

PATENT SPECIFICATION

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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Magnetic Tape Recorder.

We, AKAI ELECTRIC COMPANY LIMITED, a Japanese Corporation of No. 14, 2-chome-12, Higashi-Kohjiya, Ohta-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a tape recorder.

According to the invention, there is provided a tape recorder including a driving system constructed to act upon two open tape reels and tape so that both reels rotate and the tape is unwound from one reel, is pressed against a first rotating capstan included in the driving system and is then wound on the other reel, the tape recorder further including a first group of magnetic heads arranged to act on the tape as it passes from one reel to the other, a second capstan for driving further tape, the second capstan being mechanically coupled to the first so that the tapes are driven synchronously, a second group of magnetic heads arranged to act on said further tape, a pre-amplifier system, a recording amplifier arranged to receive output current from the pre-amplifier system and an opening in the casing through which a cartridge containing the further tape can be inserted and withdrawn so that the further tape comes into and out of a position where it can co-operate with the second capstan and the second group of magnetic heads.

The two capstans may be on a single shaft and this may be belt-driven.

The tape recorder may have switch means

arranged to connect a selected head of one of the groups of magnetic heads to the input of the pre-amplifier system and a selected head of the other group to the output of the recording amplifier so that a recording on one tape can be transferred to the other tape.

An example in accordance with the invention is described below with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of a tape recorder,

Figure 2 is a partly sectional view of part of the tape recorder shown in Figure 1, and

Figure 3 is a circuit diagram of the same tape recorder.

Referring now to the accompanying drawings, especially Figures 1 and 2, the illustrated tape recorder comprises a housing 201 having upper panel 222 above which are tape supply turn table 202; tape winding turn table 203; first selection control knob 204 for recording, reproducing and stopping; second selection control knob 205 for quick feed, rewinding and stopping; third control knob 206 for modifying equalizer constant; fourth control knob 207 for tone level adjustment; and fifth control knob 208 for tone quality adjustment, all being of conventional design. On the panel 222, there are also first control button 209, for on-off control of open reel operation mode; second control button 210 for on-off control of cartridge operation mode; third control button 211 for on-off control of dubbing operation; a removable head cover 212; a conventional pressure roller 213 adapted for

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cooperation with a rotatable capstan 214 to feed magnetic tape T_0 at a constant speed; a VU-meter 9, an input terminal 8, a tape guide post 217 and a power on-off control switch 239. Tape supply reel 218 is fixedly mounted on the turn table 202 and tape winding reel 219 is similarly mounted on the turn table 203. At the front panel at 201a of the housing 201, there is a large opening 220 for the insertion and reception of a conventional tape cartridge 230.

Within the head cover 212 and on the panel 222, there is a first head group 1 comprising a combined record and reproducing magnetic head H_1 and, an erase head H_2 , said both heads being adapted for contact with the magnetic layer on said tape T_0 , and a biasing head H_3 which is adapted for providing magnetic biasing effect towards said layer at a slight distance from the back side of the non-magnetic layer of said tape. Although not shown, the biasing head H_3 is pivotable between its operating position kept at a slight distance from the tape and its off-service position further receded from the tape.

Control knob 204 is, although not shown, operatively connected with: the pivoting mechanisms, not shown, for biasing head H_3 and pressure roller 213; conventional brake mechanisms, not shown, for both turn tables 202—3; and control mechanisms, again not shown, for switch group SW_4 and SW_5 to be described, respectively. With the knob 204 positioned at its off-service position, biasing head H_3 and pressure roller 213 are kept at their receded non-operative position; both turn tables 202—3 are kept in their braked condition; switch group SW_4 is kept in its reproducing position, while switch group SW_5 is held in its stopping position, as will be described more specifically hereinafter.

On the contrary, with the knob 204 manipulated to its recording position, both turn tables 202—3 are released from their braked condition; pressure roller 213 is brought into its position to cooperate with the rotating capstan 214 so that the tape T_0 is squeezed between capstan 214 and pressure roller 213 and fed at a constant speed; switch groups SW_4 and SW_5 are transferred to their recording position; and biasing head H_3 is brought to its operating position nearer to the now running tape T_0 .

Although not shown, knobs 207 and 208 are operatively connected with the sliders of potentiometers VR_1 and VR_2 to be described, respectively.

Control buttons 209, 210 and 211 are operatively connected with switch groups SW_1 , SW_2 and SW_3 to be described, respectively, although not specifically shown. These control buttons are so designed and arranged that when any selected only one

thereof is depressed, one or both of the remainder, if previously depressed, will be automatically brought back to their non-depressed position.

Knob 206 is operatively connected with switch group SW_6 to be described and by manipulating the knob, an equalizer circuit may be transferred to any selected one of three stages, corresponding to three selectable tape running speeds such as $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{1}{4}$ i.p.s., although the mechanical connecting means are not shown.

In Figure 2, a horizontally extending mounting plate 223 is fixedly attached to said housing 201, and a box 224 forming cartridge insertion opening 220 is fixedly attached to said plate 223 by means of screwed post 225, auxiliary plate 233 and several fixing screws 97—99.

