Ref. 200-206-12

REʼs office copy
23/1/81

BOARD HEADQUARTERS

CHIEF S. & T. ENGINEERS DEPARTMENT

CODE OF PRACTICE FOR REED TRACK CIRCUITS (JOINTED AND JOINTLESS)

2112/00321/1

DECEMBER 1980

CONTENTS

LIST OF FIGURES

LIST OF FIGURES

CODE OF PRACTICE FOR REED TRACK CIRCUITS (JOINTED AND JOINTLESS)

1. PRINCIPLES OF OPERATION

1.1 The reed track circuit equipment type RT, which may be jointed or jointless, is a development of the reed remote control equipment type RR and may be used on all electrified and non-electrified lines on B.R. It employs circuits which are tuned to a very high Q factor by means of the electromechanical tuning fork principle, having a pair of vibrating reeds which are used to produce a band pass filter which has a bandwidth of about 1 Hz and a very stable centre frequency. For track circuit equipment, the frequencies are chosen to lie between harmonics of the mains power supply frequency and the standard sets of frequencies lie between the 7th and 8th harmonics and between the 8th and 9th harmonics, the narrow bandwidth allowing channel spacings down to 3 Hz.

1.2 A track circuit consists of a transmitter which feeds audio frequency oscillations into the rail and a receiver at the relay end which is tuned to receive only that specific frequency. Immunity from sources of interference is achieved because the bandwidth of the receiver is so narrow that the amount of in-band interference is negligible.

1.3 The reed track circuits are provided in both jointed and jointless configurations. Both types use the same transmitter and receiver but differ in the manner in which the audio frequency signal is taken from the rails at the receiver or relay end. For a jointed track circuit, this is done by direct connections to the rails, as with a conventional track circuit, but in the jointless version the audio signal is inductively coupled to a loop which is laid between the rails. More details of these methods are given in later sections. The jointed version is for use where insulated block joints must be provided (eg. at points and crossings) which also require a.c. and/or d.c. immunity. The jointless version is for use on continuous welded rail and obviates the need for insulated glued joints.

1.4 The feed end equipment is provided in a standard and a high power version, the latter being for use in areas of very low ballast resistance or where the traction return current is exceptionally high.

1.5 A reed jointed track circuit can be used as a single or double rail circuit and can be either end fed or centre fed. A basic layout is shown in fig. 1. With a standard feed end transmitter the circuit will give a minimum drop shunt of 0.5 ohm for ballast resistances varying from 2 ohms/kilometre to infinity and with a high power feed end transmitter from 1 ohm/kilometre to infinity.

1.6 A reed jointless track circuit is always centre fed, except where jointless track adjoins a jointed section, in which case the transmitter or a jointed receiver must be placed at the block joint (see section 10.3.1). The basic configuration of a jointless track circuit is shown in fig. 2. With a standard feed end transmitter a minimum drop shunt of 0.5 ohm is obtainable with ballast resistances varying from 1.6 to 70 ohms/kilometre.

1.7 MAXIMUM AND MINIMUM LENGTHS OF REED TRACK CIRCUITS

1.7.1 Double Rail Track Circuits

In areas which are either non-electrified or which are electrified with double rail traction return with cross bonds via tuned impedance bonds, the following reed track circuit lengths are permitted:-

(i) Reed Jointed Track Circuits

	Minimum	Maximum
Standard Feed		
End Fed	None	1200m
Centre Fed	None	2000m

For intermediate lengths, the transmitter may be off-centre provided:-

	Minimum	Maximum
Distance between T_x and R_x	None	1000m

High Power Feed

	Minimum	Maximum
End Fed	None	2000m
Centre Fed	None	3000m

For intermediate lengths, the transmitter may be off-centre provided:-

	Minimum	Maximum
Distance between T_x and R_x	None	1500m

(ii) Reed Jointless Track Circuits

	Minimum	Maximum
Centre Fed	400m	3000m

For intermediate lengths, the transmitter may be off-centre provided:-

Distance between T_x and R_x	200m	1500m

1.7.2 Single Rail Track Circuits

In areas which are electrified with single rail traction return where the common rails are cross bonded, the following reed track circuit lengths are permitted:-

(i) Reed Jointed Track Circuits

	Minimum	Maximum
Standard Feed		
End fed	None	1000m
Centre fed	None	2000m

For intermediate lengths, the transmitter may be off-centre provided:-

	Minimum	Maximum
Distance between T_x and R_x	None	1000m

High power feed

	Minimum	Maximum
End fed	None	1000m
Centre fed	None	2000m

For intermediate lengths, the transmitter may be off-centre provided:-

	Minimum	Maximum
Distance between T_x and R_x	None	1000m

(ii) Reed jointless track circuits

	Minimum	Maximum
Centre fed	400m	2000m

For intermediate lengths, the transmitter may be off-centre provided:-

	Minimum	Maximum
Distance between T_x and R_x	200m	1000m

1.7.3 The minimum signal overlap distance which may be used with reed jointless track circuits is 183m. This is calculated from the safety requirements of the anomolous shunt condition.

1.7.4 In all diagrams that refer to the above maximum and minimum permitted lengths dimensions shown in brackets, i.e. (1000m), relate to single rail track circuits. Unbracketed dimensions refer to double rail track circuits.

2. REED FREQUENCIES AND CHANNEL ALLOCATIONS

2.1 The frequencies employed together with the channel number and associated equipment type numbers are shown in fig. 3. For ease of reference, the middle two digits of the equipment reference number are the same as the last two digits of the channel number e.g. transmitter filter RT 5120 and receiver filter RT 6120 are for use with channel f212 (frequency 366 Hz).

2.2 Jointed and jointless track circuits use four channels in rotation on each road and channels f212 to f219 are allocated. Thus for a sequence of track circuits, any two circuits at the same frequency on one road are separated by three circuits of different frequencies.

Up road - f213, f215, f217, f219, f213, f215 etc.

Down road - f212, f214, f216, f218, f212, f214 etc.

Channels f220 and f221 are allocated as spares. These are to be used to maintain frequency separation through points and crossings if necessary.

2.3 In electrified areas precautions must be taken to ensure that, for any cross bonding which connects lines of the same group of reed channels, the connections can only be made to tracks which are separated by two channels. i.e:-

f212 - f216 or vice-versa
f214 - f218 " " "
f213 - f217 " " "
f215 - f219 " " "

This will ensure that between track circuits of the same frequency in cross bonded areas either:-

(i) two block joints intervene, or,

(ii) at least two resonant shunts intervene.

3. FEED END EQUIPMENT

3.1 The feed equipment consists of an oscillator amplifier which is coupled to a reed filter to form a single unit. The choice of reed filter determines the frequency of oscillations.

3.2 The audio frequency output is fed to the track via a power amplifier and track filter, the latter being used to eliminate harmonics and to protect the feed equipment from electric traction interference. In non-electrified areas a feed resistor may be used in place of the track filter. Equipment details are given in section 8 and figs. 4 and 5.

4. JOINTED TRACK CIRCUIT RECEIVER END

4.1 At the relay end of a reed jointed track circuit, the reed frequency signal is taken from the rails by direct connections to a track filter and thence to a receiver amplifier which is tuned by a reed filter to the same frequency as the transmitter. If the reed frequency signal is present at a minimum level, the receiver amplifier generates a d.c. output which energises a reed follower relay. If a high power feed is used, an extra attenuator unit is needed between the track filter and receiver in order to give the full range of adjustment. Equipment details are given in section 8 and figure 6.

5. JOINTLESS TRACK CIRCUIT RECEIVER END

5.1 The Compound Loop

The receiver end of a reed jointless track circuit is defined by using a loop of wire placed between the rails, known as a compound loop. This loop is manufactured from a length of standard signalling cable to BRB Specification No. 872A 36 core, 9/0.30 mm Type ME2. 35 of the cores are connected in series and used to feed the receiver via an attenuator filter and the remaining single core is connected across the rails in series with a 2 ohms shunt. In non-electrified areas this shunt may be a resistor but in electrified areas it is a circuit which is resonated to the reed frequency. The exact method of manufacturing the compound loop is described in detail in section 12. Fig. 7 shows how, in a correctly connected compound loop, the current through the rails flowing past a loop is reinforced by the current through the shunt connection to induce a current in the 35 turns which are connected to the receiver. The shunt thus attenuates the reed frequency signal beyond the loop and also gives the loop some directional property since current in the rails from the opposite direction would give an opposing current through the shunt connection.

5.2 Receiver Equipment

The 35 turns loop is connected via a track filter to a receiver amplifier in a similar way to the jointed track circuit. If a high power feed is used, the receiver loop has 11 turns instead of 35 (see section 12.6). Equipment details are given in section 8 and fig. 8.

5.3 The Simple Loop

The simple loop employs the same cable loop as the compound loop except no shunt is connected across the rails (see section 12.7). This type of loop and receiver combination can be used to give an indication of when the first wheels of a train have just reached the loop or when the last wheels just clear the loop depending on the position of the transmitter with respect to the loop. Section 10.4 and fig. 21 illustrate a practical example of the use of this type of loop.

6. SHUNT ZONES OF REED JOINTLESS TRACK CIRCUITS

6.1 Figure 9 shows the shunt zones for a single, centre-fed reed jointless track circuit. The limits of the shunt zones can only be approximate (especially the 200m either side of the transmitter) since they will depend on the normal variations of such things as receiver gain, ballast admittance and rail impedance.

7. OVERLAPPING OF JOINTLESS TRACK CIRCUIT ENDS

7.1 Since the end of the shunt zone, at the receiver end of the jointless track circuit, is mid-way along the receiver loop, it is necessary to overlap the ends of adjacent track circuits in order to prevent the existence of a dead zone between track circuits. Calculations have shown that the ends of the track circuits should be overlapped so that the receiver loops are 1m apart (see fig. 10), but a greater degree of overlapping may be used where the particular circumstances make this advantageous, such as at automatic signals (see fig. 13).

8. EQUIPMENT DETAILS

8.1 All the equipment is designed for fitting in relay rooms or apparatus cases on mounting bars or frames suitable for BR standard miniature relays.

8.2 Standard Feed End Equipment

Constant Voltage Transformer NT 1202
Transmitter Reed Filter RT 5XX0 series
Oscillator Amplifier RT 5001
Power Amplifier RT 7101 or RT 7111
Track Filter RT 7202 or RT 7212
Feed Resistor PA 0111
Surge Diverter AEI type 16A with base
Surge Protection Unit RT 7501 (optional)

Note: In the above and following lists, XX denotes the last two digits of the channel number.

Note that the transmitter reed filter to be chosen is one of eight frequencies and full details are shown in fig. 3. The track filter may be replaced with a standard feed resistor type PA 0111 in non-electrified areas. The type of track filter depends on frequency in accordance with the following:-

Channel Nos.	Standard Filter	High Power Filter
f212 - f216	RT 7202	RT 7221
f217 - f221	RT 7212	RT 7271

The type of power amplifier is dependent on track circuit type as follows:-

Double rail and jointless track circuits	RT 7101
Single rail track circuits	RT 7111

8.3 High Power Feed End Equipment

To overcome conditions of low ballast resistance, particularly in long tunnels, the following high power feed equipment may be used:-

Constant Voltage Transformer NT 1302
Transmitter Reed Filter RT 5XX0 series
Oscillator Amplifier RT 5001
Power Amplifier RT 7131
Track Filter RT 7221 or RT 7271
Surge Diverter AEI type 16A with base

The notes on the standard equipment also apply.

8.4 Jointless Receiver Equipment

Details of the receiver loop are given later in section 12.

Power Supply Unit RR 9121
Receiver Reed Filter RT 6XX0 series
Receiver Amplifier RR 2002
Attenuator/Filter RT 7302
Reed Follower Relay ZS 2411
Resonant Shunt RT 7401
Resistive Shunt RT 7412
Surge Diverter AEI type 16A with base.

Note that the resonant shunt is required in electrified areas whereas the resistive shunt may be used in non-electrified areas.

8.5 Jointed Receiver Equipment

Reed track circuits may be used on track having insulated block joints where a.c. and/or d.c. immunity is required. The receiver end equipment is listed below:-

Power Supply Unit RR 9121
Reed Filter RT 6XX0 series
Receiver Amplifier RR 2002
Track Filter RT 7202 or RT 7212
Reed Follower Relay ZS 2411
Surge Diverter AEI type 16A with base
Attenuator RT 7312 (with high power feed only)

9. POWER REQUIREMENTS

9.1 Standard Feed Equipment (Jointed and Jointless)

110V 50Hz is fed to the constant voltage transformer NT 1202 which can feed up to four power amplifiers provided that no two power amplifiers are being used at the same frequency. The CVT consumes 40 VA for one power amplifier, plus 20 VA for each additional power amplifier, giving a maximum loading of 100 VA. The CVT provides a stabilised 15V a.c. to the power amplifiers which in turn provide 15V d.c. to their transmitter oscillators (see fig. 4.).

9.2 High Power Feed Equipment

110V 50Hz is fed to the power supply unit NT 1302 which can feed a single set of equipment only and draws 200 VA from the supply. The outputs from the NT 1302 are 15V d.c. for the transmitter oscillator and 24V d.c. for the power amplifier (see fig. 5). Under no circumstances can a receiver be housed in the same case as a high power feed.

9.3 Jointless Receiver Equipment

110V 50Hz is fed to the power supply unit RR 9121 which draws up to 25VA. This unit can supply two sets of receiver equipment provided the second unit is in the same location case and is of a different frequency (see fig. 8.).

9.4 Jointed Receiver Equipment

As for jointless receiver (see fig. 6).

10. TYPICAL TRACK CIRCUIT CONFIGURATIONS

10.1 Jointed Track Circuits

Configurations for jointed track circuits are similar to those for conventional track circuits. The only restrictions that apply are the maximum length and frequency separation when used in 4 road situations (see paragraphs 1.7 and 2.3). This requirement is the same for jointless track circuits and thus makes conversion from jointed to jointless track circuiting quite simple (see fig. 11). Adjustment of track circuit lengths may be necessary to maintain the frequency separation through point and crossing areas (see fig. 12).

10.2 Automatic Signal Sections

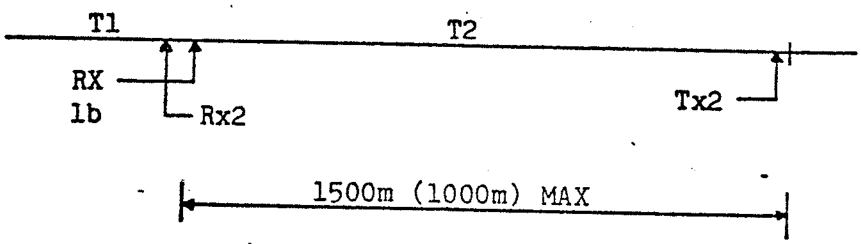
Figure 13 shows the track circuit layout to be adopted for automatic signal sections. Here the overlapping of the ends of the track circuits is made equal to the signal overlap distance and there is no separate signal overlap circuit. The signals are replaced immediately by the first wheels of the train and both track circuits are occupied, and will be indicated as such, until the train has cleared the signal overlap. With standard 183m overlaps, if the signal spacing is less than 1317m (817m) a reduction of equipment required is possible (see fig. 14). Because of the criteria described in 1.7.3 and 6.1, the overlap for signal 102 extends to a maximum of 200m beyond TX2/3. This will occur at every other signal and, provided operating practices permit, this arrangement may be used. The overlaps for signals 100 and 104 remain at 183m and the facility of first wheel replacement remains the same.

10.3 End of Jointless Sequence at a Block Joint

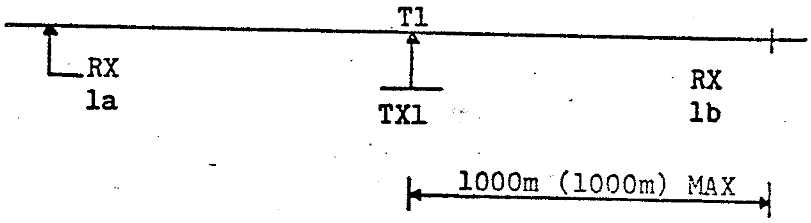
10.3.1 Termination of Sequence

A jointless sequence can be terminated at a block joint in two ways:-

(i) The transmitter end of the last jointless track can be placed at the joint.



(ii) The second half of a centre fed jointless track circuit can be terminated as a jointed receiver type track circuit.



10.3.2 - Various Track Circuit Configurations at end of Jointless Sequence

(i) When the distance between the penultimate signal and the first block joint is not greater than 1500m (1000m), see fig. 15, it can be seen that by placing a transmitter at the block joint and using a simple loop at signal 100 normal route holding and first wheel replacement are still possible without the need for a separate overlap track circuit. Track circuit 2 remains occupied and indicated as such until the train clears track circuit 3.

(ii) Referring to fig. 16, when the distance between signal 98 and the first block joint is greater than 1500m (1000m) but less than 4500m (3000m), the overlap track for signal 100 may be an end fed jointless track circuit with a transmitter at the block joint. It should be noted that, because of the presence of the block joint, the shunt zone of T3 cannot extend beyond the transmitter TX3. Therefore, in this instance, the length of T3 can be less than the 200m minimum quoted in section 1.7 and may be as short as practicable to allow for the distance needed to overlap T2 and T3.

(iii) When the block joint is not coincident with the overlap point, see fig. 17, provided the signal spacing is not greater than 2817m (1817m) (assuming a signal overlap of 183m) by extending T2 to the signal overlap no additional equipment is required.

10.3.3 Various Track Configurations at start of Jointless Sequence

The configuration for track circuits at the start of a jointless sequence is basically the same as that for a track at the end of a jointless sequence and are shown in figs. 18, 19 and 20. Fig. 20 shows how a long section before the first signal can be easily track circuited.

10.4 Signal Protecting CCTV Supervised Level Crossing

Figure 21 shows how the track circuits are arranged for a CCTV supervised level crossing where the level crossing falls within the overlap of the protecting signal. The arrangement avoids the cost of a separate jointed overlap track circuit at 101 signal whilst applying route holding and signal replacement immediately past the signal. The extra receiver RX2d is used to detect a train passing 101 signal at danger and starts the road signals flashing red. The receiver RX2e is used to initiate the raising of the barriers. The receiver RX2c is used for approach control conditions if required and RX2b for the signal overlap point. Receiver loops RX2c, RX2d and RX2e are all simple loops. Receivers RX2a and RX2b denote the limits of the track circuit and are compound loops.

