HANDBOOK OF THE

EMI AUDIO MIXER

TG 12345 Mk.II

RESEARCH LABORATORIES OF ELECTRIC & MUSICAL INDUSTRIES LTD.

HAYES MIDDLESEX ENGLAND

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1 Introduction.

The mixer has been designed to meet the following requirements:

1.1 To be suitable for fixed or mobile use.
1.2 To be light, easily dismantled and transported.
1.3 To comprise cassettes, which can be assembled in different combinations, to form mixers with up to 24 inputs for up to 8-track recording.
1.4 When a multi-track recording is being made, to provide for simultaneously feeding a 2-track stereo tape machine.
1.5 To be complete with all foreseeable facilities required for both classical and pop recording.
1.6 To have a very high degree of reliability.
1.7 Any faults which may occur to be easily located.
1.8 Spare cassettes to be easily inserted to remove faults.

2. General

2.1 Terminology

2.1.1 Drawing numbers

Throughout this handbook when a reference is made to a Drawing Number, it assumed to be preceded by TG12345 unless otherwise stated.

2.1.2 Signal levels

Signal voltage levels are expressed in dBv, this being the voltage level in decibels with respect to 0.447v (this being the r.m.s. voltage across a 200Ω resistor when dissipating one milliwatt). The figures quoted are not all strictly accurate as they do not, in general, take into account the loading effect of a high impedance load across a 200Ω or lower impedance source.

In the manufacturing test specifications which require more precision, sending levels are expressed in dBi, this being the indicated sending level of a 200Ω Gain Set. At an indicated level setting of 0dBi, the gain set would deliver a zero level signal, 0dBm, i.e. 1 milliwatt, into a 200Ω load. Thus at the output of the Gain Set when loaded with 200Ω, dBm, dBv and dBi are numerically equal. If the output is completely unloaded then dBV=dBi + 6.02

2.2 General Drawings

The general scheme of the Mixer is shown on the block schematic, Drawing number DE1.

The top panel layout of each of the six types of cassette is shown on Drawing number D143.

The Drawing numbers of the block schematics of the six types of cassette are:

Microphone Cassette	DE2
Group Cassette	DE3
Main Cassette	DE4
Track Monitor Cassette	DE5
Control Room Monitor Cassette	DE6
Studio Playback Cassette	DE7
Main Power supply unit	CE8

2.3 Mechanical Components

2.3.1 Cassettes

There are six types of cassettes, which are of uniform size. These are as follows:

Microphone Cassette described in section 3.
Group Cassette described in section 4.
Main Cassette described in section 5.
Track Monitor Cassette described in section 6
Control Room Monitor Cassette described in section 7.
Studio Playback Cassette described in section 8.

2.3.2 Frame

Two sizes of frame are available and are described in section 9. The larger frame holds up to 24 cassettes and the smaller frame holds up to 12 cassettes. Blank panels may be fitted if cassettes do not occupy all the channels available. Blank cassettes are available having plugs to accommodate the unused sockets on the cableform.

2.3.3 Main Power Unit

This is entirely separate from the frame and is preferably located some distance therefrom. If the tape machines are in a separate machine room, the Main Power unit could be in the same room.
The Main Power Unit is described in section 10.

2.4 Electrical Components and Features

2.4.1 Active Units

Each cassette contains a multiplicity of active units, each of which is designed to perform a specific function. This enables the internal signal level in the Mixer to be kept substantially constant, thereby making possible an extremely good signal to noise ratio and very low power consumption. Many of the active units are used in more than one type of cassette thereby simplifying manufacture and the maintenance of a stock of spare components.

These active units are described in Section 12.

2.4.2 Mixing

Although a mixer has to perform many functions other than that of mixing, nevertheless, this function is of predominant importance on account of the multiplicity of input and output channels which may be involved.

In the present Mixer facilities are provided for mixing the signals from microphone channels and applying them to group channels, for mixing signals from microphone and/or group channels, for mixing signals from main channels and applying them to the inputs of auxiliary stereo main channels and for mixing auxiliary signals from various channels to send to echo or cue circuits.

In order to provide for this, each output which may require to be mixed with signal from another channel is provided with an amplifier B which operates as a voltage to current converter and each input into which signals are to be mixed is provided with an amplifier C which has a virtual earth input. The circuit values are chosen so that when an amplifier C2 follows an amplifier B, the overall gain is unity. The output impedance of the voltage to current converter is of the order of 20kΩ and the virtual earth input impedance is of the order of 20Ω. Thus each extra channel which is connected to the mixing point only changes the impedance at that point by 0.1% and therefore changes the gain of existing channels by about 0.01dB. Thus, the connection of 20 extra channels changes the gain by 0.2dB, which is negligible.

2.4.3 Power Supply

Since a mixer for recording purposes will always be used with one or more mains powered tape machines, there is no need to provide for battery operation of the mixer. It is therefore designed to operate from 200/250V, 50 to 60Hz mains. If it were essential to be able to operate from a battery or other d.c. supply, a d.c. to a.c converter could be used.

Each cassette has a Power Unit attached to its underside, which provides positive and negative 20V supplies from series stabilisers. The low output impedance and the very low ripple level enable supply decoupling circuits to be cut to a minimum. Most of the amplifiers have no decoupling.

It is advantageous for equipment to work over a considerable range of mains voltages without any tap changing or other adjustment being necessary. If the series stabilisers had been designed to cope with this, there would have been greater heat dissipation in the series transistors. Although most components will operate satisfactorily over a considerable range of temperatures, it is in general advantageous to keep temperature rise to a minimum. A d.c. stabiliser, which gives an output of 240V ± 1% for a range of input voltage from 204 to 252, is therefore included in the Main Power Unit. This is followed by a step-down transformer, which gives an output at 50V with a centre tap, which is earthed. This balanced 50V supply is fed to the power transformers of all the cassette power units through a screened twisted pair cable. The cassette power transformer only has to handle about 5 watts and is therefore quite small. It is enclosed in a magnetic screening can to minimise the risk of mains hum injection into the audio channels of the mixer.

With this method of supply, the Mixer desk is classed as an “extra low voltage” piece of equipment and it is therefore not legally necessary to bond its metalwork to the mains earth, but this is normally done.

2.4.4 RF Rejection and Earthing

Any long lead connected to the mixer is liable to act as an aerial and feed RF into the mixer where, if the level is sufficiently high, it may be rectified and result in audible interference on the programme material.

This is counteracted by providing every input and output with a screened transformer. These are placed as close as possible to the respective input and output sockets and screened leads are used to connect the sockets to the transformers.

The inter-winding screen of each transformer is connected to the chassis of the cassette. The chassis of a cassette may become electrically connected to the mixer frame by the fixing screws, but as the top panel of the cassette is painted, and the fixing screws chrome plated, this cannot be relied upon. Interconnection of the chassis is effected through a lead in the main cableform and four ways of each of the multi-way plugs and sockets used for signal interconnections. As an added precaution each cassette is provided with a screw terminal and a heavy gauge lead with spade terminals, provides a very low resistance linkage.

Since all signal interconnections between cassettes are unbalanced, it is most important that the common earthy return line should be of low resistance or cross talk may be introduced.

The common signal point in each cassette, which is also the common point of the positive and negative 20V lines, is insulated from the chassis, thereby facilitating the tracing of earth faults in components or wiring. This is also connected to the corresponding point of each of the other cassettes through four ways in parallel of the multi-way plug and the main cableform. These interconnecting leads in the main cableform, and the spade terminal interconnecting lead, each have a spur near the centre provided with a spade tag. These are connected together and to the main frame of the mixer at a terminal on the frame, at which point the whole system may be connected to any suitable earth. In some circumstances it may be impossible to obtain an earth, but even under these conditions the system gives satisfactory results.

2.4.5 Metering

A VU meter is provided for each Main Cassette output, these being the outputs which feed signal to the tape machines. The meters are mounted in a meter box, which is part of the mixer frame. Since each Main Cassette contains two main channels, two meters per cassette are required and these are mounted one above the other, the upper meter being connected to the left channel and the lower being connected to the right channel. The frame has a flying lead terminating in a 7-pin plug for each pair of meters. Each main cassette has a corresponding 7-pin socket carrying the VU meter signals. Since the mixer operating level is lower than normal VU meter level, the meters are fed through amplifiers. These derive their input signals prior to the output amplifiers and under normal conditions they give an indication of 0VU when the open circuit output voltage is 0.447V rms. Under these conditions the input voltage to the meter amplifier is 10dB less than this.

Since a VU meter is a linear and not a logarithmic meter, the scale becomes very cramped at the lower end of the scale. The range of indication is extended by providing each Main Cassette with two locking push buttons. One of these increases the gain of both VU meter amplifiers by 10dB, and the other increases the gain by 20dB.

The inputs of the VU meter amplifiers are connected to a selector switch whereby they may be connected to the follow/replay key for measuring record and replay levels, to the inputs to the particular Main Cassette, to the selector switches in the Group, Control Room Monitor or Studio Playback Cassettes for measurement of levels in these cassettes, to an external socket for measurement of levels in other equipment, or to the –10dBV oscillator line. If a mixer has more than one Main Cassette, the cableform is wired so that only the first Main Cassette (i.e. Tracks 1 & 2) can be used for measurements in the Control Room Monitor and Studio Playback cassettes and this Main Cassette is also connected for measurements in the left hand Group Cassette. The second Main Cassette is used for measurements in the second Group Cassette. All VU meters can be switched simultaneously if desired, to the test oscillator so that their sensitivities and frequency response may be checked.

There are also meters associated with the Compressor/Limiters and the correlator, the indications of which will be dealt with later.

2.4.6 Switching

Stud or keyswitches are used for signal switching where these can be used without excessive complication of the switch or wiring.

Where multiple and/or remote switching is required, it is then effected by using transistors as switches. In this way the use of electro-mechanical relays, which tend to be large, heavy and power consuming, has been avoided in the signal circuits.

Transistor switching is used in the following circuits:

The solo facility described in 3.6, whereby the signal in any one microphone channel may be heard on the left hand control room monitor loudspeaker, the right hand speaker being simultaneously muted, without interfering with the recording.

The track announce circuitry described in 5.2.7 and 5.2.8, which provides a separate button for each track and a further button for announcements on all tracks simultaneously.

The operator and artist manager talkback circuitry described in 8.3.

2.4.7 Frequency response

In previous generations of mixers, each channel has included several transformers which have provided appreciable attenuation at frequencies above and below the audio band. This is advantageous since it is undesirable that unwanted frequencies should be indicated on the programme meters, or recorded on the master tape. As the present mixer only has two transformers per channel and as these have wide pass bands, particularly in the bass, each channel in each cassette is provided with a Band Pass Filter, which is described in 12.7.

Since each channel contains several separate active units, d.c. blocking capacitors are required at the interconnections. Many of these feed into resistive potentiometer controls, the impedance of which has been limited to a maximum of about 6kΩ in order to avoid excessive impedance at the slider. In order to avoid clicks when the control is operated, it is necessary to use capacitors with very low leakage currents. Hence, polyester and polycarbonate types have been selected. Very large and bulky components would be required if the total bass loss of a cassette were to be kept less than 0.1dB at 30Hz. Smaller capacitors are therefore used and an adjust on test (AOT) resistor in the Band Pass Filter on each channel is selected on test so that the bass rise of the filter before it begins to attenuate, just balances the attenuation of the couplings.

In this way the response is kept substantially flat down to 30Hz. Below this the Band Pass Filter cuts at 12 dB per octave and the coupling capacitors increase this rate. The Band Pass Filter has a further A.O.T. resistor for trimming the overall high frequency (20kHz) gain of each channel of each cassette.

2.4.8 Gain

In general, the gain of an active unit is determined by the ratio of two feedback resistors, the forward gain being so high that it has a negligible effect. The resistors employed are of the high stability type and their values are specified to ±1%. The errors in the overall gain due to deviation of resistor values can be cumulative and the unbalance of a pair of channels could be considerable of errors were of opposite sign. This is overcome without the use of very close tolerance resistors by providing one active unit in each channel of each cassette with an A.O.T. resistor for setting the gain of that channel to the nominal value. This also covers variations in the ratios of transformers, which are also specified to ±1%.
The amplifiers in which the gain is trimmed are Amplifiers E, G and K. Some channels have two separate amplifiers B. As it would not be economical to adjust the gain of these, the gain determining resistors of these are specified to ±0.5% to ensure a balance of gain within 0.1dB between the channels.

When measuring gain of mixer channels, all inputs should be fed from a 200Ω source. All outputs have an impedance of about 200Ω and are designed to feed a load of 2kΩ or greater. Thus a gain set with a 200Ω sending unit and a bridging receive unit is required. For fault finding or for checking purposes it may be necessary to measure the gain of an individual cassette. A cassette output, which feeds a bus line, is intended to work into an amplifier C, which has a virtual earth input. A test rig intended for this measurement is therefore provided with an amplifier C3, which is similar to an amplifier C2, but with a feedback resistor with a closer tolerance.

For testing a cassette having an Amplifier C at its input, a resistor of 6k8 ±0.5% is used to build out the Gain Set sending impedance to provide a current source.

2.4.9 Echo Circuits

Each microphone channel has an echo send level control and a switch whereby a signal, which is tapped off after the fader, can be routed to any of four echo lines.

Solely for convenience, and not because there is any association, the echo output circuits are located in the Group Cassettes, two output circuits being included in each Group Cassette. Thus if three or four echo output circuits are required, the mixer must have two Group Cassettes. Switching is provided whereby the echo output level may be observed on the VU meters.

A normal microphone channel is used for each echo return and the signal, suitably controlled, can be fed to any track or pair of tracks. If it is required to record without echo but to listen with echo on the monitor speakers, signal from the channels in the Track Monitor Cassette can be fed to the echo bus lines and the output of any microphone channel used as an echo return can be switched so that it is injected into the required channel. A total of eight inject lines is available. If the mixer provides for eight track recording plus auxiliary stereo, six of the inject lines connect to the monitor channels associated with the first six of the eight tracks, and the remaining two, Nos. 4A and 4B connect to the auxiliary stereo monitor channels 5A and 5B.

2.4.10 Cue Circuits

Two cue circuits are provided. Signal from any microphone channel is tapped off prior to the fader and fed through a level control to a switch whereby it can be fed to either of the two cue bus lines, or both of them simultaneously without introducing cross talk. Signal from each main channel circuit can also be fed to either or both of the cue bus lines, in this case separate level controls being provided.

Main cue level controls and line output amplifiers are provided in the Control Room Monitor Cassette, switching being provided whereby the output level may be observed on the VU meters. This cassette also contains level controls whereby two synchronous replay signals, designated left and right, which are routed through the Studio Playback Cassette, can be fed to the cue circuits, left to cue 1 and right to cue 2. The synchronous replay signals and the cue bus signals are available on the input selector switches of the Control Room Monitor and Studio Playback Cassette so that any of these signals can be fed to the control room or studio loudspeakers.

The zero level cue signals from the Control Room Monitor Cassette are fed to small power amplifiers located in the main power unit. These will provide a very loud signal for up to six pairs of 50Ω headphones in parallel or will operate a small 8Ω loudspeaker. A selector switch and two level controls are provided to enable the Artist Manager to communicate through the cue circuits. The Operator has a key switch, which connects the output from his microphone through separate pre-set level controls to both cue circuits.

3. MICROPHONE CASSETTE

3.1 Channels

Each Microphone Cassette contains two identical channels, which can be used either for two mono microphones or for a stereo pair.

3.2 Input Socket

A 5-pin Tuchel socket is used for the two inputs. Each input is provided with a screened input transformer having a step-up ratio of 1: 3.16 the primary winding of which is intended to operate from a 200Ω source.

3.3 Condenser Microphone Powering

Provision is made for 50V phantom powering of condenser microphones. A pair of 6.8 kΩ resistors the values of which are balanced to within 0.5% is connected in series across each input circuit. The common points of these two pairs are connected to the sliders of a 2-pole 4-way switch whereby neither, either or both can be connected to the positive side of a 50V D.C. supply. The unit providing this supply is located in the main power unit. Its output is brought in a pair, with the 50V a.c. supply to the Control Room Monitor Cassette. It is then distributed to the Microphone Cassettes through the main cableform. The negative side of this supply is connected to the 0 V line in the Control Room Monitor Cassette.

3.4 Input Circuit

3.4.1 Coarse Input Level Control

The Coarse input level control provides 12 steps of attenuation of 5dB each. In order to maintain a high input impedance, and to ensure that the noise of the channel is less at all intermediate settings of the input level control than at the zero loss setting, the first three 5dB steps are obtained from tappings on the input transformer secondary winding. The remaining steps are obtained by means of a resistive potentiometer of 8.33kΩ total resistance.

3.4.2 Input amplifier and Fine Gain Control

This is an Amplifier D described in 12.27. Its nominal voltage gain is 25dB. Used as it is in conjunction with the fine input gain control, which has a range of ±5dB in 0.5dB steps, an effective voltage gain from 20 to 30dB can be obtained. The fine gain control operates in the feedback circuit of the Amplifier D.

3.4.3 Range of Input Levels

For the standard level of –10dBV at the output of the Amplifier D, the level at the input of the Amplifier D can be between –30 and –40dBV. The level at the secondary of the transformer can therefore be between +30 and –40dBV so that the corresponding range of input voltage is from +20 to –50dBV.