Numeral 227 denotes a bearing for a shaft having the capstan 214 at its upper end and a second capstan 229 at its lower end, said bearing being fixedly mounted on mounting plate 223 by means of support plate 96 and a plurality of fixing screws 94—95. The shaft and the capstans and a flywheel 228 are all integral. The capstan 229 cooperates with cartridge 230 when it is within the box 224. Bottom bearing 231 is fixedly mounted in the bottom wall 224a of box 224 and supports rotatably the capstan 229 at its lowermost end. A belt 232 passes around the flywheel 228 and is drivingly connected with a main drive motor 304 of the tape recorder. The main motor 304 is energized from current source 305 by closing main switch 239 inserted in the motor drive circuit.

Spring strip 236 is attached to the upper wall plate 224b defining partially the cartridge insertion opening 220, for resiliently urging the inserted cartridge 230 into its operating position as shown in Figure 2. This cartridge is shown in Figure 1, however, in its partially inserted position for better understanding of the mode of use thereof.

While the main part of the cartridge insertion opening 220 has a rectangular cross-section for the reception of a substantial part of cartridge 230 inserted therein with minimum play, the inlet part of said opening 220 is flared, as shown in Figure 2, reducing gradually in its size inwardly and defined by a horizontally positioned auxiliary box 234, to facilitate insertion of the cartridge. At the mouth of the opening, there is a frame 235 fixedly attached to the front panel 201a, for increasing the mechanical strength at the mouth.

When the cartridge 230 fitted with pressure roller 237 is inserted in the opening 220 to a full extent as shown in Figure 2, the roller 237 presses the cartridge tape T_0 onto the capstan 229, and the tape is fed at a specified constant speed while main-

taining its sliding contact with magnetic heads H_1 and H_2 belonging to head group 2, as only schematically represented in its entirety in Figure 3.

In Figure 3, a conductor line 100, starting from first stage amplifier 3, is connected through second stage pre-amplifier 4 and recording amplifier 5 with the positive side, shown only briefly by "+B", of a d.c. voltage source, not shown.

Amplifier 3 comprises an input terminal 12 and d.c. coupling, earthed emitter transistors Tr_1 and Tr_2 , said terminal 12 being connected through coupling capacitor C_{10} to the base electrode 101 of transistor Tr_1 . The base electrode 101 is connected through resistor R_{11} to earth and through resistor R_{10} to the positive line 100, respectively, for supplying the transistor with base current. The emitter electrode 102 of the transistor Tr_1 is earthed through emitter resistor R_{13} and connected to terminal 26 leading to time constant circuit elements for negative feedback to be later described more specifically. Collector electrode 103 of transistor Tr_1 is connected through load resistor R_{12} to positive conductor 100 and directly to the base electrode 104 of transistor Tr_2 .

Collector electrode 105 of transistor Tr_2 is connected through load resistor R_{14} to positive conductor 100 and through coupling capacitor C_{12} to output terminal 13. Emitter electrode 106 is earthed through emitter resistor R_{15} .

Second stage pre-amplifier 4, again of d.c. coupling, grounded emitter type, comprises input terminal 24, transistors Tr_3 and Tr_4 and output terminal 27. Emitter electrode 107 of transistor Tr_3 is connected through resistor R_{16} for negative feedback purpose to output terminal 27. The arrangement of circuit components of this pre-amplifier 4 is similar to that of the first stage preamplifier 3 so that further detailed description may be omitted.

Recording amplifier 5 comprises earthed emitter transistor Tr_5 and input terminal 29 which receives recording signal current and is connected through variable resistor R_{17} of semi-fixed type to earth. Slider 108 of variable resistor R_{17} is connected through coupling capacitor C_{13} to the base electrode 109 of transistor Tr_5 , said electrode being connected through resistor R_{18} to positive conductor 100 and through resistor R_{19} to earth.

Emitter electrode 110 of transistor Tr_5 is connected through emitter resistor R_{20} to earth and through a series combination of capacitor C_{14} and inductor L_8 adapted for high peaking purpose so as to realize pre-emphasis, again to earth.

With higher frequency components of recording signal current applied to input terminal 29, as will be later described, the

amplifying factor of recording amplifier 5 will be increased on account of the correspondingly lowered impedance of said series combination, thereby attaining a correspondingly intensified level of otherwise weakened higher frequency signal components. Inductor L_8 and capacitor C_{14} are connected to terminal 39.

Collector 111 of transistor Tr_5 is connected through load resistor R_{21} to positive conductor 100, on the one hand, and through a coupling capacitor C_{15} and a trap circuit comprising a parallel combination of capacitor C_{16} and inductor L_7 to output terminal 41, on the other.

The said trap circuit has a high impedance value so as to trap the biasing current unintentionally conveyed from output terminal 41, so as to maintain the regular working conditions of recording amplifier 5.

Input terminal 8 which receives audio signal currents is connected through a conductor line 10 to the left-hand stationary contact a of switch S_1 belonging to switch group SW_4 . Although not shown, the conductor line 10 has an insulated outside conductor sheath which is earthed.

