c) Loss of capacity or shorts in the dual 250mfd. capacitor.

(d) Defective motor condensors.

Service in these instances will consist of.....

(a) Cleaning and/or correctly setting operating pressures as discussed under heading "Adjustment of Contacts" -- Section 2.

(b) Replacement of faulty parts.

(c) Replacement of faulty parts.

(d) Replacement of faulty parts.

Wow on beginning or end of tape	(1) Low pressure roller tension.	Adjust as described under heading "Mal-adjustment of Pressure Roller and associated Movements" (Section 2)
* "Wow" - The term applied to undesired frequency deviations occuring at frequencies below 10 to 20 CPS.	(2) Binding in Supply Motor	Check bearings and securing screws.
	(3) Brake shoe not clearing brake drum on Supply Motor	See Section 2, under heading "Brake Servicing".
	(4) Oil on Capstan	Clean with Industrial Solvent.
General Wow.	(1) As stated above	As stated above
	(2) Dirty or worn pressure roller	Clean or replace as necessary.
High Flutter. * Flutter - Same as described under "Wow" but above 20 CPS.	Generally faulty Capstan Motor.	Return to factory for repair.
NON OPERATION		
(a) Complete failure of unit.	Blown fuse on rear of Control Box.	Replace fuse - if replacement fuse also blows, check for shorts under front cover panel and inside the Control Box at rear.
(b) Amplifier only operating.	(1) Dirty or mal-adjusted contacts.	See Section 2, "Adjustment of Contacts"
	(2) Faulty solenoid coil.	Replace with new unit.
	(3) Faulty doubler capacitor (dual 250m)	Replace with new unit.

SYMPTOMS	POSSIBLE FAULTS	REMEDIES
(c) Deck only operating	(1) Blown fuse under amplifier.	Replace fuse - if replacement fails, check for shorts in amplifier high tension circuits.
	(2) Faulty valves.	Replace and check circuit voltages.
(d) Records but does not Play.	(1) Faulty 12AX7 valve or associated component.	Replace and check circuit voltages.
	(2) Dirty or deformed Input Selector Switch contacts.	Clean with Carbon-tetrachloride or replace switch if necessary.
	(3) Faulty Play head or head wiring.	Replace head or faulty section of wiring.
(e) Plays but does not Record	(1) Oscillator not functioning	
	(a) "Play Safe" switch is set to "Safe", or broken lead at switch.	Turn key to "Record", or re-solder lead.
	(b) Faulty 12AU7 valve.	Replace and check circuit voltages.
	(c) Faulty coil.	Replace with new unit.
	(d) Relevant Input Selector switch or L2 contacts not completing high tension circuit to oscillator.	Clean and adjust - if necessary, replace with new unit(s).
	(e) Faulty component in oscillator circuit.	Replace and check circuit voltages.
	(2) Faulty Record head or head wiring.	Replace and check circuit voltages.
	(3).....	
	(a) Faulty valve (12AU7) in amplifier.	Replace and check circuit voltages.

SYMPTOMS	POSSIBLE FAULTS	REMEDIES
(e) Plays but does not Record (Contd.)	(b) Faulty component in 12AU7 circuit.	Replace and check circuit voltages.
DOES NOT ERASE		
(a) Complete non-erasure.	(1) Oscillator not functioning. (See Section (e) "Plays but does not Record" for faults.)	See section (e) in sub-sections b,c,d,e.
	(2) Faulty Erase Head.	Replace with new unit.
	(3) Faulty Series capacitor. (.15mfd)	Replace with new unit.
(b) Partial Erasure	(1) Oscillator component or valve failure. Model 66. 12AU7 on Control Box at rear of tape transport - Model 77. 12B87 in same position.	Replace faulty unit and check circuit voltages.
	(2) Faulty Erase Head.	Replace with new unit.
	(3) Faulty Series Capacitor (.15mfd.)	Replace with new unit.
	(4) Imperfect Tape Contact.	Clean head of oxide deposits.
TAPE OVER-RUN SWITCH		
(a) Does not operate.	(1) Mechanical - has oiled up.	Clean, and if necessary open up the bore of the moulding. (For details refer to Section 2 of Manual under heading "Tape Over-run Switch".)
	(2) Electrical - Contact trouble.	Clean and adjust - more return spring tension may be necessary.
(b) Operates too readily.	(1) Return spring tension too heavy.	Slacken off and if necessary, reduce operation pressure on switch contacts.