3.4.4 Re-Record Inputs

Each coarse input level control has a further five positions in which it can select signals for re-recording via the microphone input bus lines. There are ten of these lines numbered 1A to 5A and 1B to 5B. The A series being available on the left hand channel of each Microphone Cassette and the B series being available on the right hand channel of each Microphone Cassette. These bus lines are fed at a level of –10dBV from the outputs of Amplifiers A1 in the Track Monitor Cassettes, line 1A, 1B, 2A and 2B coming from the extreme left Track Monitor Cassette, lines 3A, 3B, 4A and 4B coming from the next cassette and lines 5A and 5B coming from the extreme right hand Track Monitor Cassette this being the one for use with the Auxiliary Stereo tape machines.

Between each bus line and the corresponding stud on the input selector control a 25dB loss resistive pad is inserted to reduce the level from –10 to –35dBV. The fine gain control is available to give ± 5dB of fine adjustment of the level.

3.4.5 Test Input

The extreme anticlockwise position of each coarse input level control makes connection with an oscillator bus line. The Oscillator is located in the Studio Playback Cassette and, when the Oscillator level control is at 0, the level on this bus line is –35dBV, this being the standard level at the point of injection.

3.5 <u>Signal Path</u>

3.5.1 Band Pass Filter

The output of each Amplifier D is connected to the input of a Band Pass Filter, the circuit of which is described in 12.7. These contain adjust on test (AOT) resistors whereby the overall frequency response of the channel is trimmed.

The output of the Band Pass Filter is at about –6V and is directly connected to the input of the Compressor/Limiter. In order not to apply this potential to the inject socket an a.c. coupling consisting of a 6.8μF capacitor and 33kΩ resistor is inserted.

3.5.2 Compressor/Limiter

This is described in 12.22. A 3-position locking key is provided in each channel, the positions being marked “Out”, “Compress” and “Limit”. In the Out position, the Compressor/Limiter is removed from the forward path but its input is left connected so that its meter indicates the signal level.

A Third locking key is provided which is marked Gang. When this is set to the forward position the two compressor/limiters are controlled by which ever of the two control voltages is instantaneously the greater. When this is used the two other keys should both be set to Compress or Limit. The hold and recovery controls are coaxial. The recovery control is the lower of the two and is a stud switch with six positions numbered 1 to 6. The recovery times corresponding to these positions are approximately 0.1, 0.25, 0.5, 1, 2 and 5 seconds respectively. An approximate calibration of the hold control which is a logarithmic 10kΩ carbon potentiometer is marked on the panel. Normally the hold control will be adjusted prior to a take and the setting is then most easily made by observing the relevant limiter meter and setting the hold control so that the meter reads the desired number of decibels of compression or limiting. If it is found necessary to alter the hold control during a take, the calibration on the panel will be found useful but it is not as precise as the meter reading. When the compressor/limiters are ganged only the left hand hold control functions.

Connection is made to both the meters through a 7-way chassis mounting socket on the rear of the cassette and a mating plug on a flying lead from the meter box of the console. The socket also has the +20V, 0V and –20 V lines connected to socket pins 3, 4 and 5 respectively for test purposes.

3.5.3 Inject

Although the mixer is intended to be completely self-contained with all normal facilities, occasions may arise when, to produce some unusual effect, it is necessary to introduce some other device. For this purpose an inject socket for each channel is provided on the underside of the chassis. For normal operation this must be provided with a plug with pins 1 and 2 shorted together. The external device must be connected through an injection unit, which complies with the specification given in 12.30. This requires the provision of input and output transformers to maintain r.f. rejection and to remove the possibility of earth loops.

3.5.4 Presence Controls

The circuit of these is described in 12.1. Each channel has two controls. One of these is marked dB Presence and provides 0, 2, 4, 6, 8 or 10dB boost or cut at the frequency selected by the other, which is marked kHz Presence. The frequencies available are 0.5, 0.8, 1.2, 1.8, 2.8, 4.2, 6.5 and 10kHz. The curves obtained in the ± 10dB conditions are shown on Drawing No. 376.

3.5.5 Bass Control

This provides a flat position and five 2dB steps of lift or cut. Although it is called a bass control, the frequency of half lift or cut is actually 500Hz. The frequency response obtained at the various settings is shown in Drawing No. 375. The circuit is described in 12.2. Since the circuit has no output capacitor, a 6.8μF capacitor is provided externally with 150kΩ to the 0 V line to prevent a large plop when the fader is inserted.

3.5.6 Fader

This follows the bass control and is a quadrant type instrument, in which the control enters through a bearing near the bottom, thereby minimising the entry of dust. It has two chains of resistors connected in parallel. The sliders are staggered half a stud and the resistors are such that the instrument provides 30 steps of 0.5dB followed by a graded law of 26 steps to –64dB and Off. The input resistance is 3.19kΩ and, when fed from a low impedance, it gives its indicated voltage loss into 50kΩ. Since the fader is designed to feed a 50kΩ load, a buffer amplifier is necessary between it and the following pan pot and echo level controls in parallel.

Since the setting of the fader for standard level through the channel is at 5dB loss, it is desirable that this amplifier should have 5dB of voltage gain. The Amplifier E serves this purpose. Its input impedance is 50kΩ and its output is designed to feed a pan pot and echo level control in parallel. Its circuit is described in 12.6

3.5.7 Pan-pot

This consists of two reverse connected potentiometers each having a total resistance of 11kΩ with the inputs in parallel. If the outputs from the sliders are fed to a stereo channel, the control may be used to pan the signal full left, full right or to any of 19 intermediate positions. The extreme positions provide the means of switching the signal to either of two output channels that are not a stereo pair.

3.5.8 Output Circuits

Each pan-pot slider is connected to the input of an Amplifier B which acts as a voltage to current converter. This amplifier is described in 12.4.

The outputs of the two Amplifiers B in one channel are connected to the sliders of the output selector, a 2-pole, 11-way stud switch. The extreme anticlockwise position is “off”. For a current source, the normal connection for “off” is a short circuit. If however this stud were connected to the 0V line, since the switch is of the shorting type, the transition from the first to second stud would put a short circuit on the input of the amplifier connected to the second stud. As this is a virtual earth input amplifier, it generates a click under these conditions. This is avoided by using a 3.3kΩ resistor on the first stud and this provides a reasonably low load for the Amplifier B in the off position.

The remaining ten positions of the channel selectors are connected to bus lines. In each case the channel to which signal is fed when the pan pot is in its anticlockwise position is connected to an A bus line and the other channel (clockwise pan pot) to a B bus line. The A and B bus lines feed to the left and right channels of the subsequent cassette. Provision is made for two Group Cassettes (G1A, G1B, G2A and G2B), for four Main Cassettes (Main 1A, 1B to 4A, 4B) and for eight channels (Monitor 1A to 4B) to Track Monitor Cassettes. If a mixer has less than the maximum numbers of Group, Main and Track Monitor cassettes, some of these bus lines will not be used.

The purpose of the monitor bus lines is to allow a recording to be made without added echo but to be able to listen to it on the monitor speakers with added echo. In this case, the cassette selector of the microphone channel used for echo return is switched to the desired monitor channel where it is added to the direct signal. (See 6.5.2)

Although with 8-track and simultaneous auxiliary stereo working there are 10 monitor channels in use, it is thought that the 8 monitor inject channels provided are quite adequate. In this set up lines 1A, 1B, 2A and 2B, are routed to the extreme left hand Track Monitor Cassette, lines 3A and 3B to the upper channels of the second Track Monitor Cassette and lines 4A and 4B to the upper channels of the Track Monitor Cassette at the right hand end of the Mixer, this being the one used for the auxiliary stereo channels.

3.6 Solo Facility

3.6.1
This facility allows signal from any microphone channel to be fed to the left-hand monitor loudspeaker in the control room without interfering in any way with any recording which is in progress, the right hand loudspeaker being simultaneously muted.

3.6.2
To allow the signal or noise on a channel to be heard when the fader is closed, the tapping is taken from the input to the fader, and, in order to provide isolation, is fed to the input of an Amplifier G. This amplifier, which is described in 12.8, has a voltage gain of unity and a low output impedance.

3.6.3
Each channel is provided with a push button located near the upper end of the fader. Operation of this button connects the output of the Amplifier G through a 16kΩ resistor to the solo bus line and also operates the solo active relay in the Control Room Monitor Cassette. This relay removes existing signals from the loudspeakers and feeds signal from the bus line to the left-hand speaker.

3.7 Cue Channels

3.7.1 Cue Level Control

In order that a signal from a channel may be available for cueing purposes when the fader is closed, the cue tapping must be taken from the input side of the fader. This is the same point as is used for the solo facility so the output of the Amplifier G is also fed to the cue level control, a logarithmic 5kΩ carbon potentiometer.

3.7.2 Cue Line Selector

The slider of the cue level control potentiometer is connected to the cue channel selector whereby the inputs of two Amplifiers B may neither, either or both be connected thereto. In positions where an amplifier input is not connected to the signal line, it is connected to the 0V line.

3.7.3 Cue Bus Lines

The outputs of the two Amplifiers B in each microphone channel are connected to the Cue 1 and Cue 2 bus lines which are connected to the Cue Line Output circuits in the Control Room Monitor Cassette.

3.8 Echo Circuits

3.8.1 Echo Level Control

The Echo Level Control is connected in parallel with the pan-pot. It is a miniature stud switch potentiometer of about 6.8kΩ total resistance. It provides 20 steps of 2dB of attenuation and an “off” position. This control is used in several places in the Mixer and is referred to as the general-purpose attenuator. In this particular case it is scaled from –40dB in the penultimate anticlockwise position to 0dB in the fully clockwise position.

3.8.2 Echo Selector

The output of the level control is fed to an Amplifier B and thence to the echo selector whereby it may be connected to any of four echo bus lines. There is also an “off” position in which the amplifier output is connected to the 0V line through a 3.3kΩ resistor for the reason described in 3.5.8. The Amplifier B shares a board with the Amplifier G in the cue circuit.

3.8.3 Echo Bus Lines

Echo bus lines Nos. 1 and 2 connect to echo line output circuits in the left hand Group Cassette and lines Nos. 3 and 4 connect to similar circuits in the right hand Group Cassette. (See 2.4.9) If there is only one Group Cassette then only Nos. 1 and 2 echo send circuits are available.

3.9 Power Supply

A cassette power unit, the circuit of which is described in 12.21 is mounted on the underside of the cassette. It receives its input at 50V with an earthed centre tap, 50 or 60Hz on a 6-pin plug. This is of the same type as the 7-pin plug used elsewhere but pin 2 is removed and socket 2 is plugged so that they are not interchangeable. Soldered connections are made between the +20, 0 and –20V outputs of the power unit and the corresponding rails of the cassette. The +20, 0 and –20V outputs also appear on pins 3, 4 and 5 respectively of the input plug for test purposes.
The maximum rating of the power supply unit is 75mA at +20V and 120mA at –20V. The microphone cassette actually consumes 58mA at +20V and 82mA at –20V.

4. GROUP CASSETTE

4.1 Contents

Each Group Cassette contains two identical and independent group channels and two identical and independent Echo Line Output circuits.

4.2 Group Channel

4.2.1 Input Gain Control

The input to each group channel is a group bus line and therefore requires to feed into an Amplifier C the circuit of which is described in 12.5. At this point, it is desirable to have some degree of gain control. Firstly, the level at the input will increase with increasing number of input channels. Doubling the number of channels will result in a 3dB increase if the signals are not related or a 6dB increase of the signals are identical. Secondly, if the signal has been limited in the

Microphone Cassette and if the fader is set to 0, the output of the Microphone Cassette will be a standard level signal as measured by the limiter meter which is a peak reading meter. Depending on the signal waveform this may be substantially less than a standard level signal as measured on a V.U. meter where it will be fed to the tape machine. In the first case, it is desirable to have less gain available and in the second case more gain is required. The standard Amplifier C2 has a feedback resistor of such value that an Amplifier B plus an Amplifier C2 has unity overall gain. In this case an Amplifier C1 is employed. This has a feedback resistor of greater value than the C2 and this, when shunted by the input gain control provides a range of ±10dB in 2dB steps.

4.2.2 Compressor/Limiter

This is identical in every respect with that in the Microphone Cassette (see section 3.5.2). The controls and meters are identical and are similarly positioned. The a.c. coupling, consisting of 6.8μF and 33kΩ between the C1 Amplifier output and the Out-Compress-Limit key, would at first sight appear to be superfluous since the Amplifier C1, itself has an output coupling capacitor. The Compressor/Limiter introduces a small amount of bass loss when feeding into the fader. This bass loss is counteracted by trimming the band pass filter. The a.c. coupling introduces a bass loss equal to that of the compressor limiter and maintains a similar frequency characteristic whether or not the Compressor/Limiter is in circuit.

4.2.3 Inject

This is identical with the facility provided in the microphone channels (see 3.5.3).

4.2.4 Fader

The fader used is electrically identical with that in the microphone channels. In this case, the left-hand fader is provided with an optional mechanical ganging device. If the two faders are set to the same reading and the projection on the right hand side of the left-hand control knob is pressed home, the two faders can be operated as a ganged pair. The two controls can easily be separated by lifting the ganging member.

4.2.5 Poling

As some channels may be routed directly from Microphone to Main Cassettes and other channels may be routed through a Group Cassette, it is essential that a Group Cassette should not introduce a reversal of polarity. As the circuit of this cassette is one side earthy throughout, each channel must contain an even number of active elements, which produce a reversal of polarity. The Amplifier C, Amplifier B and Band Pass Filter all reverse so it is necessary to add a fourth. Therefore, instead of using an Amplifier E to counteract the 5dB loss of the fader at its normal operating point as in a microphone channel, an Amplifier K, which gives a phase reversal, is used for this purpose. The circuit of the Amplifier K is described in 12.12.

4.2.6 Presence Controls

These are identical with those used in the Microphone Cassette and are similarly positioned.

4.2.7 Band Pass Filter

This is similar to that in the Microphone Cassette but two of the components in the part of the circuit which is used for trimming the high frequency response of the cassette have slightly different values.

4.2.8 Output

The Band Pass Filter feeds an Amplifier B the output of which is connected to the output selector whereby it may be routed to any of eight main channel input bus lines. An “off” position is also provided. The Amplifier B is one of two on a B + B board, the other one being unused. In the event of a fault the unused one could be brought into use by suitable wire links.

4.3 Echo Output Circuit

4.3.1 Main Level Control

Each echo bus line feeds an Amplifier C2 (fixed gain) the output of which is connected to a general-purpose attenuator. This is the main control of the level sent to the particular echo device (chamber, plate, etc.) and it is calibrated from 0 to –40dB and “off”.

4.3.2 Output Amplifier

This is an Amplifier R and is described in 12.17. Together with the output transformer, it provides 10dB of voltage gain to give an output of 0dBV into open circuit. The output impedance is approximately 200Ω and it is intended to work into an impedance of 2kΩ or greater. Under these conditions it will handle a level of +20dBV without clipping. The two echo outputs from a cassette are available on a 5-pin Tuchel socket.

4.4 Metering

The V.U. meter switch in the corresponding Main Cassette when turned to “Check Group” connects the relevant V.U. Meter Amplifiers to the sliders of the check switch in the Group Cassette. This is a 3-position switch of which the centre is an off position in which terminating resistors to the 0V line are provided. The other positions allow the V.U. Meters to measure the levels either at the outputs of the main channel Amplifiers C, this being the nearest point to the cassette input at which a measurement can be made, or at the echo outputs. Since the V.U. Meter Amplifiers require an input level of –10dB and the output transformers have a step-up ratio of 1:1.77 (5dB) the metering point is taken from a 5dB resistive potentiometer across the Amplifier R output. Thus ‘0’ on the V.U. meter corresponds to an open circuit output voltage of 0.447V.

4.5 Power Supply

The Power Unit is identical with that used on the Microphone Cassette. The Group Cassette consumes about 57mA at +20V and 93mA at –20V.

5. MAIN CASSETTE

5.1 Contents

Each Main cassette contains two identical main channels, the signal in each of which can also be fed, if desired, to an auxiliary stereo channel and to the two cue channels.

5.2 Main Channel

5.2.1 Input Gain Control

Each input is a main channel bus line. As in the case of a Group Cassette input, it is desirable to have a gain control. An input circuit consisting of an amplifier C1 with a feedback control giving a range of ±10dB in 2dB steps is therefore provided.

5.2.2 Inject

This facility is identical with that provided in the Microphone and Group cassettes (See 3.5.3).

5.2.3 Fader

Faders with optional ganging are provided as in the Group Cassettes (See 4.2.4).

5.2.4 Poling

In order to maintain correct overall polarity a phase reversal is required so, as in the Group Cassette, an Amplifier K is used to provide this and the 5dB gain necessary to counteract the 5dB loss of the fader at its normal working position.

5.2.5 Presence Controls

These are identical with those used in the Microphone and Group Cassette.

5.2.6 Band Pass Filter

This again is similar to that used in the Microphone Cassette. Since in this case it is followed by a switch, an output a.c. coupling C2, R1 (C4, R2 in the right channel) is provided.