The middle stationary contact b of said switch S_1 is connected through conductor 11 to input terminal 12 of preamplifier 3 and the right-hand stationary contact c of the same switch is connected through junction 57 to the left-hand stationary contact a of switch S_2 and through lead 56 to the right-hand stationary contact c of switch S_2 . It should be noted that the left-hand, the middle and the right-hand stationary contact of each of the three-contact transfer switches shown in Figure 3 are denoted commonly by a , b , and c for simplicity of the drawing and for better and comparative understanding of operations of these switches.

Output terminal 13 of first stage preamplifier 3 is connected through junction point 15 and conductor 16 to stationary contact b of switch S_{12} of switch group SW_2 for cart-ridge service; contact a of the last mentioned switch is connected through conductor 17 to contact b of switch S_7 of switch group SW_1 .

Contact c of switch S_7 is connected through conductor 18 to contact c of switch S_{13} , which contact c is connected in turn through conductor 19 to level adjusting potentiometer VR_1 which is earthed at the opposite end.

Contact a of switch S_7 is connected through junction point 22 and conductor 23 to input terminal 24 of second stage pre-amplifier 4.

Time constant elements consisting of series-connected resistor R_1 and capacitor C_1 for negative feedback purpose for pre-amplifier 3 are connected between contact a 130

of switch S_4 and junction point 61, while series-connected resistors R_4 and R_5 are connected between contact b of switch S_{20} belonging to switch group SW_5 and junction point 61. Contact a of switch 20 is idle, while contact c of the same switch is connected to an intermediate point between said resistors R_3 and R_4 . Said junction 61 is connected through conductor 90 to terminal 26 of preamplifier 3. The movable contact of switch S_{20} is connected through resistor R_5 to junction 61 and through capacitor C_4 , junction 60 and conductor 59 to contact b of switch S_{13} . Resistors R_3 , R_4 and R_5 and capacitor C_4 serve as time constant elements for de-emphasis purpose in the course of open reel reproducing operation to be described. By manipulating the switch group SW_6 , the time constant may be modified according to the selected tape speed.

Junction 60 is connected, through series-connected resistor R_6 and capacitor C_7 , constituting the time constant elements used for cartridge reproducing operation, to contact c of switch S_4 belonging to switch group SW_4 , said contact being connected in turn through conductor 58 to contact a of switch S_{13} of switch group SW_7 , contact c of switch S_{13} being connected in turn to junction point 61. Contact b of switch S_4 is connected through conductor 25 to junction point 15.

Output terminal 27 of second stage preamplifier 4 is connected through junction point 28 to input terminal 29 of recording amplifier 5, having output terminal 41 which is connected through junction 43 and conductor 44 to contact b of switch S_{14} belonging to switch group SW_1 . Contact a of switch S_{14} is connected through conductor 45 and junction 46 to contact c of switch S_2 belonging to switch group SW_4 , and to contact a of switch S_3 . Contact b of switch S_2 is connected to earth.

Intermediate terminal 39 of recording amplifier 5 is connected to contact b of switch S_8 belonging to switch group SW_1 through conductor 40, contact a of said switch S_8 being connected in turn through conductor 75 to contact b of switch S_{10} of switch group SW_6 and contact c of said switch S_8 being connected through conductor 76 to movable contact d of switch S_{19} . An intermediate point between capacitors C_2 and C_3 serving as time constant elements for pre-emphasis purposes in recording operation is connected to earth, while one side of said capacitor C_3 is connected to contact a of switch S_{19} . One side of said capacitor C_2 is connected to contact b of switch S_{10} and through conductor 75 to contact a of switch S_8 .

By manipulating switch group SW_6 depending upon selected tape speed, the time

constant elements to be included in recording amplifier 5 may be thus modified. Contact c of switch S_{10} is idle.

Output terminal 27 of second stage preamplifier 4 is connected through junction 28 and conductor 30 to junction 31, thence through series-connected capacitor C_5 , potentiometer VR_2 and capacitor C_6 , constituting tone quality control circuit, to earth.

Slider 63 of potentiometer VR_2 is connected to contact c of switch S_5 of switch group SW_4 . Contact a of switch S_5 is idle. Junction 31 is connected through conductor 32 and resistor R_5 to input terminal 33 of main amplifier 6. Contact b of switch S_5 is connected through junction 64 and conductor 65 to input 33 of main amplifier 6. Output terminal 34 of the latter is connected through conductor 35, junction point 36 and conductor 66 to the operating coil 303 of loud speaker SP, thence to contact c of switch S_6 .

VU-meter 9 is connected by its one side to junction point 36 and by its other side through junction 37 and conductor 38 to contact a of switch S_6 , contact b of which is earthed. Junction 37 is earthed through resistor R_9 .

Working coil L_1 of combined recording and reproducing head H_1 for open reel service is earthed by its one end and connected by its another end through conductor 48 to contact a of switch S_{11} belonging to switch group SW_2 .

Working coil L_2 of erase head H_2 is earthed by its one end and connected by its other end through conductor 55 to contact c of switch S_{10} belonging to switch group SW_1 .

Working coil L_3 of biasing head H_3 is earthed by its one end and connected by its other end through conductor 53 to contact c of switch S_9 of switch group SW_1 .

Working coil L_4 of combined recording and reproducing head H_4 for cartridge service is earthed by its one end and connected by its other end through conductor 72, junction point 71 and conductor 70 to contact c of switch S_{11} . On the other hand, junction point 71 is connected to stationary contacts c of switch S_{14} .