11. PHYSICAL DIMENSIONS AND EQUIPMENT LAYOUT

11.1 As previously stated, the reed equipment is designed to be fitted in relay rooms or apparatus cases on mounting bars suitable for BR standard miniature relays. Each unit of equipment occupies one or more standard spacings and the layout of equipment is shown in figs. 22-26.

11.2 The layout diagrams, as shown in figures 22-26, do not show the power supply units. In all cases, the power supply units must be positioned so that their output wires to the reed units are as short as possible with the pairs of wires twisted together and tied to the nearest convenient metal framework. This assists in reducing any possibility of interference due to electromagnetic radiations. Units containing transformers must be mounted such that the transformer is on the wiring side of the rack.

11.3 Special reference must be made to the constraints described in sections 9 and 14.4. It should be noted that figures 22-26 are examples of layouts. Other variations are possible provided that the groups of modules (i.e.feed end or receiver end) are installed in their correct relative positions in the left hand or right hand side of the apparatus case.

12. INSTALLATION OF RECEIVER LOOPS

12.1 Detection Loop

The cable to be used to construct the loop is standard signalling cable 36 core 9/0.30 mm Type ME2 to BR Specification 872A. The loops are constructed using standard length cable of 13.3m. This cable length will be suitable for 3 out of the 4 standard sleeper spacings as used on C.W.R. i.e. 30, 28 and 26 sleepers per 60 feet. To cater for the 4th spacing, 24 sleepers per 60 feet, an alternative cable length of 13.52m is to be used (see figs. 27-30). The loops are fixed to the rails using clips and the transverse sections of the loops are to be fixed to the sleepers according to regional practice.

12.2 Loop Jointing

The loop joint is formed using Reed Loop Jointing Kit No. 1 with connections as shown in fig. 31. Reed Loop Jointing Kit No. 1 consists of the required material to joint the loop to a 4 core 50/0.25mm Type MD5 tail cable to form an epoxy resin filled joint. To assist in jointing and to ensure that the loop is fitted to the rails correctly, the left hand side of the joint should be marked with coloured tape and to assist in maintaining the correct lay of the loop the 4 core tail cable leaves this joint on the left hand side.

12.3 Positioning of the Loop

The loop is fitted so that the loop joint is as near to the left hand rail web as possible. (Left hand side when facing transmitter). The compound loop is directional and must be aligned such that the loop joint is at the end of the loop which is furthest from the transmitter. The 4-core tail cable is 1.5m long, thus providing a disconnection point outside the 4 foot.

12.4 Disconnection Point Jointing

At the disconnection point, the 4-core feed cable (50/0.25mm Type MD5) to the location case and the single core track lead cables (50/0.25 mm Type MD4), are jointed using Reed Loop Jointing Kit No. 2. The connection are shown in fig. 32. Reed Loop Jointing Kit No. 2 consists of the materials required to make the above connections and encase the joint in a P.V.C. sleeve. The rail connections are not provided in this kit, pending determination of a standard rail connection. The track lead lengths are 1.5m and 3.0m, the 1.5m lead being for the left hand rail and the 3.0m lead for the right hand rail.

12.5 Feed Cable Length Restrictions

Restrictions on the length of feed cables to the location case require that the feed cable maximum length is 60m (loop resistance 1 Ω). The resonant shunt and receiver equipment can be located at two different sites. The restrictions are then 60m (loop resistance 1 Ω) for the resonant shunt equipment and 1200m (loop resistance 20 Ω) for the receiver equipment.

12.6 Use of Loops with High Powered Transmitters

When a high powered transmitter is used the equipment at the receiver end is the same except that the loop is 11 turns instead of 35. The 4 core tail cable connection is then core 1 to 25L not 1L.

12.7 Details of Simple Loops

When a simple loop is required i.e. no rail connections, the 4 core tail cable is still terminated as before but the feed cable to the location is a 2 core as no resonant shunt is required. The receiver equipment can be up to 1200m away (loop resistance 20 Ω) from the loop joint (see fig. 33).

12.8 General Schematic Layout

A schematic layout is given in fig. 34.

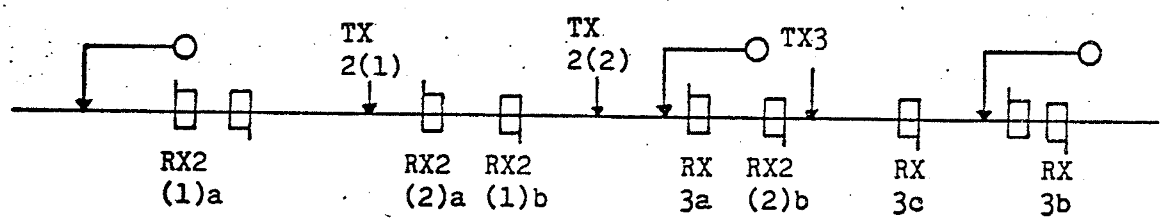
12.9 Maintenance Precautions

When maintenance work requires the disconnection of a compound loop the resonant shunt or resistive shunt (as appropriate) must be temporarily connected across the track, in its original position, in order that the characteristics of the remaining track circuits are not degraded.

13. METHODS OF INDICATING REED JOINTLESS TRACK CIRCUITS ON PLANS

13.1 Manufacturer's Drawings

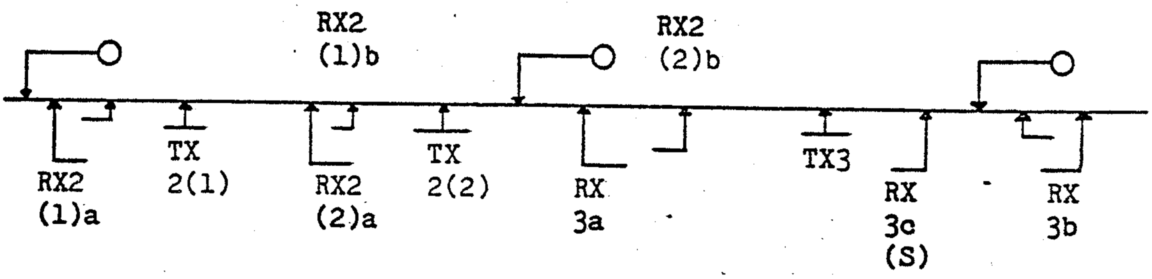
In the manufacturer's diagrams the loops are shown with a "tail" indicating the end of the loop which is jointed; the tail is thus remote from the associated transmitter. Although, in diagrams, the track circuit lengths are shown measured to the tails of the loops, the limit of shunt is mid-way along the loop and loops must be physically positioned with this in mind. An example of the manufacturer's diagrams is shown below:-



RX3C Simple loop with single receiver (extra receiver giving indication of train clearing this point)

13.2 BR Scheme Plans

To simplify the layout on signalling scheme plans it is recommended that receiver loops be shown by an arrow at the limit of the shunt. The receiver arrows will then have a tail added which is bent in the direction of the associated transmitter. The example below is similar to that shown in para. 1 above:-



The symbol (S) indicates a simple loop. It must be remembered that when track circuit ends are overlapped with the loops 1m apart, this is the measurement between the closest ends of the loops and the shunt limits will actually be 6m apart as shown in fig. 10.

14. INSTALLATION AND SETTING UP PROCEDURES

INSTALLATION

14.1 Mounting of Equipment

The equipment is designed to be mounted on standard BR racking as found in location cases and relay rooms. Rules for the layout of equipment are described in section 11.

14.2 Equipment Wiring

All wiring to be kept as short as possible and where shown in figs. 4, 5 and 6 to be carried out in twisted pairs. Where possible the wiring should be tied to the ironwork of the rack.

14.3 Lead Length Restrictions

14.3.1 Transmitter Feed Cables

The track feed cables must be kept as short as possible. For track circuits less than 650m the lead length must be less than 240m (loop resistance 4 Ω). For track circuits longer than 650m the lead length must be less than 60m (loop resistance 1 Ω).

14.3.2 Jointed Receiver Feed Cables

The track feed cables must be kept as short as possible. For track circuits less than 650m the lead length must be less than 240m (loop resistance 4 Ω). For track circuits longer than 650m the lead length must be less than 60m (loop resistance 1 Ω).

14.3.3 Jointless Receiver Feed Cables

Again the lead lengths should be kept as short as possible. Restrictions which apply are that the resonant/resistive shunt equipment is within 60m (loop resistance 1 Ω) of the receiver loop and that the receiver equipment is within 1200m (loop resistance 20 Ω) of the receiver loop.

14.4 Separation of Equipment

To gain full utilisation of power supply equipment up to 4 transmitters can be run from one NT1202 unit and 2 receivers from one RR9121 unit. Restrictions apply such that no two units (transmitters, receivers or one of each) of the same frequency may be operated from the same power supply unit or housed in the same location case (see also paragraph 9.3).

SETTING UP

14.5 Preliminary Checks

On all reed track installations check that:-

(a) All wiring conforms to that as specified on wiring diagrams.

(b) All equipment is mounted in the correct position.

(c) All power supply voltages are of the correct magnitude and polarity before plugging in any unit.

14.6 Measurements at a Transmitter Site (Jointed and Jointless)

(a) Check that the flying lead on the track filter is connected to the terminal marked with the channel number in use.

(b) Measure mains supply voltage. It must be between 93.0 and 127.0V.

(c) Measure output voltage of power supply units.

STANDARD FEED	NT1202	OUTPUT 14.0-16.0 V a.c.
HIGH POWERED FEED	NT1302	OUTPUT 15.0-17.0 V d.c. (t5 +, t6 -)
		23.0-26.0 V d.c. (t3 +, t4 -)

(d) Measure voltage on RT5001 oscillator amplifier plugboard. 13.5-16.5 V d.c. (A1 +, A2 -).

(e) Measure output current of power amplifier by inserting a meter in series with the track feed on the outgoing links and placing a short circuit on the rails at the feed point:-

(1) For a single rail track circuit RT7111, the current should be 1.1-1.4 A.

(2) For a double rail track circuit RT7101, the current should be 1.2-1.5 A.

(3) For a high powered feed unit, set the output current to approximately 5A by the selection of terminals 2 to 5.

(f) Tune all impedance bonds.

(g) With the high powered feed only, maximise the output current from the track filter RT72XX by selection of the optimum tapping.

14.7 Measurements at a Jointed Receiver Site

(a) Check that the flying lead on the track filter is connected to the terminal marked with the channel number in use.

(b) Measure mains supply voltage. It must be between 93.0 and 127.0 V.

(c) Measure the output of the power supply unit RR9121 on the receiver amplifier plugboard. It should be 12.0-13.8 V d.c. (D2 +, A3 -).

(d) Measure the a.c. output of the track filter RT72XX. It should be 150-400 mV. If greater than 400 mV connect the input lead to t22 or t21 instead of t23 to reduce the output to 400 mV or less.

(e) If a high power feed is in use the attenuator RT7312 needs adjustment as follows. Replace the receiver amplifier RR2002 with a dummy amplifier XV1020 and measure the reed filter output voltage. Set the receiver dummy amplifier output initially to as near 75mV as possible and measure the drop shunt. This should be not less than 0.5 ohm. If the drop shunt is less than 0.5 ohm, the dummy amplifier output may be reduced down to a minimum of 60mV. In these circumstances, a drop shunt of not less than 0.3 ohm is acceptable. The attenuation is adjusted by selecting primary and secondary taps on the transformer in the RT7312 attenuator. Replace the RR2002 receiver amplifier.

(f) Measure the voltage on the reed follower relay ZS2411. It should be 11.5-18.0 V d.c. (R1-R2).

14.8 Measurement at a Jointless Receiver Site

(a) On electrified lines ensure that the flying lead on the resonant shunt RT7401 is connected to the correct terminal for the channel in use.

(b) Measure mains supply voltage. It must be between 93.0 and 127.0 V.

(c) Measure the output of the power supply unit RR9121 on the receiver amplifier plugboard. It should be 12.0-13.8 V d.c. (D2 +, A3 -).

(d) Ensure that the incoming 4 core cable is terminated correctly. Cores 1 and 2 to the attenuator/filter RT7302 and cores 3 and 4 to the resonant/resistive shunt RT7401 or RT7412.

(e) Adjust the attenuator/filter RT7302 as follows. Change the receiver amplifier RR2002 for a dummy amplifier XV1020 and measure the reed output voltage. Set the receiver dummy amplifier output initially to as near 75 mV as possible and measure the drop shunt. This should be not less than 0.5 ohm. If the drop shunt is less than 0.5 ohm, the dummy amplifier output may be reduced down to a minimum of 60 mV. In these circumstances, a drop shunt of not less than 0.3 ohm is acceptable. The attenuation is adjusted by selecting two series resistors with the flying leads. Start with both leads at the bottom of the terminal block, move one lead to obtain coarse setting and then the second lead for finer adjustment. Replace the RR2002 receiver amplifier.

(f) Measure the voltage on the reed follower relay ZS2411. It should be 11.5-18.0 V d.c. (R1-R2).

(g) Drop shunt readings should be taken on the transmitter side of the loop approximately 6m from the rail connections.

(h) When a high power feed is used repeat as above but use an 11 turns loop instead of a 35 turns loop (see section 12.6).

14.9 Measurements at an Intermediate Jointless Receiver Site.

(a) Measure mains supply voltage. It must be between 93.0 and 127.0 V.

(b) Measure the output of the power supply unit RR9121 on the receiver amplifier plugboard. It should be 12.0-13.8 V d.c. (D2 +, A3 -).

(c) Adjust the attenuator/filter RT7302 as follows. Change the receiver amplifier RR2002 for a dummy amplifier XV1020 and measure the reed output voltage. Set the receiver dummy amplifier output initially to as near 75mV as possible and measure the drop shunt. This should be not less than 0.5 ohm. If the drop shunt is less than 0.5 ohm, the dummy amplifier output may be reduced down to a minimum of 60 mV. In these circumstances, a drop shunt of not less than 0.3 ohm is acceptable. The attenuation is adjusted by selecting two series resistors with the flying leads. Start with both leads at the bottom of the terminal block, move one lead to obtain a coarse setting and then the second lead for finer adjustment. Replace the RR2002 receiver amplifier.

(d) Measure the voltage on the reed follower relay ZS2411. It should be 11.5-18.0 V d.c. (R1-R2).

(e) Drop shunt readings should be taken on the transmitter side of the loop approximately 6m from the end of the loop.

(f) When a high power feed is used repeat as above but use an 11 turns loop instead of a 35 turns loop (see section 12.6).

APPENDIX I

ADDITIONAL REED TRACK FREQUENCY FOR USE ON D.C. ELECTRIFIED LINES ONLY

In areas of d.c. traction utilising double rail traction current return the frequency range for reed track circuits is f211 to f218. The incorporation of f211 in place of f219 enables Westinghouse Style 'S' impedance bonds to be tuned with a single value of capacitance over the whole frequency range. Details of channel f211 are shown below:

FREQUENCY	CHANNEL NUMBER	TRANSMITTER FILTER		RECEIVER FILTER	
363 Hz	f211	RT5110	ACGHM	RT6110	ACGJM

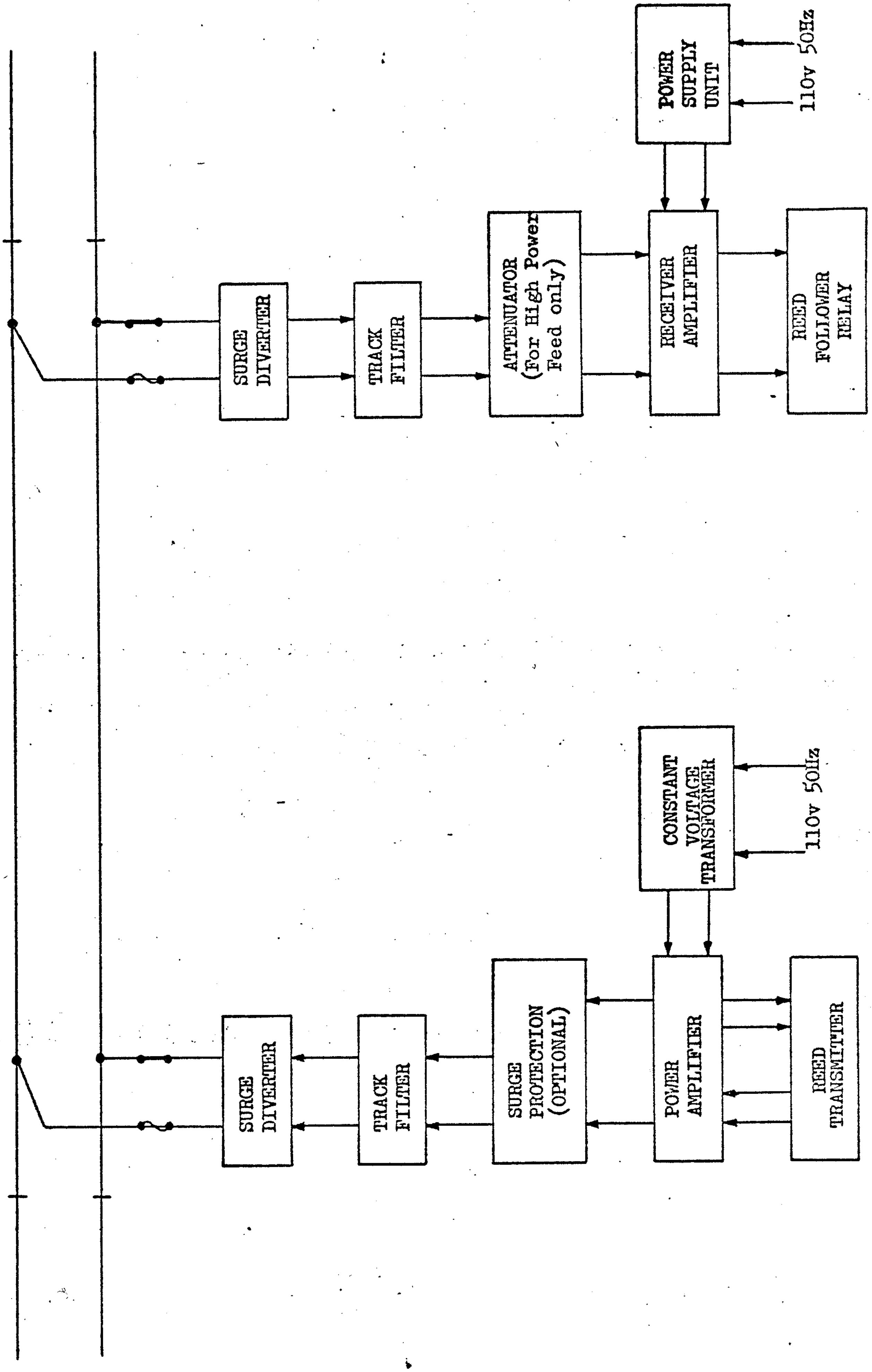
Track Filter for Channel f211.

