

ELECTRIC & MUSICAL INDUSTRIES, LIMITED.

RECORDS & INTERNATIONAL DIVISION.

Recording Equipment Production Department.

"STEREOSONIC" MIXER 4/8 WAY, TABLE MODEL,

TYPES REDD.43 & REDD.43X.

List of Contents:-

Page.

1

SUMMARY.

Power Supplies.

General Arrangement, Size and Weight.

2

Microphone Channel Facilities.

Microphone Arrangements.

General Facilities.

3

Installation.

4

Setting for Local Mains Voltage.      WARNING.

CIRCUIT DESCRIPTION & OPERATING INSTRUCTIONS.

General.

Circuit Impedances.

Setting Up for Mono or Stereo.

5

Microphone Levels.

Input Attenuation --- General.

Page.

- 6      Microphone Equaliser Bass Lift/Pad.  
Fine Pre-Set Attenuators.
- 7      Line Amplifiers Type 812 and Type REDD.47.  
Tone Controls.
- 8      E.M.I. "Stereosonic" Circuits.  
Edgewise Miniature Faders.  
Splitter Transformers.
- 9      Pan Pots.  
Combiner Networks.
- 10     Earthing Terminals --- Use.  
Main Attenuator (Main Gain Control).  
Line Amplifiers.  
Main Coupling Switch (Stereo/Mono).  
Echo Pots.
- 11     Echo Return Circuits.      WARNING.
- 12     Delta Pots. --- Auxiliary Mono.  
Line In Selector Switch.

Page.

- 13      Line Out Selector Switch.  
         Line In/Line Out (A/B) Key.  
         Replay Circuits (from Tape Recorders).  
         Monitoring Circuits.  
         Monitor Coupling Switch (Stereo/Mono).
- 14      Monitor Poling Push Button.  
         Level Indicators.  
         Studio Playback Circuits.  
         Studio P/B Coupling Switch ("Off - Stereo - Mono").  
         Talk-Back/Announce.
- 15      Amplifier Test Position.  
         Test Unit Type REDD.43/B52 or Type REDD.53.  
         General Testing.
- 16      REDD.43 --- Voltage Gains and Losses --- dB.
- 17      REDD.43X -- Voltage Gains and Losses --- dB.

WARNING:-    DO NOT PLUG IN OR REMOVE AMPLIFIERS  
                 FROM A LIVE RANK.

REDD.M43.

"STEREOSONIC" MIXER, 4/8 WAY, TABLE MODEL, TYPES REDD.43 & REDD.43X.

SUMMARY.

The Mixers Type REDD.43 & REDD.43X are portable stereo recording equipments designed primarily for use with the TR.90 Stereo Tape Recorder but capable of being used with almost any other tape recorder. The equipment is self-contained and apart from the tape recorder, the only additional items required consist of the microphones, mic. stands, and loudspeakers, together with the necessary cables, and a suitable table or desk on which to place the Mixer.

Although designed as stereo recording equipments, both types of Mixer are equally suitable for single channel operation, although naturally there is then some slight redundancy in the circuit elements provided.

The two types are basically similar. Type REDD.43 is fitted with Line Amplifiers Type 812 (voltage gain 19 - 49 dB) and Peak Level Indicators Type REDD.44 (scale range -30 to +12 dB).

Type REDD.43X has Line Amplifiers Type REDD.47 (voltage gain 34, 40 or 46 dB) and Level Indicators Type REDD.48 (scale range -50 to +6 dB).

Power Supplies.

Both types operate from 90 - 140 or 205 - 255 volts, 50 - 60 c/s mains.

Type REDD.43X consumes 0.9 A at 230 V (207 VA), and Type REDD.43 slightly less.

General Arrangements, Size and Weight.

The Mixer proper is contained in a central case having a gently sloping panel. The overall size of this case is  $25\frac{1}{2}$  inches (650 mm.) from side to side,  $18\frac{3}{4}$ " (477 mm.) from front to back, and  $11\frac{3}{4}$ " (298 mm.) overall height, of which  $5\frac{1}{2}$ " (139.7 mm.) is normally below the table top. \*

Two metal cases contain the 9 amplifiers, the 2 level indicator amplifier units and the test fitting which enables these units to be operated when withdrawn from the cases for possible fault tracing. These cases are arranged to lock on to the central mixer case, one on either side. The size of each of the two side cases is 16" (407 mm.) wide, and  $16.3\frac{3}{8}$ " (416 mm.) from front to back. The overall height of each, excluding the feet, is  $6.5\frac{5}{8}$ " (159 mm.). Of the last two dimensions,  $3\frac{3}{8}$ " (9mm.) is occupied by the ventilation cover which rises slightly above and projects slightly in front of the central case\*

\* The prototype mixer, Serial No.59010A, was slightly smaller.

The weight of the central mixer is  $107\frac{1}{2}$  pounds (48.5 kg.), and that of each side case, complete with plug-in units, is 49 lbs. (22.3 kg.).

#### Microphone Channel Facilities.

The equipment is designed for 4 main microphone channels, but will accommodate up to 8 inputs. Each of the 4 microphone channels is fully equipped with microphone amplifier, tone controls, fader, etc. These 4 main input channels are designated M1, M2, M3 and M4.

On channels M3 and M4 it is possible to use auxiliary inputs, designated M3a and M4a. The required balance between the main and auxiliary input is then set by means of a fine pre-set attenuator having steps of 2 dB. The output from this attenuator is then combined with that from the main input M3 and is fed to the microphone amplifier, etc. of that channel, and similarly for M4a and M4.

Two extra faders are provided and are normally intended for use on the echo return lines (designated H.1 and H.2), but may be used to accommodate additional microphones, provided that the output level from the head amplifier of such microphones is sufficiently high. Alternatively, if the Echo Amplifier is not in use, it may be placed in the "Test" position and the Spare and Test amplifiers may then be patched (jumpered) into circuit and used as additional microphone amplifiers. If preferred, an additional spare amplifier may be supplied if specially ordered. (See warning on Page 11).

#### Microphone Arrangements.

The equipment will accommodate various microphone arrangements, of which the following are typical examples:-

- (a) 2 stereo microphones (on inputs M1, M2 & M3, M4);  
2 return lines from a stereo microphone in the echo chamber (on H.1, H2).
- (b) 4 single channel microphones (on the main inputs M1, M2, M3, M4);  
2 single channel microphones (on the auxiliary inputs M3a, M4a);  
2 echo return lines (on the extra faders H.1, H.2). Many intermediate arrangements, such as a mixture of stereo and single channel microphones, are possible.

#### General Facilities.

Although intended as a light and reasonably portable equipment, the REDD. 43/43X Mixer uses best quality components and is suitable in every way for the highest quality of work.