Working coil L_5 of erasing head H_5 is earthed at its one end and connected by its other end through a lead 73 to stationary contact a of switch S_{10} .

Numerical 7 denotes a high frequency oscillator of conventional design and thus shown schematically only by a block. This oscillator 7 is designed and arranged to supply high frequency currents for biasing service as well as erasing service, and provided with output terminals 51 and 54 for respective purposes.

Output terminal 54 is connected to stationary contact b of switch S_{10} , while

output contact 51 is connected through a lead 52 to contact *b* of switch S_9 . Stationary contact *a* of switch S_9 is connected through variable resistor VR_3 for adjusting the biasing current to junction point 43.

Stationary contact *a* of switch S_{15} belonging to switch group SW_3 for dubbing service is connected through a lead 21 to junction point 22, while second stationary contact *b* of the same switch S_{15} is connected to the wiper 20 of variable resistor VR_1 for volume control service and third contact *c* of the same switch is connected through lead 80 and junction point 64 to stationary contact *b* of switch S_5 .

Second stationary contact *b* of switch S_{11} belonging to switch group SW_2 is connected through a lead 47 to second stationary contact *b* of switch S_3 belonging to switch group SW_4 .

Movable contact *d* transfer switch SW_5 having two stationary service contacts *a* and *b* and an idle contact *c* is mechanically coupled with first selection control knob 204 on the panel 222, as was referred to hereinbefore, and electrically connected to the d.c. source "+B". The first stationary contact *a* of the same switch is connected through junction point 49 and lead 50 to the input of the oscillator 7 and the second contact *b* is connected through a lead 300 to the third stationary contact *c* of switch S_{16} belonging to switch group SW_3 . Second contact *b* of switch S_{16} is connected through a lead 301 to the first contact *a* of switch SW_5 . First contact *a* of switch S_{16} is idle.

The operation of the tape recorder so far shown and described is as follows:

Preliminary Manipulation

In order to initiate any one of the several operations of the tape recorder to be described, main switch is at first manipulated to close. Then, drive current is supplied from the current source 305 to main drive motor 304. Rotation is transmitted from the motor 304 through transmission belt 232, partially shown in a simplified manner only by a single line, to flywheel 228 which thus drives both capstan 214 and 229 in unison.

Open Reel Recording

When it is desired to initiate an open reel recording service, first control knob 204 is turned manually in the clockwise direction from its neutral, shown in Figure 1, to its recording position, and third control knob 206 is kept in its shown position which corresponds to a second speed step of $3\frac{1}{2}$ i.p.s. By this manipulation, the tape T_0 is caused to run from tape feed reel 218 to wind-up reel 219 by the engagement of pressure roller 213 with upper capstan 214. Next, first control button 209 for initiating

the open reel operation is depressed. By these manual control operations, all the constituent switches of switch groups SW_1 , SW_2 , SW_3 , SW_4 , and SW_5 are positioned at their respective first positions shown by full lines in Figure 3, and the switches of group SW_6 are in their illustrated position for carrying out the desired open reel recording operation.

Under this operating condition, when audio signal current is applied on input terminal 8 from a source such as microphone, record player or the like, not shown, it flows thence through lead 10, contacts *a* and *b* of switch S_1 , and lead 11 to the input terminal 12 of preamplifier 3. The audio current is conveyed further through coupling condenser C_{10} to the base 101 of transistor Tr_1 and the thus amplified current appears at the collector 103. The current is further conveyed therefrom to the base 104 of transistor Tr_2 , and the thus again amplified current appears at the collector 105, thence through coupling condenser C_{12} to output terminal 13.

The amplified audio current is still further conveyed through lead 14, junction point 15 and lead 16 to second contact *b* of switch S_{12} , thence through contact *a* of the same switch S_{12} ; lead 17; contacts *b* and *c* of switch S_7 ; leads 18 and 19 to potentiometer VR_1 , thence further through its slider 20; contacts *b* and *a* of switch S_{15} ; lead 21 junction point 22 and lead 23 to the input terminal 24 of a second stage preamplifier 4.

On the other hand, a part of the amplified current in preamplifier 3 is conveyed through junction point 15; lead 25; contacts *b* and *a* of switch S_4 ; condenser C_1 and resistor R_1 serving as time constant elements; junction point 61; lead 90; and terminal 26 for feedback purposes to emitter 102 of transistor Tr_1 , thereby constituting a conventional negative feedback circuit so as to improve the frequency response, linearity and stability in operation of the preamplifier.

The audio current applied to the input terminal 24 of the second stage preamplifier 4 is amplified as before and appears at output terminal 27. A part of the amplified current is conveyed through feedback resistor R_{16} back to the emitter 107 of transistor Tr_2 for negative feedback purposes as before.

The amplified current in the second stage preamplifier 4 is fed from output terminal 27 through junction point 28 to the input terminal 29 of recording amplifier 5. This applied current is fed thence through semi-fixed resistor R_{17} provided for level adjusting purpose, its slider 108 and coupling capacitor C_{13} to the base 109 of transistor Tr_3 , thereby the amplified current appearing at the emitter 111. The amplified current is conveyed thence through coupling

condenser C_{15} and the trap circuit comprising inductor L_7 and capacitor C_{16} , to output terminal 41.