5.2.7 Track Announce – Individual

For announcement on an individual track, each channel has a push button with change-over contacts which transfer the input of the subsequent amplifier from the output of the Band Pass Filter to the track announce signal bus line, and make contacts which connect together the track announce control bus lines. These lines are linked to the studio playback cassette where their connection operates an active control relay RL1, which in turn quiets the control room loudspeakers. The track announce signal bus line also originates in the Studio Playback Cassette and, when the oscillator key is in its central position, receives the amplified output from the operator's microphone through a pre-set level control.

5.2.8 Track Announce – Multi

When the multi-track announce button in the Studio Playback Cassette is operated, it operates RL1 to quiet the control room loudspeakers and applies a voltage to pin3 of the track announce relay RL5 in each main cassette. Each relay RL5 provides two control signals to each of the switching control Amplifiers N, the circuit of which is described in 12.14.

The application of these control signals causes the switching amplifier to perform the same function as the changeover contacts on the individual track announce push-button. The Amplifier N has unity voltage gain.

5.2.9 Output Amplifiers

The output amplifiers and output transformer are identical with those used in the Group cassette for the echo outputs (see 4.3.2). Since it is common practice to run two tape machines in parallel, two 5-pin Tuchel output sockets wired in parallel are provided.

5.3 Cue Circuits

In order to allow signal from any Main Channel to fed to the cue circuits, a connection is taken from the output of the Amplifier N and fed through an isolating Amplifier G to a cue selector switch, as used in the Microphone Cassettes. Instead of the common level control used in the Microphone Cassette, the Main Cassette provides a separate level control for each cue channel. These feed through Amplifiers B to the cue bus lines.

5.4 Auxiliary Stereo

When a multi-track master is being made, it may be desired also to have a twin track stereo tape which can be replayed on a normal type machine, without the mixing facilities required for the multi-track version.

5.4.1 Auxiliary Stereo Channel

A tapping is taken from the output of the input Amplifier C1 in each channel to feed the following chain:

a. Band Pass Filter (B14 or B28).
b. Coupling Capacitor (C1 or C3).
c. Level Control (General-purpose attenuator).
d. Amplifier G (unity gain).
e. Pan Pot.
f. Pair of Amplifiers B.
g. Auxiliary Stereo bus lines, Left and Right.

5.4.2 Auxiliary Stereo Bus Lines

If auxiliary stereo working is provided for, the left and right auxiliary stereo bus lines which are fed from each channel of each of the multi-track Main Cassettes are connected to the left and right inputs of an extra Main Cassette. The main outputs of this feed the auxiliary stereo tape machine(s). The auxiliary stereo channels of the extra Main Cassette are not connected to anything, and the auxiliary stereo channels of this cassette are completely unused (the level controls should be left at OFF) but they are fitted so that all Main Cassettes are interchangeable.

5.5 Metering

5.5.1 Meter Connections

The two VU Meters associated with a Main Cassette have a 7-pin plug on a flying lead, which is inserted into socket SK3 of the cassette. On this socket the +20 and –20V supplies are available for test purposes.

5.5.2 Meter Amplifier

Each VU Meter is driven by an Amplifier U, the circuit of which is described in 12.19. The amplifier has an output impedance of 3.9kΩ so no build-out resistor is required. When the standard internal signal level of –10dBV is applied to the Amplifier U, the corresponding VU meter will give a reading of 0VU. Push buttons PB1 and PB2 modify the feedback of both amplifiers to boost the gains by 10dB and 20dB respectively.

5.5.3 Meter Selector

The inputs of amplifiers U are connected to the slider of the meter selector switch, which has the following positions:

1. Off
2. Record/Replay
3. Input to Main
4. Check Group
5. Check CRM
6. Check SP
7. External
8. Oscillator

The switch employed is of the shorting type. In order to prevent two measuring points being shorted together when the switch is being operated, alternate studs are provided with 2kΩ series resistors which are mounted inside the switch. This is low, compared with the input impedance, and therefore introduces negligible error.

In the "off" position the studs are directly connected to the 0V line. In the "record/replay" position connection is actually made to the moving contacts of the follow/replay key which is in the Control Room Monitor Cassette. With this key and the record/replay key suitably set the V.U. meters can measure either record or replay level. The record signal is supplied to the keys from the output of the

Amplifier G in the cue channel associated with the main channel under consideration, this being a point, isolated from the main channel, which has the correct signal level at a low source impedance (see 5.3).

The "input to main" position derives its signal from the output of the Amplifier C1 at the input to the Main Cassette and therefore measures the signal level after the input gain control.

In the "Check Group", "Check CRM" and "Check SP" positions the "check" switches in these cassettes are brought into circuit for making measurements. The "Check CRM" and "Check SP" positions only apply in the extreme left hand Main Cassette. In the case of "Check Group", groups 1A, 1B are available in the extreme left hand Main Cassette and groups 2A, 2B are available in the adjacent Main Cassette.

In the "external" position connection is made to SK6, a 5-pin Tuchel socket. This facility can be of use in tracing faults in the Mixer and also for measuring levels from other pieces of equipment. For example if SK8 is connected to SK4 or 5 by a suitable jumper, the actual output level can be measured. If this is other than 10dB above the level indicated when switched to "Record", then there is probably a fault in the relevant Amplifier G or R or output transformer or the wiring thereto.

In the "Oscillator" position connection is made to the –10dBV oscillator bus line. Under these conditions, with the oscillator attenuator at 0 the V.U. meter should also read 0. The frequency characteristics of the Amplifier U plus V.U. Meter can be checked by varying the oscillator frequency and observing the meter reading. The 10dB and 20dB boost can be checked by setting the oscillator attenuator to –10dB and –20dB and pressing the corresponding boost button when the meters should again read 0.

5.6 Power Supply

The power supply is identical with that used in the Microphone Cassette. The Main Cassette consumes about 42mA at +20V and 78mA at –20V.

6. TRACK MONITOR CASSETTE

6.1 Function

This cassette has eight inputs which can accept the replay outputs of up to two 4-track tape machines. It provides facilities for routing these to microphone channels for re-recording and also to the control room monitor and studio playback channels.

6.1 Inputs

Four 5-pin Tuchel input sockets are provided each of which carries two channels. The upper pair is designated Machine No. 1 and the lower pair Machine No. 2. As seen from the back of the Mixer, the right hand pair carries channels 1 and 2 and the left hand pair channels 3 and 4. For 8-track working the second Track Monitor Cassette will carry tracks 5 to 8 on the inputs marked 1 to 4 respectively. These inputs feed eight screened input transformers the primary windings of which are floating. Since these are intended to accept nominally zero level signals and since the normal internal working level of –10dB is required within the Mixer, these transformers have a step down ratio of 3.16 : 1.

6.3 Re-Record

Two re-record selector switches are provided. The left hand one, S1, selects tracks 1 and 2 (or 5 and 6) from Machine 1 (or from Machine 2). The right hand one, S12, selects tracks 3 and 4 (or 7 and 8) from Machine 1 (or Machine 2). Both these switches have central "off" positions. The outputs of these selector switches feed general purpose attenuators which are calibrated from +10 to –30dB and "off". At this point, the terminology changes from that of track numbers to that of the re-record input bus lines in the Microphone Cassettes.

The re-record selector No. 1 has this number on its knob and it feeds microphone input bus lines 1A and 1B through level controls with knobs bearing these inscriptions. Similarly for re-record selector No. 2, and for Nos. 3 and 4 if the mixer has provision for 8-track working.

If the mixer has provision for auxiliary stereo working, another Track Monitor Cassette is required of which only half is employed. By using a standard cassette it acts as a spare for the multi-track positions.

In the auxiliary stereo Track Monitor Cassette the record selector knobs are engraved 5 and -, the upper level controls are engraved 5A and 5B and the lower level controls are unmarked. If, due to a fault, it is necessary to interchange cassettes the knobs can easily be interchanged also.

6.4 Monitor Channels

Each Track Monitor Cassette contains four monitor channels.

6.4.1 Tape Machine Selection

Each Track Monitor Cassette is provided with a 4-pole change over key which performs a function similar to the two re-record selectors. Since this key is used in conjunction with the record/replay key to perform A/B checks on both tape machines, it is located in the Control Room Monitor Cassette near to the record/replay key but, to facilitate the understanding of its operation, it is shown on the block schematic diagram of the Track Monitor Cassette, those leads thereto which are external to this cassette being shown in broken lines.

6.4.2 Amplifier

The impedance of the secondary winding of the input transformer is about 200Ω. The tape machine selector switch which is followed by the record/replay key (see 7.3.2) is followed by a nominally unity gain Amplifier G in which the overall gain of the channel is trimmed.

Each monitor channel then consists of:

(a) An Amplifier G to provide for trimming the gain of the channel.
(b) A Band Pass Filter
(c) A coupling capacitor

(d) A Monitor track Level Control (general purpose attenuator) calibrated 0 to –40dB and off
(e) An Amplifier B.
(f) An Amplifier C2.
(g) A Pan Pot.
(h) Two Amplifiers B feeding output bus lines. These lines are paralleled in pairs within the cassette and the pairs are paralleled in the track monitor cassette socket of the main cableform.

6.5 Echo Channels

6.5.1 Echo Send

In order to be able to add to a monitor channel echo which is not recorded, a tapping is taken from the output of the monitor track level control and fed through the following:

(a) An Amplifier G.
(b) An echo level control (general purpose attenuator) calibrated 0 to –40dB and "off".
(c) An Amplifier B.
(d) An echo channel selector as used in the Microphone cassette which can select any of the four echo bus lines.

6.5.2 Echo Return

A Microphone channel is used for echo return and, as described in 3.5.8 this can be switched to certain monitor channels. The point of return is the virtual earth input of the Amplifier C2. Connection is made to this point through a 47Ω resistor, which prevents parasitic oscillation.

6.6 Power Supply

The power supply is identical with that used in the microphone cassette (see 3.9). A Track Monitor Cassette consumes about 36mA at +20V and 59mA at –20V

7. CONTROL ROOM MONITOR CASSETTE

7.1 Function

This cassette contains the record/replay switching and provides the controls for the control room monitor loudspeakers including signal selection, level, poling, muting and quieting. It also contains the correlator switching and circuitry, the provision for sending synchronous replay to cue, the cue line output circuitry and the buzzer and red light buttons.

7.2 Loudspeaker Channel

7.2.1 Input Key

A single key K2 is used for both channels to select either the multi-track bus bars or the auxiliary stereo bus bars.

7.2.2 Input Amplifiers

The bus bars selected by K2 are connected to the inputs of fixed gain Amplifiers C2.

7.2.3 Monitor Selectors

These are two five position switches, one for each channel. Each has an “off” position, a normal position, position for Cue 1 and Cue 2 and a synchronous replay position.

In the normal position signals are taken from the outputs of the Amplifiers C2. The cue signals are derived from the cue output circuits, which are located in this cassette and are described in 7.6.

The synchronous replay signals are available on lines from the Studio Playback Cassette (see 8.1.1) and the signals on the left and right can only be switched to the left and right channels respectively.

7.2.4 Level Control

The selected signals pass through Band Pass Filters and coupling capacitors to the Control Room Monitor Level control. This is a ganged control with 20 steps of 2dB calibrated from +20 to –20. There is no “off” position. Each of the potentiometers has a total resistance of 3.2kΩ. The output level with the control at zero is –30dBV.

7.2.5 Pole

A spring return push button is provided which when pressed reverses the polarity of the signal in the right hand channel. The polarity change is effected by using an Amplifier P, the circuit of which is described in 12.28. In each channel the Amplifier P carries two separate amplifiers connected in series, both of which introduce phase reversals. The first amplifier has a voltage gain of 16dB and the second amplifier has unity voltage gain. Each amplifier output is built out with a 5.1kΩ resistor and, when actually used as an output, is terminated externally in 5.1kΩ, thereby introducing a voltage loss of 6dB. The overall voltage gain is therefore 10dB and, since the input level is –30dBV, the output level is –20dBV.

In the left hand channel, the output of the second amplifier only is used, this being in phase with the input. In the right hand channel the in phase second amplifier output is the one normally used, but pressing the Pole Button changes over to the phase reversed output of the first amplifier.

7.2.6 Solo

The solo bus line is connected to the terminal B of the Amplifier P in the left hand channel. This terminal is coupled to the virtual earth input of the second amplifier. Since the solo signal from a microphone channel is -10dBV signal fed through 16kΩ, and since the feedback resistor of the amplifier is 20kΩ, there is a gain of about 2dB giving an open circuit output voltage of –8dBV for solo and –14 dBV for main channel signals.

The coupling between the output of each first amplifier (Terminal A), and the input of the corresponding second amplifier (Terminal B) is made through a chain of three resistors in series on the Solo Relay board. The total value of these is about 20kΩ, which is equal to the value of the feedback resistor in the second amplifier thereby producing unity gain. The Solo Relay board is described in 12.24.

Pressing a solo button not only injects signal from that microphone channel into the left loudspeaker channel as described above but also short circuits the solo control bus bars. This causes four transistors to be switched on to provide low impedance connections to the 0V line from the resistor junctions in the two coupling chains of three resistors. This effectively switches off the normal monitor signal in both channels and leaves only the solo signal in the left hand loudspeaker channel.

7.2.7 Control Room Loudspeaker Switch

This provides for the following:

(a) Off.
(b) Left (both channels on left loudspeaker).
(c) Right (both channels on right loudspeaker).
(d) Stereo (each channel or corresponding loudspeaker).
(e) Parallel (both channels on both loudspeakers).

In positions (b), (c) and (e) above the signals from the two channels are mixed by connecting together the Amplifier P outputs which are built out with 5.1kΩ resistors. Thus each provides a termination for the other. In position (d) each channel requires a 5.1kΩ termination and these are provided on the switch.

7.2.8 Loudspeaker Quiet – Remote Control

An Amplifier J described in 12.11 follows the loudspeaker switch in each channel. This serves two purposes, firstly it raises the level from –20 to –10dBV. Secondly it contains three transistors each of which, when it is turned on, quiets the loudspeaker. One of these is turned on when a track announce button is operated and this reduces the loudspeaker level about 23dB. The second of these is turned on when the operator uses the talkback. The amount of quieting can be adjusted by a screwdriver operated preset control, which has a range of from 4dB to 20dB. The third is turned on when the artist manager uses the talkback. There is a preset control with a similar range. The two preset controls are ganged pairs operating on both channels and are located just above the control room monitor level control. Another output is taken from the Amplifier J to the correlator switch. This is not affected by the quieting circuits but is provided with a series resistor to prevent low loading when the correlator switch is operated.

7.2.9 Loudspeaker Quiet – Direct

A key is provided just above the record/replay key for quieting the loudspeakers without use of the normal level control. This also has a pre-set control (labelled KEY) grouped with the OP and AM pre-sets and which has a range from about 3dB to 23dB. On each side of the loudspeaker quiet key is a spring return push button which mutes the corresponding channel.

7.2.10 Loudspeaker Line Output

Each channel has an Amplifier R and an output transformer as used for all other line outputs. A 5-pin Tuchel Socket is provided for connection of the loudspeaker amplifier leads.

7.3 Record/Replay Switching

7.3.1 Tape Replay Selection

Grouped with the input key are the three tape machine selection keys referred to in 6.4.1.

7.3.2 Record/Replay

This is a 12-pole change over key of which only 10 poles are actually used, eight for 8-track working and two for auxiliary stereo for switching the monitor loud speakers. In the record position, signal is received from the outputs of Amplifiers G in the Main Cassettes (see section 5.5.3). In the replay position signal is received from the tape machine selection keys (see 7.3.1). The movers of this key are connected to the monitor channel inputs in the Track Monitor Cassettes (see 6.4.2) and also to the follow contacts of the follow/replay key.

7.3.3 Follow/Replay

This also uses 10-poles of a 12-pole change over key. Its fixed contacts connect to the movers and replay contacts of the record/replay key and its movers connect to the record/replay contacts on the V.U. Meter selector switches in the Main Cassettes (see 5.3.3). It thus enables the V.U. Meters either to follow the changes of the record/replay key or to be left on replay.

7.4 Correlator

7.4.1 Correlator Switch

This is a 2-pole 8-position switch, the positions being marked Off, Mon., 1, 2, 3, 4, 5 & 6. The two poles handle the two inputs of the Correlator. In the “off” position these are connected to the 0V line. In the Mon. position they derive signal from the special outputs of the Amplifier J (section 7.2.8). In positions 1 to 6 the switch is wired to the movers of the follow/replay key so that in positions 1 to 5 the correlator meter indicates the correlation between the signals on the two V.U. Meters associated with Main Cassettes Nos. 1 to 5 respectively. Since the signal is taken from the output side of the follow/replay key, the indication can be switched to record or replay by the record/replay key if the follow/replay key is set to follow. In order to prevent the shorting together of two channels when the switch is operated, series resistors are connected in series with alternate studs within the switch.

7.4.2 Correlator

The circuit of this is described in 12.18. It gives a positive indication on the meter if the signals at the two inputs are in phase and a negative indication if they are out of phase. If the two signals are completely uncorrelated the meter will remain on its centre zero. The circuitry is such that indication is inhibited if the signal levels in the two channels differ by more than about 20dB.