As a brief summary of its capabilities the following points are worthy of mention:-

- A). It will accept input levels ranging up to 0 dBm (equivalent to 0.477 V = 1 mW in 200 ohms), thus allowing for the loudest "Pop" conditions and also for the direct connection of a tape recorder output to the inputs of the Mixer.

- B). The amplifiers have adjustable voltage gain, thus allowing convenient fader settings to be obtained with ease.
- C). Plug-in tone controls are fitted as standard, thus permitting the use of different types for classical and "Pop" recording.
- D). Edgewise miniature microphone faders are used, thus giving finger tip control.
- E). The full benefits of the E.M.I. "Stereosonic" system are available, on both stereo microphone pairs simultaneously if desired.
- F). Single microphones may be injected into the stereo system and the signals from such microphones may be placed in the desired angular position by means of pan-pots.
- G). For artificial reverberation, separate "echo send" controls are provided on each of the main input channels.
- H). Provision is made for the simultaneous recording of single track (mono) and stereo tapes, if desired.
- I). Fully professional level indicating, monitoring and studio playback arrangements are provided.

#### Installation.

It is recommended that the equipment should be installed on a special table or console desk having the usual height of 30" (760 mm.). A cut-out of the same width as the central Mixer should be made in the table top, extending from the back to a distance of 10" (254 mm.) from the front. Suitable support for the central Mixer should be arranged,  $5\frac{1}{2}$ " (139.7 mm.) below the table top. The faders will then be conveniently placed for operation, and the 10" or so of table surface in front of the Mixer will form a convenient arm rest. It is recommended that the edge of the cut-out, immediately in front of the Mixer, should be bevelled, to allow the panel to open fully.

The two side units stand on the table top, but this table top must either be cut away almost completely, or alternatively drilled with a large number of holes, so as to provide very free ventilation for the amplifiers. Slots should be cut to accommodate the four P.V.C. feet on each side case. Slots are preferable to round holes, as they enable the side cases to be removed more easily in case of need. Needless to say, air should be able to enter below the table top so that a through draught is maintained.

For portable use, a light table may be constructed on similar lines to the above, but with folding legs. Alternatively, for use where space is very limited, a small table may be made for the central Mixer only; the two side units may then be placed on the floor and connected up by means of the extension cables provided.

REDD.M43.

The plastic feet of the side cases are made specially large so that, when it is necessary to place the cases on the floor, adequate ventilation is still obtained, even though they may be standing on a carpet with a thick pile.

IMPORTANT.

Setting for Mains Voltage.

The equipment is normally supplied set for 230 V. mains, and may need adjustment to suit the local voltage. The setting should be based on the lowest actual mains voltage, rather than on the nominal figure. For example, if the supply voltage is nominally 230 but often drops to 215 and never exceeds 225, the equipment should be strapped for 215 V.

For operation on the lower range, both 115 V. windings must be connected in parallel aiding, i.e., Start to Start and Finish to Finish.

For mains voltages above 115 or above 230, the auxiliary winding must be connected in series aiding, i.e., Finish of 115 V. winding(s) to Start of auxiliary winding.

For mains voltages below 115 or below 230, connect the auxiliary winding in series opposing.

CIRCUIT DESCRIPTION & OPERATING INSTRUCTIONS.

General.

Reference should now be made to the functional diagram, which is REDD.C31/A1 for the REDD.43 and REDD.43/B1 for the REDD.43X.

The drawing numbers of individual circuits forming part of the equipment are clearly shown. As much detail as possible is given on all circuit diagrams and in many cases it is unnecessary to elaborate further in this write-up.

Circuit Impedances.

The general principle is that all amplifiers in the system operate from a source impedance of 200 ohms. In other words, the 200 ohm circuits are not closed by terminating resistors of 200 ohms.

Setting Up.

For normal use, the mixer requires no jumpers for its internal connections, all of which can be made by means of "U"-links. When plugging up the "U"-links, reference should be made to the block schematic diagram which shows the normal order of the various circuit elements. For Mono working, the Sum & Difference, Spreader and Shuffler circuits are, of course, omitted.

For Stereo working using crossed figure-of-8 microphones (otherwise known as crossed cosine), it is recommended that these circuits should be included.



For Stereo working using cardioid/cosine microphones, the 1st Sum & Difference circuit should be omitted, as the outputs from such microphones are already in the Sum & Difference form.

If a Stereo pair is being used on inputs M3 and M4, the Pan Pots on these channels should normally be set fully Left and Right, respectively.

#### Microphone Levels.

The output level from the microphone may vary between roughly -50 dBm for a very insensitive ribbon microphone picking up quiet chamber music, up to an equivalent of about zero level (0 dBm) into open circuit for a sensitive condenser type (such as the U.47) placed very close to powerful instruments such as trombones.

#### Input Attenuation - General.

The purpose of the attenuators on the input circuits is to ensure that the higher levels of this tremendously wide range do not overload the following microphone amplifiers. Warning of this danger is given by unusually low settings of the faders and/or main gain control.

Wherever the sensitivity of the microphone allows it, the object should be to obtain a level of approximately 0 dBm from the microphone amplifier output, although there is no objection to allowing this level to go up to +6 dBm.

By reference to the functional diagram, it is a fairly simple matter to work back from the output end and thus to determine the actual level at the output of the microphone amplifier for any particular conditions. For example, if the settings are as shown on the diagram and zero level is being obtained at the output of the Line Amplifiers, then the Mic. Amp. output level must be as shown if only one microphone is in use, or may be somewhat lower if several microphones are contributing to the Line In level. Similarly, if the Main Attenuator is set, say, 6 dB higher than shown, then the Mic. Amp. output level must be 6 dB lower. In this way, the relationship between the settings and the Mic. Amp. output level can be rapidly established. Alternatively, if found more convenient, the input of one of the level indicator units may be connected across the output of the desired microphone amplifier and the level read directly on the level indicator meter.

The levels shown on the block schematic are for information only, and need not be rigorously followed. The input level is based on the typical signal which can be expected from a KM.56 microphone used at a distance of 20 feet (6 metres) from, and turned to an angle of 45° with a respect to, a 40 piece orchestra playing mezzo-forte. Note that the level of -33 is the open circuit voltage with respect to 0.447 Volt and this can be simulated by means of an unterminated gain set set to "-39". For convenience, on the block schematic diagram the amplifiers are shown set to maximum gain, but there is no objection to reducing this setting, providing that the warnings contained in the separate write-ups on the amplifiers are observed.



REDD.M43.

The object should be to obtain a comfortable working position on the Faders, somewhere near the middle of the 15 steps of 1 dB. It is not recommended that the gain of the Line Amplifiers should be set to maximum unless found necessary, (for example, when using insensitive microphones), as the input signal to the Line Amplifiers would then have to be set somewhat on the low side.