Standard Filter RT 7202

High Power Filter RT 7221

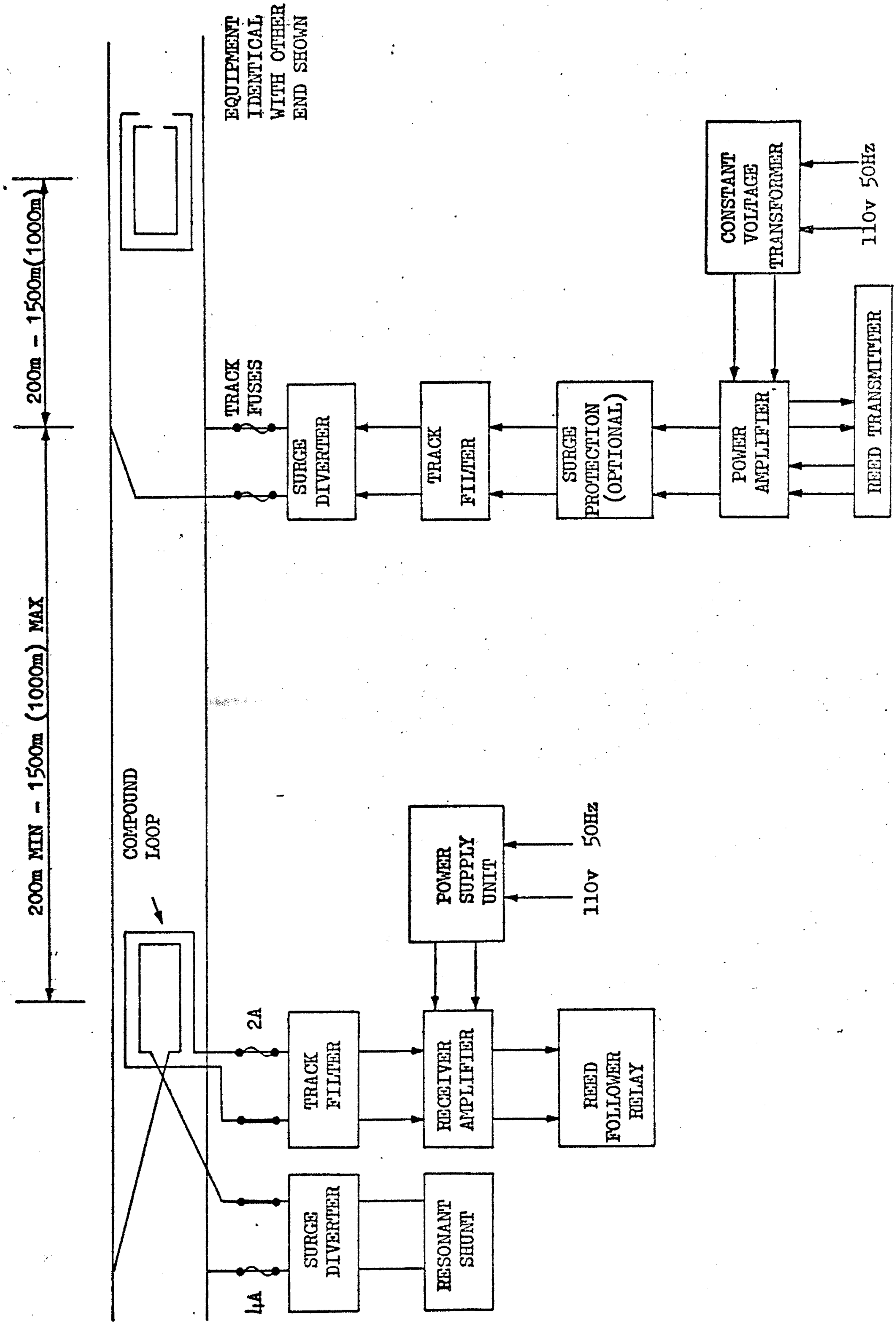
NOTE

Westinghouse P3 and G.E.C. DE 4131 type impedance bonds can be resonated with a single value of capacitance over the frequency range of reed track circuits f211 to f219.



BLOCK SCHEMATIC DIAGRAM OF REED JOINTED TRACK CIRCUIT (END FED)

fig. 1



BLOCK SCHEMATIC DIAGRAM OF STANDARD REED JOINTLESS TRACK CIRCUIT

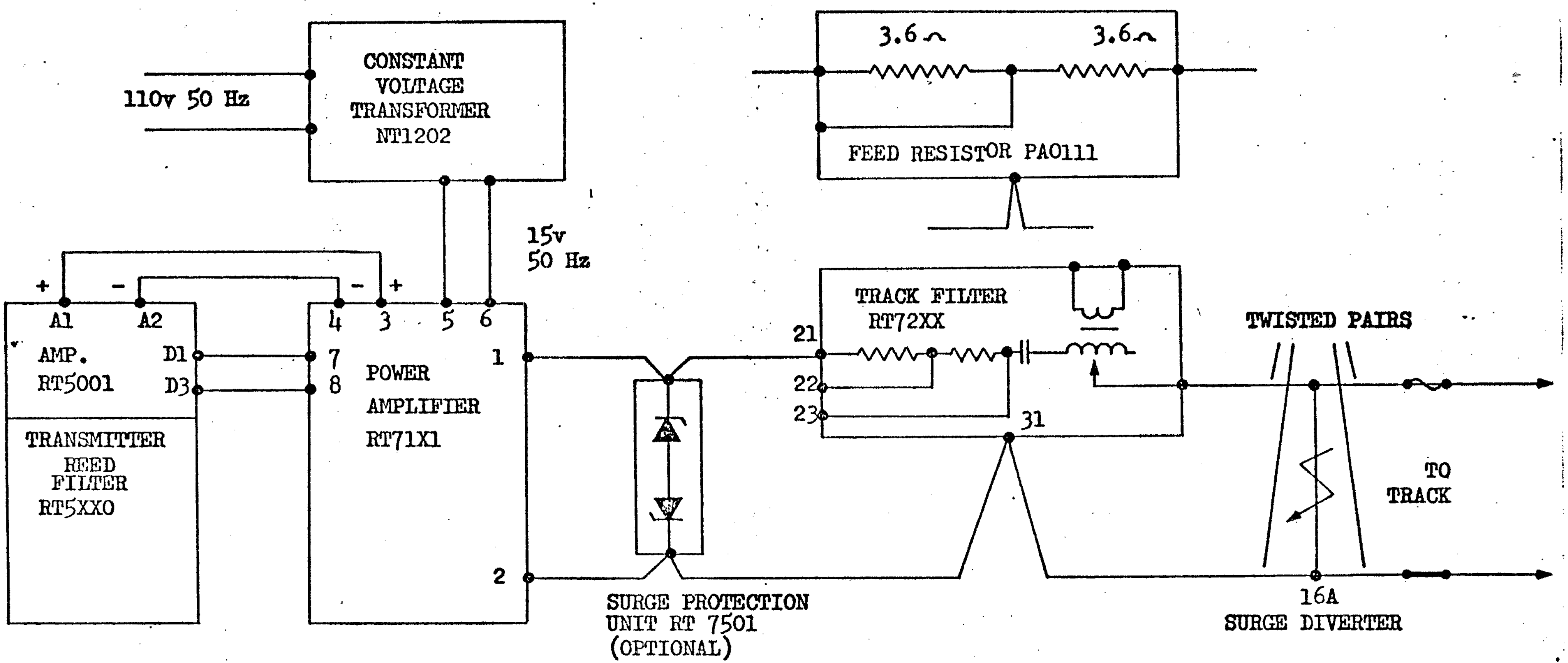
fig. 2

FREQUENCY Hz	CHANNEL NUMBER	TRANSMITTER FILTER	PLUGBOARD PIN CODE	RECEIVER FILTER	PLUGBOARD PIN CODE	COMMENTS
366	f212	RT5120	ACGKM	RT6120	ACGLM	
369	f213	RT5130	ACHJM	RT6130	ACHKM	
372	f214	RT5140	ACHLM	RT6140	ACJKM	
375	f215	RT5150	ACJLM	RT6150	ACKLM	
378	f216	RT5160	ADEFM	RT6160	ADEGM	
381	f217	RT5170	ADEHM	RT6170	ADEJM	
384	f218	RT5180	ADEKM	RT6180	ADELM	
408	f219	RT5190	ADFGM	RT6190	ADFHM	
	f220	RT5200	ADFJM	RT6200	ADFKM	SPARE
	f221	RT5210	ADFLM	RT6210	ADGHM	SPARE

REED FREQUENCIES, CHANNEL NUMBERS AND FILTER REFERENCES.

fig. 3

FOR NON IMMUNE TRACK CIRCUITS
FEED RESISTOR PA0111 MAY BE USED.