7.4.3 Low Level Meters

The Correlator requires an amplifier in each channel which will be linear at low levels but which will limit at high signal levels. These amplifiers have been made to meet a double purpose by adding rectifiers and meters. The meters are the same size as the limiter/compressor meters, and are similarly mounted. They are calibrated from –60 to –40dB these being levels with respect to a 0dBV signal at an output. Since the normal internal signal level is –10dBV, this range corresponds to –70 to –50dBV at the input to the correlator. These meters are useful for giving an indication of the level of very low level signals or of excessively high noise levels. Since the correlator inputs are taken from points in the monitor channels subsequent to the control room monitor level control, the low level meter readings are correct only when this control is on zero. By use of this control, the range of the meters can be extended 20dB in either direction. Thus with a range extending to –80 V.U. the noise of various parts of the mixer itself can be checked.

7.4.4 Meter Connections

An 11-pin socket is provided to receive the flying lead with a mating plug which connects to the Correlator and the two low level meters on the frame. The +20V and –20V are also available on this socket for test purposes.

7.5 <u>Synchronous Replay</u>

7.5.1 Input – Synchronous

Replay signals are available on the selector switches for the control room loudspeakers and also for the studio playback. The input socket and input transformers are located in the Studio Playback Cassette (see 8.1.1) and –10dBV lines are brought through the main cableform to the Control Room Monitor Cassette where the left and right signals are available at the left and right monitor selector switches.

7.5.2 Synchronous Replay to Cue

The input lines are connected to the inputs of unity gain Amplifiers G the outputs of which feed 5kΩ carbon potentiometers, which act as level controls. The sliders of these are connected to the inputs of Amplifier B the outputs of which feed the Cue Bus Lines, Left to Cue 1 and Right to Cue 2.

7.6 Cue Output

The Cue output circuits are identical with the echo output circuits in the Group Cassette which are described in 4.3

7.7 Cue to Loudspeakers

In order that the cue signals shall be available on the control room monitor and studio playback loudspeakers, the V.U. Meter outputs on the cue output Amplifiers R are both connected to both the input selector switches on both the Control Room Monitor Cassette and the Studio Playback Cassettes.

7.8 Metering

A 3-position, centre "off", switch similar to that in the Group Cassette allows the V.U. Meter tapping either in the loudspeaker output amplifiers or in the cue line output amplifiers to be routed to the "Check CRM" position on the meter switch on the left hand Main Cassette, so that signals at these outputs can be measured on the V.U. Meters associated with No. 1 Main Cassette.

7.9 Signalling

Push buttons are provided at the front of this cassette for operating the buzzer and red light. The former is non-locking and the latter is optionally locking by turning when depressed.

The push buttons energise 24V relays in the Main Power Unit whereby the mains supply is fed to the buzzer and red lights. The relay connections to the Main Power Unit are made through a 7-pin plug PL3 which plug also carries the 50V supply for condenser microphone powering, this supply being fed to the Microphone Cassettes by way of the main cableform.

7.10 Power Supply

The cassette employs the standard power unit. It consumes about 72mA at +20V and 111mA at –20V.

8. STUDIO PLAYBACK CASSETTE

8.1 Function

This provides for selection and control of signals sent to studio loudspeakers, and also includes synchronous replay input circuits, talkback circuitry, track announce switching and the test oscillator.

8.1.1 Synchronous Replay

A 5-pin Tuchel socket is connected to two transformers of the type used at the Track Monitor Cassette inputs (ratio 3.16:1), to give signals at –10dBV which are available on the input selectors of this and the Control Room Monitor Cassette.

8.2 Loudspeaker Channels

8.2.1 Input Selectors

Each channel has an input selector with positions identical with those of the monitor selectors in the Control Room Monitor Cassette (Section 7.2.3).

8.2.2 Level Controls

The outputs of the input selectors are passed through Band Pass Filters and coupling capacitors to level controls. Since the two channels may be used to handle unrelated signals, independent controls are provided. Electrically these are similar to the twin control used in the Control Room Monitor Cassette but they are calibrated from +10dB to –30dB.

8.2.3 Pole

The facility of reversing the polarity of the right hand channel by means of a spring return push button is provided as in the Control Room Monitor Cassette. As the facilities for the solo feature are not required in the studio playback circuits, the Amplifier H is used which is a simplified form of Amplifier P. Amplifier H is described in 12.10.

8.2.4 Loudspeaker Switch

This is identical with that used in the Control Room Monitor Cassette (section 7.2.7).

8.2.5 Studio Talkback

In order to provide for the replacement of normal signal by talkback, a switching Amplifier N is included in each channel, this being the amplifier used in the Main Cassettes for switching track announce. The control signals for switching the Amplifiers N are supplied by active relay RL4, the operation of which is described in 8.3.

8.2.6 Output

The output circuits consist of Amplifiers R and output transformers with a 5-pin Tuchel output socket as used for echo outputs in the Group Cassette (section 4.3.2).

8.2 Talkback

8.3.1 Operator’s Microphone

The Studio Playback Cassette has no meter associated with it so its meter space in the frame is used for the microphone for the operator. It is a 200Ω moving coil type and it is provided with a 6-pin miniature Tuchel plug on a flying lead, a mating socket SK7 being provided on the cassette.

8.3.2 Gain

The microphone signals are amplified by an Amplifier A4 with 40dB of gain followed by an Amplifier A3 with 20dB of gain.

8.3.3 Studio Talkback, 'Normal'

The Studio Talkback Normal button PB1 when operated connects the output of the Amplifier A3 (B9) through a 10kΩ mixing resistor R102 to VR9 and R107 in series. Normally signal is taken from the common point of these amplifiers by another 20dB Amplifier A3 (B21) to K3 which, in its central position marked Studio LS, passes the signal to the Studio Talkback Normal level control VR4 the slider of which feeds the A inputs of the Amplifiers N in the Studio loudspeaker chain.

A further make contact on PB1 operates active relay RL2 to quiet the control room loudspeakers and also operates active relay RL4 to switch the Amplifier N from their normal inputs to their A inputs.

8.3.4 Studio Talkback, 'Loud'

Pressing this button transfers the input of Amplifier A3 (B21) from the lower end of VR9 to the slider thereof. According to the setting of this control up to 10dB more gain will be introduced when the loud button is pressed. VR4 (Normal) and VR9 (Loud) are screwdriver adjustable controls located just in front of the respective buttons. *In order to obtain the loud condition the 'normal' and 'loud' buttons must both be pressed.*

8.3.5 Artist Manager's Microphone

This is a hand microphone of 25Ω impedance and is provided with a "press to speak" switch. When pressed this switch removes a short circuit from the output and closes an independent pair of contacts. A screened quad lead is provided with a miniature Tuchel 6-pin plug for insertion into SK8 on the rear of the cassette.

8.3.6 A.M. Gain

The microphone output is adjusted by a level control VR5 which has a screwdriver slot and has a range of about 20dB. This is followed by a 40dB Amplifier A4. As this microphone is normally held close to the mouth its output is much greater than that of the operator's microphone so less gain is provided.

8.3.7 A.M. Mixing

With the Artist Manager selector switch at Talkback, signal is mixed with that from the operator's circuit through another 10kΩ resistor R101. R103 and R104 are included at the input ends of the mixing resistors to reduce the change of gain through one channel which is caused by switching on the other channel. To minimise this effect these resistors should be equal to the output impedance of an Amplifier A, but this would low-load the amplifier output. The value chosen is a compromise. From this point at which the signals are mixed the operator and the artist manager have the same facilities. The independent pair of contacts in the Artists Manager's microphone is used to operate active relay RL3 to quiet the control room monitor loudspeakers and to operate active relay RL4 to switch the Amplifiers N from normal signal to talkback.

8.3.8 R.F. Suppression

The microphone connections constitute leads entering the Mixer at low level with no input transformers and no Band Pass Filters. In order to minimise the risk of these leads introducing r.f. interference, these inputs are shunted by capacitors, 0.1μF in the case of the 25Ω microphone and 0.022μF in the case of the 200Ω microphone.

8.4 Alternative Talkback

At the right hand side of the panel beyond the Studio Talkback Loud button is a 3-position key. In its central position marked Studio LS the talkback system operates as described above. In both the other positions the signal from the Amplifier A3 (B21) is disconnected from the Studio Talkback Normal level control and connected to VR 8 marked ALT T/B Level on the block schematic diagram. This is a screwdriver operated control located just in front of the key which brings it into circuit. This control feeds a normal line output circuit consisting of an Amplifier R and output transformer the output of which is available on pins 4 and 5 of 5-pin Tuchel socket SK2 for feeding to a power amplifier and loudspeaker.

In the forward position marked ALT a pair of contacts on the key is used to break the energising supply to RL4 thereby preventing it from being energised so that the signal to the studio loudspeakers is unchanged.

The backward position is marked ALT (M), the (M) indicating that the studio speakers are muted. This is realised by allowing RL4 to operate, thereby feeding the studio loudspeakers from the talkback line, but as the signal has been removed from this line, the loudspeakers are muted.

8.5 Intercom

This allows the operator to talk to another location, possibly a remote machine room.

Signal from the output of the Amplifier A3 (B9) can also be switched by a key located to the left of the alternative talkback key, through a preset level control in front of the key to another Amplifier R and output transformer. The output is available at line level on pins 1 and 2 of SK2.

8.6 Cueing

8.6.1 Operator to Cue

By operating the intercom key in the reverse direction, which is marked OP to Cue, signal is applied to two level controls with "off" positions. These controls are marked CUE 1 and CUE 2 and they allow signal to be routed through Amplifier B to the cue bus lines.

8.6.2 Artist Manager to Cue

By operating the selector switch in the box marked Artist Manager the output from this microphone can be diverted from the talkback circuit to either Cue 1 or Cue 2. The box contains separate level controls for the two circuits and these controls feed to cue bus lines through Amplifiers B.

8.7 Track Announce

8.7.1 Signals

Signal from the output of the operator's Amplifier A3 (B9) is fed to a preset level control at the bottom right and corner of the panel. This is padded out with resistors at both ends so that it has a range of about 5 to 25dB of loss. With the oscillator key K2 in its normal central position, signal from the level control is connected to the input of an Amplifier M (see 12.13). Output 2 of this amplifier is connected to the track announce inputs of the Main Cassettes.

8.7.2 Switching – Separate Tracks

Operating a track announce button on a Main Cassette connects the signal line of 8.7.1 with that channel in place of the existing signal, and also short circuits pins 25 and 35 of PL1 on the Studio Playback Cassette to operate active relay RL1, thereby quieting the control room monitor loudspeakers.

8.7.3 Switching – Multi-Track

Operating the multi-track announce button which is at the bottom left hand corner of the cassette, operates active relay RL1 to quiet the control room monitor loudspeakers and through a lead on pin 21 of PL1 operates the active relays RL5 in all the Main Cassettes, thereby providing control signals to switch the Amplifiers N to the track announce signal line.

8.8 Oscillator

The circuit is described in 12.20.

8.8.1 Frequencies

The oscillator frequency switch selects any of the following frequencies 0.03, 0.06, 0.1, 0.5, 1, 3, 5,8, 10, 12 and 15kHz.

8.8.2 Level

The output level from the oscillator is +10dBV at all frequencies. The output feeds a general purpose attenuator calibrated from +10dB to –30dB and "off" so that the level at the slider is that indicated by the calibration.

8.8.3 Distribution

When the oscillator key is in the mid position, the oscillator is disconnected from the attenuator. In both other positions the output of the oscillator control is connected to the input of the Amplifier M in place of the track announce signal. The Amplifier M has three outputs. With the oscillator level control set to zero the outputs are as follows:

Output No. 1 is at a level of –35dBV which, when the oscillator key is in the “on” position, is connected to the oscillator position on the input selectors on the Microphone Cassettes, this being the level required for standard level in a microphone channel. In other positions of the oscillator key this output line is connected the 0 V rail.

Output No. 2 is at a level of –10dBV and, in addition to feeding the track announce inputs on the Main Cassettes, also supplies level for checking the V.U. Meters through the oscillator positions of the meter selector switches.

Output No. 3 is a zero level output which is available on both channels of Sk4, a 5-pin Tuchel socket. It is a low impedance output, which must not be loaded with less than 2kΩ.

8.8.4 Tape Machine Test

For sending tone to tape machines the oscillator key is set to the up position marked “To Tracks”. The oscillator is fed to the track announce line as in the “on” position but in addition RL5 is energised to operate the change-overs in the Amplifiers N to accept the oscillator from the track announce line. In addition, RL1 is operated to quiet the control room monitor loudspeakers.

8.9 Metering

As in the Control Room Monitor Cassette a 3-position, centre “off”, switch is provided. This enables the levels either at the two studio playback line outputs or at the alternative talkback and intercom line outputs to be observed on the V.U. meters associated with the left hand Main Cassette when the meter switch in that cassette is suitably set.

There is no meter socket on the cassette but the +20V and –20V are available on SK6 for test purposes.

A spare socket SK5 is also provided.

8.10 Power Supply

The cassette employs the standard power unit. It consumes about 49mA at +20V and 91mA at –20V.

9. FRAME

9.1 Capacity

Two frames are available one of which will accommodate up to 12 cassettes and the other will accommodate up to 24 cassettes. A smaller number can always be used.

Blank panels are available to fill vacant spaces. These have plugs on which the sockets of the cableforms can be parked.

9.2 Cassette Requirements

These are as follows:

1 Microphone Cassette for every 2 microphone channels and every two echo return channels, up to a maximum of 12 cassettes frames should be made to accommodate more if necessary.

1 Group Cassette for every 2 group channels with a maximum of 2 cassettes. Each Group Cassette also provides 2 echo output channels so that it is possible that the number of Group Cassettes is determined by the number of echo outputs required.

1 Main Cassette for every 2 main outputs, up to 4 for 8-track working. An extra cassette must be added to provide for auxiliary stereo working if this is required.

1 Track Monitor Cassette for every 4 main tracks. An extra cassette is required for auxiliary stereo.

1 Control Room Monitor Cassette.

1 Studio Playback Cassette.

9.3 Construction

Lateral rigidity is provided by the use of steel angle, welded to form a rectangular member extending laterally substantially the full length of the frame and vertically from the top of the visible part of the legs up to the meter box.

The forward portion, which houses the cassettes, is made of sheet aluminium assembled with bolts so that it can be dismantled and packed substantially flat. The frame for 24 cassettes consists of two sections each similar to that used in the frame for 12 cassettes.

The legs are also made of sheet aluminium and can readily be unbolted for transit. They are identical for the two sized of frame. The hand rest which extends the full length is Formica faced wood supported on easily detachable brackets. The end trim is also wood.

9.4 Cable Forms

Only two cable forms are used and these are completely separate from the frame. There is no permanent wiring on the frame except the leads from the microphones and meters, which terminate on plugs for insertion into the relevant cassettes.

9.4.1 Main Cableform

This has a multi-pin socket for each cassette and provides all the inter-cassette signal connections. It has two spade terminals on flying leads for connecting the circuit earth chassis to a terminal on the frame.

9.4.2 Power Cableform

This has a 6-pin socket of which only two pins are used for supplying 50V a.c. to the cassette Power Units, the centre tap of this supply being earthed at the Main Power Unit. The plugs on the cassette Power Units to which these sockets are applied have +20, 0 and –20V on pins 3, 4 and 5 respectively for test purposes.

In order to minimise the risk of hum injection into the signal cableform from the power cableform, the latter employs twisted screened cable, the screen of which is also earthed at the Main Power Unit. A power supply cable extension lead using an 11-pin plug and socket is used to connect the power cableform to the Main Power Unit.

10. MAIN POWER UNIT

10.1 Function

This accepts mains supplies 204V to 252V, 45 to 65Hz. It contains an a.c. stabiliser and a step-down transformer to provide the 50V, centre tap earthed supply for the Cassette Power Units. It also contains cue Output Amplifiers and their Power Units, condenser microphone power units, relays to operate the buzzer and red light, relay power supply and metering.

10.2 A.C. Constant Voltage Regulator

This uses a solid state control circuit. It is set for 240V out and for an input range of –15%, +5%, i.e. from 204V to 252V. If desired this can be altered to ±10%, i.e. from 216V to 264V. The ranges are selectable by changing the connections to both the input range terminals.
The following are its other main features:

Output current	1.5 amps max
Output accuracy	±0.3% r.m.s., zero to full load
Time constant	0.1 sec.
Frequency range	45 to 65Hz.
Distortion	Total harmonics less than 3.5% at unity power factor. Slightly greater at other power factors.
Environment	Rated for use up to 45°C Ambient temperature.

Temperature Coefficient	Within 0.02% per °C.
Maintenance	No routine maintenance is required or recommended. In case of failure, a replacement control amplifier should be ordered.

10.3 50 V A.C. Supply

This is provided by a step-down transformer T1, the primary of which is fed from the a.c. stabiliser. The centre tap of the secondary winding is linked to the chassis which is also connected to the earth pin of the mains input plug.
The 50V supply is fed through SK1 and an extension lead to the Mixer power cableform and through SK2 to the cue Power Units and any other units which may be mounted in the rack which houses the cue units.

10.4 Relay Power Supply

D1 and D2 provide bi-phase rectification from the 50V a.c. supply and together with R6 for peak current limiting and C6 for smoothing constitute the relay power supply.

10.5 Buzzer Operation

Pressing the buzzer button on the Control Room Monitor Cassette connects together sockets 1 and 2 of Sk6 thereby operating RL1, which applies mains supply to Sk3 for operating a mains buzzer plugged therein.