Microphone Equaliser Bass Lift/Pad.

On this equipment a single control on each microphone channel serves to bring in the required amount of pre-set attenuation, or, alternatively, to provide some 10 dB of "bass lift" (actually middle and top cut, of course) together with the required attenuation. The "bass lift" is intended as microphone equalisation to compensate for the falling characteristic which is a feature of all known types of figure-of-8 condenser microphones. Anti-clockwise rotation of the knob brings in successive steps of attenuation, whereas clockwise rotation of the knob first brings in 10 dB of bass lift followed by successive steps of attenuation. Thus, at the full anti-clockwise position of the control on the first three (REDD.43) equipments there is 20 dB of attenuation (30 dB on later REDD.43X equipments), and, at full clockwise rotation of the knob, 10 dB of bass lift and 10 dB of attenuation is obtained on the REDD. 43 (whereas the REDD.43X gives 10 dB of bass lift and 20 dB of attenuation).

The form of "bass lift" provided enables nearly a full 10 dB of "lift" to be obtained at low frequencies, even though the actual voltage loss at high frequencies is equivalent to only 6.9 dB. The connection loss at high frequencies is 3.1 dB, thus making the total H.F. loss 10 dB, and the input impedance of the "bass lift" circuit alone is then approximately 400 ohms. At very low frequencies, however, the input impedance becomes very high and the connection loss then disappears.

The input impedance is made high, particularly at low frequencies, as a precaution against the severe distortion which occurs at high levels in the head amplifier of the majority of condenser microphones when the output of the head amplifier is terminated by its matched impedance, (normally 200 ohms).

The high resistance across the condenser in the bass lift circuit minimises switching clicks due to static charges.

Regarding the attenuator portion of the circuit, it will be seen that the greater the loss, the higher the input impedance becomes.

Fine Pre-Set Attenuators.

The fine pre-set attenuators and the associated 6 dB pads permit two microphones to be fed to input M3 (and similarly on M4), and to be individually balanced as required.

Again, the greater the loss, the higher the input impedance becomes. This is a further precaution against the distortion mentioned above.

REDD.M43.

It is important to note that each Fine Pre-Set Attenuator switch must be left in its "off" position unless there are 200 ohm sources (e.g., microphones) connected to both the main and to the auxiliary inputs.

Line Amplifiers Type 812 and Type REDD.47.

For descriptions of the amplifiers used in all positions of the equipment, please see the separate, respective write-up.

Tone Controls.

A completely new type of tone control, as used on the last two REDD.37 and the REDD.51 "Stereosonic"/4-Track Mixers, is provided on each of the four main mic. channels. Two separate control knobs are fitted on each channel in the usual way, but the range of each has been increased to  $\pm 10$  dB in 2 dB steps. Furthermore, the reactive components associated with the tone controls are accommodated in separate plug-in boxes and they may therefore readily be changed in order to obtain the most suitable characteristics. Each of the plug-in boxes contains all the necessary inductors and condensers for two of the mic. channels, and the equipment is supplied complete with two boxes marked "Classic" and two boxes marked "Pop". The attenuator switches remain on the panel and provide the necessary control for either type of plug-in box.

The "Classic" type gives a stepped response which is somewhat similar to that given by older tone controls, (such as those used on the RS.64 Input Control Panel and on the RS.70 8-Way Mixer), except, of course, that the range is now  $\pm 10$  dB instead of only  $\pm 6$  dB.

The "Pop" type is a development of the type which has been used during the last year or so on the equipment for No.2 Studio at Abbey Road. On this type, the controls are considerably "fiercer". The bass control operates not only on the extreme bass but also has considerable effect on the higher bass frequencies. Similarly, the top control operates at a much lower frequency than normal. The top cut is of the usual "stepped" type, but the top boost consists of a circuit which is broadly tuned to 4,700 c/s. Because the operating frequencies are much nearer to the middle of the spectrum than usual, it follows that there is considerable inter-action between the top and bass control. The effect of the "Pop" tone controls has been drawn out, and eleven sets of curves are provided which together cover all possible settings.

Unlike the earlier form of tone controls, the circuit consists of a single bridged-"T" across which the whole of the tone control is applied. Consequently, the insertion loss is only 10 dB, and not 20 dB as might be expected. As for any properly designed bridged-"T" circuit, the impedance looking back from the output end remains constant providing that input end is terminated by its matched impedance, (200 ohms in this case).

A special test socket is provided, to assist in the location of possible faults. If the L/C box is removed and the test socket substituted, either the top or the bass control switch should operate as a simple 0 - 20 dB attenuator. (Obviously, for this test, it would not be expected that both switches could be set to the "+10" positions at the same time, as this would imply that the circuit had gain).

Although special provision has been made in the Mixer to hold the Tone Control L/C boxes in position, it is recommended that they should be removed for transit over long distances.

#### E.M.I. "Stereosonic" Circuits.

The special E.M.I. Stereosonic circuits, consisting of the 1st Sum & Difference Transformers, Spreader, Shuffler, and 2nd S. & D. Transformers, are covered by a separate write-up, which also mentions the reasons for including the faders within the Sum & Difference Channels.

#### Edgewise Miniature Faders.

The 6 Faders are of the bridged-"T" type. As the source impedance is 200 ohms, the impedance looking back into the Fader will remain constant at 200 ohms. As will be seen from the diagram, the Fader has no insertion loss at its maximum setting.

Early types with beryllium copper contacts should be cleaned regularly with benzine and lubricated with a 5% mixture of pure petroleum jelly in benzine, or treated with the special Painton fader cleaning outfit.

Later types with silver alloy contacts and silver graphite wipers should not be cleaned or lubricated in this way, and should need little, if any, attention.

#### Splitter Transformers.

The splitter transformer divides the signal obtained from a 200 ohm source equally, and in phase, between two 400 ohm loads without inter-action, and thus without cross-talk. A balance resistor, nominally of 800 ohms, is required, but 820 ohms is used here, being slightly more suitable in that it allows for the resistance of the transformer windings. When the circuit is operating normally, the balance resistor serves no useful purpose; it is included chiefly to avoid the puzzling effects which can occur in such circuits when, for example, a broken wire elsewhere upsets the correct working.

Note that the output voltage into each 400 ohm load is substantially equal to the input voltage. The power delivered into each 400 ohm load is, of course, half that of the source, i.e., 3 dB less, ignoring transformer losses which are very small.

REDD.M43.

### Pan Pots.

The so-called Panorama Pots enable mono microphones on channels M.3 or M.4 to be artificially placed in the required angular position. This, of course, gives only point sources at these positions, which should not be confused with true stereo working.