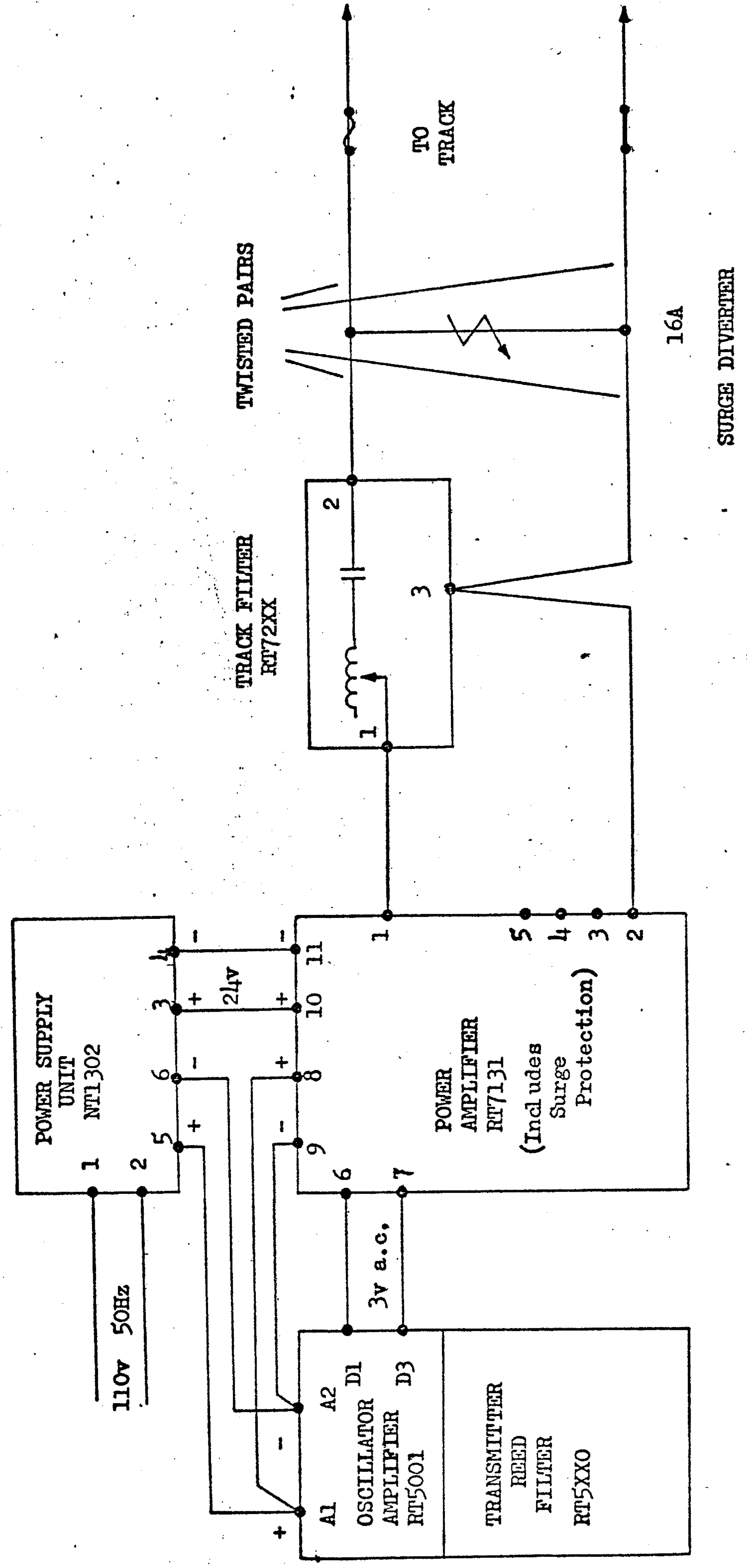


POWER AMPLIFIER RT7101 FOR DOUBLE RAIL & JOINTLESS TRACK CIRCUITS

POWER AMPLIFIER RT7111 FOR SINGLE RAIL TRACK CIRCUITS

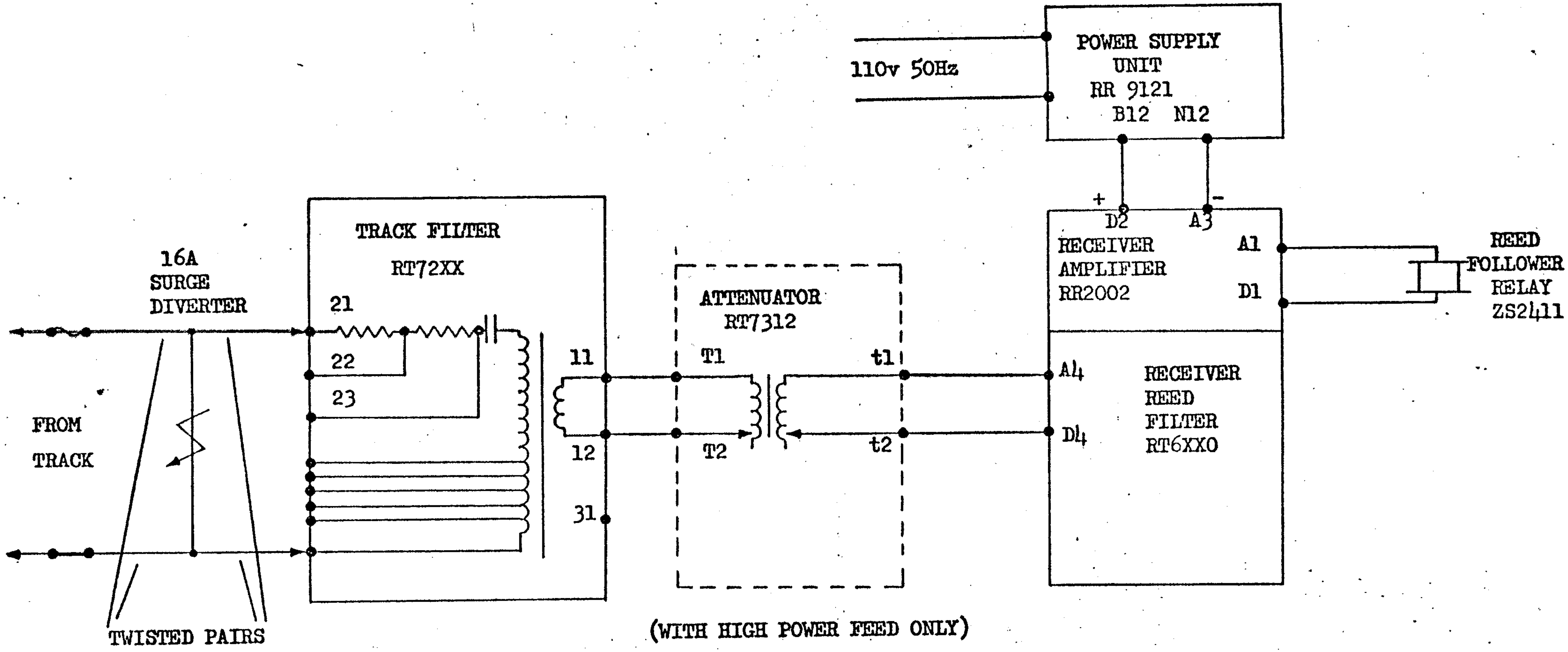
STANDARD FEED END EQUIPMENT

fig. 4



<u>HIGH POWER FEED END EQUIPMENT</u>

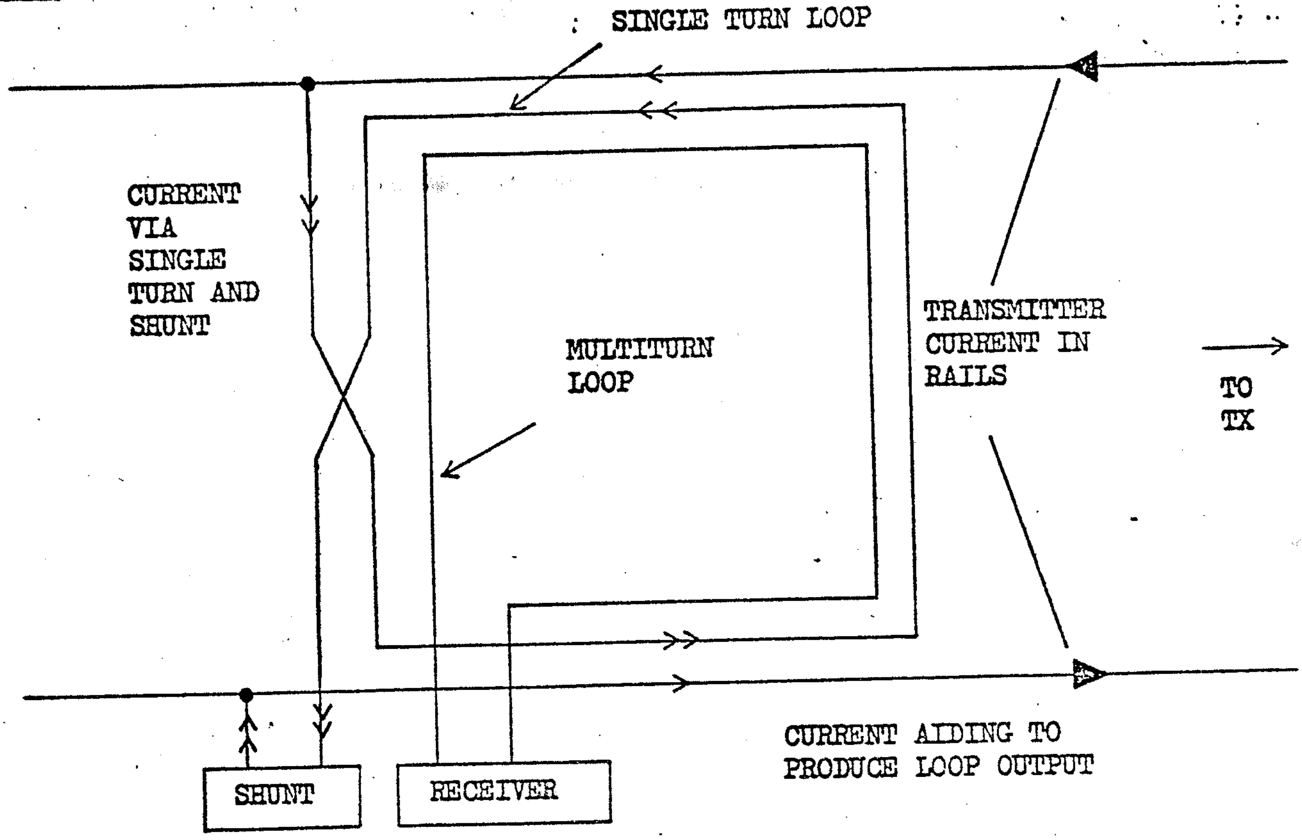
fig. 5



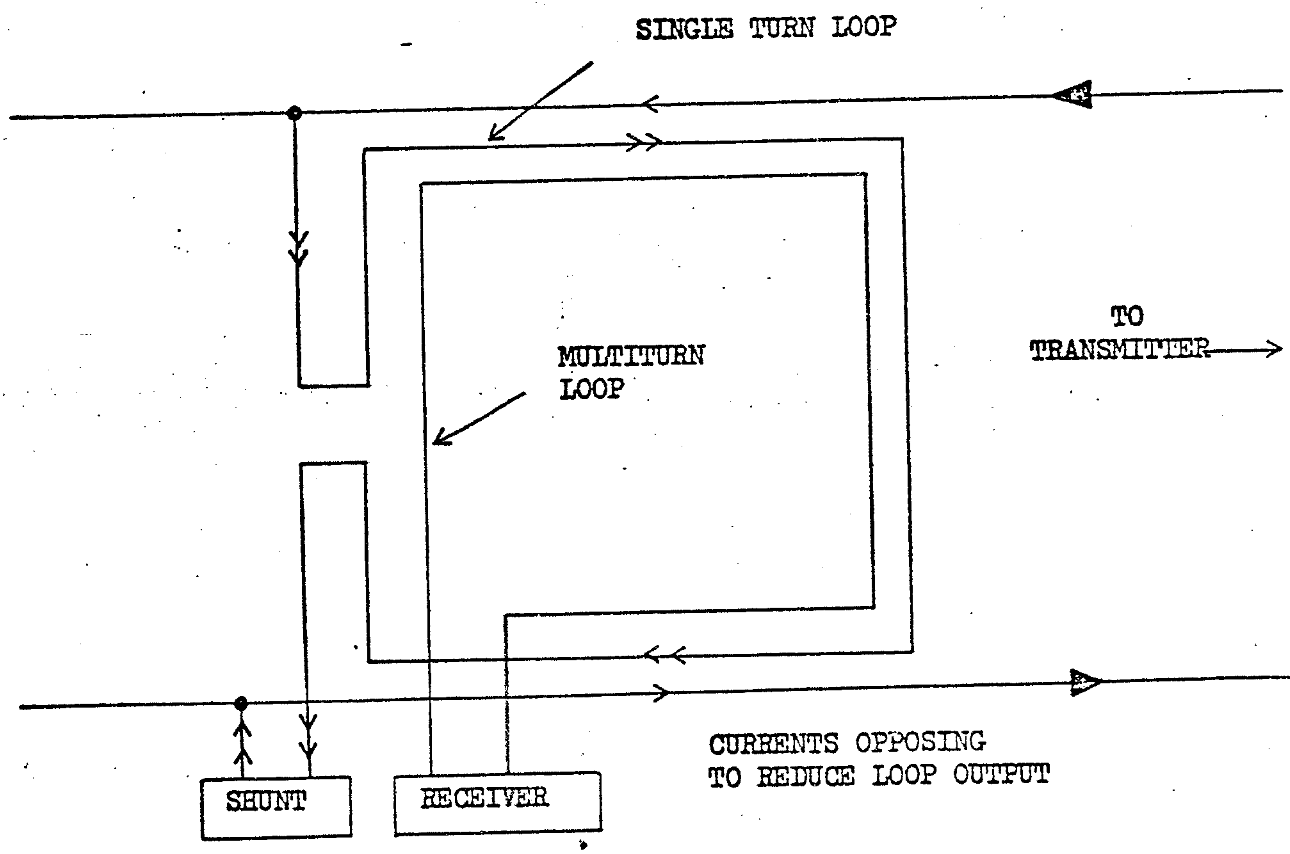
JOINTED RECEIVER END EQUIPMENT

fig. 6

CORRECT

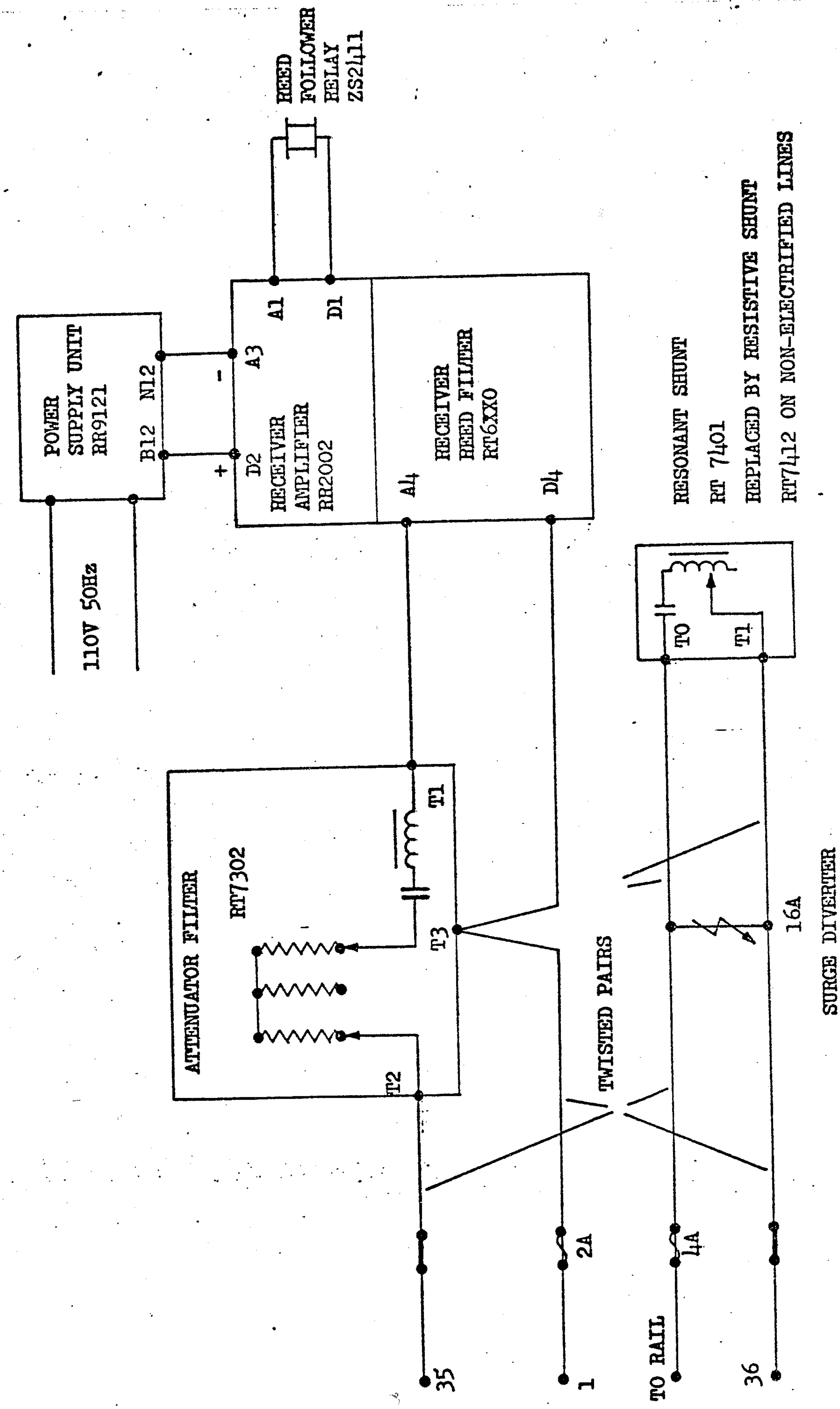


INCORRECT



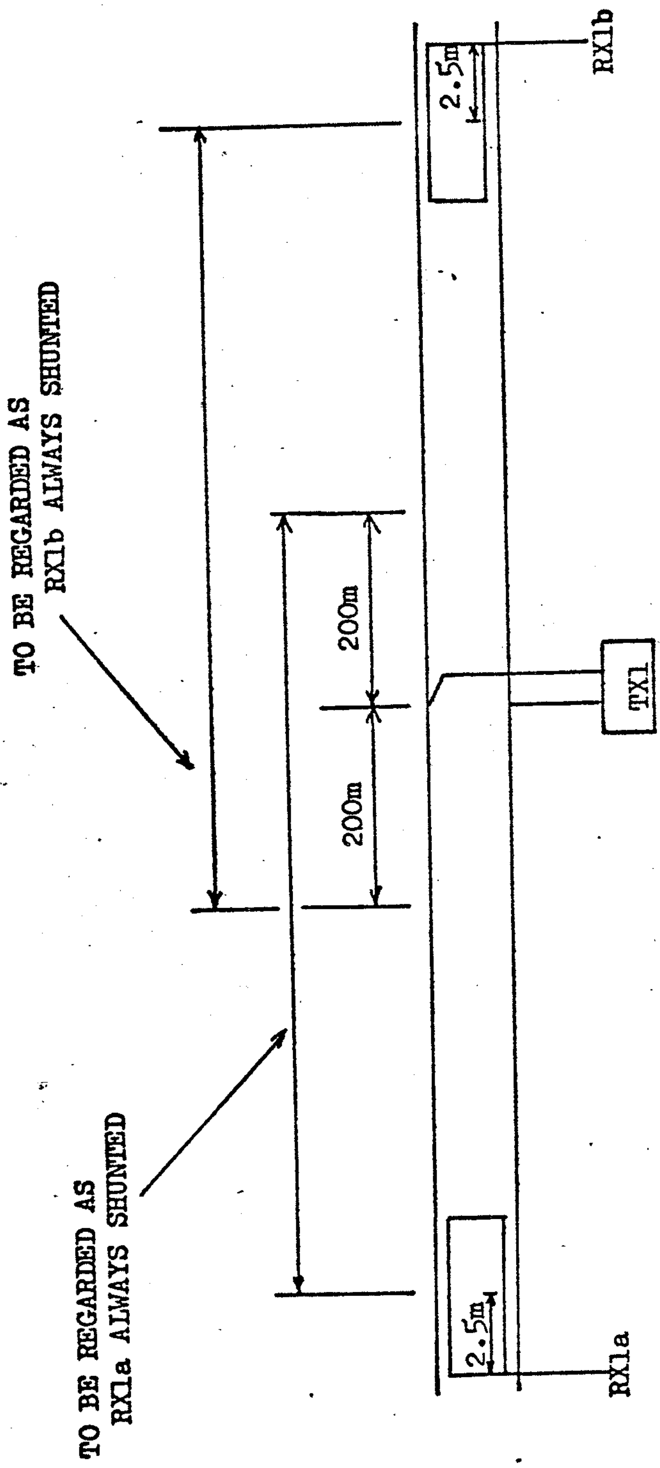
METHOD OF CONNECTING COMPOUND LOOP SHUNT