In the recording amplifier 5, there is provided a pre-emphasis circuit consisting of a series combination of inductor L_a and capacitor C_{14} , which capacitor is connected to earth in parallel with condenser C_2 through terminal 39; lead 40; contacts b and c of switch S_3 ; lead 76; and contacts d and b of switch S_{10} . By manipulating the movable contact d of switch S_{10} by means of control knob 206 which is, for this purpose, operatively connected with switches S_{10} and S_{20} , although the connecting particulars are omitted from the drawing only for simplicity, a proper pre-emphasis effect is obtained according to the preselected tape running speed.

The amplified current in the recording amplifier 5 is delivered from output terminal 41 through lead 42; junction point 43; lead 44; contacts b and a of switch S_{14} ; lead 45; junction point 46; contacts a and b of switch S_3 ; lead 47; contacts b and a of switch S_{11} ; and lead 48 to the working coil L_1 of the combined head H_1 .

A part of the amplified signal current in preamplifier 4 is conveyed from junction point 28 through lead 30, junction point 31, lead 32 and resistor R_5 to input terminal 33 of main amplifier 6, the amplified current being conveyed to output terminal 34.

This amplified audio signal current is then conveyed through lead 35 and junction point 36 to VU-meter (or volume unit indicator) 9 so as to operate the latter, thence conveyed through junction point 37, lead 38 and contacts a and b of switch S_8 .

A d.c. drive current flows from current source "+B" to biasing oscillator 7 through movable contact d and stationary contact a of transfer switch SW_5 , operatively connected as already referred to, with first control knob 204; junction point 49 and lead 50, so as to bring the oscillator into operation. The biasing current delivered from the latter flows through output terminal 51, lead 52, contacts b and c of switch S_6 and lead 53 to the working coil L_3 of biasing head H_3 , thereby the biasing effect being imposed on the open-reel magnetic tape T_0 , and thus the audio signal is magnetically recorded on the latter by means of the combined head H_1 , as is commonly known.

On the other hand, an erasing current is fed from oscillator 7 through output terminal 54; contacts b and c of switch S_{10} ; and lead 55 to the working coil L_2 of erasing head H_2 , as again commonly known.

Open-Reel Playback Operation

When it is desired to initiate an open-reel playback operation, the first control knob 204 is turned in counter-clockwise direction

in Figure 1, from the position shown therein, to its playback position, and the first control button 209 is depressed.

By these manipulations, all of constituent switches of switch groups SW_4 and SW_5 are brought into respective transferred position as shown by dotted lines in Figure 3, while the constituent switches of switch groups SW_1 , SW_2 , and SW_3 are kept at their respective former positions shown by full lines and the switches of groups SW_6 are in the illustrated positions.

Under these conditions, recorded tape T_0 will run in the same direction and manner as before and audio signal will be picked up from the running tape by means of the combined head H_1 .

The pick-up current in the working coil L_1 of the head H_1 is conveyed therefrom through lead 48; contacts a and b of switch S_{11} ; lead 47; contacts b and c of switch S_3 ; lead 56; junction point 57; contacts c and b of switch S_1 and lead 11 to the input terminal 12 of first stage preamplifier 3.

The audio pick-up signal current is then amplified in the preamplifier as before and fed from its output terminal 13, thence through lead 14; junction point 15; lead 16; contacts b and a of switch S_{12} ; contacts b and c of switch S_7 ; lead 18; lead 19; potentiometer VR_1 and its slider 20; contacts b and a of switch S_{16} ; lead 21; junction point 22; and lead 23 to the input terminal 24 of second stage preamplifier 4.

A part of the amplified current in the preamplifier 3 is conveyed therefrom through junction 15; lead 25; contacts b and c of switch S_4 ; junction point 57; lead 58; contacts a and b of switch S_{13} ; lead 59; junction point 60; and condenser C_4 to the contact b of switch S_{20} , and further conveyed, on the one hand, through resistors R_3 and R_4 to junction 61; on the other hand, through a parallel passage thereto, including resistor R_2 ; thence further conveyed through lead 90 and terminal 26, back to the preamplifier 3, for attaining an equalizing effect as conventionally.

The audio signal current fed to preamplifier 4 is subjected to amplification therein as already referred to and appears at the output terminal 27, thence conveyed through junction point 28, lead 30 and junction point 31.

Part of the current leaving the point 31 goes to a tone quality control circuit, comprising the series-connected condenser C_5 , potentiometer VR_2 and condenser C_6 , upstream of which some of the current is branched off through the slider 63 of the potentiometer VR_2 ; lead 302; contacts b and c of switch S_5 ; junction point 64 and lead 65 to the input terminal 33 of main amplifier 6. The rest of the current leav-

ing the point 31 is fed through high resistor R_5 to the same input terminal 33.

The audio signal current amplified in main amplifier 6 is delivered from its output terminal 34 through lead 35, junction point 36 and lead 66 to the working coil 303 of loud speaker SP, thence flowing through contacts c and b of switch S_6 to earth, thereby sounds corresponding to the recording on tape T_0 are delivered from the speaker.