The Pan Pots are actually not potentiometers but bridged-"T" networks for 400 ohm circuits. The section connected to the right hand channel operates in the same way as a normal fader, there being no loss when the knob is turned fully clockwise. The left hand section is similar but has an inverse action. At its mid-position, the Pan Pot produces a loss of 3 dB in each channel, and thus maintains constant total power in the monitoring room.

Each Pan Pot has 5 steps on either side of the central position, consisting of 4 steps of  $7\frac{1}{2}^{\circ}$  apparent angular movement, (based on a total subtended angle of  $90^{\circ}$  between the loudspeakers), and a "Full Left" or "Full Right" position.

### Combiner Networks.

The Combiner Networks used are of a particularly low loss type. They are followed by the twin Main Attenuator (see below) and, when this is at its maximum position, the impedance looking into the Combiner is 400 ohms for the 400 ohm inputs from the Pan Pots and 600 ohms for the other (200 ohm) inputs. As the Main Attenuator setting is reduced from the fully clockwise position, it will give a loading effect across the output of the Combiner Networks. The impedance looking into the Combiner will then fall somewhat below the values given above. It follows that the signal voltage at the input of the Combiner will also vary slightly with the setting of the Main Attenuator. This has no practical disadvantage, and is of academic interest only, (see below), but it is worth mentioning that the levels shown on the block schematic are calculated for the Main Attenuator at "0", (clockwise).

The effective loss on each input is 6 dB (compared with a matched load impedance). However, because the load on the 200 ohm channels M1, M2, H1 & H2 is 600 ohms (with the Main Attenuator at "0"), the input voltage for these channels will rise by an amount equivalent to 3.5 dB, but will be attenuated in the Combiner by an amount equivalent to 9.5 dB, thus restoring equality with channels M3 & M4. The levels shown in brackets on the block schematic at the M2 and H2 inputs of the right hand Combiner represent the setting of a gain set to obtain the conditions shown.



REDD.M43.

### Earthing Terminals.

Three earthing terminals are provided, the upper one being connected to the earthy side of the microphone Faders, Echo Pots and Main Combiners, the centre terminal to the earthy sides of the Replay, Monitor, and Studio Playback circuits, and the lower terminal to frame. In order to prevent break-through, particularly at the higher frequencies, bridged-"T" circuits must have their earthy side connected to earth or, at least, to the cable braids and chassis (frame) of the equipment. The three terminals should therefore be connected together; they are provided purely as an engineering facility, as it is very much easier to find spurious earths on a circuit if the official earth connection can be easily removed.

For safety, the frame of the equipment should be connected to earth, either by means of a wire running, for example, to a water pipe, or by means of the 3-core mains lead provided, which makes connection to the frame automatically.

### Main Attenuator.

The Main Attenuator is a twin bridged-"T" type for 200 ohm circuits. In this equipment it is used unterminated, and the impedance looking into the input of the attenuator will therefore vary from 200 ohms in the "Off" position, up to the input impedance of the following Line Amplifiers when the attenuator is effectively removed from the circuit by turning its knob fully clockwise. As it is fed from its matched impedance, it will, however, give its correct attenuation at all settings.

### Line Amplifiers.

Two Line Amplifiers are used to drive the tape recorder(s). The low impedance outputs are used, thus avoiding undesirable loading effects when the monitor circuits are thrown across this point.

### Main Coupling Switch.

For driving a mono tape machine or machines, (as an alternative to a stereo machine), the outputs of the two Line Amplifiers are connected in series and are fed to all 4 output sockets.

### Echo Pots.

The 4 Echo Pots enable any desired mixture of the signals appearing on the 4 Main Mic. Channels to be sent to the echo chamber. They are logarithmic potentiometers, calibrated arbitrarily from "0" to "10".

REDD.M43.

Echo Return Circuits.

Channels H.1 and H.2 are primarily intended for use as echo return circuits when a pair of microphones is used in the echo chamber for stereo working. In order to keep down the size, weight and cost of the equipment, no hybrid circuits are used, and the amount of artificial reverberation which may be applied in this way therefore has an upper limit, although it should prove more than adequate for ordinary requirements. It will be seen that the limit occurs when the loop gain reaches unity, around the circuits from the output of the Faders, via the Echo Pots, Echo Chamber, Echo Return Channels, Combiner Network and back to the output of the Faders.

When more than the usual amount of artificial reverberation is required and when adequate microphone level from the studio is available, attenuator pads may be introduced into the main Mic. Channels M.1, 2, 3, 4 after the Faders, thus reducing the gain of the loop circuit mentioned above. Convenient "T" pads, built into U-link plugs, are available if required.

For extreme cases, when a very large amount of reverberation is wanted, it would not be difficult to devise alternative methods of obtaining it. For example, the echo return could be made to the input of the Line Amplifier via a high impedance pad, thus introducing the additional loss of the Main Fader into the loop circuit. Alternatively, a separate microphone could be placed in the studio and used to feed direct to the echo chamber.

WARNING:-

The two Echo Return Faders should be fed from 200 ohm sources. If either or both of the Echo Return circuits are not fed in this way, the Echo Return Faders should be kept at their "Off" positions. The impedance looking back from the output of these faders will remain constant at 200 ohms only if they are fed from 200 ohm sources. If these Faders are not in use and one of them is accidentally opened, there will be a serious unbalance between the Left and Right channels, due to the removal, or partial removal, of a 200 ohm load on the Combiner. If desired, this danger can be avoided by removing the "U"-links and plugging in 200 ohm resistors mounted in 3-pole plugs immediately before the Echo Return Faders. Termination loads of this type, suitably marked and engraved, are available to special order if required.

Similarly, there is a danger of an unbalance if the Echo Return Faders are fed from any impedance other than 200 ohms. If it is desired to use the Spare amplifier and an amplifier in the Test position as Echo Return boosters, their 200 ohm outputs must be used, and spare positions exist on the socket strips which could be used for this purpose.

On the REDD.43X, two 10 dB Pads are provided for use in the Echo Return channels, assuming that the external echo equipment can provide sufficient level. Also, the monitoring check points are taken from before the pads, instead of after. This provides a higher level to the monitoring circuits for checking the Echo Return signals.



REDD.M43.

Delta Pots.

Two "Delta" pots are provided, connected across the outputs of the two Line Amplifiers. The name "Delta" has been chosen as being representative of a control which can produce only a small change. An examination of the circuit will reveal that the maximum range of each of these controls is only 6 dB on the REDD.43 and 10 dB on the REDD.43X.