SYMPTOMS	POSSIBLE FAULTS	REMEDIES
(b) Operates too readily. (Contd.)	(2) Supply motor torque too low.	Check that motor runs freely in its bearings.
Operates only while Play or Record button depressed. (Edit position normal).	Tape Over-run switch contacts dirty.	Remove front panel of tape transport and clean Over-run switch contacts. (located adjacent to guide roller.)
Failure to Shuttle in either direction.	As above.	As above.
Tape wraps round Pressure Roller when machine is started.	(1) Brake solenoid not operating.	See section 2, under heading of "Unreliable or non-release of brakes".
	(2) Dirty or mal-adjusted L2 contacts.	Clean and adjust contacts.
	(3) Dirty or mal-adjusted tape shuttle contacts.	Clean and adjust contacts.
	(4) Faulty brake solenoid coil.	Replace with new unit.
	(5) Faulty Take-up motor.	Replace with new unit.
	(6) Poor connection at Tape Shuttle Control switch	Clean and if necessary, adjust contacts.
Pressure Roller tension on Capstan inadequate.	(1) Tape Lift Arm fouling in recess in head block.	Straighten Tape Lift Arm until clearance is obtained.
	(2) Slackness in mechanical linkages....	
	(a) Rivets on armature assembly	Re-clinch rivets or replace with new unit.

SYMPTOMS	POSSIBLE FAULTS	REMEDIES
Pressure Roller tension on Capstan inadequate. (Contd.)	(b) Solenoid frame has rotated slightly.	Re-position and lock in place.
	(c) Armature fixing screws loosened.	Tighten screws and lock them.
	(3) Capstan Motor bearing housing(s) has slackened allowing Capstan to move sideways.	Return motor to factory for repair.
	(4) Dirty Pressure Roller or Capstan.	Clean with Carbon-tetrachloride.
	(5) Worn pressure roller.	Replace with new unit.

MAGNETIC TAPE RECORDERS

SERVICE AND MAINTENANCE MANUAL

PART TWO -- MODEL "77"

SECTION 1. General description of the Tape Transport Mechanism

As with the Model "66" the tape transport for the Model "77" is powered by two capacitor induction spooling motors and a capstan motor which is single phase, synchronous, two speed and with inbuilt flywheel.

Mechanical linkages have been eliminated from the tape drive to keep wow and flutter at an absolute minimum and the capstan motor shaft is precision ground to correct size to provide the actual capstan.

The large brake drums are moulded onto the spooling motor extension shafts and are again precision ground for smooth operation. Brake shoes align automatically and are self energising in opposite directions, thus providing more powerful braking to whichever spool is unwinding tape and precluding the possibility of tape throwing during shuttling.

The brakes are held ON by damped springs and are released by the operation of a common solenoid taking up two connecting tie-rods.

A second solenoid carries an arm on which is mounted the pressure roller and tape lift arm. When the machine is in a condition ready for shuttling, i.e. the pressure roller solenoid is de-energised, the tape lift arm holds the tape away from the heads and opens the Record and Play head shields.

Set in the pressure roller arm is a cross arm which operates a bank of contacts on the right hand side. The opposite end of this arm runs on the Shuttle Monitor Control cam.

The two solenoids (pressure roller L1, brake L2) are operated from a full wave voltage doubler circuit comprising a selenium rectifier and a dual 250 mfd. electrolytic capacitor. This results in a peak voltage of approximately 45 volts no load, dropping to approximately 25 volts when both solenoids are energised, giving an initial surge current through the solenoids to ensure a safe margin for their reliable operation. The positive of this doubler circuit returns to the common ground, whilst the negative connects to each of the two solenoids. (L1 and L2).