fig. 7



JOINTLESS RECEIVER END EQUIPMENT

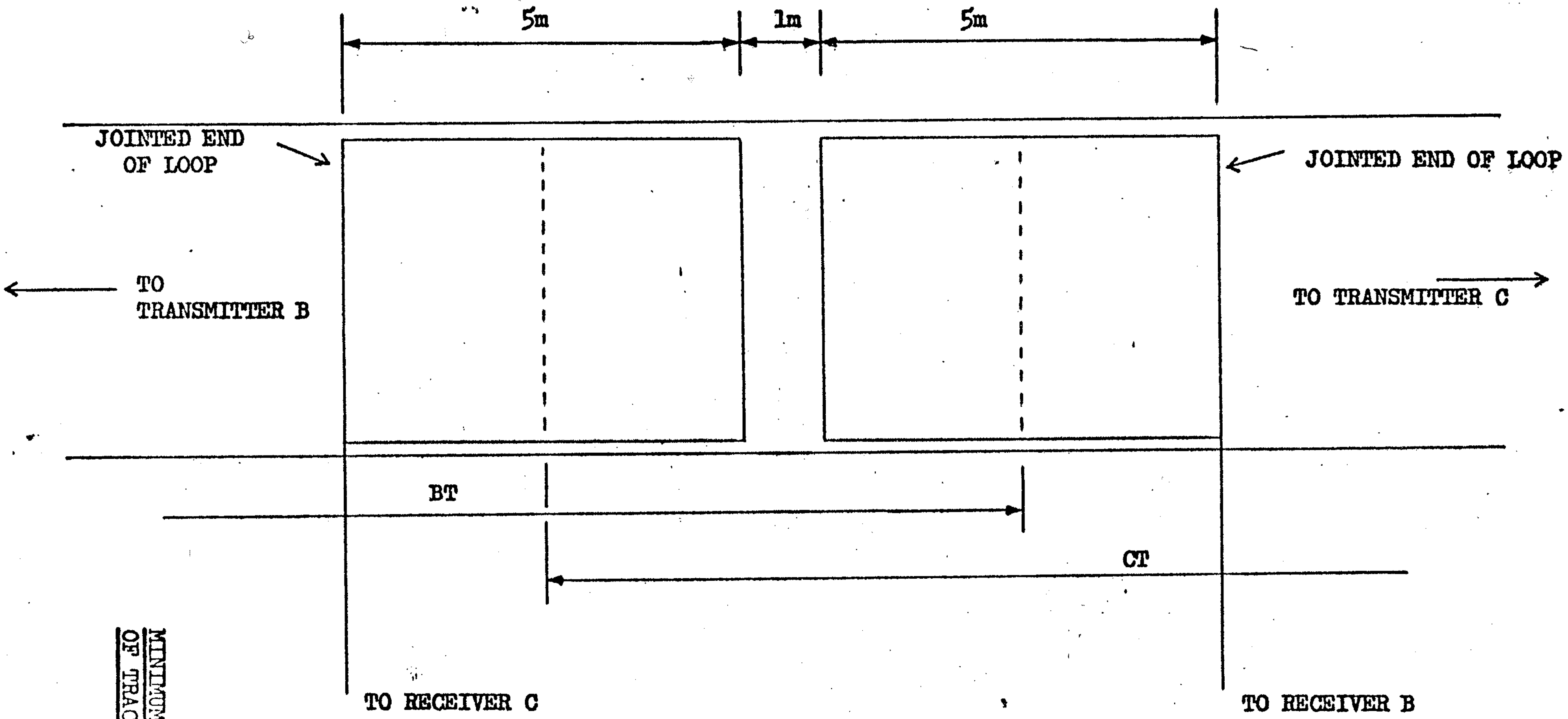
fig. 8



N.B.: (1) LIMITATIONS OF SHUNT ZONES ARE APPROXIMATE
(2) A SINGLE CENTRE FED TRACK IS SHOWN
(3) NOT DRAWN TO SCALE

SHUNT ZONES OF REED JOINTLESS TRACK CIRCUITS

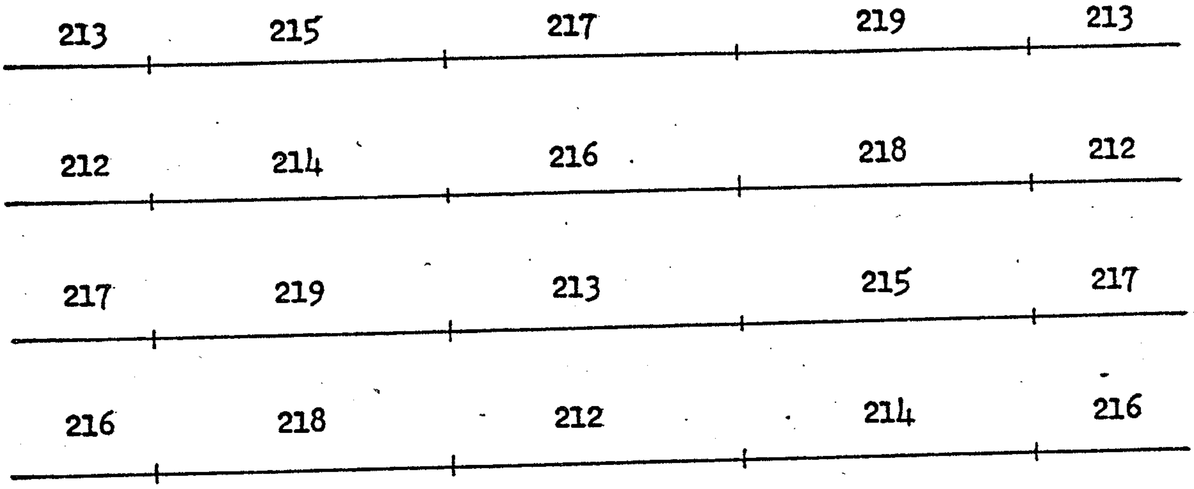
fig. 9



N.B.: LIMIT OF SHUNT IS AT THE CENTRE LINE OF THE LOOP

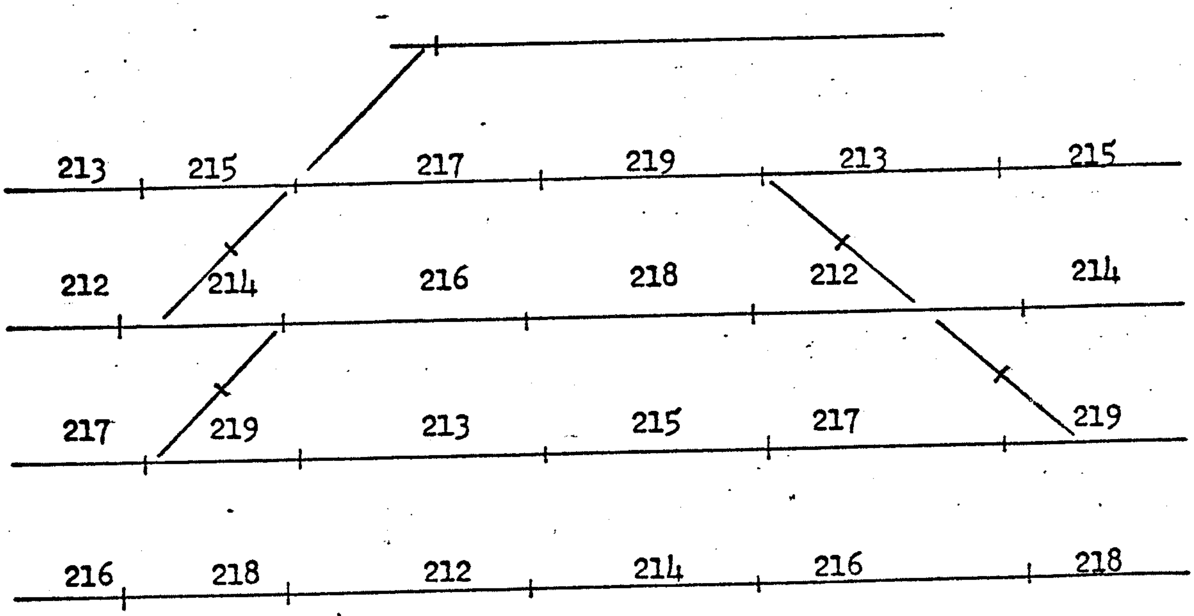
MINIMUM OVERLAPPING
OF TRACK CIRCUITS

fig.10



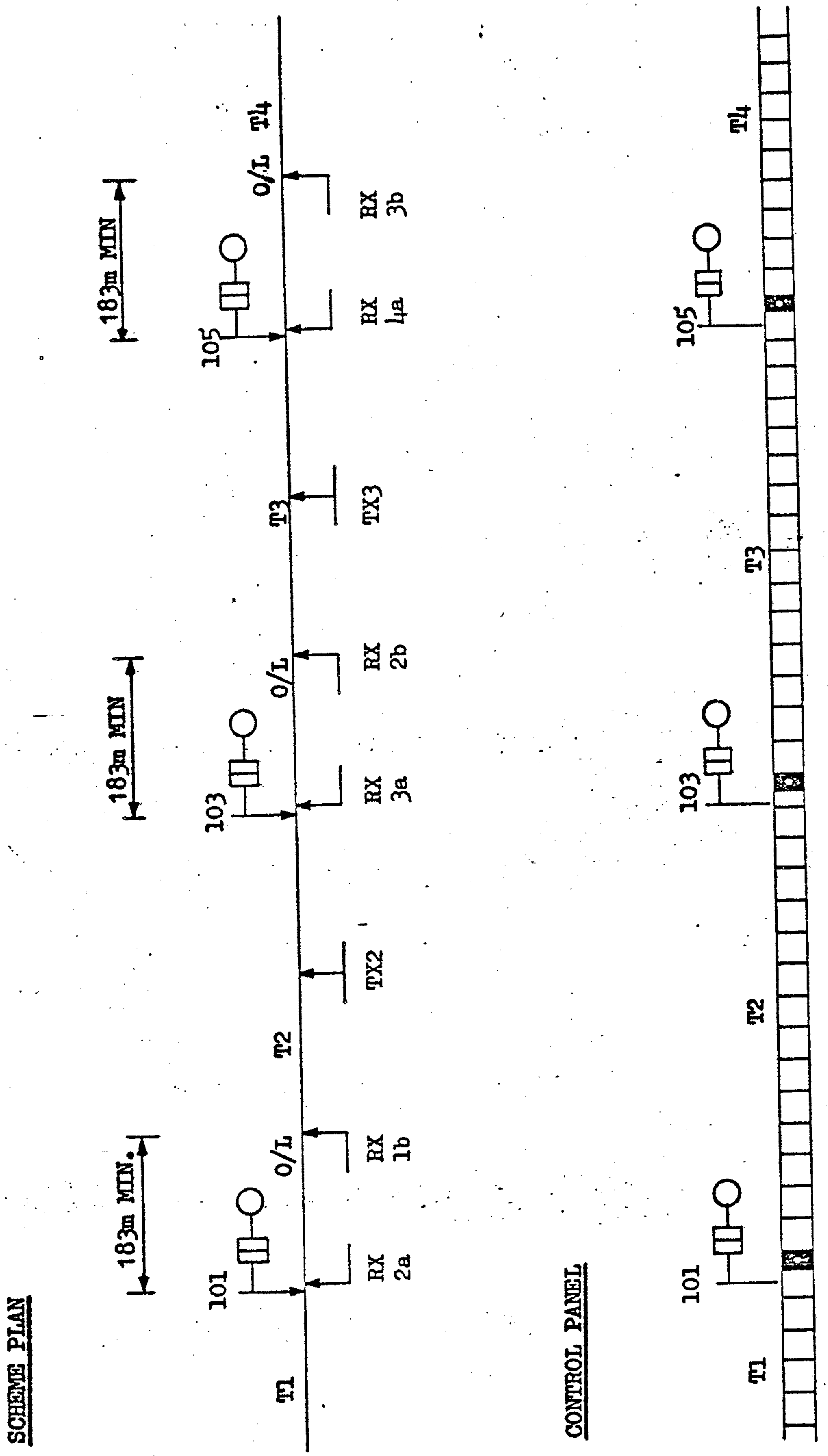
PARALLEL ROAD FREQUENCIES SEPARATED BY TWO CHANNELS

fig.11



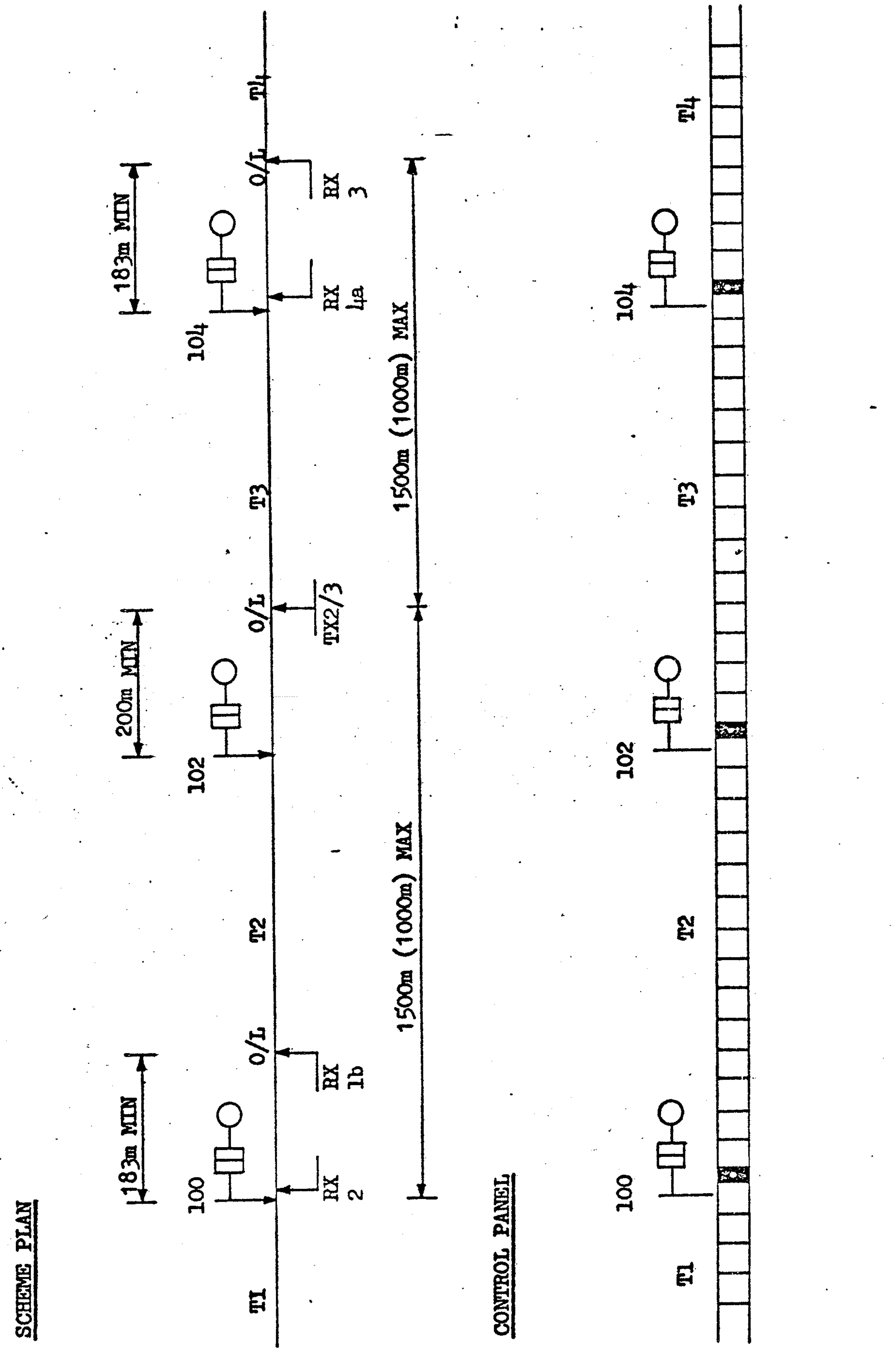
TWO CHANNEL SEPARATION THROUGH P. & C.

fig.1



TRACK CIRCUITS IN AUTO AREAS (CASE 1)

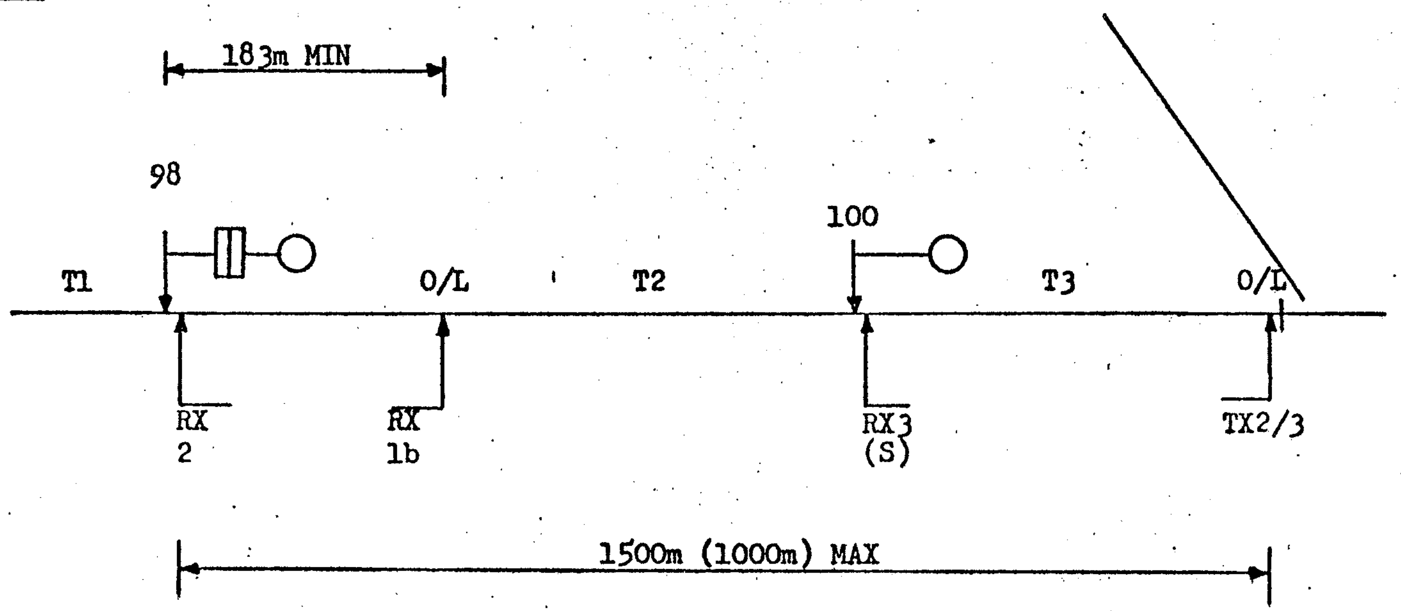
fig. 13



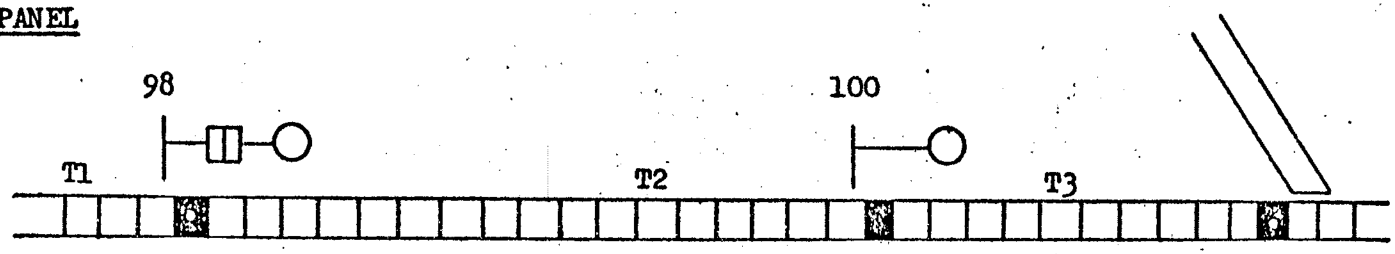
TRACK CIRCUITS IN AUTO AREAS (CASE 2)