When making a single track (mono) master tape, or a normal mono disc transfer, from a stereo tape, difficulty is sometimes experienced due to the fact that the two tracks on the stereo tape may not be perfectly in-phase. This results in partial cancellation of the higher frequencies. Apart from the fact that both capsules of a stereo mic. cannot be physically in exactly the same place, the most common cause of this effect is the mis-alignment of the stereo record and replay heads on the tape machine. At frequencies around 15,000 c/s, with tape speeds of 15" per second, we are dealing here with mere fractions of a thousandth of an inch, and it will be seen, therefore, that it is not difficult for these conditions to arise as wear occurs on the heads. The purpose of the Auxiliary Mono output is to provide a means of avoiding this trouble by recording simultaneously on a single track tape machine, if so desired.

As one Delta Pot is fed from the Left output and the other from the Right. it is possible to make a slightly different balance, if desired, on the Auxiliary Mono output.

The Delta Pots also provide for level control in conjunction with the adjustable gain steps of the "Spare" amplifier which is used to drive the mono tape recorder.

Provision has been made for monitoring the Auxiliary Mono output by connecting a jumper across the "test" type U-link plug on the output of the Spare amplifier and plugging in the other end of this jumper to the left hand side of the 2nd position on the Line In Selector Switch. The output from the mono tape machine may, of course, be monitored by connecting it to the left hand side of the 2nd Line Out monitoring circuit.

Line In Selector.

When the Line In/Line Out (A/B) Key is switched over to the left, the Line In Selector Switch enables the following to be monitored:-

- a). The main output from the mixer, either mono or stereo, going to the Line In of the Tape Recorder(s).
- b). The record head current of a tape machine such as the BTR/3 which has special provision for this purpose. Alternatively, the Auxiliary Mono output, as described above; (the U-link on the record head current circuit should then be removed, of course).
- c). The signal being sent to the Echo Chamber; this appears on the left hand side of the monitor circuit.

REDD.M43.

### Line Out Selector.

With the Line In/Line Out Key over to the right, the Line Out Selector Switch enables the following to be monitored and also to be fed to the Studio via the Studio Playback circuits:-

- a). Line Out of Tape Recorder No.1, either mono or stereo.
- b). Ditto from Tape Recorder No.2, if used.
- c). Echo Return Lines H.1 and H.2, thus providing a means of checking the return signal(s) from the echo chamber without having to unplug the main microphone channels.

### Line In/Line Out (A/B) Key.

In addition to picking up the outputs from the Selector Switches mentioned above, the Line In/Line Out Key has a central "Off" position.

### Replay Circuits.

In order to maintain A/B balance on a tape recorder which has been set up in the normal way, the mixer must provide 200 ohm terminations for the outputs of the replay amplifiers. These 200 ohm terminations consist of 220 ohm resistors, across which the 2,500 ohm impedance of the Monitor and Studio Playback circuits normally appears. One side of each 220 ohm resistor is earthed. Without this earth, there would be a danger of switching clicks, which could occur if the primary/secondary insulation of the replay amplifier output transformer were less than perfect; the output cable could then become charged up to the full amplifier H.T. (B+) voltage.

### Monitoring Circuits.

The Monitor circuits proper begin with isolating transformers which present an impedance of approx. 5,000 ohms to the preceding circuits. They are followed by a ganged bridged-"T" attenuator of the same type as the Main Attenuator. Next comes a pair of 200 - 400 ohm pads which are terminated by 400 ohm resistors when the Monitoring Coupling Switch is set to "Stereo", and by the 400 ohm impedance of the other pad in the other two positions of this switch. This provides a means of coupling the two circuits in such a way that there is no great change in level when the coupling switch is operated. The terminated pads provide the correct termination for the Monitor Attenuator and enable the latter to operate correctly.

### Monitor Coupling Switch.

The purpose of this switch is to enable stereo signals to be heard combined into a mono signal if desired. The combined signal may be reproduced either on the Left monitor loudspeaker only, or on both L.S.'s.

REDD.M43.

Monitor Poling Push Button.

A push button in the output of the right hand monitor circuit enables the phase of that circuit to be reversed. This provides a useful check when doubt exists as to the correct poling of a stereo microphone, stereo tape machine, etc.

Note that the Poling Push Button will not operate if there is an earth on one side of the input of the power amplifier in the Monitor Loudspeaker. This amplifier should therefore be fitted with an isolating input transformer.

Level Indicators.

For details of the REDD.44 Peak Level Indicator or of the REDD.48 Level Indicator, please see appropriate separate write-up. There are also separate write-ups covering the use of a pair of level indicators in this equipment.

Studio Playback Circuits.

The Studio Playback Circuits are identical to the circuits which feed the Monitor Loudspeakers, apart from the coupling switch. (See below).

Studio Playback Coupling Switch.

This switch has three positions, giving:-

- a). Both Studio Playback L.S.'s "Off".
- b). Normal Stereo operation.
- c). Both sides of the Studio Playback Circuits combined and fed to both outputs. (It is assumed that if only a Mono Playback is required, then only one Studio Playback L.S. will be provided, or, if REDD.36 "Column" L.S.'s are used, that two will be connected in parallel).

Talk-Back/Announce.

By operating the key switch on the main panel, the hand microphone is connected to the input of Line Amp. L, and thus take numbers, etc. may be recorded on the left hand tape track.

By pressing the push-button on the hand microphone, a relay is operated and talk-back may be made to the studio via the L.H. Studio P/B channel.

During announcements, both Monitor L.S. channels are attenuated by 23 dB in order to prevent howl-back.

During talk-back, only 15 dB of attenuation is introduced, as there is less chance of howl-back due to the double circuit path involved and also because it is necessary to keep the Monitor L.S.'s operating at as near to maximum sensitivity as possible. The howl-back point will vary somewhat with local conditions, and it is recommended that, if found possible, the two 43 ohm resistors should be changed to a higher value giving less attenuation.

REDD.M43.

Amplifier Test Position.

The feeds of any of the Amplifiers Type 812 or REDD.47 may be measured by withdrawing the Test Unit and putting the amplifier into its place. Input and output connections are provided on Siemens sockets in the usual way.

Test Unit.

The Test Unit is fitted with an extension cable which enables units to be operated outside the equipment for maintenance purposes. It has two uses, viz:-

- a). It may be used in the "Amp. Test" position or in any of the other amplifier positions when it is desired to inspect an amplifier.
- b). It may be used in either of the Level Indicator positions when it is desired to inspect a Level Indicator Unit.

When using the Test Unit, care must be taken to avoid cross-connections between amplifier positions and Level Indicator Units, and vice versa.

General Testing.