The 16 volts A.C. supply required for the rectifier is obtained from a special winding on the amplifier power transformer through pins No. 5 and 6 of the amplifier power source socket at the rear left side of the transport mechanism.

This 16 volts A.C. supply is also brought out to a jack on the Control Box lid for use with a 16 volts head de-magnetiser and other ancillary items, but is dropped to 12 volts for the 12BH7 oscillator valve heaters.

PLAY MODE

When the "PLAY" button is pressed, a circuit is made through the L2 (brake) solenoid via tape shuttle control contacts A and B, and "PLAY" button contacts to ground.

As the solenoid (L2) closes, the brake shoes are opened, thereby operating the bank of contacts designated "L2" on the circuit diagram. One pair of this bank of contacts completes a circuit through the Pressure Roller (L1) solenoid, which in turn closes contacts "L1".

With the solenoids energised, an alternative or holding circuit is made through.....

(a) Pins 1 and 2 of Remote Control Socket (bridged in dummy plug).

(b) The "STOP" button.

(c) L1 contacts A and B. (closed by pressure roller cross arm).

(d) L2 contacts C and D. (closed by brake shoe being released).

(e) Tape Over-run Switch. (held closed by tape tension on actuating arm.)

(f) The 10 ohms 2 watts resistor to ground.

Thus when the "PLAY" button is released, the solenoids remain energised through their holding circuit.

When the L2 contacts are operated by the right hand brake shoe being lifted from the brake drum by its solenoid, the capstan motor and spooling motors are energised (via appropriate resistances) from the mains supply.

Pressing the "STOP" button or releasing tape tension on the actuating arm of the tape over-run switch breaks the holding circuit, the solenoids drop out, brakes are applied and the motors switched off.

RECORD MODE

Pressing the "RECORD" button forms a circuit through L2 (brake) solenoid via tape shuttle contacts A and B, Record button contacts, Record relay coil L3, Play Safe Switch contacts A and B and a 2.5 ohms 1 watt resistor to ground.

With this circuit made, L3 is energised which in turn connects high tension voltage (appearing on pin No.4 of the amplifier power source socket) to the oscillator circuit and also, via a filter to pin No. 7 of the amplifier power source socket, thereby switching on the record stage in the amplifier section.

As the solenoid L2 closes, the L2 contacts are operated. One pair energises L1 solenoid which in turn closes contacts L1.

In this instance the holding circuit is made through...

(a) Pins 1 and 2 of Remote Control socket. (bridged in dummy plug)

(b) The "STOP" button.

(c) L1 contacts A and B. (closed by Pressure Roller cross arm).

(d) L2 contacts C and D. (closed by release of brake shoe).

(e) Tape Over-run Switch. (closed by tape tension).

(f) The 10 ohms 2 watts resistor to ground.

With L3 contacts C and D now closed (by initial operation of relay) this relay is now connected across the 10 ohms resistor which has sufficient voltage across it (developed from the solenoid current) to hold the L3 relay in circuit.

Should the "PLAY" button be pressed while the machine is in the "RECORD" mode, the relay (L3) coil is shorted out via the 2.5 ohms resistor and will drop out of circuit, disconnecting the high tension to the oscillator and Record stages.

If the "RECORD" button is pressed while the machine is still in the "PLAY" mode, the relay L3 will again operate on the developed voltage across the 10 ohms resistor and recording will again take place.

It will be seen therefore that with the Model 77 it is practicable to alternate between Record and Play while the tape is in motion by merely operating the respective press buttons.

In both the Record and Play modes the Supply Reel motor is connected in series with a resistance to the mains supply via L2 contacts A and B. The Take-up Spool motor is similarly treated but in this instance the resistance in series is lower in value. This provides optimum take-up and hold-back torques for correct tape tension.

TAPE OVER-RUN SWITCH

The actuating arm for this switch would normally cause some inconvenience during threading of the tape, but a small solenoid is incorporated which holds the arm out of the tape path when it is pressed to its extreme position toward the bottom of the transport.