fig. 14

SCHEME PLAN

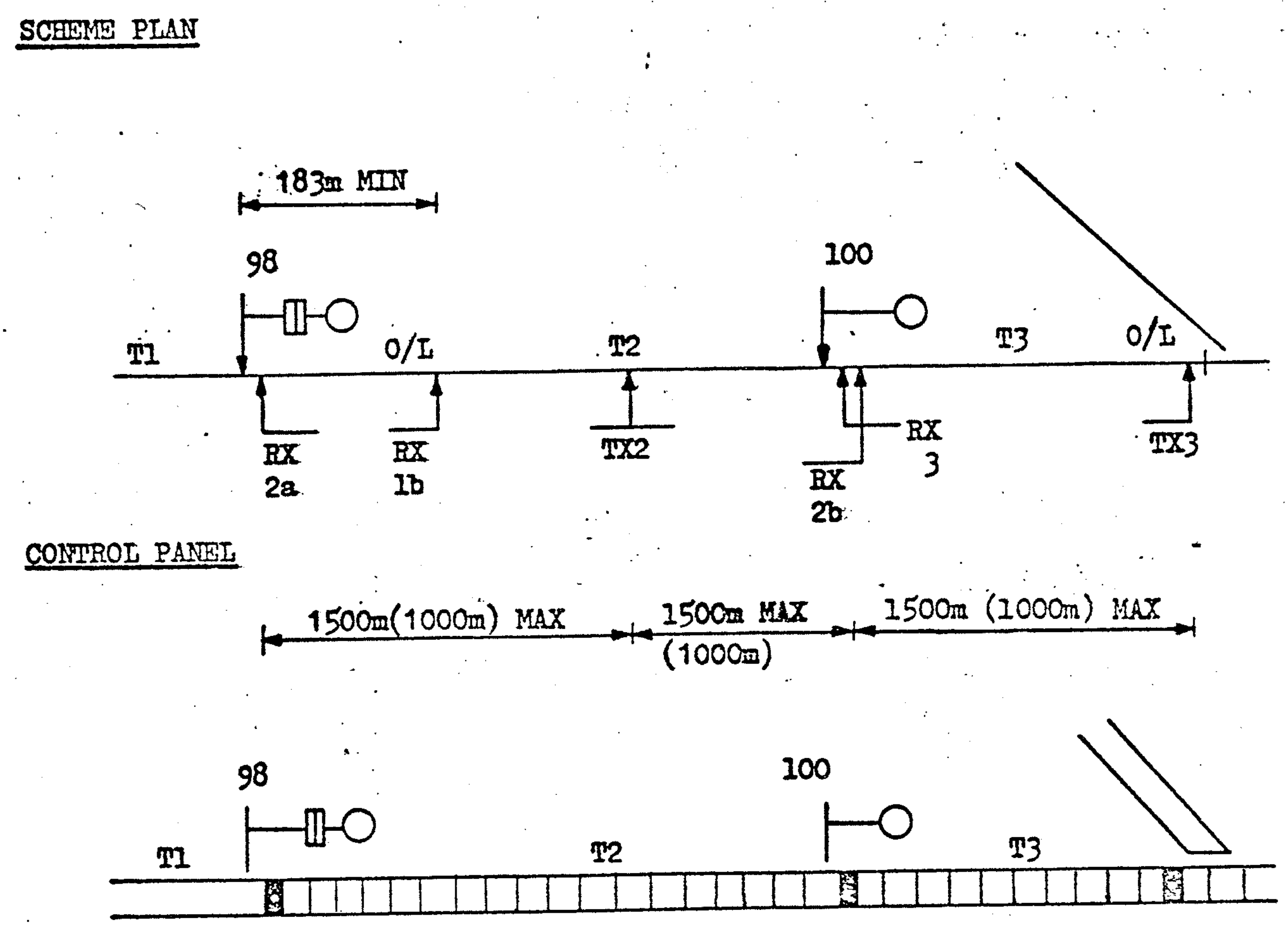


CONTROL PANEL



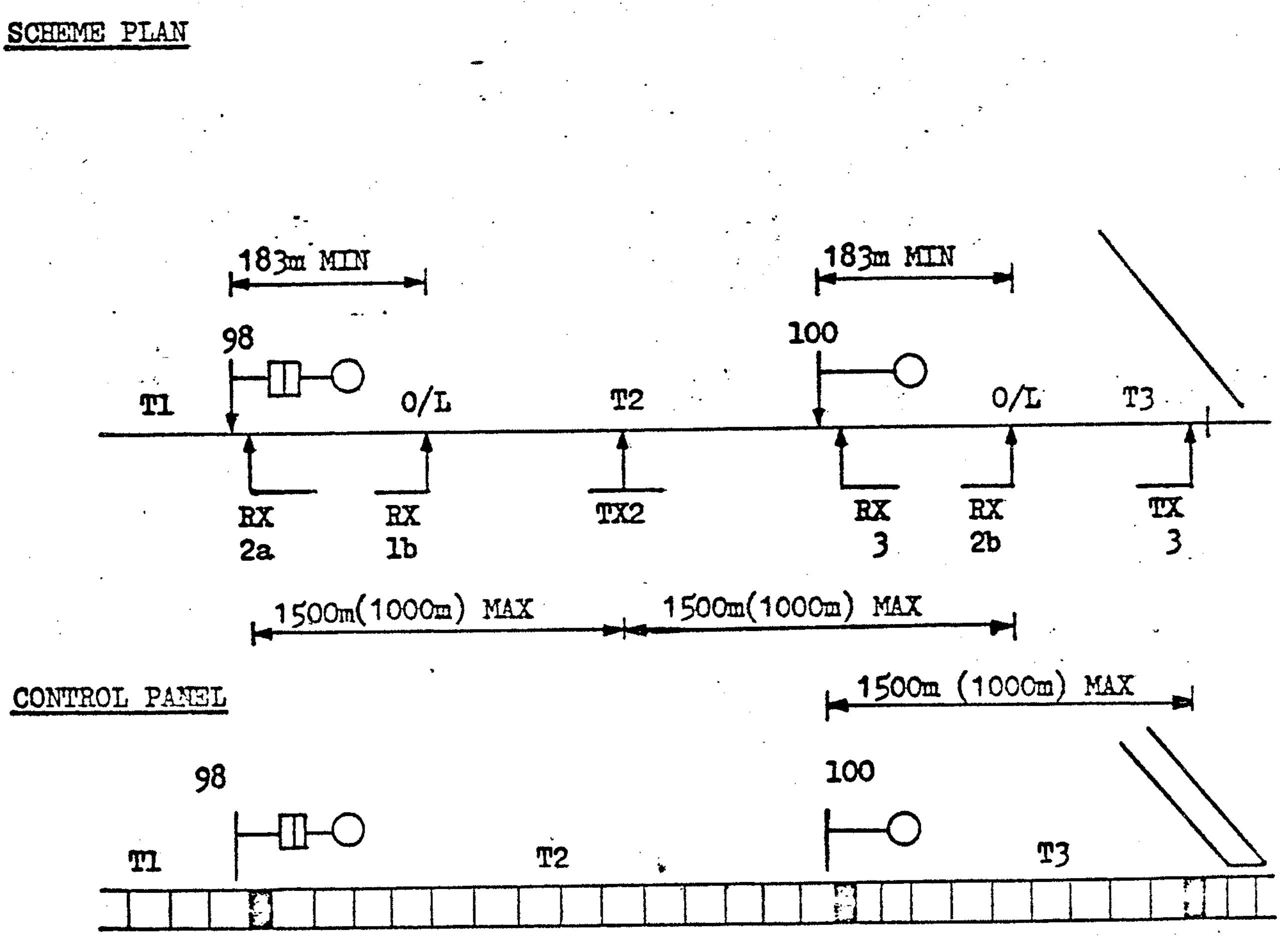
END OF JOINTLESS SEQUENCE (CASE 1)

fig. 15



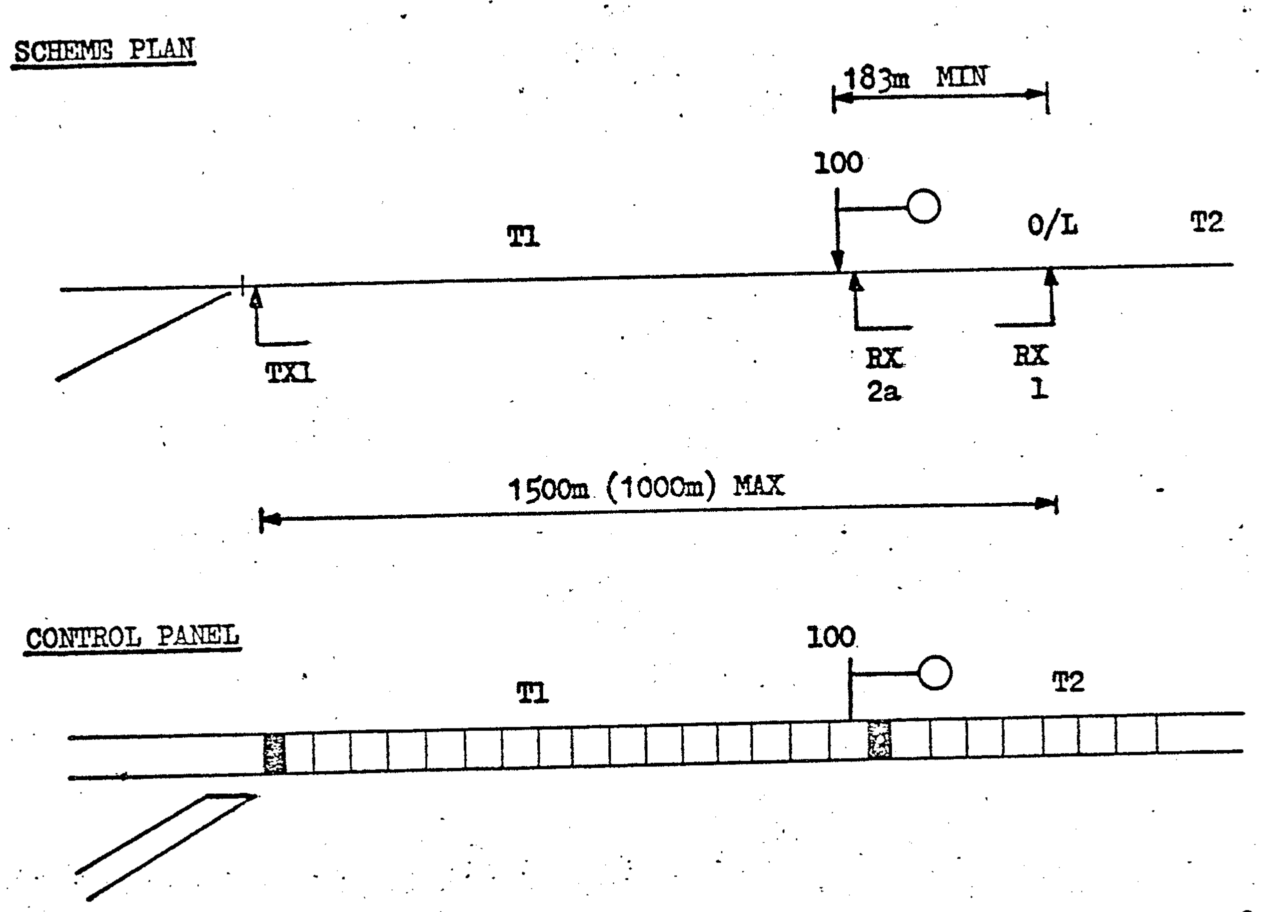
END OF JOINTLESS SEQUENCE (CASE 2)

fig. 16

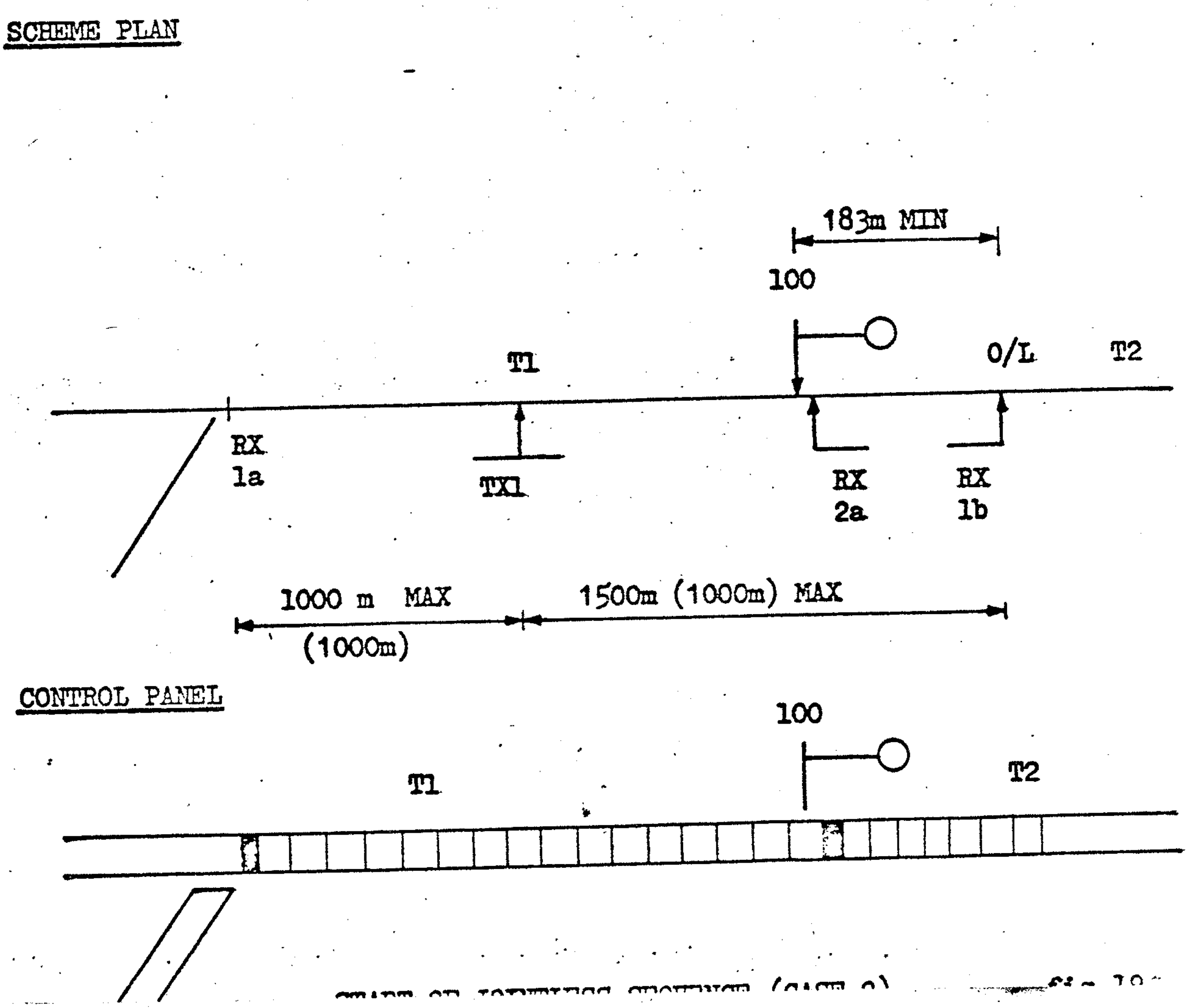


END OF JOINTLESS SEQUENCE (CASE 3)

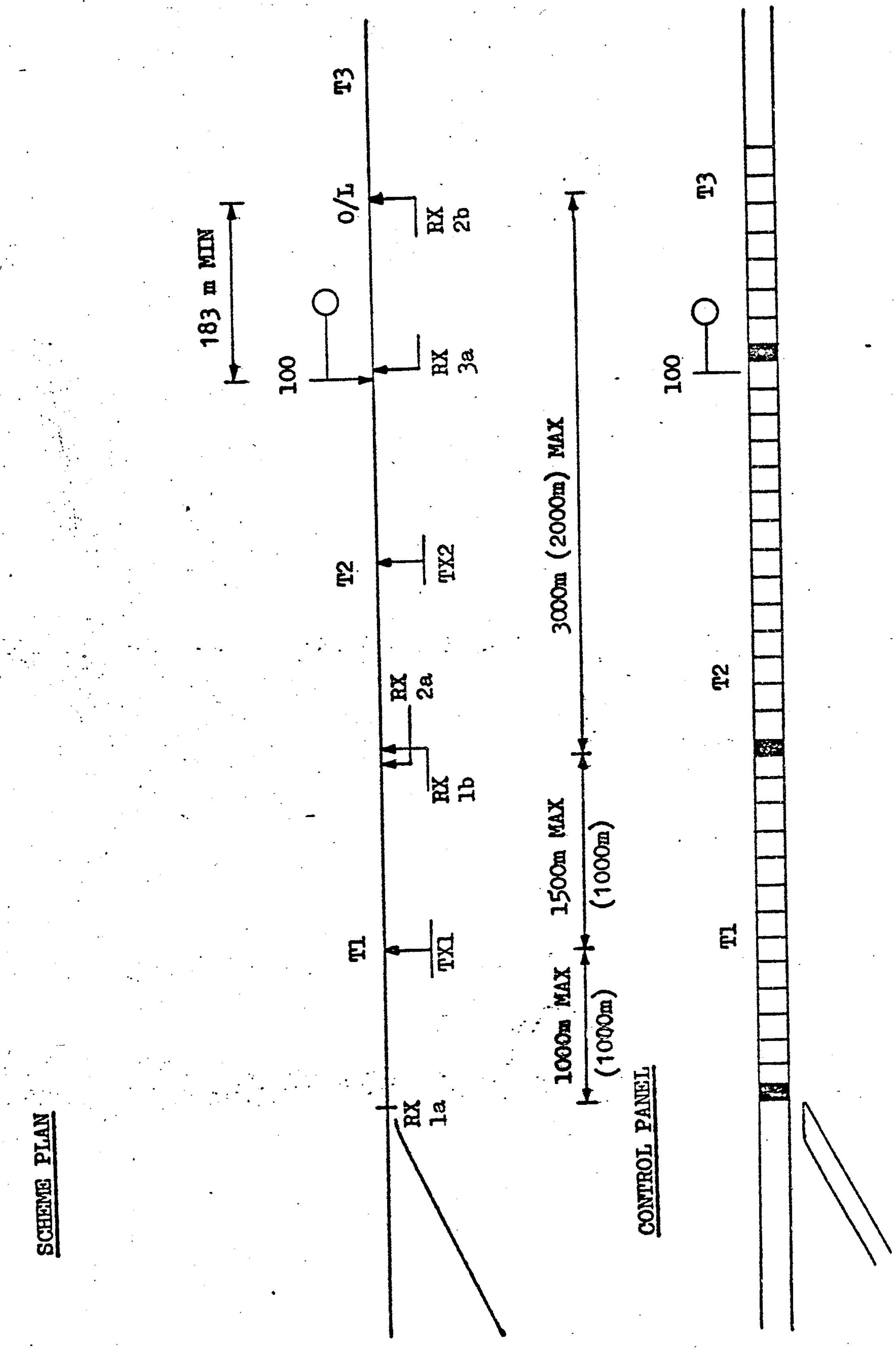
fig. 17



START OF JOINTLESS SEQUENCE (CASE 1) fig. 18



START OF JOINTLESS SEQUENCE (CASE 2) fig. 19



START OF JOINTLESS SEQUENCE (CASE 3)