The gain to be expected from any part of the circuit can be seen by reference to the block schematic. For example, on a REDD.43 a voltage gain of 33 dB (insertion gain of 39 dB) can be expected on Mic. Channel M4 (or on M3) under the conditions shown, with the Pan Pot set fully Left or Right. If the output of the Line Amplifier is closed by 200 ohms (by the "Receive" of a gain set, for example), these figures will drop by 1 dB. Removing the Sum & Difference, Spreader and Shuffler circuits would cause the gain to rise by 4 dB.

Similarly, on a REDD.43X the same conditions can be established (although with both the Fader and the Main Attenuator set 2 dB higher). The output impedance of a REDD.47 Line Amplifier is 50 ohms, compared with 20 ohms for a Type 812, and the figures will therefore drop by 2 dB if the output of the Line Amplifier(s) is terminated.

The tables on the following pages give details of the gain figures to be expected on both types of equipment under various conditions.

REDD.43 --- VOLTAGE GAINS AND LOSSES --- dB.

812 Mic. Amp. @ "34 + 15"	+49			
180 ohm Build-Out.		-5		
Tone Controls.		-10		
Combiner.		-6		
812 Line Amp. @ "34 + 15".	+49			
Output open circuit.	+1		o/c	Terminated
	+99	-21	=	+78
				+77
10 dB Mic. Equal. Pad.		-10		
	+99	-31	=	+68
				+67
Mic. Fader @ "-9".		-9		
	+99	-40	=	+59
				+58
Main Attenuator @ "-22".		-22		
	+99	-62	=	+37
				+36
S. & D. and Shuffler.		-4		
As on Block Schematic.	+99	-66	=	+33
				+32

NOTE:-

Insertion gain, as measured on normal gain set with unterminated input, will be 6 dB higher.

REDD.M43.

REDD.43X --- VOLTAGE GAINS AND LOSSES --- dB.

REDD.47 Mic. Amp. @ "46".	+46			
150 ohm Build-Out.		-4		
Tone Controls.		-10		
Combiner.		-6		
REDD.47 Line Amp. @ "46".	+46			
Output open circuit.	+2		O/c	Terminated.
	+94	-20	=	+74
				+72
10 dB Mic. Equal. Pad.		-10		
	+94	-30	=	+64
				+62
Mic. Fader @ "-7".		-7		
	+94	-37	=	+57
				+55
Main Attenuator @ "-20".		-20		
	+94	-57	=	+37
				+35
S. & D. and Shuffler.		-4		
As on Block Schematic.	+94	-61	=	+33
				+31

NOTE:-

Insertion gain, as measured on normal gain set with unterminated input will be 6 dB higher.

WARNING: DUE TO THE LARGE CAPACITY OF THE SMOOTHING CONDENSERS IN THE REDD.47 LINE AMPLIFIERS, THE MAINS MUST BE SWITCHED OFF AND A FEW SECONDS ALLOWED FOR THE CONDENSERS TO DISCHARGE, BEFORE PLUGGING IN OR REMOVING AN AMPLIFIER FROM THE SIDE CASES.

LAP/AV.

July, 1960.



CALIBRATION OF REDD.43X MIXER. SERIAL NO:- 59082G.

GENERAL TEST CONDITIONS.

All amplifiers set to "40" (Voltage Gain 40 dB). Rumble Filter in. Stereo/Mono function switch set to "Stereo" for all tests.

"Straight through condition" means without Sum & Difference, Spreader or Shuffler in circuit.

All runs carried out sending from 200 ohm unterminated gain set and Receiving into 200 ohm load.

SERIAL NOS. OF AMPLIFIERS (TYPE REDD.47) AND CIRCUIT POSITIONS.

<u>SERIAL NOS.</u>	<u>FUNCTION.</u>	<u>POSITION.</u>
59100 J	Microphone Amplifier	M1
59100 K	" "	M2
59100 L	" "	M3
59100 M	" "	M4
59100 N	Echo Amplifier	ECHO
59100 P	Talk-Back Amplifier	TALK BACK/ANNOUNCE.
59100 Q	Line Amplifier	LEFT
59100 R	" "	RIGHT
59100 S	Auxiliary Mono Amplifier	SPARE

SERIAL NOS. OF LEVEL INDICATORS (TYPE REDD.48).

<u>SERIAL NO.</u>	<u>POSITION.</u>
59120 J	LEFT
59120 L	RIGHT

*G. Math*

## HUM & NOISE READINGS.

All readings measured into 200 ohm load.

### 1. HUM & NOISE REFERRED TO INPUTS OF MICROPHONE AMPLIFIERS.

#### CONDITIONS:-

Measured at outputs of microphone amplifiers.  
Input switches in "flat" position.  
Inputs of mixer loaded with 200 ohm.

M1	--	-123 dB
M2	--	-123 dB
M3	--	-121 dB
M4	--	-124 dB

### 2. HUM & NOISE REFERRED TO INPUTS OF LINE AMPLIFIERS.

#### CONDITIONS:-

Measured at line out. Main gain control at "OFF".

Left	--	-117 dB
Right	--	-116 dB

### 3. HUM & NOISE REFERRED TO INPUT OF ECHO AMPLIFIER.

#### CONDITIONS:-

Measured at echo out. Echo pots. at minimum.

Echo	--	-116 dB
------	----	---------

### 4. AUXILIARY MONO CIRCUITS.

#### HUM & NOISE REFERRED TO INPUTS OF LINE AMPLIFIERS.

#### CONDITIONS:-

Measured at auxiliary mono out. Delta pots. at minimum.  
Main gain control at "OFF".

Noise	--	-116 dB
-------	----	---------

#### HUM & NOISE REFERRED TO INPUT OF SPARE AMPLIFIER.

#### CONDITIONS:-

Measured at auxiliary mono out. Input of amplifier loaded with 200 ohm.

Spare	--	-110 dB
-------	----	---------

CROSSTALK READINGS.

The crosstalk in all cases is the crosstalk measured between two adjacent channels. i.e. between M1 & M2 or M3 & M4. To measure crosstalk between M1 & M2 send balanced to M1 and read signal level received from RIGHT HAND line out. In the same way crosstalk between M3 & M4 is measured, sending to M3 instead of M1. To measure crosstalk between M2 & M3 send balanced to M2 and read signal level received from LEFT HAND line out. In the same way crosstalk between M4 & M3 is measured, sending to M4 instead of M2. The sending level is the level required for zero level at line out across 200 ohm. (of channel being sent to). Faders and main gain control at maximum. Spreader in central position.

CONDITION 1.

Mixer in straight through condition.

FREQ. c.p.s.	CROSSTALK BETWEEN:-			
	<u>M1 - M2</u>	<u>M2 - M1</u>	<u>M3 - M4</u>	<u>M4 - M3</u>
40	-54	-52	-53	-52
1000	-54	-52	-53	-52
15000	-48	-50	-46	-50

CONDITION 2.