10.6 Red Light Operation

Pressing the red light button on the Control Room Monitor Cassette connects together; sockets 2 and 3 of Sk6 thereby operating RL2 and RL3, RL2 applies mains to SK4 for operating a mains red light circuit. RL3 short circuits the contacts of SK5 which can be used to operate a separate relay operated, or other self powered, system. C1 to C5 and R1 to R5 provide interference suppression.

10.7 Microphone Powering

Provision is made for powering Neumann Transistor Condenser Microphones series f.e.t. 80 or microphones requiring a similar supply. The supply is adequate for up to 24 of these microphones. T.2 is a transformer of the type used in the Cassette Power Units. Here it is used to provide an earth-free 50V supply for half wave rectification in the Microphone Power unit the circuit of which is described in 12.29. The output of this power unit is routed through SK6 and the corresponding connecting lead to the Control Room Monitor Cassette from which it passes through the main cableform to all the Microphone Cassettes.

10.8 Metering

Three meters are provided. A 300V moving iron meter is connected to a switch whereby it can be connected either to the mains input or to the output of the a.c. stabiliser. The scale has a mark at 240V and a black band extending from 210V to 250V (On early model 195V to 255V).

A 60V moving iron meter is permanently connected across the 50V a.c. output. This has a mark at 50V and a black band extending from 48.5V to 53.3V.

An hours meter is permanently connected across the output of the a.c. stabiliser to indicate the total use of the unit.

11. CIRCUIT DESIGN – GENERAL PRINCIPLES

In order to minimise temperature rise and weight the power consumption has been kept to a minimum. Thus the current in each stage has a value no higher than that which allows for the maximum current swing to be expected under the accepted margin of overload.

Since tape machines all have reasonably high input impedance's the output amplifier has been designed to work into a load of 2kΩ minimum. This allows for each output to feed two tape machines, each with an input impedance as low as 4kΩ.

The other outputs including echo, cue, loudspeaker, intercom, and alternative talkback have been made identical with the main channel outputs. Small power amplifiers are provided in the Main Power Unit for use on the cue, intercom, and alternative talkback outputs if desired.

To have made each line output suitable for feeding a 200Ω load would have involved increasing the power dissipation of the output stage by a factor of 10. In rare cases where it may be required to drive a device with an input impedance of less than 2kΩ, it is much more economical to provide a suitable amplifier than to increase the power to all the Mixer output amplifiers.

All amplifiers incorporate a considerable amount of negative feedback so distortion remains very low almost as far as the clipping point and then increases very rapidly. Most bus lines are of the virtual earth type. This means that they are fed from high impedance current sources (Amplifiers Type B) and are terminated by very low input impedance, virtual earth amplifiers (Type C). This method of mixing requires far less power (and therefore bulk and weight) and produces a better signal to noise ratio than conventional resistive mixing. It is also more flexible because an almost unlimited number of current sources may be connected without altering the transmission via existing circuits. Cross talk between bus lines is very small, even though they are not screened, because the signal voltages upon them are minute. This reduces considerably the built and cost of the cable form.

The signal level chosen within the Mixer is –10dBV. This is the highest level which, with a 20dB overload margin, can be handled simply and conveniently, without transformers, by transistors fed with ±20V supplies.

In order to obtain a good signal to noise ratio the microphone input level is raised in the first amplifier (Type D) which has a very good noise figure and subsequently is not allowed normally to fall below –15dBV (except in the CRM and SP cassettes) by using active tone controls. This technique produces an overall signal to noise ratio normally determined sensibly by the input amplifier alone and which is therefore as high; as can be obtained by any technique.

12. CIRCUIT DESCRIPTION. INDIVIDUAL BOARDS

12.1 Presence

12.1.1 Component Parts

There are four sections, the complete circuit being shown in Drawing No. BE.200.

The active components together with the reactive components for determining the two highest presence frequencies are assembled on Board B51/3. (This board with some components different is also used on AE.202).

The reactive components for the remaining frequencies are assembled on Board B78/2.

The frequency selection is made by switch S1, kHz Presence.

The amount of presence is determined by switch assembly S2, dB Presence, the circuit of which is shown on Drawing No. B30.

12.1.2 Active Circuitry

The active circuitry comprises two d.c. coupled transistors acting as a virtual earth amplifier. VT1 is a high gain stage and VT2 is an emitter follower providing a low impedance output R7, C4 in the forward path and R6, C5 in the return path serve to prevent r.f. oscillation.

With S2 in its central position the feedback path consists of R5 (20kΩ) in parallel with the total resistance between terminals 1 and 2 on S2, which is also 20kΩ. The forward path consists of R1 (20kΩ) in parallel with the total resistance between 4 and 5 of S2 (again 20kΩ).

The forward and feedback paths to the base of VT1 are therefore equal resulting in unity voltage gain.

12.1.3 Reactive Components

The 10kHz series tuned circuit consists of the inductance of the section of L1 between terminals 2 and 3 and capacitor C3.

For the next lower frequency, 6.5kHz, the total inductance of L1 is employed and the capacitor is C2.

For 4.2kHz the inductance is the sum of that of L1 and that of L3 between its end 1 and tap 4 and capacitance is provided by C16 and C17 in parallel.

For the remaining frequencies inductance is added successively by two more sections of L3 and three sections of L2. In all cases except 1.2kHz two capacitors in parallel are required to obtain the required value of capacitance.

The tolerance on the larger capacitors is ±5% and the inductance tolerance is ±1% so that there is a tolerance of ±3% on the frequency at which the presence peaks.

12.1.4 Operation

It will be seen that the resonant circuit selected by S1, together with a series resistor R2, can by means of S1, be connected across various amounts of either the forward or the feedback circuit to give 2, 4, 6, 9 or 10dB of boost or cut at the resonant frequency.

12.1.5 Output

The output is taken direct from the emitter of VT2 which has a potential of about +0.5V. the output impedance is low. The output will deliver at least 1.8V r.m.s. into 3kΩ.

The output is in anti-phase with respect to the input.

12.2 Bass

12.2.1 Component parts

There are two sections the complete circuit being shown on Drawing No. AE.202. The active and reactive components are assembled on Board B51/3 as used for the presence circuit.

The amount of bass is determined by switch S1 which is identical with switch S2 used in the presence circuit.

12.2.2 Active Circuitry

This is identical with that used on the presence board with the exception that the input and feedback capacitors C1 and C4 are each 4.7μF.

This is necessary to prevent any tuning effect when either of them is in series with L1.

12.2.3 Reactive Component

The frequency of operation is determined by a Ferroxcube Inductor L1 having an inductance of 1.93H. This, with its resistance built out by R2 (750Ω) yields a half lift or cut frequency of 500Hz.

12.2.4 Operation

Switch S1 connects L1 and R2 in series across various amounts of either the forward or the feedback circuit to give a step function having a total boost or cut of 2, 4, 6, 8 or 10dB.

12.2.5 Output

This is identical with that of the presence circuit described in 2.1.5.

12.3 Amplifier Type A

12.3.1 Types

There are three types of Amplifier A. Type A1 had a voltage gain of 10dB and is used in the re-record circuits of the Track Monitor Cassette.

Types A3 and A4 have voltage gains of 20 and 40dB respectively and they are used in the microphone circuits of the Studio Playback Cassette.

12.3.2 Circuit

The circuit of the three types is shown on Drawing No. AE.203

12.3.3 Circuit Description

The circuit comprises three d.c. coupled transistors. VT1 and VT2 provide voltage gain and VT3 is connected as an emitter follower output stage. Overall feedback is provided by connecting the emitter of VT1 to a tapping across the output. The voltage gain is determined mainly by the ratio of:

(R5 + (R6 // AOT1) to R6 // AOT1).

The three values of gain are obtained by using suitable values of R6. In the case of the Amplifier A1 which is used in the re-record signal path, the voltage gain in set on test to 10 ±0.03dB by choice of a suitable value for A.O.T.1. The value 15kΩ given in the table is a typical one. Amplifiers A3 and A4 are only used in the operator's and Artist Manager's microphone circuit where a precise value of gain is unnecessary so no gain adjustment is made on test. C2 in the forward path and C5 in the feedback path serve to prevent r.f. oscillation. The decoupling capacitor C3 is reduced in value in the Amplifier A4 to increase the negative feedback at low audio frequencies to give a bass cut.

The Amplifier A1 feeds a mic. Input bus line which is connected to a resistive attenuator in each microphone channel. To maintain good bass response the output capacitor C6 is a 25μF electrolytic. In the other cases a 1μF is adequate. The direct output A is not used.

12.3.4 Output

The output impedance is low. The output will deliver at least 1.4V r.m.s. into 3kΩ. The output is in phase with the input.

12.4 Amplifier Type B + B

12.4.1 Component Parts

This contains two amplifiers which are completely independent apart from the supply lines. The inputs are “a” and “b” and the outputs “A” and “B” respectively.

12.4.2 Circuit

The Circuit diagram is shown in Drawing No. AE.204.

12.4.3 Circuit Description

Each amplifier acts as a voltage to current converter. In the following description the circuit reference of the “a” – “A” amplifier are used. The base of transistor VT1 is biased to about –12.5V by a potential divider R3, R4 across the –20V supply. An emitter load R6, 6.8kΩ and a collector load R5, 27kΩ are provided and the output is taken through a coupling capacitor C3. It will therefore be seen that the amplifiers will feed a low impedance load connected to the output with 1/6.8 mA per input signal volt from an impedance of 27kΩ. In order that the gain of an Amplifier B shall be within 0.1 dB of any other Amplifier B, the tolerance on the value of emitter resistor R6 is specified at ±1/2%.

12.4.3 Output

Amplifiers B are used throughout the Mixer for mixing purposes and they are always followed by an Amplifier C which has a virtual earth input. Any number of Amplifiers B can be connected simultaneously to an Amplifier C. The amplifier will deliver at least 0.4mA r.m.s without clipping.

12.5 Amplifier Type C

12.5.1 Versions

There are two versions of the Amplifier C Type C2, when fed from an Amplifier B, gives unity overall voltage gain. Type C1, when used in conjunction with a control to Drawing No. A40 has unity gain when the control is in the central position. This control can increase and decrease the gain by 10dB in 2dB steps.

12.5.2 Circuit

The circuit diagram is shown on Drawing No. AE.205.

12.5.3 Circuit Description

The circuit comprises two transistors, VT1 is connected as a high gain amplifying stage and VT2 is an emitter follower output stage. The two transistors are d.c. coupled and d.c. coupled feedback is provided by R5 between the output emitter and the input base. Input and output coupling capacitors are provided. C2 and R6 in the forward path and C3 and R4 in the feedback path serve to prevent r.f. oscillation. The table shows the values of R2 and R5 which are different in the two versions. In the C2 version the value of the feedback resistor R5 is 6.8kΩ, this being the value of the emitter resistor in the Amplifier B. This results in the Amplifiers C2 giving 6.8 volts out per milliampere in so that a B + C2 combination gives overall a voltage gain of unity. When the Amplifier C1 is used the A40 control is connected between the output and the input. It is therefore effectively in parallel with the feedback resistor and its resistance values are such that, in parallel with R5 (47kΩ) the required 2dB steps of gain are obtained.

12.5.4 Output

The output impedance is low but varies with the setting of the A40 control in the case of the Amplifier C1. The output will deliver at least 2.4V r.m.s. into a load of 3kΩ. The output of an Amplifier C is in phase with the input of the Amplifier B preceding it.

12.6 Amplifier Type E

12.6.1 Purpose

In order to maintain the nominal level within the Mixer it is necessary to provide 5dB gain after each fader since the faders, when set to “0”, introduce 5dB of loss. The Amplifier E is used to provide this gain in the Microphone Cassette where, in order to maintain correct overall poling, an amplifier is required which does not reverse the phase. (See 12.12, Amplifier K for phase reversing amplifier used in Group and Main Cassettes.)

12.6.2 Circuit

The Circuit diagram is shown as Drawing No. AE.207.

12.6.3 Circuit Description

The circuit comprises two d.c. coupled transistors, d.c. coupled feedback being provided by connecting the emitter of the input transistor to a tapping on the load in the collector circuit of the output transistor. The base of the input transistor is held at –10V by R2 and R3. Input and output coupling capacitors are provided. The AOT resistor R7 is initially 51kΩ ±2%. On overall test of the complete cassette a value is chosen to set the channel gain to the nominal figure. R1, R2 and R3 in parallel present an input impedance of 50kΩ this being the load into which the fader is designed to give its indicated attenuation.

12.6.4 Output

The output impedance is low. The output will deliver at least 2.2V r.m.s. into a load of 2.4kΩ. The output is in phase with the input.

12.7 Band Pass Filter (F)

12.7.1 Purpose

This filter serves two purposes. Firstly, it provides 12dB per octave attenuation below about 25Hz and above about 25kHz to reduce the risk of trouble from sub-audio rumble and from r.f. interference. Secondly, it provides the means for trimming the overall frequency response of a channel.

12.7.2 Types

There are four types designated F1 to F4. These involve small differences in value of two of the components controlling the high frequency cut-off characteristic to enable the overall response of the cassettes in which they are used to be trimmed. Type F1 is used in Microphone Cassettes. Type F2 in Group Cassettes, Type F3 in Main Cassettes and Type F4 in the remaining cassettes.

12.7.3 Circuit

The circuit diagram is shown on Drawing No. AE208.

12.7.4 Circuit Description

The circuit comprises two capacitor-resistor time constants giving attenuation below about 25Hz and two capacitor-resistor time constants giving attenuation above about 25kHz. Two d.c. coupled unity gain pairs of transistors serve to isolate each time constant from the other of similar frequency and overall negative feedback is applied.

The d.c. conditions for the circuit are established by R6 and R7 which hold the base of VT3 at about –4.65V. This determines the potential at the output and hence, through the d.c. feedback path, the potential of the base of VT1, the input being a.c. coupled.

The low frequency time constants are given by C1 + C2 with R1 + R2 (assuming the source impedance to be low) and C4 with R6 and R7 in parallel. The high frequency time constants are given by C3 with R3 and C5 with R8 and R9 in parallel.

The filter is tested as a board with a value of 360Ω for R1 and R8 omitted. When overall tests are performed on the cassette, values for R1 and R8 are selected to give the best low and high frequency response curves respectively.

12.7.5 Output

The output is at approximately –5V and therefore an external coupling capacitor is required unless the subsequent unit has an input capacitor.

The output impedance is low. The output will deliver at least 3V r.m.s. into a load of 3kΩ. The output is in phase with the input.

12.8 Amplifier Type G

12.8.1 Purpose

The amplifier G is a unity gain device which is used where it is required to connect a resistive control and the loading which this would impose cannot be tolerated.

12.8.2 Circuit

The circuit diagram is shown on Drawing No. AE209.

12.8.3 Circuit Description

This differs from the Amplifier E only in minor details. As unity gain is required in the present case, only a low value of resistor is required between the collector of the VT2 and the emitter of VT1. In this case it is an adjust on test component only. For testing the board this has a value of 620Ω but it is replaced by the value required to provide the correct channel gain when the cassette is on test. R1 is included to provide about 0.5dB of loss so that by selection of AOT1 a range of gain on both sides of unity can be covered. The input base is held at –3.5V by R3 and R4. Since this amplifier is used after an attenuator which is designed to have a 50kΩ load, the input impedance has this value.

12.8.4 Output

The output is similar to that of the Amplifier E except that the G is designed to deliver a minimum of 2.1V r.m.s. into a load of 3kΩ.

12.9 Amplifier Type G + B

12.9.1 Purpose

For convenience of cassette layout it is desirable to have a board with one Amplifier G and one Amplifier B on it.

12.9.2 Circuit

The circuit diagram is shown on Drawing No. AE210. Apart from component references the circuits are identical with those shown on Drawing Nos. AE209 and AE204, so no further description is necessary. The small letters "g" and "b" denote the inputs and the capital letters "G" and "B" denote the outputs of the Amplifiers G and B respectively.

12.10 Amplifier Type H

12.10.1 Purpose

This is used in the studio loudspeaker channels in the Studio Playback Cassette. It serves three purposes. Firstly it provides 10dB of gain to restore the signal to standard level following the 10dB of loss introduced by the level control at its normal setting. Secondly it provides two equal outputs in anti-phase so that, by switching from one to the other, the signal can be poled. Thirdly it provides outputs suitable for parallel connection so that both channels can be fed to one loudspeaker.

12.10.2 Circuit

The circuit diagram is shown on Drawing No. AE211.

12.10.3 Circuit Description

VT1 and VT2 are d.c. coupled as in Amplifier E. The base of VT1 is held at about –12.3 V by R1 and R2. The d.c. conditions of VT2 are then determined by R4 and R5 whilst the a.c. gain is determined by R4 and R5 shunted by R6 and AOT1 in series. The output capacitor C5 feeds output A through a 5.1kΩ resistor R15. Since the collector of VT2 is a low impedance point, the output impedance is approximately 5.1kΩ. The output, when used, is always loaded by 5.1kΩ thus introducing a 6dB voltage loss. The voltage gain of the transistor is therefore 16dB to give the required overall 10dB gain.