On the other hand, a part of the output current from the main amplifier is delivered through junction point 36, VU-meter 9, junction point 37 and resistor R_6 to earth, thereby the output signal level being indicated on the meter 9.

The output from the recording amplifier is conveyed through leads 42 and 44, switch S_{14} , lead 45 and switch S_2 to earth, and thus has no influence on the reproducing operation.

Cartridge Recording Operation

When it is desired to initiate a cartridge recording, the first control knob 204 is manipulated to its recording position as before and the second control button 210 for cartridge operation is depressed. In this case, however, no manipulation of the third or equalizer adjusting knob 206 is necessary, as will be described more in detail herein-after.

By the above manipulations, all the constituent switches of switch groups SW_4 and SW_5 mechanically coupled with the knob 204 are caused to occupy the positions shown by full lines in Figure 3, in the same manner as the case of the open reel recording operation.

On the other hand, all the constituent switches of switch groups SW_1 and SW_2 mechanically coupled to the button 210 are brought into their dotted line position, while all the constituent switches of switch group SW_3 are kept at their full line position. Also the switches of groups SW_6 are not in the illustrated positions.

In the same way as in the case of the open reel magnetic recording, audio signal current applied to input terminal 8 is conveyed thence through preamplifiers 3 and 4 and recording amplifier 5 to output terminal 41, being thus amplified.

In the pre-emphasis circuit contained in the recording amplifier 5, the condenser C_2 is included by the way of terminal 39, lead 40, contacts b and a of switch S_8 and lead 75, regardless of the transfer of the movable contact d of transfer switch S_{10} . It may be thus noted that the equalizer adjusting knob 206 must not be manipulated in the case of cartridge recording operation. This is based upon the fact that the tape speed for cartridge recording operation is always constant both for recording as well as playback operation.

On the other hand, d.c. current is supplied from the source "+B" through the movable contact d and first stationary contact a of switch SW_5 ; junction point 49; and lead 50 to oscillator 7 which is thus brought into operation. The biasing current thus generated is delivered from the oscillator through its output terminal 51, lead 52; contacts b and a of switch S_9 ; variable resistor VR_3 adapted for adjusting the biasing current; added at junction 43 with the recording current coming from the output terminal 41 of recording amplifier 5, thence further conveyed through lead 44; contacts b and a of switch S_{14} ; lead 45; junction point 46; contacts a and b of switch S_3 ; lead 47; contacts b and c of switch S_{11} ; lead 70; junction point 71 and lead 72 to the working coil L_4 of the combined recording and playback head H_4 for cartridge use, thence to earth. In this way, the recording is carried into effect on the cartridge magnetic tape T_0 contained in the cartridge case 230, also see Figure 2.

At the same time, erasing current is delivered from the same oscillator 7 through its output terminal 54; contacts b and a of switch S_{10} ; and lead 73 to the working coil L_5 of erasing head H_5 for cartridge use, which head thus operates to perform the erasing function upon the previously recorded cartridge tape. The VU meter is again energised.

Cartridge Playback Operation

When it is desired to initiate a cartridge playback operation, first control knob 204 is manipulated to turn in the counter-clockwise direction in Figure 1 to its playback position and the second or cartridge operation button 210 is depressed. In this case, also no manipulation of the equalizer adjusting knob 206 is necessary.

By the above manipulating operations, all the constituent switches of switch groups SW_1 , SW_2 , SW_4 and SW_5 are brought into their transferred position shown in Figure 3 by dotted lines, while those of SW_3 are kept at their full line position. The switches of group SW_6 are not in the illustrated positions.

In this case, the current picked up by the head H_4 from the recorded cartridge tape T_0 is converted from the pick-up coil L_4 through lead 72, junction point 71; lead 70; contacts c and b of switch S_{11} ; lead 47; contacts b and c of switches S_3 ; lead 56; junction point 57; contacts c and b of switch S_1 ; lead 11 to the input terminal of first stage preamplifier 3.

The thus amplified current is delivered therefrom through output terminal 13; lead 14; junction 15; lead 16; contacts b and c of switch S_{12} ; lead 19 to the variable resistor VR_1 adapted for adjusting the audio

signal level; thence through the slider 20; contacts *b* and *a* of switch S_{15} ; lead 21; junction point 22; and lead 23 to the second stage preamplifier 4.

5 A part of the amplified current in the preamplifier 3 is conveyed through junction point 15; lead 25; contacts *b* and *c* of switch S_4 ; register R_6 ; condenser C_7 ; lead 59; contacts *b* and *c* of switch S_{13} ; lead 78; junction point 61 and lead 90 back to terminal 26, thereby an equalizing action being carried into effect as already mentioned.

15 In this case, the transfer of time constant elements by switch group SW_6 mechanically coupled with knob 206 will be non-effective, since the group consisting of condenser C_4 and resistors R_2 , R_3 and R_4 is shunted through lead 59, contacts *b* and *c* or switch S_{13} and lead 78.

20 The audio signal current fed to the amplifier 3 is then processed through preamplifier 4, tone quality control circuit and main amplifier 6 and led to the working coil 303 of speaker SP, which thus delivers the reproduced audio signal and to the VU-meter 9. The processing operation through the second stage preamplifier 4 and so on is just the same as in the case of the open reel playback operation so that the detailed description may be omitted.