Mixer with Sum & Difference only in circuit.

FREQ. c.p.s.	CROSSTALK BETWEEN:-			
	<u>M1 - M2</u>	<u>M2 - M1</u>	<u>M3 - M4</u>	<u>M4 - M3</u>
40	-47	-46	-49	-49
1000	-38	-38	-40	-40
15000	-17	-16	-17	-17

CONDITION 3.

Mixer with Sum & Difference and Shufflers in circuit.

FREQ. c.p.s.	CROSSTALK BETWEEN:-			
	<u>M1 - M2</u>	<u>M2 - M1</u>	<u>M3 - M4</u>	<u>M4 - M3</u>
40	-42	-41	-45	-46
1000	-19	-19	-19	-19
15000	-15	-15	-15	-15

CALIBRATION OF LOW LEVEL AMPLIFIERS TYPE REDD.47.

FREQ. C. P. S.	INSERTION GAIN dB.								
30	46.0	46.1	46.1	46.2	46.1	46.1	46.1	46.1	46.0
50	"	46.0	46.0	46.1	46.0	46.0	46.0	46.0	"
100	"	"	"	46.0	"	"	"	"	"
200	"	"	"	"	"	"	"	"	"
500	"	"	"	"	"	"	"	"	"
1000	"	"	"	"	"	"	"	"	"
2000	"	"	"	"	"	"	"	"	"
3000	"	"	"	"	"	"	"	"	"
5000	"	"	"	"	"	"	46.1	"	"
7000	"	"	46.1	"	"	46.1	"	46.1	"
9000	"	46.1	46.2	46.1	"	"	46.2	"	"
11000	"	"	46.3	"	"	46.2	46.4	46.2	"
13000	"	46.2	46.4	46.2	"	46.3	46.5	46.3	"
15000	"	"	46.5	"	"	"	46.6	"	"
20000	"	46.3	46.6	46.3	45.9	"	46.7	46.4	"
NOISE:-	-76	-76	-76	-77	-76	-76	-76	-76	"

SERIAL NO:-

59100Y 59100K 59100L 59100M 59100N 59100P 59100Q 59100R 59100S

CONDITIONS:-

Measured with amplifier in test position of REDD.43X.  
 Send and Receive balanced. Amplifier gain switch at "40".  
 Noise measured at output of amplifier with input loaded with 200 ohm.  
 and amplifier gain switch at "40".  
 Gain switch calibration checked.  
 Overall phase checked.  
 Amplifier to Sheet 1 of REDD.47 Production Modification Note No.2.

FREQUENCY RESPONSE OF LEVEL INDICATORS TYPE REDD.48.

FREQ. C. P. S.	RESPONSE WITH RESPECT TO 1000 C.P.S.		CONDITIONS:-
	LEFT.	RIGHT.	
30	-0.8	-0.4	Send balanced to level indicators LEFT and RIGHT inputs in turn.
50	-0.3	-0.1	
100	-0.1	0	
1000	0	0	Results are variations of sending level required to maintain a meter reading of -20 dB.
5000	-0.1	0	
11000	-0.2	0	
13000	-0.2	-0.1	Scaling of meter checked O.K.
15000	-0.2	-0.1	
20000	0	-0.2	

SERIAL NO:-

59120J.

59120L.

# CALIBRATION OF MICROPHONE EQUALISER BASS LIFT CIRCUITS.

FREQ. c.p.s.	M1	M2	M3	M4	The result at 1000 c.p.s. is obtained as follows:-	
30	38.9	38.9	39.4	39.0	Insertion gain of amplifier	= +46 dB
40	38.7	38.7	39.6	38.8	Loss of bass lift circuit.	= -10 dB
50	38.1	38.1	39.0	38.3	Loss of 150 ohm build out.	= -4.1 dB
					∴ Gain at 1000 c.p.s.	= 31.9 dB.
60	37.6	37.6	38.3	37.7		
100	35.6	35.7	35.9	35.7		
200	33.2	33.3	33.4	33.3		
500	32.1	32.1	32.1	32.1		
1000	31.9	31.9	31.9	31.9		

## CONDITIONS:-

Send balanced to inputs M1 - M4 in turn.  
Input switch in "Bass Lift" position.  
Receive balanced from microphone amplifier out.

## OVERALL FREQUENCY RESPONSE. 1. "STRAIGHT THROUGH".

FREQ. c.p.s.	RESPONSE WITH RESPECT TO 1000 c.p.s.			
	M1	M2	M3	M4
30	-1.8	-1.4	-1.0	-1.1
50	-0.3	-0.1	-0.6	-0
100	0	0	+0.2	+0.1
200	0	0	+0.1	0
500	0	0	0	0
1000	0	0	0	0
2000	0	0	0	0
3000	0	0	0	0
5000	0	0	+0.1	0
7000	0	+0.1	+0.2	+0.1
9000	+0.2	+0.2	+0.3	+0.2
11000	"	+0.3	+0.5	+0.3
13000	+0.3	"	+0.6	+0.4
15000	+0.4	+0.4	+0.8	+0.5
20000	+0.3	"	"	+0.4

## CONDITIONS:-

Send balanced to inputs M1 - M4 in turn.  
Receive balanced from line out LEFT or RIGHT as applicable.  
All faders and main gain control at maximum.  
Input switch in flat position.  
Mixer in straight through condition.  
Insertion gain of complete channel = 66 dB at 1000 c.p.s.

OVERALL FREQUENCY RESPONSE. 2. WITH SUM & DIFFERENCE.

FREQ. c. p. s.	RESPONSE WITH RESPECT TO 1000 c. p. s.			
	M1	M2	M3	M4
30	-1.7	-1.3	-1.0	-1.1
50	-0.4	-0.1	+0.5	0
100	-0.1	0	+0.1	+0.1
200	0	0	0	0
500	"	"	"	"
1000	"	"	"	"
2000	"	"	"	"
3000	"	"	"	"
5000	"	"	"	"
7000	"	-0.1	+0.1	"
9000	"	"	+0.2	"
11000	+0.1	-0.2	+0.4	"
13000	"	-0.3	"	"
15000	"	-0.4	+0.5	-0.1
20000	-0.1	-0.9	+0.2	-0.3

CONDITIONS:-

Send and Receive with control settings as for condition 1.  
Sum & Difference transformers only in circuit.

Insertion gain of complete channel = 62.6 dB at 1000 c.p.s.

OVERALL FREQUENCY RESPONSE. 3. WITH SHUFFLER.