VT3 and VT4 constitute a unity gain phase reversing amplifier. It is of the virtual earth type and has unity gain because the forward and feedback resistors R7 and R9 are equal in value. C4, R10 and C3, R11 serve to prevent r.f. oscillation. This amplifier is d.c. coupled except in that the output (output B) is provided with a coupling capacitor C6 and a build-out resistor R16 as in the case of output A.

12.10.4 Output

Each output will deliver at least 1.4V r.m.s. into a load of 5.1kΩ.

12.11 Amplifier Type J

12.11.1 Purpose

This provides 10dB of gain to counter half the 20dB loss introduced by the control room loudspeaker level control at its normal setting and also provides three independent quieting circuits.

12.11.2 Circuit

The circuit diagram is shown on Drawing No. AE212.

12.11.3 Circuit Description

The amplifier transistors VT1 and VT2 use the same circuit as the Amplifier E except that the gain adjusting resistor is in series with R5 in this case and in shunt in the Amplifier E. The input base is held at about –14.4V by R2 and R3 and the value of R1 has been chosen to obtain an input impedance of 50kΩ. The output of the amplifier stages is taken through coupling capacitor C2 and fed through build-out resistors R8 and R15 to OUT ‘A’ and OUT ‘B’ respectively. OUT ‘A’ is the main signal output and R8 increases the impedance so that about 20dB of quieting can be realised by the shunt circuits provided. The switching is affected by transistors VT3, VT4 and kVT5 which are turned off or on by control signals from the Active Relay board (see 12.23) applied to their bases through resistors R10, R11 and R12. In the “off” condition the transistors have high impedances between their emitters and 0 V so OUT ‘A’ is unloaded. Where VT3 is switched on its impedance from emitter to 0 V becomes low, so R9 is connected as a shunt on the output thereby introducing a loss of about 22dB, this having been found by experience to be a suitable amount of quieting during track announcements. In the case of operator and artist manager talkback the amount of quieting is controlled by 1kΩ preset

potentiometers with screwdriver adjustment. Each of these is a 2-gang unit to control the two loudspeaker channels. The maximum quieting is determined by R13 and R14 and is about 20dB. The minimum quieting is about 8dB.
OUT 'B' is connected to the correlator input selector switch.

12.11.4 Output

The output is intended to work into an impedance of 50kΩ and it will deliver at least 1.1V r.m.s.

12.12 Amplifier Type K

12.12.1 Purpose

Amplifier K is used following the fader in Group and Main Cassettes where a phase reversal is required in order to maintain correct poling through these cassettes. As in the case of the Amplifier E the gain of the Amplifier K is 5dB.

12.12.2 Circuit

The circuit diagram is shown on Drawing No. AE213.

12.12.3 Circuit Description

VT1 is connected as an emitter follower. Its base is held at about +6.3V by R2 and R3. R1, R2 and R3 in parallel give the required input impedance of 50kΩ. VT2 and VT3 are connected as a fully d.c. coupled virtual earth amplifier very similar to that of Amplifier H. For initial test of this amplifier a short circuit is provided in place of R4 (AOT 1). The value for this resistor is chosen on overall test of the cassette in order to adjust the overall gain of the channel to the nominal value.

12.12.4 Output

The output is d.c. coupled and has a potential of about +3V. It must therefore be followed by a coupling capacitor. It will deliver at least 1.8V r.m.s. into a load of 3kΩ.

12.13 Amplifier Type M

12.13.1 Purpose

This amplifier is used in the Studio Playback Cassette. Its input is switched between track announce signal and the output of the oscillator level control. It has three outputs. One is at a level of –35dBV and is fed to one stud of each of the Microphone Cassette input switches. Another is at a level of 10dBV and this is connected to the V.U. Meter switches in the Main Cassette as a check of the meters and their amplifiers and also to the track announce bus line whereby either track announce signal or oscillator signal can be fed to the tape machine. The third output is at 0dBV and appears on a Tuchel socket for feeding to external equipment. The associated switching is such that the track announce signal does not get fed to the Microphone Cassettes.

12.13.2 Circuit

The circuit diagram is shown on Drawing No. AE215.

12.13.3 Circuit Description

VT1 and VT2 are d.c. coupled as a unity gain amplifier. The input base is held at about –3.5V by R2 and R3. An input coupling capacitor C1 is provided and R1, R2 and R3 in parallel present an input impedance of 50kΩ, the value required for the attenuator from which it is fed to give its indicated loss.

The output from this amplifier pair is coupled by C3 to the oscillator output socket, a 5-pin Tuchel with parallel connections to both channels. Since the oscillator output (see 12.20) is at a level of +10dBV and since the zero of the scale of the oscillator level control is at the stud at which 10 dB of loss is introduced, this output is at 0dBV.

For the –10dBV output a second d.c. coupled unity gain amplifier VT3, VT4 is provided. The potential of the base of VT3 is established mainly by R8 and R9. The 10 dB loss is determined by R6 + R7 working into R8 and R9 in parallel, the precise loss being adjusted on test by selecting a value for R7. Since the potential drop across R6 and R7 is small, the d.c. conditions of VT3 and VT4 are almost unchanged by the selection of R7.

The –35dBV output is obtained from the –10dBV output by a potential divider consisting of R13, R12 and R14. Its impedance is therefore about 68Ω.

12.13.4 Output

The output connected to the oscillator socket will deliver at least 2.2V r.m.s with a load of 2kΩ from a low source impedance.

The V.U. and track Announce output will deliver at least 0.7V r.m.s. into a load of 2.4kΩ.

12.14 <u>Amplifier Type N</u>

12.14.1 Purpose

This is used in the Main Cassette for providing the multi-track announce facility and in the Studio Playback Cassette for providing talkback on the studio loudspeaker.

12.14.2 Circuit

The circuit diagram is shown on Drawing No. BE216.

12.14.3 Circuit Description

The normal input is coupled to the base of VT1 which is held at about –10.8V by R2 and R3. Since R10 feeds into a virtual earth amplifier, the collector load is R4 in parallel with R10. Since this is equal to the emitter load R5, VT1 has unity gain, provided that BT2 is switched off. When a control signal is fed to the base of VT2 to turn it on, R8 (1kΩ) is shunted across the collector load introducing about 20dB of loss. The d.c. coupled virtual earth amplifier VT5, VT6 has a feedback resistor R20 equal in value to the input resistor R10 and the overall gain is therefore unity.

The auxiliary input A is connected through R11, R12 and R15 to the input capacitor C3 of the virtual earth amplifier. When the control signal at terminal 1 is such as to hold VT2 in the "off" condition, the control signal at terminal 2 is such as to hold VT3 VT4 in the conducting condition. In this condition R11 with VT3 and R12 with VT4 act as a two-stage attenuator which has sufficient loss to prevent a signal at the auxiliary input from entering the main channel.

When the control signals on terminals 1 and 2 are interchanged, VT2 is turned on and provides about 20dB of quieting in the main channel, VT3 and VT4 are simultaneously turned off thereby removing the attenuation and leaving R11 + R12 + R15 (a total of about 20kΩ) feeding signal from the auxiliary input to the virtual earth amplifier. This provides a path with unity gain from auxiliary input to the output.

12.14.4 Output

The output is d.c. coupled and is at a potential of about 3.3V. It will supply at least 1.4V r.m.s into a load of 3kΩ.

12.15 Amplifier Q Power Unit

12.15.1 Purpose

This unit supplies the necessary power for two Amplifiers Q.

12.15.2 Circuit

The circuit diagram is shown on Drawing No. BE217.

12.15.3 Circuit Description

This unit receives a 50V mains frequency supply from the main step-down transformer in the Main Power Unit. The centre tap of this supply is earthed in the Main Power Unit and this is carried through as the 0V line of the output. Three pairs of rectifiers are connected in separate bi-phase circuits. D1 and D2 with a current limiting resistor R1 and reservoir capacitor C3 provide a low current supply at –26V. D3, D4, R2 and C2 provide a similar supply at +26V.

The main supply is rectified by high current diodes D5 and D6 and fed through R3 to the reservoir capacitor C1 which is not on the printed board. From here the current is fed through R7 and R8 in parallel and a series stabiliser transistor VT2 which is also not on the printed board. The base of this is held by an emitter follower VY1. The base of VT1 is held at about +18V by a pair of zener diodes D7 and D8 which are supplied from the +26V line through a smoothing circuit R5, C4 and a series resistor R6. Capacitor C5 is included to prevent r.f. oscillation.

12.15.4 Output

The low current outputs will each supply about 4mA.

The high current outputs will give about 15.5 to 18.5V into a load of 1kΩ. The output voltage may fall by up to 1 volt when the load resistance is reduced to 20Ω.

12.15.5 Mechanical

The unit is assembled on a plug-in board which is housed in the Main Power Unit case.

12.16 Amplifier Type Q

12.16.1 Purpose

This amplifier receives its input from the nominal zero level cue line output, intercom, or alternative talkback output and will deliver up to 0.5 watt into a load of 8Ω. For cueing this will normally be fed to headphones. With headphones of normal sensitivity, a very loud signal can be produced into 6 pairs of 50Ω headphones in parallel. For other purposes a reasonably loud signal can be produced from an 8Ω loudspeaker.

12.16.2 Circuit

The circuit diagram is shown on Drawing No. BE218.

12.16.3 Circuit Description

VT1 acts as an input amplifier stage which feeds current through coupling capacitor C3 to the virtual earth input of the main part of the amplifier. Since this amplifier is not in a main signal channel of the Mixer, the time constant C1 R2 is less than normally used and therefore gives a small bass roll-off.

VT5 and VT6 are power transistors of the same type arranged as a transformerless class AB push pull output stage. VT5 is driven by an emitter follower VT3 (n p n). VT6 is driven by VT4 (p n p) with 100% feedback from the collector of VT6 to the emitter of VT4. The bases of VT3 and VT4 are dirven from the collector of VT2. R10, R11, R12, and R13 are 2Ω high dissipation resistors connected in the emitter and collector circuits of VT5 and VT6 for peak current equalization and limitation.

Feedback is taken from the output (prior to the output coupling capacitor C9) through R14 and R15 in series to the virtual earth input. It will be seen that VT2 and VT6 are fully d.c. coupled both in the forward and in the feedback directions.

D1 and D2 are included to assist thermal stability. AOT 1 is selected on test to give the correct quiescent current in the output stage which is 0.5 mA at ambient temperatures between 15°C and 20°C. The value must by varied by ±1.5mA for temperature ranges of ±5° respectively outside these limits.

A ferrite bead L1, capacitors C4, C5, C6, C8 and the combination R17, C10 are all included for the prevention of r.f. oscillation.

The heavy current +17V supply and the output each have two contacts in parallel on the plug and socket connector whilst the heavy current 0V line has three contacts and on the board this line is kept separate from the remainder of the 0V line, the two parts being connected together at the socket.

12.16.4 Mechanical

The unit is assembled on a plug-in board of the same size as the Q Amplifier Power Unit and is housed in the same frame.

12.17 Output Amplifiers Type R

12.17.1 Purpose

This is a line output amplifier which receives signal at a level of –10dB and, in conjunction with an output transformer type B35A it delivers a signal at zero level into a load of 2kΩ or greater. It is used for main channel outputs to tape machines, for echo outputs, for control room monitor and studio playback loudspeaker outputs and for the auxiliary talkback and intercom outputs.

12.17.2 Circuit

The circuit diagram is shown on Drawing No. AE219.

12.17.3 Circuit Description

As in the Amplifier E, the gain is obtained by two d.c. coupled transistors, the feedback also being d.c. coupled. The base of VT1 is held at about –11.6V by R2 and R3. R1, R2 and R3 in parallel present an input impedance of 50kΩ. C2, R5 serve to prevent r.f. oscillation. The output capacitor must have a value sufficiently large to avoid tuning with the inductance of the transformer which it feeds and hence has to be of the electrolytic type. On test the value of AOT 1 is selected to give a voltage gain of 5dB. The output transformer with which it is used has a step up ratio of 1:1.78 thereby yielding the desired overall gain of 10dB.

The Amplifier U which is used to drive a V.U. Meter requires and input at a level of –10dBV. This can be obtained from the –5dBV output of Amplifier R by a resistive potentiometer R9, R8 , R10 which introduces a loss of 5dB.

The amplifier board is tested without a transformer using a resistive load of 680Ω into which it will deliver at least 2.7V r.m.s.

12.17.4 Output

The output is unbalanced, is in phase with the input and its impedance is low. At the secondary of the transformer the output impedance is about 200Ω this being mostly the resistance of the transformer.

12.18 Correlator

12.18.1 Purpose

The correlator receives signals from a pair of channels and indicates on an associated meter whether these signals are in phase or out of phase with one another. No indication is given if the signals in the two channels differ in level by more than about 20dB.

The correlator unit also includes the circuitry for driving two low level meters which are calibrated over the range –40VU to –60VU. These levels are with reference to a zero level signal at an output of the Mixer. Since this corresponds with a –10dBV signal within the Mixer the actual range of input levels to the correlator unit is –50dBV to –70dBV.

12.18.2 Circuit

The circuit diagram is shown on Drawing No. DE221.

Board B94/1 carries the circuitry for Forward Path A and Low Level Meter A.

Board B95/2 carries the circuitry for Forward Path B and Low Level Meter B.

Board B96/1 carries the Inhibitor circuitry.

Board B97/2 carries the circuitry of the gates and for the correlator meter.

12.18.3 Circuit Description

12.18.3.1 Forward Path A

VT1 and VT2 are a d.c. coupled low gain (about 6dB) pair which provide a high input impedance (more than 2MΩ) and have a considerable overload margin (more than 20dB) so that the high input impedance is maintained at high input levels. R1 and R2 provide a potential of –10.3V to which the base resistor R3 is connected. The common point of these three resistors is boot-strapped to the emitter of VT1 by C2 so as to raise the input impedance.

The collector of VT2 is coupled by C3 to the circuit R7 and R8, D1, VT3. The base of VT4 receives the potential across D1 which at low signal levels is non-conducting. As the signal level is increased D1 limits the negative excursions of the base of VT4 to about 0.5V, and on positive excursions VT3 is turned on so these are also limited to about the same voltage.

When VT3 is off, current flows from the +20V line through R10 and R9 in series to charge C12 in the inhibitor section.

VT4 provides a gain of about 18dB for low level signals. As the signal from VT4 reaches about 0.5V D2 limits the negative swing and VT5 limits the positive swing, VT5 also switching current to the inhibitor similarly to VT3.

VT6, VT7 and D3 and associated components provide another stage identical with the previous one.

VT8, VT9 and D4 and associated components provide a further very similar stage. The nominal gain is 16dB but it is adjusted by selection of AOT8 so that the gain from the input to the collector of VT8 is 58dB.

The collector of VT9 is connected through D5 to the base of VT10. The diode is included to prevent reverse voltage breakdown of VT10. The emitter is connected to the mid point of a potential divider R29, R30 across the positive supply and the collector is connected to a negative point provided by R31, R32 across the negative supply. A connection is taken from this collector through terminal 2 of this board to terminal 2 of the gates board.

12.18.3.2 Low Level Meter A

The circuit for driving this meter is tapped from Forward Path A by connecting the emitter of VT8 to the base of VT11. At this point the nominal gain from the input is 42dB so that the signal level at this point is –8dBV for a reading on the meter of –40VU. The level at this point is unaffected by AOT8. VT11 is an amplifying stage, the current in which is adjusted by AOT19 and AOT20 to give the required potential at the collector, and the gain of which is adjusted by AOT22 to give the required overall gain. D6 and D7 are 7.5V zener diodes which prevent the bottoming of VT11 which would otherwise occur in overload. Bottoming of VT11 would both reduce its input impedance which would upset the gain of VT8, and prevent instantaneous recovery from overload which is essential for correct meter indication. This collector is connected to the bases of two complementary transistors VT12 and CT13, the emitters of which are connected to the bases of VT14 and VT15. The sum of the currents of VT14 and VT15 is held constant at about 3 mA by VT16. The meter is connected in the collector circuit of VT14 and is shunted by a large value capacitor C11. AOT21 is selected to set the meter current, in the absence of signal, to 70μA. AOT19 and AOT20 are selected so that the collector potential of VT11 is the average of the values at which VT12 and VT13 begin to conduct. When the signal is sufficient to cause these two transistors to conduct the current in VT15 decreases and that in VT14 increases causing deflection of the meter.

12.18.3.3 Forward Path B

This is similar to Forward Path A. The major difference is that the feed to the inhibitor circuit must in this case be from the negative supply.

The B input stage is identical with the A input stage except that its negative supply is taken through an emitter follower VT31. In the first limiting stage the diode D10 is connected in the reverse direction and so limits the positive peaks and a pnp transistor VT33 limits the negative peaks and, when it is non conducting, current flows from the inhibitor circuit through R8 and R89 to the negative line.

The second limiting stage is identical with the second stage of the other channel except for the reversal of limiting functions of the diode D11 and the transistor VT35.

The third limiting stage is identical with the second except for the provision of means for returning the earthy and of D12 to a potential slightly positive of negative if necessary in order to compensate for any difference in the limiting voltages of D12 and VT37 so as to minimise meter deflection as limiting takes place. If a positive potential is required AOT12 is made 20kΩ and AOT14 is omitted. If a negative potential is required AOT14 is made 20kΩ and AOT12 is omitted. In both cases the optimum potential is obtained by selection of AOT13.