Dubbing Operation

When it is desired to reproduce the audio signal recorded on the open reel tape T_0 and to re-record it on the cartridge tape T_c so as to carry out the so-called dubbing operation, the first control knob 204 is manipulated to its playback position as before; third control knob 206 is manipulated to, for instance, the middle tape speed; 3½ i.p.s. and third control button 211 for dubbing service is depressed. In this case, all the constituent switches of switch groups SW_1 , SW_2 , SW_4 and SW_5 are transferred to the positions shown by dotted lines in Figure 3, while the constituent switches of switch group SW_3 are kept at their full line position and the switches of group SW_6 are in the illustrated position.

50 In the present case, the processing of the audio current in preamplifiers 3 and 4 is just the same as in the case of the corresponding open reel playback service and the processing in the recording amplifier 5 is the same as that adopted in the foregoing cartridge recording operation.

60 The audio current picked up by the combined head H_1 for the open reel service is fed from its working coil L_1 to the input terminal 12 as in the case of the open reel playback operation and amplified therein, the amplified current appearing at the output terminal 13, thence further conveyed through lead 14; junction point 15; lead 16;

65 contacts *b* and *a* of switch S_{12} ; lead 17 contacts *b* and *a* of switch C_7 ; junction point 22 and lead 23 to the input terminal 24 of preamplifier 4.

70 The thus amplified current in the preamplifier 4 appears at output terminal 27 and a part of the current is conveyed through junction point 28 and 30 to the tone control circuit and to the main amplifier 6, as in the case of the open reel playback operation, and the thus amplified current passes through VU-meter 9 and the working coil 303 of speaker SP, thus the meter 9 being operated to show the signal level and the speaker being brought into operation. On the other hand, the audio current applied to input terminal 29 of recording amplifier 5 from junction point 28 is amplified and appears at output terminal 41.

85 Current is supplied from the source "+B" through contacts *d* and *b* of switch SW_7 ; contacts *c* and *b* of switch S_{16} ; junction point 49; and lead 50 to the oscillator 7 which is thus brought into operation.

90 Erasing current is delivered from oscillator 7 at its output terminal 54 through contacts *b* and *a* of switch S_{10} and lead 73 to the working coil L_5 of erasure head H_5 , for performing erasure action on the cartridge tape T_c .

95 Biasing current is delivered from the oscillator 7 at its output terminal 51 through lead 52; contacts *b* and *a* of switch S_9 ; variable resistor VR_3 , joined at junction point 43 with the output current from the recording amplifier; thence further conveyed through lead 44; contacts *b* and *c* of switch S_{14} ; junction point 71 and 72 to the working coil L_4 of the combined head H_4 , thus performing a recording operation on the cartridge tape T_c .

105 Although not shown and described, the arrangement can be modified to enable one to carry out a reversed dubbing operation from the cartridge tape to the open reel tape.

WHAT WE CLAIM IS:—

1. A tape recorder including a driving system constructed to act upon two open tape reels and tape so that both reels rotate and the tape is unwound from one reel, is pressed against a first rotating capstan included in the driving system and is then wound on the other reel, the tape recorder further including a first group of magnetic heads arranged to act on the tape as it passes from one reel to the other, a second capstan for driving further tape, the second capstan being mechanically coupled to the first so that the tapes are driven synchronously, a second group of magnetic heads arranged to act on said further tape, a pre-amplifier system, a recording amplifier arranged to receive output current from the



signal level; thence through the slider 20; contacts *b* and *a* of switch S_{13} ; lead 21; junction point 22; and lead 23 to the second stage preamplifier 4.

5 A part of the amplified current in the preamplifier 3 is conveyed through junction point 15; lead 25; contacts *b* and *c* of switch S_4 ; register R_4 ; condenser C_7 ; lead 59; contacts *b* and *c* of switch S_{13} ; lead 78; junction point 61 and lead 90 back to terminal 26, thereby an equalizing action being carried into effect as already mentioned.

15 In this case, the transfer of time constant elements by switch group SW_5 mechanically coupled with knob 206 will be non-effective, since the group consisting of condenser C_4 and resistors R_2 , R_3 and R_4 is shunted through lead 59, contacts *b* and *c* or switch S_{13} and lead 78.

20 The audio signal current fed to the amplifier 3 is then processed through preamplifier 4, tone quality control circuit and main amplifier 6 and led to the working coil 303 of speaker SP, which thus delivers the reproduced audio signal and to the VU-meter 9. The processing operation through the second stage preamplifier 4 and so on is just the same as in the case of the open reel playback operation so that the detailed description may be omitted.

Dubbing Operation

35 When it is desired to reproduce the audio signal recorded on the open reel tape T_0 and to re-record it on the cartridge tape T_c so as to carry out the so-called dubbing operation, the first control knob 204 is manipulated to its playback position as before; third control knob 206 is manipulated to, for instance, the middle tape speed; 3 1/2 i.p.s. and third control button 211 for dubbing service is depressed. In this case, all the constituent switches of switch groups SW_1 , SW_3 , SW_4 and SW_5 are transferred to the positions shown by dotted lines in Figure 3, while the constituent switches of switch group SW_2 are kept at their full line position and the switches of group SW_6 are in the illustrated position.