fig. 20

GENERAL LEVEL CROSSING LAYOUT

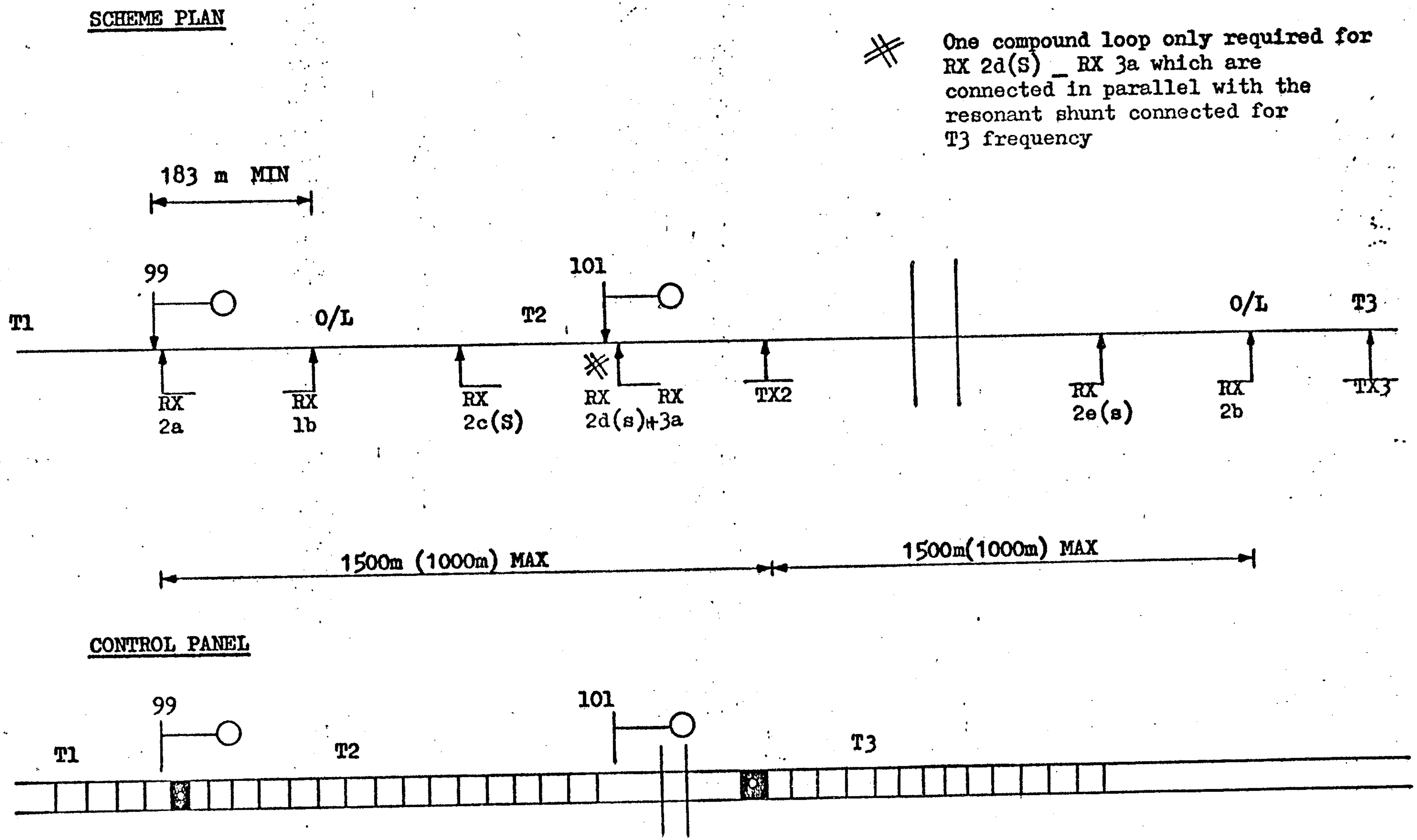
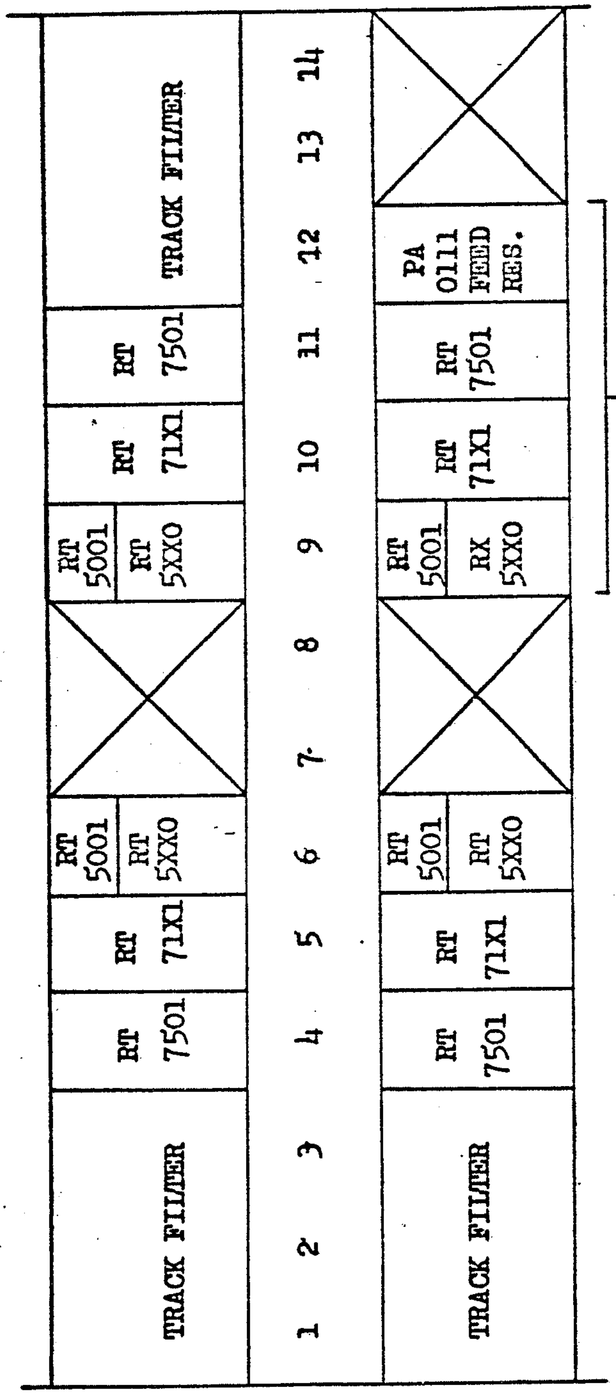


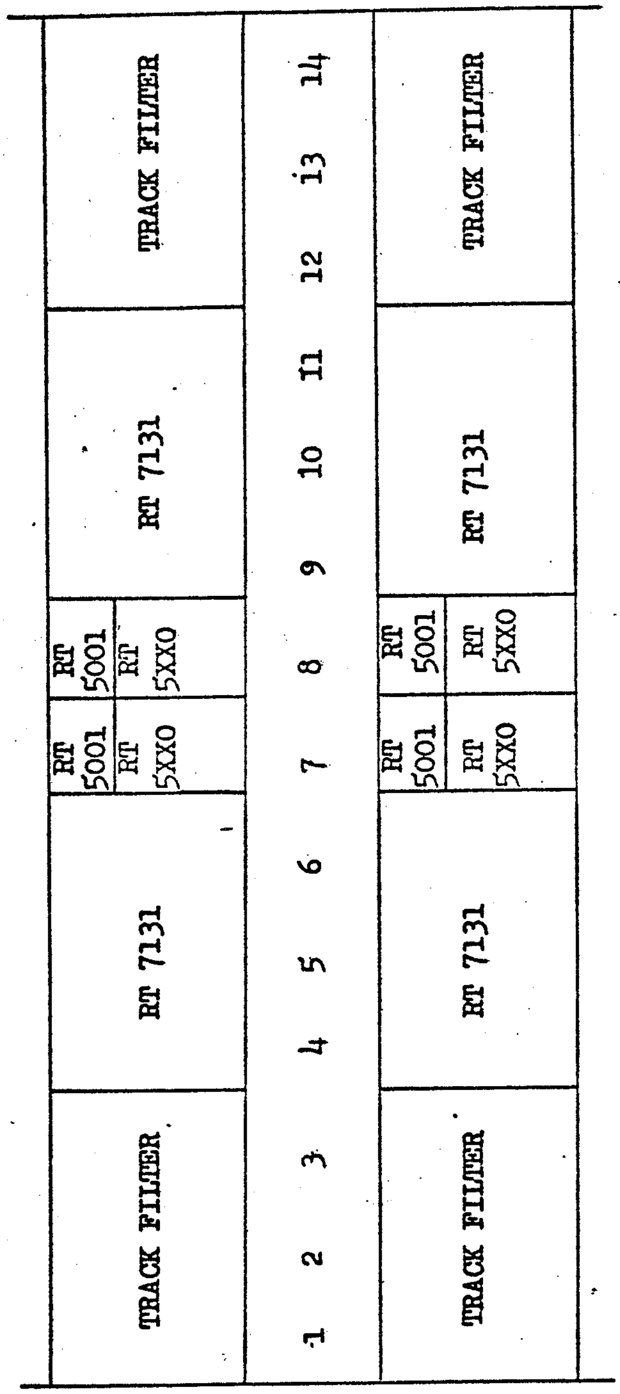
fig. 21



CONSTANT VOLTAGE TRANSFORMER NT1202 MOUNTED ON A SEPARATE ROW
(NT 1202 REQUIRES 5 SPACES)

<u>STANDARD LAYOUT OF UP TO 4 FEEDS</u>

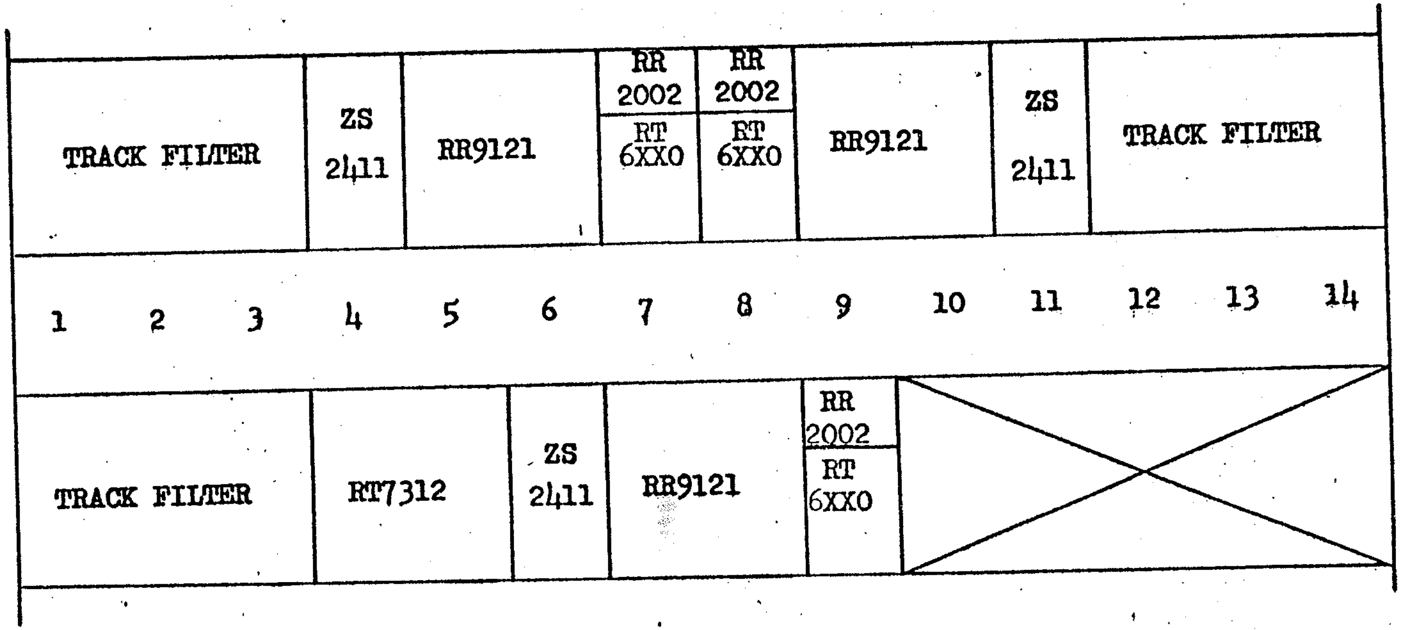
fig.22



POWER SUPPLY UNIT NT 1302 MOUNTED ON LOCATION BACKBOARD
(NT 1302 DIMENSIONS 180mm x 370mm)

STANDARD LAYOUT OF UP TO 4 HIGH POWER FEEDS

fig. 23



TOP ROW:- 2 STANDARD JOINTED RECEIVERS

SECOND ROW: 1 JOINTED RECEIVER WITH ATTENUATOR

STANDARD LAYOUT OF JOINTED RECEIVERS

fig. 2

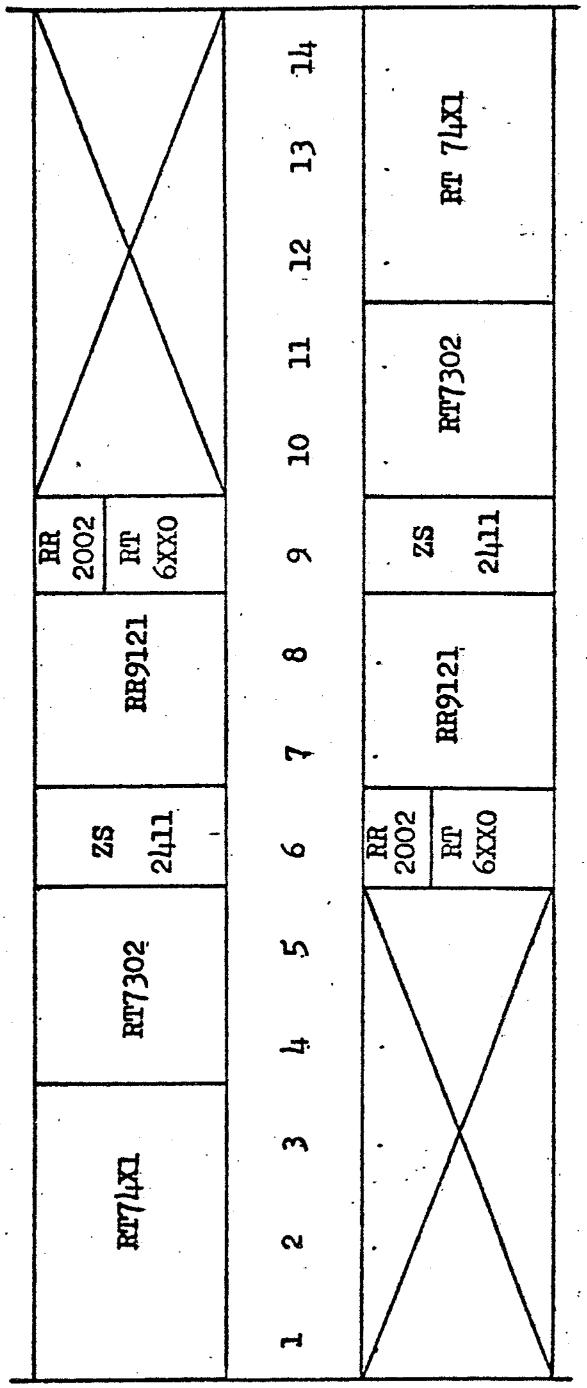
1	2	3	4	5	6	7	8	9	10	11	12	13	14
RT7302		ZS 2411	RR9121		RR 2002 / RT 6XX0	X		RR 2002 / RT 6XX0	RR9121		ZS 2411	RT7302	
RT7302		ZS 2411	RR9121		RR 2002 / RT 6XX0	X		RR 2002 / RT 6XX0	RR9121		ZS 2411	RT7302	

RESONANT/RESISTIVE SHUNTS MOUNTED ON LOCATION BACKBOARD

THE LAYOUT ABOVE IS ALSO USED FOR SIMPLE RECEIVERS

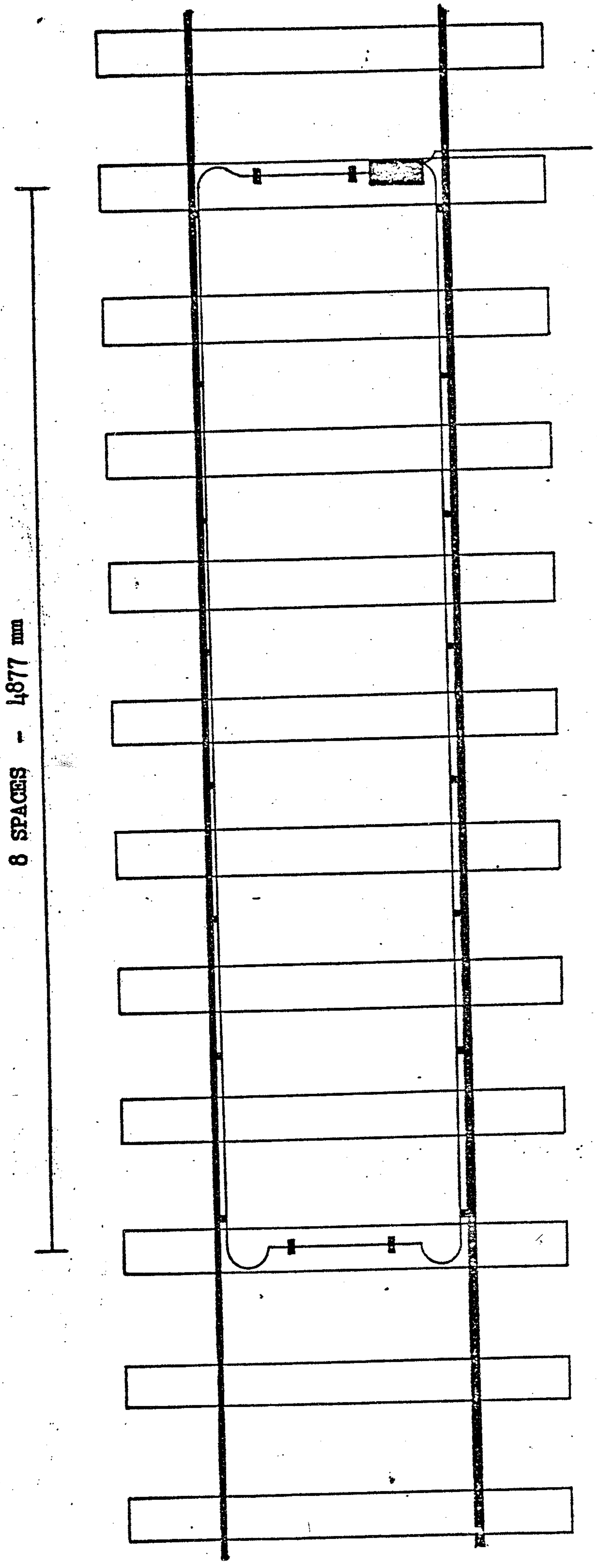
STANDARD LAYOUT OF UP TO 4 JOINTLESS RECEIVERS