The next stage VT38 is an amplifier stage similar to VT8 but with difference component values but it is not followed by a limiting stage. It is a.c. coupled to the base of VT39, the emitter of which is connected to the gates board through terminals numbered 5 on each board. The correct potential required at the gates board is realised by selection of AOT10 and AOT11 in the bias chain R106 and R107 which holds the base of VT39 through resistor R105.

The gain of this forward path from the input to output 5 is adjusted by AOT9 to 58dB.

12.18.3.4 Low Level Meter B

The circuitry of this is identical with that of Low Level Meter A, its input being in this case derived from the emitter of VT38.

12.18.3.5 Inhibitor

The inhibitor input (terminal 1) is connected through resistors R9. R15, R21 and R27 to the collectors of transistors in Forward Path A and through R88, R94, R100 and R122 to the collectors of transistors in or associated with Forward Path B. R122 and the associated transistor are actually on the gates board which has not yet been described.

For low level signals, in both paths which do not operate any of the limiters, all eight transistors are switched off. Each of the four resistors in Path A feeds about 22μA from the positive supply and each of the four in Path B returns about 22μA to the negative supply. The voltage at the input of the inhibitor is therefore about zero.

If the input signal level to Path A exceeds that in Path B by more than about 18dB (the gain of each stage in the absence of limiting)then the number of Path A limiters operating will be one or more greater than the number of Path B limiters operating. If this number is unity there will be a net drain of 11μA (because the limiting transistors operate for only half of each signal wavelength) from the input of the inhibitor, and this current results in the input voltage falling to –0.55V. For numbers greater than unity this negative voltage will increase in steps of about 0.55V.

Similarly if the signal level in Path B exceeds that in Path A, the potential at the input of the inhibitor will be about +0.55V for each increment of 18dB difference of level.

In order to meet the requirement that the phase meter shall not give an indication if the signals differ in level by more than about 20dB, the inhibitor is required to inhibit the meter if the input voltage is more positive than about +0.6V or more negative than about –0.6V.

VT17 is an emitter follower, the emitter of which drives the base of VT18 which provides a gain of about five times so that the signal level at the output of VT18, which just causes inhibition of the meter, is about ±3V. The temperature coefficients of VT17 and VT18 cancel one another. Connected to this point are the bases of VT19 and VT23. VT19 and VT21 are a long tail pair with the base of VT21 held at about +10 V whilst VT23 and VT25 are a complementary long tail pair with the base of VT25 held at about +4.5V. when the input to VT17 is more negative than 0.6V the output from VT18 will be more positive than +10V so that VT19 will be turned on and this turns on VT20 which turns on VT24. The output lead from this board to the gates board which is held (by R64 and R65) at about +2V when VT24 is off falls to about –0.6V when VT24 is on. When the input to VT17 is more positive than +0.6V the output from VT18 will be more negative than +4.5V therefore VT19 and VT20 are off but VT23 is on which turns on VT24.

For a range of input voltage centred on zero VT19 and VT23 are off resulting in VT24 being off thereby producing an output of +2V.

12.18.3.6 Gates and correlator Meter

In the absence of signal in Forward Path A, or in the presence of signal at too low a level to turn on VT9, input 2, which is applied to the base of VT46, remains at about –1.6V thereby keeping VT46 cut off. Under these conditions, signal from input B, which has been limited in the forward path to become a symmetrical substantially rectangular waveform at input 5, is applied to the bases of two complementary transistors VT49 and VT50. These are switched on alternately by the positive and negative half waves and produce a similar waveform but with an amplitude of ±9V at the base of VT51. VT51 is an emitter follower, the output of which is applied to a smoothing circuit R134 C28 having a time constant of about 0.4 second. The output of this passes to a super alpha pair VT52, VT53 and thence to the centre zero meter. This is a 0.5, 0, 0.5mA meter the resistance of which is built out by R137. Its zero reading is set in the absence of signal by selection of AOT5. In the presence of signal at input B but none at input A, the resulting symmetrical waveform at the emitter of VT51 produces no deflection of the meter. If this input signal is sufficient to produce a negative swing greater than about 0.5V at input 5, then VT47 is turned on to provide an incremented of current to the inhibitor, this being the fourth such transistor operated by signal in Forward Path B. (With increasing signal level it is actually the first one to operate.)

If there is signal in the path and none in the B path, the base of VT46 is driven but no deflection results on the meter.

If there is signal in both paths simultaneously the squared signal in the A path operates VT46 as a switch to turn the squared signal in the B path on and off.

If the difference of level in the two channels exceeds 20dB, the inhibitor switches VT48 on to prevent any signal going further.

If the two signals are random then the signal at VT49 and VT50 will on the average be equally distributed on the positive and negative sides of its zero signal datum, and the meter will therefore remain on zero.

If the signals in the two channels are identical then the signal in the B path will be switched on when it is negative and off when it is positive. This turns VT50 on, thereby pulling the base of VT51 positive and giving a positive deflection of the meter.

If the signals are identical but in opposite phase then the signal in the B path will be switched on when it is positive and negative deflection of the meter will result.

Since the device is to intended to be a linear phase meter but is required to be a indicator of in-phase or out-of-phase signals in the two channels, the scale shape is deliberately distorted by clamping diodes D15 and D16. AOT7 and AOT6 are selected for positive and negative full scale deflection respectively.

12.18.3.7 Power Supply

The correlator derives its supply from the stabilised supply on the Control Room Monitor Cassette. As this unit contains squared waveforms, which contain considerable amounts of high order harmonics of the normal signal waveform in the Mixer, it is liable to introduce spurious signals into other parts of the cassette, due to the common impedance of power unit and/or wiring, or to coupling in the wiring. To prevent this the correlator includes filtering stabilisers. Those for the Forward Path A and the Inhibitor are on the board carrying the latter. Those for the rest of the circuitry are on the gates board and they are identical with the previous ones except for the values of two resistors.

Each stabiliser has a series transistor, acting as a constant current source, and a shunt transistor, acting as an emitter follower. The upper positive stabiliser on the circuit diagram has a series transistor VT26, of which the emitter is fed through R66 and the base potential is determined by D8, R70, R71 and AOT1, D8 being included for temperature compensation. The base of the shunt transistor VT27 is held at +17.4V by R74 and R75, C15 being included to remove any supply borne interference. R67 is included so that the current in VT27 can be measured by a voltmeter and set to the desired value of 3mA by selection of AOT1. This ensures that under all signal conditions the emitter follower VT27 operates correctly with an adequate current margin.

The negative stabilisers are similar but require npn instead of pnp transistors.

12.19 Amplifier Type U

12.19.1 Purpose

This receives signal at a level of –10dBV and provides an output to drive a standard VU meter to a scale reading of 0 VU. It also has provision for increasing the gain by 10dB or 20dB by means of the boost buttons.

12.19.2 Circuit

The circuit diagram is shown on Drawing No. AE222.

12.19.3 Circuit Description

VT1 and VT2 constitute a d.c. coupled pair as used in Amplifier E. In the present case a high input impedance is required so that junction of resistors R6 and R7 is boot-strapped to the emitter of VT1 by C. The effective impedance from the emitter of VT1 to the 0 V line is therefore R6, R7 and R10 in parallel (= 2.65kΩ). The voltage gain which is determined by this impedance and R9 is therefore about 10.5dB resulting in a signal level of about +0.5dBV at the base of VT3.

A VU meter has an impedance of 3.9kΩ and is intended to be fed from a 600 Ω line terminated in 600Ω, that is from 300Ω, through a 3.6kΩ resistor. In order to economise in power, in the present case the identical operating conditions for the meter are obtained by coupling it through C3 to the junction of R12 and R13. These in parallel provide the required source impedance of 3.6kΩ + 300Ω and signal current is fed to the junction from the collector of VT3. The magnitude of the current supplied is determined by the total impedance in the emitter circuit of VT3. This consists of the parallel combination of R15 and R14 and AOT1 in series. AOT1 is selected, on test of the board, to give a voltage gain of 13.1dB into a resistive load of 3.9kΩ. AOT2 is then selected so that, when terminal "20" is connected to 0 V the gain is 33.1dB. AOT3 is then selected so that when terminal "10" is connected to 0 V the gain is 23.1dB.

12.20 Oscillator

12.20.1 Purpose

This enables the performance of the Mixer itself to be checked by direct injection into the input circuits of the Microphone Cassettes. It can also be switched through the track announce circuit to all tracks for setting up tape machines. It is also available for testing other external equipment.

12.20.2 Circuit Diagram

The circuit diagram is shown in Drawing No. BE224.

12.20.3 Circuit Description

The oscillator is of the Wien bridge type, C1 and C2 being the capacitors, R4 (2.4kΩ) being the resistor in series with C2 and R3 plus the parallel combination of R1 and R2 (= 200 + 2.7k//12k = 200 + 2.2k = 2.4kΩ) being the effective shunt resistance across C1. C1 and C2 are mounted on separate boards and are selected in pairs by the frequency switch which is also external. The values of C1 and C2 and the corresponding frequencies are shown in the table.

A d.c. coupled pair of transistors VT1 and VT2 is used to provide the necessary gain. The voltage gain is determined by R8 and the thermistor Th1. The amplitude of oscillation builds up until the resistance of the thermistor is precisely twice the value of R8 thereby giving the minimum voltage gain of 3 required to maintain oscillation. The potential of the base of VT1 is determined by R1 and R2. C3 and R6 serve to prevent spurious r.f. oscillation. C4 and C5 in parallel present a low impedance between one end of R8 and the 0V line.

The oscillator is required to give a constant output level independent of ambient temperature. With the circuit so far described the output would depend upon the temperature. The oscillator signal from the collector of VT2 is therefore applied to an emitter follower VT3, and peak rectified by D1 to charge C7 and C8 in parallel. This circuit has long charge and discharge time constants due to the high values of R10 and R11 respectively. The potential on C7 and C8 is compared with the potential at the junction of R16 and AOT1 by emitter followers VT4 and VT7, which are d.c. coupled to the bases of a long tail pair VT5 and VT6. If the former potential exceeds the latter, VT6 is turned on and the current from its collector passes through R8 and TH1. This provides extra heating in Th1, which in turn tends to decrease the oscillator signal, thereby producing the required stabilisation of the signal amplitude. On test of the board AOT1 is selected so that the collector current of VT6, measured by inserting a suitable meter in place of the test link, is:

0.5mA	if ambient temperature	20C to 25C
0.55mA	if ambient temperature	15C to 20C
0.6mA	if ambient temperature	10C to 15C

The output circuit comprises a unity gain d.c. coupled pair VT8 and VT9. The input to this pair is successively adjusted by AOT2 and AOT3 so that the output is 1.414V r.m.s. ±0.05dB.

Because of the appreciable time taken for the output to become stabilised after switching on, the oscillator is kept on even when it is not actually being used. In order to minimise the risk of cross-talk into other circuits, decoupling is provided in the positive and negative supply rails by R23, C11 and R24, C12 respectively.

12.21 Cassette Power Unit

12.21.1 Purpose

One of these is mounted on the underside of each cassette to supply the +20V and –20V supply lines thereof.

12.21.2 Circuit

The Circuit diagram is shown on Drawing No. BE225.

12.21.3 Circuit Description

The input transformer receives a 50V supply at 50 or 60Hz and has a centre tapped secondary, the overall ratio being 1:1.04. The centre point of the secondary winding is connected to the 0 V line. From the secondary winding D1 and D2 are connected as bi-phase rectifiers to provide the main positive supply, C3 being the reservoir capacitor. D3 and D4 provide a similar negative supply C4 being the reservoir capacitor. D5, D7, C1, C5 are connected as a voltage doubling circuit, using one half of the transformer secondary, to provide an auxiliary low current positive supply. R1 serves to limit the peak current and C5 is returned to the positive end of C3 to avoid the use of a higher voltage capacitor. D6, D8, C2, C6, R2 are similarly connected to the other half of the secondary of the transformer to provide an auxiliary low current negative supply.

The positive stabiliser contains VT2 and VT4 in parallel as a series unit, separate emitter resistors R8 and R9 being provided to equalise the currents. A fraction of the output determined by R22, AOT1, AOT2, R23 is fed to the base of VT8, the emitter of which is held by a 6.8V zener diode D11 shunted by C13, to reduce its noise and impedance. The collector of VT8 is fed through a load resistor R21 from a point approximately 9 V positive with respect to the +20V rail obtained by a 9.1V zener diode D10 which is fed through R15 from the auxiliary positive supply in which extra smoothing is provided by R13, C10. VT8 therefore operates as a high gain d.c. amplifier of the difference between a fraction of the output and the reference voltage provided by D11. The temperature coefficients of VT8 and D11, both of which are prior to the high gain, cancel one another. The collector of VT8 is connected to the base of an emitter follower VT1, the emitter of which is connected to the bases of VT2 and VT4. In order to realise an extremely low ripple voltage at the output, a fraction of the ripple across the series transistors is obtained by AOT4 and R7, and this fraction is coupled to the base of VT8 by C14. AOT1 and AOT2 are selected to give a precise output voltage of 20.0, and AOT4 is then selected for minimum ripple.

The negative stabiliser uses the +20V supply as its reference instead of a zener diode. An emitter follower VT7 has its base held at approximately 0V by the resistive chain R17, R18, R19, AOT13 connected between the +20V and – 20V rails. The emitter of VT7 is connected to the base of the high gain amplifier stage VT6. This in turn is connected to an emitter follower VT3 which controls the base of the series transistor VT5. VT6 collector is fed from the auxiliary negative supply in the same way as VT8 collector is fed from the auxiliary positive supply. The collector of VT7 is fed from D11 solely because this is a point at a suitable potential. AOT3 is selected to give the precise output voltage, and AOT5, which controls the ripple fed to the base of VT7 via C12, is selected for minimum ripple at the negative output. R3 and R5 serve to limit current in overload conditions. The temperature coefficients of VT6 and VT7 cancel one another.

12.21.4 Output

The rated output is 75mA from the +20V rail and 120mA from the –20V rail. The noise output varies with supply voltage but is of the order of 5μV r.m.s. over the audio bandwidth measured flat.

12.22 Limiter

12.22.1 Purpose

The so-called limiter is provided with a switch which enables it to be used either as a 2:1 compressor or as a limiter with up to 20dB of compression or limiting.

12.22.2 Circuit

The circuit diagram is shown in Drawing No. CE226.

12.22.3 Circuit Description

The input is coupled by C1 to a pair of transistors VT1, VT2 connected as a direct coupled pair with direct coupled feedback to give a gain of 14dB. The base of VT1 is held at about –16V by R2 and R3 which, together with R1, provide an input impedance of 20kΩ. The positive and negative supplies to this pair are decoupled by R7, C2 and R8, C3 respectively.

The output of this pair is coupled to the base of VT3, an emitter follower, the emitter of which is connected to the base of VT6. VT5 and VT6 form a long tail pair, the tail being mainly the collector impedance of VT24.

Zener diodes have the property that their impedance is approximately a logarithmic function of the current. Two diodes are provided in each of the collector circuits of VT5 and VT6. The voltage gain of each of these transistors is therefore the ratio of the impedance of the two zener diodes in the collector circuit to the impedance in the emitter circuit, R10 or R20. The impedance of these zener diodes is determined by a control current supplied by VT24.

The total signal at the collectors of VT5 and VT6 therefore contains the desired signal in push-pull together with an undesired control signal in push-push. It is most important that no appreciable amount of control signal shall appear in push-pull. To realise this the diodes are selected as matched pairs before being fitted. D1 and D3 are one matched pair, and D2 and D4 are another matched pair and these components must only be replaced as matched pairs.

Although only VT6 is directly fed with signal, in order to maintain the balance of VT5 and VT6 with changes of temperature, it is necessary to provide these two transistors with similar bias supplies. The base of VT5 is therefore fed from an emitter follower, having base and emitter resistances equal to those of VT3. The bias chain is common to the two transistors as far as possible. R 12 and R16 being common. For initial balancing AOT7 and AOT9 are provided. In order to avoid the need for high values of the AOT resistors, R13 and R14 are made much less than R10 and R11. In order to equalise the resistances seen by the bases of VT3 and VT4, R15 is added. The transmission of signal to the base of VT4 is prevented by C5. In order further to improve the matching of the pairs of zener diodes, at the low impedance (high control current) end of their range of operation, R19 and AOT8 and 10 are included. If any component which affects the balance of VT5 and VT6 has to be replaced, the setting-up procedure for AOT7, 8, 9 and 10 must be carried out.

The collectors of VT5 and VT6 are connected to the bases of another long trail pair VT7 and VT8, the long tail being the collector impedance of VT9. This stage provides a gain of about 7dB for the push-pull signal and rejects the push-push signal.

A d.c. coupled unity gain pair VT10, VT11 is connected to the collector of VT8, and provides a low impedance output through d.c. blocking capacitor C8.