When, in any mode, the machine is operated, the L2 contacts open the circuit to this solenoid, releasing the actuating arm which is spring loaded to ride against the tape.

SPEED CHANGE

When the Change Speed switch is moved to the higher speed position, a circuit is made from the voltage doubler negative to pin No.8 on the amplifier power source socket. This voltage is utilised to operate the equalising relays in the amplifier section.

TAPE SHUTTLING

When the Tape Shuttle control is rotated to either of the "EDIT" positions, contacts C and B (tape shuttle control contacts) are opened, thereby breaking any circuit through solenoid L1 and cancelling any previous mode of operation.

Contacts A and B are also broken and at the same time, contacts A and D / A and E are made. This has the effect of energising L2 only and L2 contacts are operated as is also the Tape Shuttle control switch.

One pair of L2 contacts (A and B) connect the A.C. mains to the two spooling motors via the Tape Shuttle control switch and an appropriate resistor.

The Spooling Motors now have equal torque in opposite directions and remain static, keeping the tape under tension. This condition allows the tape to be rocked over the heads for Editing, Cueing etc.

Turning the control to position 1 opens Tape Shuttle Control contacts A and E but leaves contacts A and D made. Contacts B and C remain open. The L2 solenoid circuit is now through Tape Shuttle contacts A and D L2 contacts C and D and via Tape Over-run switch to ground.

The Tape Shuttle control switch now also supplies the spooling motor, toward which it has been turned, with power through series resistances. Through further series resistances power is applied to the opposing spooling motor to provide hold-back tension whilst shuttling.

This condition conversely applies when the control is turned in the opposite direction.

In positions 2, 3 and 4, spooling hold-back torque and tape shuttle control contacts remain as in position 1, but the torque is increased on the motor toward which the control has been turned.

Should the Tape Over-run Switch be operated, the solenoid L2 becomes de-energised and the machine will stop.

The control must then be returned to the "STOP" position before any further operation may be commenced. When the machine is shuttling and the control is returned to "STOP", contacts A and D open, releasing the solenoid and stopping the machine. All contacts are now at normal and ready for further operations.

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PART TWO - MODEL "77"

SECTION 2. Service and Maintenance.

REFER TO PART ONE, SECTION TWO OF THE MANUAL.

PART TWO - MODEL "77"

SECTION 3. Azimuth Adjustment.

REFER TO PART ONE, SECTION THREE OF THE MANUAL.

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SERVICE AND MAINTENANCE MANUAL

PART TWO - MODEL "77"

SECTION 4. Electronic Assembly.

The amplifier for the Mark II Series Model "77" has been designed to permit the simultaneous recording, playing and monitoring of a signal on magnetic tape.

These functions can proceed independently and simultaneously, thus giving great operational flexibility to the machine.

In order to understand the manner in which this is accomplished it is convenient to consider separately the four main sub-sections of the amplifier....

(a) The Recording Channel

(b) The Play Channel

(c) The Monitor Channel

(d) The 600 ohms Line Channel

RECORD CHANNEL

The input from the 50 ohms microphone socket is coupled through a balanced and shielded transformer to an EF86 low noise penthode microphone amplifier. Provision is made through resistive networks to couple to the primary of this transformer from a 600 line source either with 600 ohms impedance or bridging.

The output of this stage is at a level sufficient to feed to the monitor amplifier. The output is also coupled through a level control ("Record Gain") into the first half of a 12AU7.

This stage incorporates a feedback loop which, as well as giving a low output impedance for connection to the 600 ohms line amplifier, can also be used to adjust the frequency response of the Record Amplifier. A small trimming capacitor is connected across the series input resistance for this purpose.

The output from this stage is coupled to the 600 ohms line amplifier and also, through a potentiometer, to the second half of the same valve. This potentiometer (Record Gain pre-set) allows the recording level to be adjusted, independent of the meter readings, to compensate for the various tapes in current

use. It also can be used for setting the recording levels to match other equipment as desired.