50 In the present case, the processing of the audio current in preamplifiers 3 and 4 is just the same as in the case of the corresponding open reel playback service and the processing in the recording amplifier 5 is the same as that adopted in the foregoing cartridge recording operation.

55 The audio current picked up by the combined head H_1 for the open reel service is fed from its working coil L_1 to the input terminal 12 as in the case of the open reel playback operation and amplified therein, the amplified current appearing at the output terminal 13, thence further conveyed through lead 14; junction point 15; lead 16;

65 contacts *b* and *a* of switch S_{12} ; lead 17 contacts *b* and *a* of switch C_7 ; junction point 22 and lead 23 to the input terminal 24 of preamplifier 4.

70 The thus amplified current in the preamplifier 4 appears at output terminal 27 and a part of the current is conveyed through junction point 28 and 30 to the tone control circuit and to the main amplifier 6, as in the case of the open reel playback operation, and the thus amplified current passes through VU-meter 9 and the working coil 303 of speaker SP, thus the meter 9 being operated to show the signal level and the speaker being brought into operation. On the other hand, the audio current applied to input terminal 29 of recording amplifier 5 from junction point 28 is amplified and appears at output terminal 41.

85 Current is supplied from the source "+B" through contacts *d* and *b* of switch SW_5 ; contacts *c* and *b* of switch S_{16} ; junction point 49; and lead 50 to the oscillator 7 which is thus brought into operation.

90 Erasing current is delivered from oscillator 7 at its output terminal 54 through contacts *b* and *a* of switch S_{10} and lead 73 to the working coil L_5 of erasure head H_5 , for performing erasure action on the cartridge tape T_c .

95 Biasing current is delivered from the oscillator 7 at its output terminal 51 through lead 52; contacts *b* and *a* of switch S_8 ; variable resistor VR_3 , joined at junction point 43 with the output current from the recording amplifier; thence further conveyed through lead 44; contacts *b* and *c* of switch S_{14} ; junction point 71 and 72 to the working coil L_4 of the combined head H_4 , thus performing a recording operation on the cartridge tape T_c .

105 Although not shown and described, the arrangement can be modified to enable one to carry out a reversed dubbing operation from the cartridge tape to the open reel tape.

WHAT WE CLAIM IS:—

1. A tape recorder including a driving system constructed to act upon two open tape reels and tape so that both reels rotate and the tape is unwound from one reel, is pressed against a first rotating capstan included in the driving system and is then wound on the other reel, the tape recorder further including a first group of magnetic heads arranged to act on the tape as it passes from one reel to the other, a second capstan for driving further tape, the second capstan being mechanically coupled to the first so that the tapes are driven synchronously, a second group of magnetic heads arranged to act on said further tape, a pre-amplifier system, a recording amplifier arranged to receive output current from the

5 pre-amplifier system and an opening in casing through which a cartridge containing the further tape can be inserted and withdrawn so that the further tape comes into and out of a position where it can co-operate with the second capstan and the second group of magnetic heads.

10 2. A tape recorder according to claim 1 having switch means arranged to connect a selected head of one of the groups of magnetic heads to the input of the pre-amplifier system and a selected head of the other group to the output of the recording amplifier so that a recording on one tape can be transferred to the other tape.

15 3. A tape recorder according to claim 1 or 2 in which the two capstans are on a single shaft which is belt driven.

20 4. A tape recorder according to any preceding claim in which there is a main amplifier the input of which is permanently connected to the output of the pre-amplifier system.

25 5. A tape recorder according to any preceding claim in which there are switching means enabling one to set the recorder to operate in the following modes:—

Mode 1: recording on the open reel tape.

30 Mode 2: playback from the open reel tape.

Mode 3: recording on said further tape.

Mode 4: playback from said further tape.

35 Mode 5: transference of recording from the open reel tape to said further tape.

40 6. A tape recorder according to claims 4 and 5, having a volume indicator which is operated from the main amplifier in each of the five modes.

7. A tape recorder according to claim 4 and claim 5 or 6 having a loudspeaker

which is operated from the main amplifier in Modes 2, 4 and 5.

8. A tape recorder according to any one of claim 5 to 7 having an oscillator which operates in modes 1, 3 and 5.

9. A tape recorder according to claim 8 in which in mode 1 the output current of the oscillator is applied to a magnetic biasing head in the first group of magnetic heads.

10. A tape recorder according to claim 8 or 9 in which in modes 3 and 5 the output current of the oscillator is added to the output current of the recording amplifier and the resultant is applied to a magnetic head in the second group of magnetic heads.

11. A tape recorder according to any one of claims 8 to 10 in which the output current of the oscillator is applied to an erase head in the first (Mode 1) or the second (mode 3 or 5) group of magnetic heads.

12. A tape recorder according to any one of claims 5 to 11 in which the input of the recording amplifier is permanently connected to the output of the pre-amplifier system but its output current flows to earth in Modes 2 and 4.

13. A tape recorder substantially as described above with reference to the accompanying drawings.

14. A combination of a tape recorder according to any preceding claim, two open tape reels and a tape extending between them and pressed against the first capstan and further tape pressed against the second capstan.

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