For the control chain, another push-pull amplifying stage VT12, VT13 is direct coupled to VT7, VT8, and provides about 9dB of gain. The collectors of this stage are a.c. coupled to the bases of a further push-pull pair VT15, VT16. The earthy ends of the base resistors of VT15 and VT16, are connected to a low impedance point, held at about –13.3V by an emitter follower VT14, which provides temperature compensation for VT15 and VT16. These two transistors are connected as a long tail push-pull pair, and the output is taken from the collectors through diodes D6 and D7 to the base of an emitter follower VT17. The combination of VT15, VT16, D6, D7 and VT17 provides a back-off system which requires the signal level at the bases of VT15, VT16 and hence the output signal level to exceed a predetermined value before any signal appears at the emitter of VT17. Less back-off is required for compression than for limiting. To effect this, the compress-limit switch short circuits a part of the tail resistance (R41, AOT5, AOT6) thereby increasing the current to VT15 and VT16 and so reducing the collector potential.

VT18 and VT19 are connected as a d.c. coupled virtual earth amplifier. In the “compress” condition the gain is quite low being about 3dB (the ratio of R46 to R44). In the “limit” condition R45 with D8, D9 and D10 in series are shunted across R44, thereby increasing the gain to about 20dB. The purpose of the diodes is to round off the sharp knee which would otherwise be present in the transfer characteristic.

The emitter of VT19 is connected through D11 and R50 to C12 so that, when the emitter swings positively, C12 charges. The charging time constant is about 8 ms, this having been found to be the optimum value, C12 discharges through a recovery control B247A, mounted on the top panel which provides recovery time constants of approximately 0.1, 0.25, 0.5, 1, 2 and 5 seconds.

The control voltage across C12 is fed to a d.c. coupled unity gain pair of transistors VT21, VT22. The current in this stage is determined by VT23 and is about 1mA. Thus the standing potential of the collector of VT23 is about –14V and its excursions are identical with the control voltage at C12. VT24 converts these voltage excursions into current variations, the effective emitter load being R54 and R55 in parallel. This equals 4.7kΩ and therefore a control current of 0.21mA per control volt is generated. The control current is fed to VT5 and VT6 and thence to the gain controlling zener diodes D1, D2, D3 and D4. It also passes through a meter Type A49 which is calibrated in decibels of voltage gain. The range is 0 to 20 with 0 near the top and 20 near the bottom. The scale above 0 is coloured red since this is an overload region. This red range covers 3dB of an 8dB overload margin before peak clipping occurs. In the overload margin the total harmonic distortion at a frequency of 1kHz is of the order of 0.5% but is normally less than 0.2% in the normal working range of levels. Left and Right hand meters are provided for the two channels in a cassette.

For the purpose of temperature compensation, the base of VT23 is held by the emitter of an emitter follower VT20, the base of which is held at about –15.5V by R47 and R48.

VT25 has its base held at –6.7V by R57 and R58 and, for normal signal levels, is cut off. In the overload region it becomes conducting, thereby connecting R60, in shunt with R54 and R55, as emitter load of VT24. The relation between control current and control voltage thus changes to about 1.2mA per volt. This rapid rise of control current with rise of control voltage minimises distortion in the 8dB overload region. When switched to act as a compressor, the function in the overload region is that of a limiter.

The hold control is a 10kΩ linear potentiometer, mounted with its control coaxial with the recovery control. It is fed, through R56, from the point which is decoupled from the +20V supply by R49, C11 and which feeds the collector of VT19 and the emitter of VT22. This results in the upper end of the hold control being at about +10V. The potential from the slider is connected to the junction of D11 and R50. Thus the hold control sets a potential, below which the effective control voltage cannot fall. Thus the hold control determines the increase of gain with falling signal level and therefore controls the amount of compression or limiting.

The earthy lead from the recovery switch is taken to the slider of the hold control so that the discharge of C12 is exponential to the potential on the slider.
Terminal K is connected to a ganging switch. When this is switched to the "gang" position this terminal is connected to the corresponding terminal of the limiter in the other channel of the cassette. In this condition both units are controlled by whichever control voltage is higher. In this state, only the left hand hold control is operative, and the recovery controls should be set to the same setting.

The hold control should never be set so as to allow the meter to enter the lower red band or distortion may result.

Drawing AE378 gives some notes on the use of this limiter.

12.23 <u>Active Relays</u>

12.23.1 Purpose

This contains transistor circuits which, when operated by mechanical switches, provide the control signals necessary for remote control of audio signals.

12.23.2 Circuit

The circuit diagram is shown on Drawing No. CE227.
In order to facilitate an understanding of the complete system this drawing also shows the connections to other components. The components on the actual printed board are those within the large dashed enclosure. The location of the remaining component is given in the circuit description below.

12.23.3 Circuit Description

The circuit comprises eight transistors connected as four similar but not identical long tail pairs. Taking the simplest of these, VT3 and VT4 are provided with a long tail R7 connected to the +20V line. The base of VT3 is connected, through R6, to a +9V rail, obtained from R22, R23 and R24 connected across the +20V supply. The base of VT4 is held at about +7V by R9 and R10, also across the +20V supply. The collector of VT4 is connected to the 0V line and the collector of VT3 is connected through R8 to a –3V line obtained from the –20V supply by R25 and R26. Under these conditions VT4 is turned on and VT3 is turned off so that terminal 8, which is also connected to the collector of VT3, is held at about –3V.

When the talkback button is depressed, the base of VT3 is connected to a +6V line, also obtained from the chain R22, R23, R24. This turns VT4 off and VT3 on, thereby passing about 4.5mA to the two Amplifiers J in the Control Room Monitor Cassette, thereby turning; on VT4 in each of these amplifiers, and thereby quieting the two monitor loudspeakers. C2 serves to slow the operation and thereby suppress switch clicks.

The circuitry of VT5 and VT6 is identical with that of VT3 and VT4. This pair is however operated by the closure of the Artist Managers microphone button, provided that his selector switch is set to Talkback. This circuit quiets the monitor loudspeakers by turning on VT5 in each Amplifier J.

VT1 and VT2 are required to quiet the monitor loudspeakers either if the multi-track announce button is operated, or if any individual track announce button is operated. These cannot, however, be connected directly in parallel, since only the multi-track announce button must operate the RL5 in each of the Main Channel Cassettes. D3 is therefore included, to prevent the operation of RL5 by the individual announce buttons. Since a silicon diode has a contact potential of about 0.5V, D4 is included so that the potential of the base of VT1 is the same, whichever button is pressed. Since this potential is therefore 0.5V more positive than the potential applied to VT3 and VT5 for switching, the potential of the base of VT2 is made 0.5V more positive than the bases of VT4 and VT6 by making R3 24kΩ as compared with 27kΩ for R9 and R14.

It will be seen that RL1 and RL5 can also be simultaneously operated by setting the oscillator key to position 1. Another leaf of this key (not shown) applies the oscillator to the track announce bus line. RL5 switches this to the tape machines for setting up purposes and RL1 quiets the monitor loudspeakers.

VT7 and VT8 provide the control currents required for the change-over switches in the Amplifiers N in the studio loudspeaker circuits. In this case the current from both collectors is used so they are both fed in the same way. Since this relay is to be operated, either by the talkback button or the Artist Manger's microphone button, hold-off diodes are again required, these being D1 and D2. Also R19 has the same value as R3. In this case a somewhat greater output current is required so the tail resistor R18 is reduced to 2.7kΩ.

In series with the operating push buttons is a section of the talkback key. In the position marked 3 on the circuit diagram (key with lever down) the connection from the buttons to RL4 is broken, so that talkback is routed, by a second section of the key, to the alternative talkback system, without any change in the studio loudspeaker system. In the mid position of the key, RL4 is operated by the push buttons and the second section of the key applies the talkback signal to the A inputs of the Amplifiers N, which are now routed to the studio loudspeakers thus giving talkback on the studio loudspeakers. In the remaining position (marked 1) of the key RL4 is still operated by the push buttons, but the second section of the key leaves the A input of the Amplifiers N without a signal, so the studio loudspeakers are muted. The second section of the key connects the talkback signal to the alternative talkback channel, thus resulting in alternative talkback with studio loudspeakers muted (marked ALT.(M) on the panel).

12.24 Solo Relay

12.24.1 Purpose

This is used in conjunction with the solo buttons to mute the right hand monitor loudspeaker and to feed to the left hand monitor loudspeaker the signal from only the channel of the pressed solo button.

12.24.2 Circuit

The circuit diagram is shown on drawing No. BE229.

12.23.3 Circuit Description

VT1 and VT2 are a long tail pair with the base of VT2 held at about +0.8V from the potential divider R1, R2, R3 connected across the +20V supply. R17 connects the base of VT1 to the common emitter point, and therefore VT2 is turned on and VT1 is held off. The current in VT2, determined by the base potential and R6, is about 3.5mA. The base of VT1, and the junction of R2 and R3 which is at a potential of about 6V are connected to the control contacts of all the solo buttons. When any one of these is pressed, these two points are connected together thereby reducing the voltage of VT1 base to about 6V. This turns VT1 on and VT2 off. The collector of VT1, which was previously held slightly negative by R4, R5 connected across the -20V supply now passes its 3.5mA through R7, R13, R8, R14, which serve to equalise the sharing to the bases of VT3, VT4, VT5 and VT6, thereby turning on these four transistors.

Terminals A and B, left and A and B, right are connected to corresponding terminals in the Amplifiers P in the left and right control room monitor loudspeaker circuits. This puts these terminals in series with the normal signal paths to the loudspeakers. Thus when VT3, VT4, VT5 and VT6 are in the “off” condition, normal signal transmission takes place through the series resistors, which total about 20kΩ, thereby causing the virtual earth amplifier VT4, VT5 of Amplifier P to have unity gain.

When the four transistors are in the “on” conditions, each channel has a two stage attenuator each stage of which introduces at least 40dB of attenuation. The normal signals in both channels are therefore effectively switched off. The solo signal bus is fed with signal from the channel in which the button is pressed, through a 16kΩ resistor. The solo signal bus is connected to the left hand channel terminal B interconnection, between the Solo Relay board and the Amplifier P board. It therefore feeds into the virtual earth amplifier BT4, VT5 of Amplifier P, which has a feedback resistor of 20kΩ. This amplifier thus gives a gain of 2 dB so that a –10dBV signal produces a –8 dBV output signal. This is higher than the nominal level at this point in the Amplifier P but it produces a more acceptable sound level from the single loudspeaker fed from a single channel.

12.25 Re-Record Attenuators

12.25.1 Purpose

These provide the 25dB of attenuation which is required for a re-record signal which leaves the Track Monitor Cassette at a level of –10dBV to be applied to the Microphone Cassette input switch at the required level of – 35dBV.

12.25.2 Circuit

The circuit diagram is shown on Drawing No. AE230.

12.25.3 Circuit Description

One board serves both channels of a Microphone Cassette. It contains 10 identical attenuators the inputs being on two sets of terminals numbered 1 to 5 and the corresponding outputs being on two sets of terminals numbered 6 to 10. Separate 0V lines are provided, to be connected to the 0V lines of the two channels in the cassette.

The input impedance of each attenuator is about 38kΩ so that when, in a 24-input mixer, 12 of these are connected in parallel, each A1 amplifier in a Track Monitor Cassette which feeds one of the Mic. Input Bus Lines will have a load impedance of just over 3kΩ. The output impedance of each attenuator which, when in use, becomes the input impedance of an Amplifier D, is about 2kΩ.

12.26 Track Announce Relay

12.26.1 Purpose

One of these is located in each Main Channel Cassette. It is designated RL5 in the Block Schematic DE1. It receives a control signal (+6V) from the Studio Playback Cassette and provides the currents require to operate two Amplifiers N.

12.26.2 Circuit

The circuit diagram is shown on Drawing No. AE231.

12.26.3 Circuit Description

The circuit is identical with that of VT7 and VT8 of Active Relays (see 12.23.2) with the exception that the 150kΩ resistor connected to the base of the first transistor is in this case returned to the common emitter point and not to a +9V line as in Active Relays. The operation is as in Active Relays, the outputs being in the present case terminals 1 and 2 which connect to the corresponding terminals of two Amplifiers N.

12.27 Amplifier Type D

12.27.1 Purpose

This is used as the input amplifier in the Microphone Cassette. In conjunction with a control to Drawing No. A191 it provides a gain of 25 ±5dB, the control having 20 steps of 0.5dB.

12.27.2 Circuit

The circuit diagram is shown in Drawing No. BE232.

12.27.3 Circuit Description

The circuit is very similar to that of Amplifier A3 (see 12.3). The forward path is identical but only a direct coupled output is provided. Provision for the gain control is made by blocking capacitor C6 and resistor R8 connected between the emitter of VT1 and the Gain Control Terminal. The actual control, which at maximum gain has a value of 0Ω and at minimum gain has a value of 1.2kΩ, is connected between this terminal and 0V. AOT1 is selected to set the gain to 20dB with 1.2kΩ connected between "Gain Control" and 0V.

12.27.4 Output

The output has no d.c. blocking capacitor. It is in phase with the input and will deliver at least 1.4V r.m.s. into a load of 3kΩ.

12.28 Amplifier Type P

12.28.1 Purpose

In that it provides in phase and out of phase outputs for use with a poling button and that it's outputs are suitable for connection to a loudspeaker selector switch, this amplifier is basically the same as an Amplifier H (see 12.10). Amplifier P is however required to work in conjunction with the Solo Relay (see 12.24) which requires some differences.

12.28.2 Circuit

The circuit diagram is shown on Drawing No. BE233.

12.28.3 Circuit Description

For the working of the Solo Relay, the normal output must be the second output and hence two phase reversing amplifiers are required. These, apart from the values of the gain determining components, are both very similar to the phase reversing pair in Amplifier H. Being of the virtual earth type, it is not possible directly to realize the required 50kΩ input impedance. The first amplifier is therefore preceded by an emitter follower VT1. R1 and R2 provide the required input impedance and hold the base at about +6.7V. R3 serves to reduce the risk of r.f. oscillation. AOT1 is used for setting the overall gain of the channel in the cassette and is initially a short circuit on the board. The gain of the amplifier VT2, VT3 is approximately the ratio of R8 + AOT1 to R3 or about 16dB. The output of this amplifier is coupled through C5 to terminal A and, through a 5.1kΩ build-out resistor R21, to OUT 2 (Anti-phase).

In the normal condition the Solo Relay provides a resistance of 20kΩ between terminals A and B. Terminal B is coupled by C8 to the input of the second amplifier VT4, VT5, the feedback resistor of which, R15, also has a value of 20kΩ. This therefore has unity gain and the output is coupled through C9 and build-out R20 to OUT 1 (In-phase).

12.28.4 Output

Each output will deliver at least 1.1V r.m.s. into a 5.1kΩ load.

12.29 Microphone Power Unit

12.29.1 Purpose

This unit provides a 50V d.c. supply, with low ripple, for phantom powering of microphone head amplifiers.

12.29.2 Circuit

The circuit diagram is shown in Drawing No. BE238.

12.29.3 Circuit Description

A transformer B189A as used in the Cassette Power Unit is fed from the 50 V a.c. supply and the whole of the secondary winding is used to feed a bridge rectifier circuit D1, D2, D3 and D4. The output is fed through a current limiting resistor R1 to reservoir capacitors C1 and C2 in parallel. The positive line passes through R4 and a series control transistor VT2 to the output. Two 16V zener diodes dΩ and D7, carrying the emitter current of VT3 and about 1.8mA supplied through R6, hold the emitter of VT3 at about +32V. The base of VT3 is connected to a potential divider consisting of R7, AOT and R8 connected across the output. The collector of VT3 has a load resistor R5 and it is connected to the base of VT2, thus forming a high gain feedback circuit which stabilises the output voltage. The AOT resistor is chosen to give the required 50V output. C5 provides an a.c. by-pass across the upper part of the potential divider, and therefore increases the loop gain at a.c. and so reduces the output ripple.

D5 is a 7.5V zener diode holding the emitter of VT1 7.5V below the rectified supply. The base of VT1 is connected through a current limiting resistor R3 to the output line. Thus if the rectified voltage rises in excess of about 8V above the output, VT1 is turned on and takes current which reduces the rise of voltage. It therefore acts as a shunt stabiliser.

12.29.4 Output

The until will deliver up to 20mA at 50V with a total regulation of about 0.2V. The ripple does not exceed 10mV.

12.30 Injection Unit (Specification)

Any equipment connected to an inject socket should comply with the following:

12.30.1

Screened Transformers should be used both in the send and the return leads. These should be connected to the inject plug by twisted screened pair leads.

12.30.2

The impedance at the primary of the send transformer should not be less than 3kΩ and the impedance at the secondary of the return transformer should not be greater than 200Ω.

12.30.3

The send transformer will be fed from 20Ω in series with a capacitor of nominally 6.8, 4.7 or 2.7µF.

The receive transformer will feed into not less than 3kΩ.

12.30.4

The nominal level at both send and return will be –10dBV and at least 20dB overload margin should be allowed for.

Appendix A

Modifications

Solo and Cut modification.

Abbey Road consoles received a modification to the “Solo” switch and were also fitted with a “Cut” switch on every channel, along with an LED indication of the operation of either the Solo or Cut switch.

The circuit of these modifications is detailed in drawing No.TG12345/AR008.
This drawing should be read in conjunction with TG12345/DE2.

The original solo push-button was replaced by a latching miniature 2-pole changeover toggle switch, and a similar switch was added adjacent to each channel fader, for use as a cut switch.
The LED indicator was fitted adjacent to the fader, between the solo and the new cut switch.
The addition of the cut switch and LED indicator require drilling the front panel of the cassette.