The output of the second half of this 12AU7 then feeds the Recording Amplifier stage, which is another half 12AU7 operated with a high cathode impedance to raise its plate resistance to give constant current through the Recording Head.

Equalization is applied by means of a by-pass on this feedback circuit adjusted to the tape speed in use.

This adjustment is accomplished automatically by a relay coupled to the Change Speed switch.

THE PLAY CHANNEL

The output from the Play head is connected to an EF86 as an input stage, followed by an EF86 as feedback type equalising stage. The playback equalisation provided is in accord with the C.C.I.R. specifications and is adjusted by a relay as the tape speed is changed.

The output from the equalising stage is made available to both the monitor amplifier and the 600 ohms line amplifier.

THE MONITOR CHANNEL

The Monitor Amplifier consists of half a 12AU7 coupled to an N78 output stage which supplies power to the built in speaker - both positive and negative feedback is used in this amplifier to conserve space and minimise distortion.

The output from this amplifier is also available for external use on the front panel at the output jacks marked "2 OHMS".

The input to this amplifier comes through a center tapped potentiometer. The center tap is connected to earth and either end goes to the appropriate points on the Play and Record amplifiers.

The input grid of the monitor amplifier goes to the moving arm. It is then apparent that movement of the potentiometer controls both the source and the amplitude of the signal.

600 OHMS LINE CHANNEL

This amplifier consists of a 12AX7 with one half operating as an amplifier and the other as a phase changer.

This is followed with a 12AU7, both halves operating in push-pull.

Feedback is applied to the cathode of the 12AX7 amplifier stage from a tertiary winding on the output transformer.

The output of this amplifier is connected to the V.U. Meter and is also available on the front panel output jacks marked "600 OHMS".

The input for this amplifier can be selected by a switch from either the Record or Play channel, thus allowing the V.U. Meter to be used on either as required.

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PART TWO - MODEL "77"

SECTION 5. Electronic Maintenance.

REFER TO PART ONE, SECTION FIVE OF THE MANUAL.

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PART THREE - AUXILIARY SPOOLING MECHANISM

SECTION 1. General Description.

The Auxiliary Spooling Mechanism consists of two spooling motors mounted on a chassis of identical dimensions to that of the Mark II Series Tape Transport Mechanism.

The unit mounts directly above and in line with the Tape Transport. Adaptor Hubs are supplied to accommodate 10½" N.A.B. spools.

Power supply is derived from the tape transport via the Octal socket located on the Control Box lid (marked "AUXILIARY SPOOLING MECHANISM") at the rear of the transport. Normally this socket is fitted with a dummy plug.

Removal of this dummy plug disconnects the spooling motors of the transport and provides connection to the two motors and the brake solenoid of the auxiliary mechanism.

MOTORS.

These differ slightly from those used in the Tape Transport in that the torque is increased to allow for comfortable handling of the larger 10½" spools.

BRAKE SOLENOID

A rectifier system is employed to supply the brake solenoid with D.C. power and it should be noted that this system, unlike that of the Tape Transport, is DIRECTLY CONNECTED TO THE A.C. MAINS AND CARRIES 240 VOLTS.

The solenoid is more powerful than the unit used in the Tape Transport - this again to provide adequate control of the larger spools.

An adjustment has been provided for seating the armature on the poles when the solenoid has been energised. This consists of two nuts located on the armature spring.

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SERVICE AND MAINTENANCE MANUAL

SECTION 2. Service and Maintenance.

MOTORS AND BRAKES

Service and maintenance of the auxiliary spooling mechanism in regard to spooling motors and braking is identical with that described under the respective headings in Part 1, Section 2 of the manual.

ADJUSTMENT OF BRAKE SOLENOID.

This adjustment should be made only if the solenoid becomes noisy during service.

No hard and fast rule can be laid down for the adjustment and no great alteration of existing setting of the nuts will be necessary to quieten the unit.

Experimental rotation of either or both nuts, over a maximum of one quarter of a turn will usually remedy any error.