FREQ. c. p. s.	RESPONSE REFERRED TO CONDITION 2.			
	M1	M2	M3	M4
30	-2.2	-1.9	-1.5	-1.7
50	-0.8	-0.6	0	-0.6
100	-0.6	-0.5	-0.4	-0.6
200	-0.6	-0.6	-0.6	-0.7
500	-0.7	-0.7	-0.9	-0.9
1000	-1.0	-1.0	-1.1	-1.2
2000	-1.3	-1.2	-1.5	-1.5
3000	-1.4	-1.3	"	-1.5
5000	"	-1.4	"	-1.6
7000	"	-1.4	-1.4	"
9000	"	-1.5	-1.3	"
11000	"	-1.6	-1.2	"
13000	"	-1.7	"	-1.7
15000	"	-1.9	"	-1.7
20000	-1.7	-2.5	-1.4	-2.1

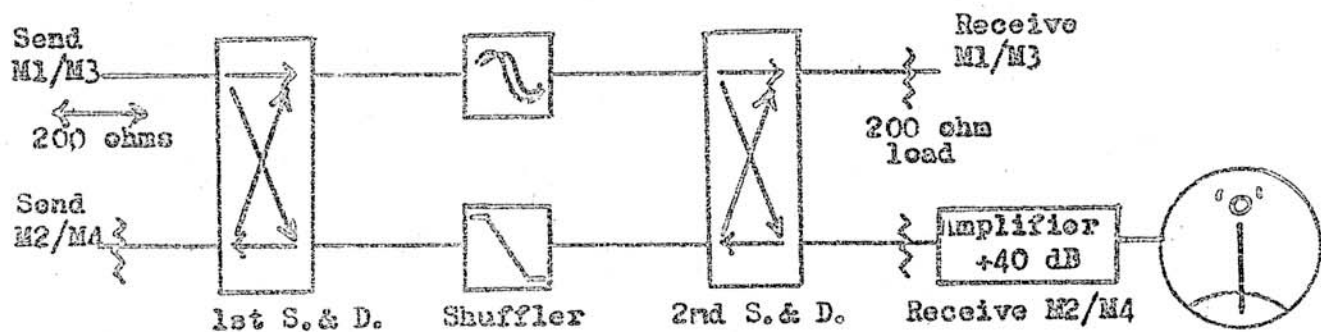
CONDITIONS:

Results obtained with condition 2 when Shuffler is in circuit.  
Spreader in central position.



CROSSTALK INTRODUCED BY SHUFFLER CIRCUIT.

FREQ. C.P.S.	CROSSTALK BETWEEN:- (-dB).			
	M1 - M2	M2 - M1	M3 - M4	M4 - M3
30	45.0	45.0	50.4	50.4
50	45.5	45.5	51.9	51.7
100	48.5	48.5	51.5	51.4
200	42.5	42.9	40.0	39.9
500	26.5	26.6	25.9	26.1
1000	20.2	20.3	20.0	20.0
2000	17.8	17.9	17.6	17.7
3000	17.2	17.3	17.0	17.1
5000	16.8	17.0	16.7	16.9
7000	16.7	17.0	16.6	16.8
9000	16.6	16.9	16.5	16.8
11000	16.6	16.9	16.5	16.8
13000	16.5	16.8	16.4	16.8
15000	16.4	16.8	16.3	16.8
20000	16.1	16.6	16.1	16.6

CONDITIONS:

M1 - M2 Send unbalanced to M1. Receive from M2 as shown.  
 M2 - M1 Send unbalanced to M2. Receive from M1 via amplifier.  
 M3 - M4 Send unbalanced to M3. Receive from M4 as shown.  
 M4 - M3 Send unbalanced to M4. Receive from M3 via amplifier.  
 Spreader (not shown) in central position.

Results obtained as follows:-

Loss of S. & D. and Shuffler.	= -4 dB
Gain of Amplifier.	= +40 dB
°. Gain of complete channel	= 36 dB

Result = 36 dB - Sending Level.

FREQUENCY RESPONSE OF AUXILIARY MONO CIRCUITS.

FREQ. c.p.s.	RESPONSE WITH RESPECT TO 1000 c.p.s.	
	M1	M2
30	-3.0	-2.5
50	-0.6	-0.2
100	0	0
200	0	+0.1
500	0	0
1000	0	0
2000	0	0
3000	0	0
5000	0	+0.1
7000	+0.1	+0.2
9000	+0.3	+0.4
11000	+0.5	+0.6
13000	+0.7	+0.8
15000	+0.9	+1.0
20000	+1.1	+1.0

CONDITIONS:-

Send balanced to inputs M1 - M2 in turn.

Receive balanced from auxiliary mono out.

Mixer set in straight through condition.

All Faders, Main Gain Control and Delta Pots. at maximum.

Both line out sockets loaded with 200 ohm.

Delta Pots. checked O.K. at min. setting.

Insertion gain of complete channel = 66 dB at 1000 c.p.s.

FREQUENCY RESPONSE OF ECHO CIRCUITS.

FREQ. c.p.s.	RESPONSE WITH RESPECT TO 1000 c.p.s.			
	M1	M2	M3	M4
30	-5.4	-5.6	-4.3	-5.1
50	-2.1	-2.1	-1.1	-2.0
100	-0.6	-0.5	-0.2	-0.6
200	-0.2	-0.1	0	-0.1
500	0	0	0	0
1000	0	0	0	0
2000	0	0	0	-0.1
3000	-0.1	-0.1	-0.1	-0.1
5000	-0.2	-0.2	-0.2	-0.2
7000	-0.4	-0.3	-0.3	-0.3
9000	-0.6	-0.4	-0.4	-0.5
11000	-0.7	-0.6	-0.5	-0.6
13000	-0.9	-0.7	-0.6	-0.8
15000	-1.2	-0.8	-0.7	-1.0
20000	-1.2	-1.4	-1.2	-1.4

CONDITIONS:-

Send balanced to inputs M1 - M4 in turn.

Receive balanced from Echo out.

Main gain control at "OFF".

Echo Pot. of channel under test at maximum, others at minimum.

All Faders at maximum.

Mixer in straight through condition.

Insertion gain of complete channel = 47 dB at 1000 c.p.s.

OTHER TESTS.

Frequency response of Shuffler agrees with drawing:- REDD.C27/D1.  
Crosstalk of Spreader agrees with drawing:- REDD.C1A/D2.  
Tone Control response agree with drawing:- REDD.37/D261 & D267.  
Pan Pot. circuits and calibration agree with drawing:-REDD.Z20/D1.  
All Fader, Input Attenuators M3A & M4A, M1-M4 Input Pads and Main  
Gain Control calibrations O.K.  
Monitor and Studio Speaker circuits checked O.K.  
Metering circuits O.K.  
Overall Phase O.K.  
Talk Back circuits checked.