fig. 25



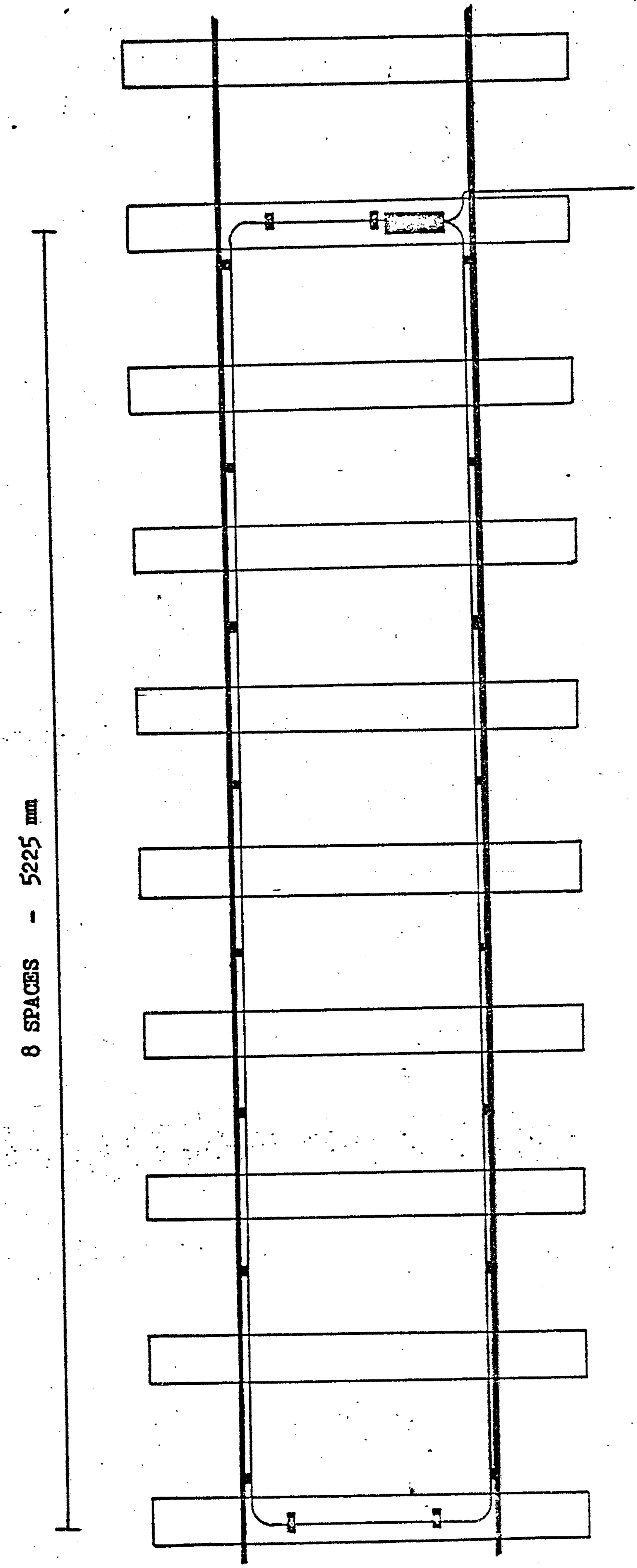
<u>LAYOUT OF JOINTLESS RECEIVERS WITH RESONANT/RESISTIVE SHUNTS RACK MOUNTED</u>

fig.26



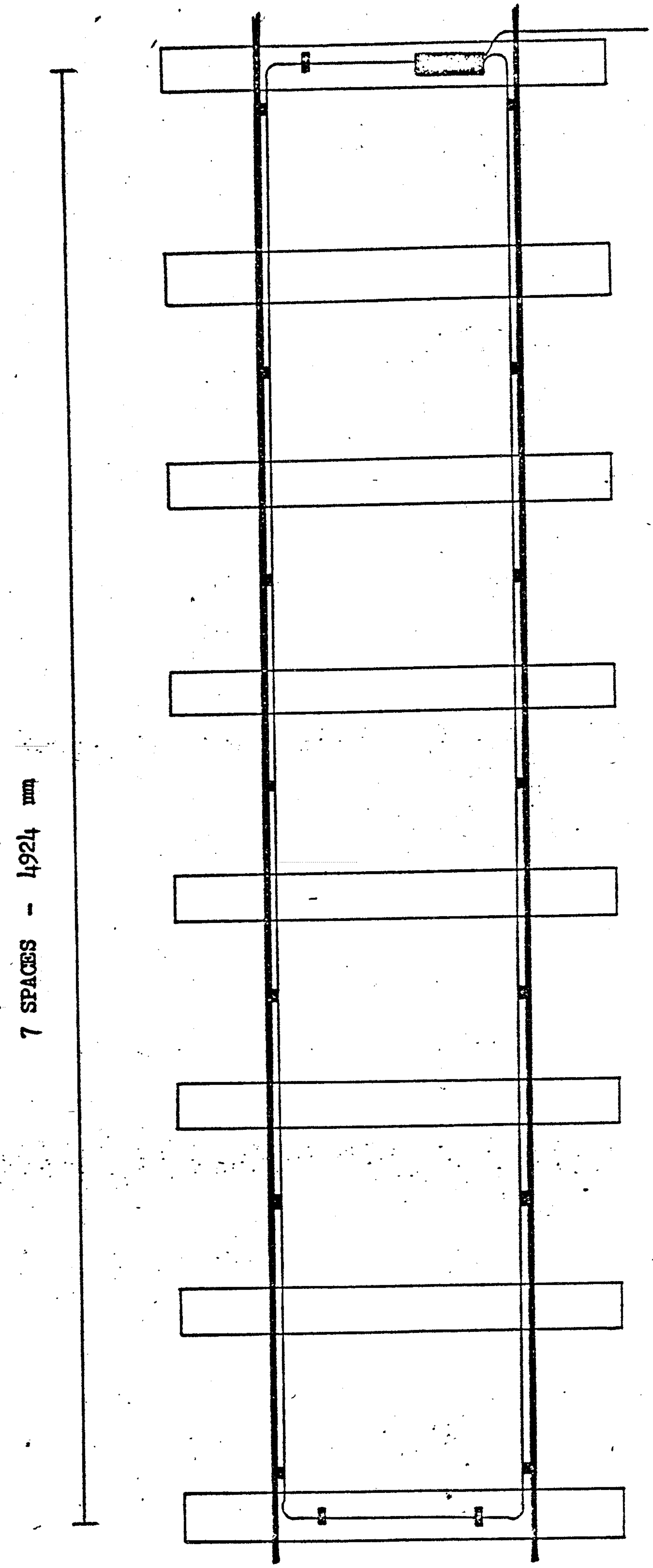
30 SLEEPERS PER 60 FOOT SPACING

fig. 27



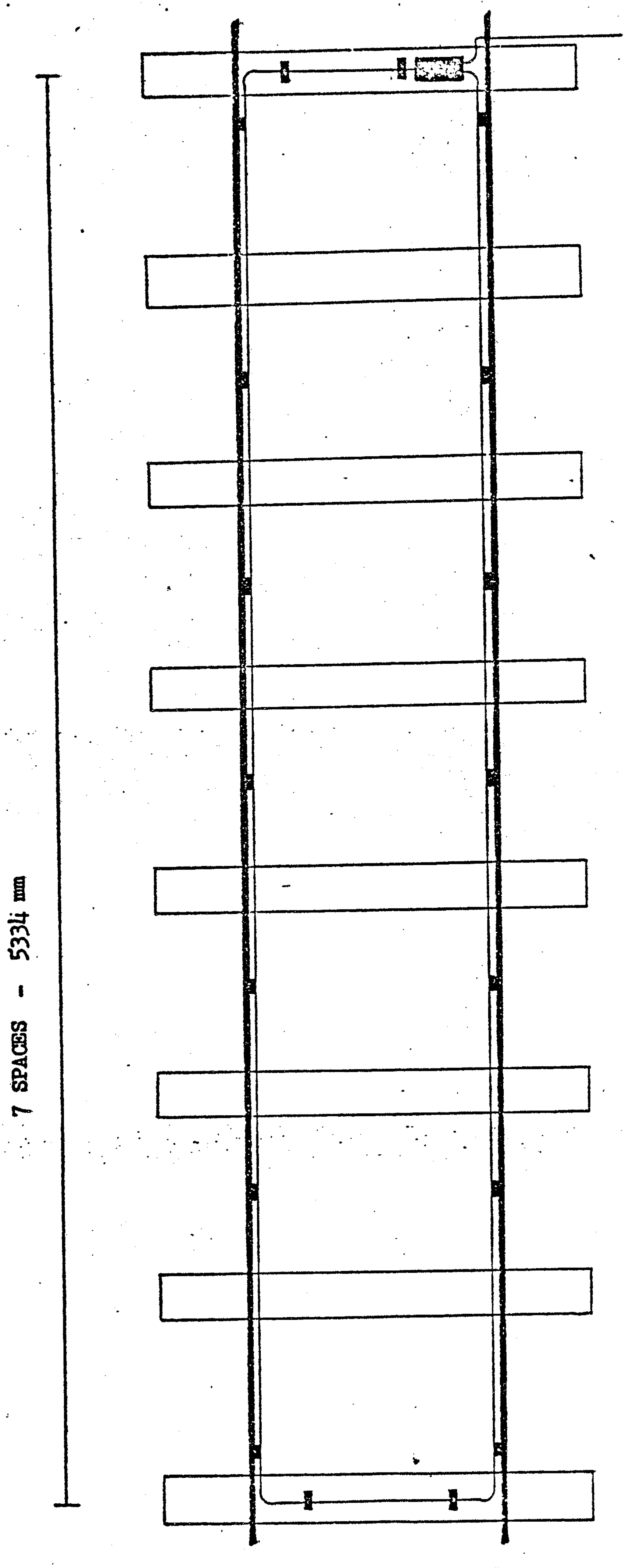
28 SLEEPERS PER 60 FOOT SPACING

fig. 28



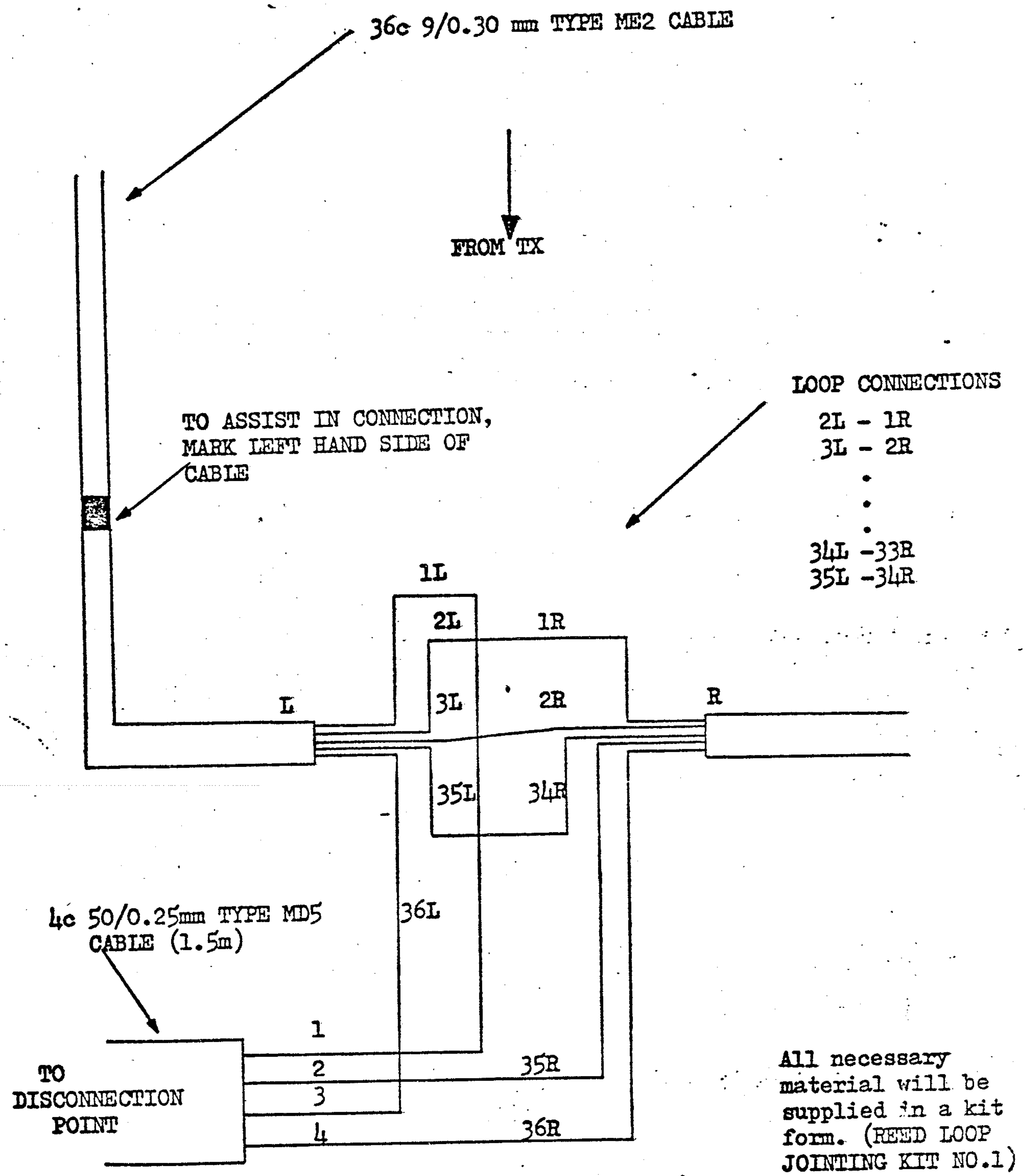
26 SLEEPERS PER 60 FOOT SPACING

fig. 29



24 SLEEPERS PER 60 FOOT SPACING

fig. 30

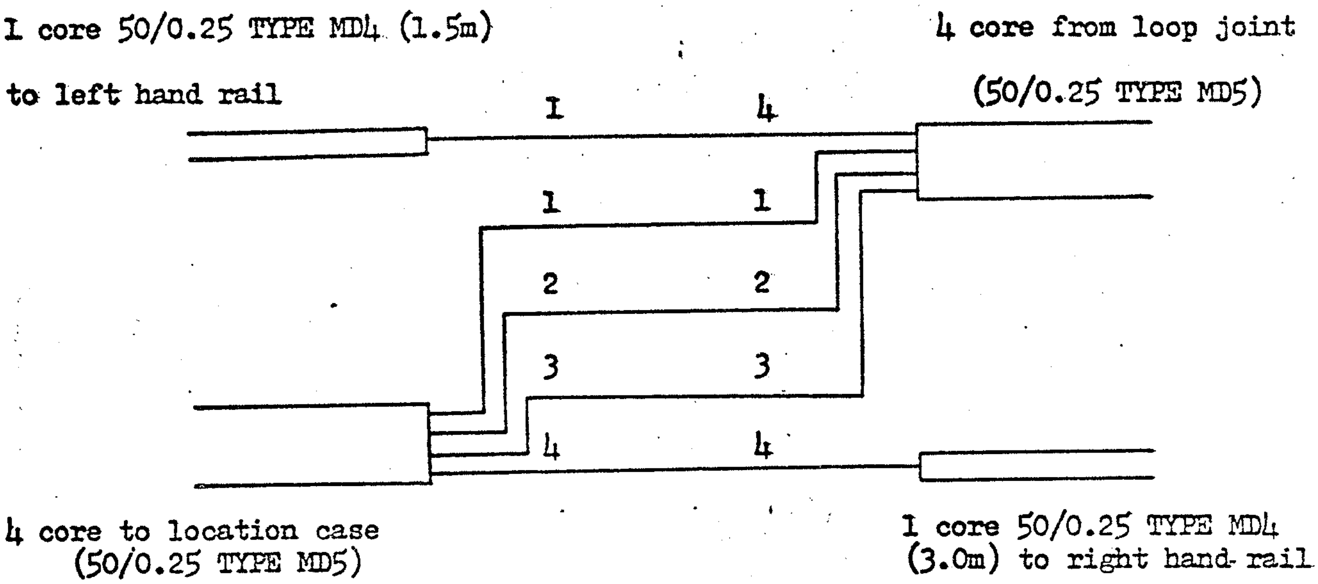


4 Core Terminations

CORE 1	-	36 core 1L
CORE 2	-	36 core 35R
CORE 3	-	36 core 36L
CORE 4	-	36 core 36R

JOINT NO.1 WIRING DIAGRAM

fig. 31



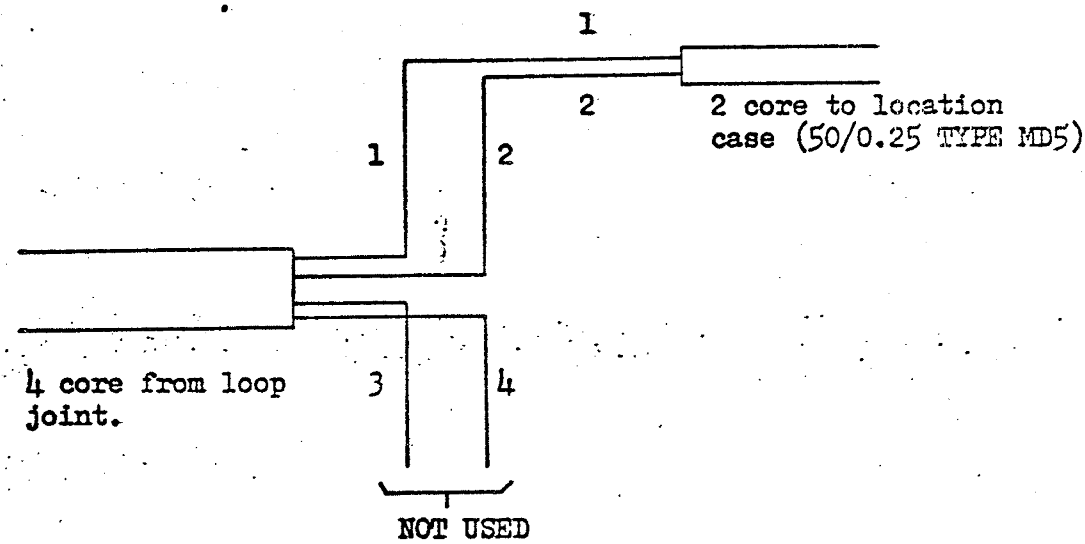
All jointing material supplied in kit form (REED LOOP JOINTING KIT NO.2)

LOCATION TERMINATIONS

CORES 1 & 2 TERMINATE ON RECEIVER
CORES 3 & 4 TERMINATE ON RESONANT SHUNT

JOINT NO.2 WIRING DIAGRAM(WITH SHUNT)

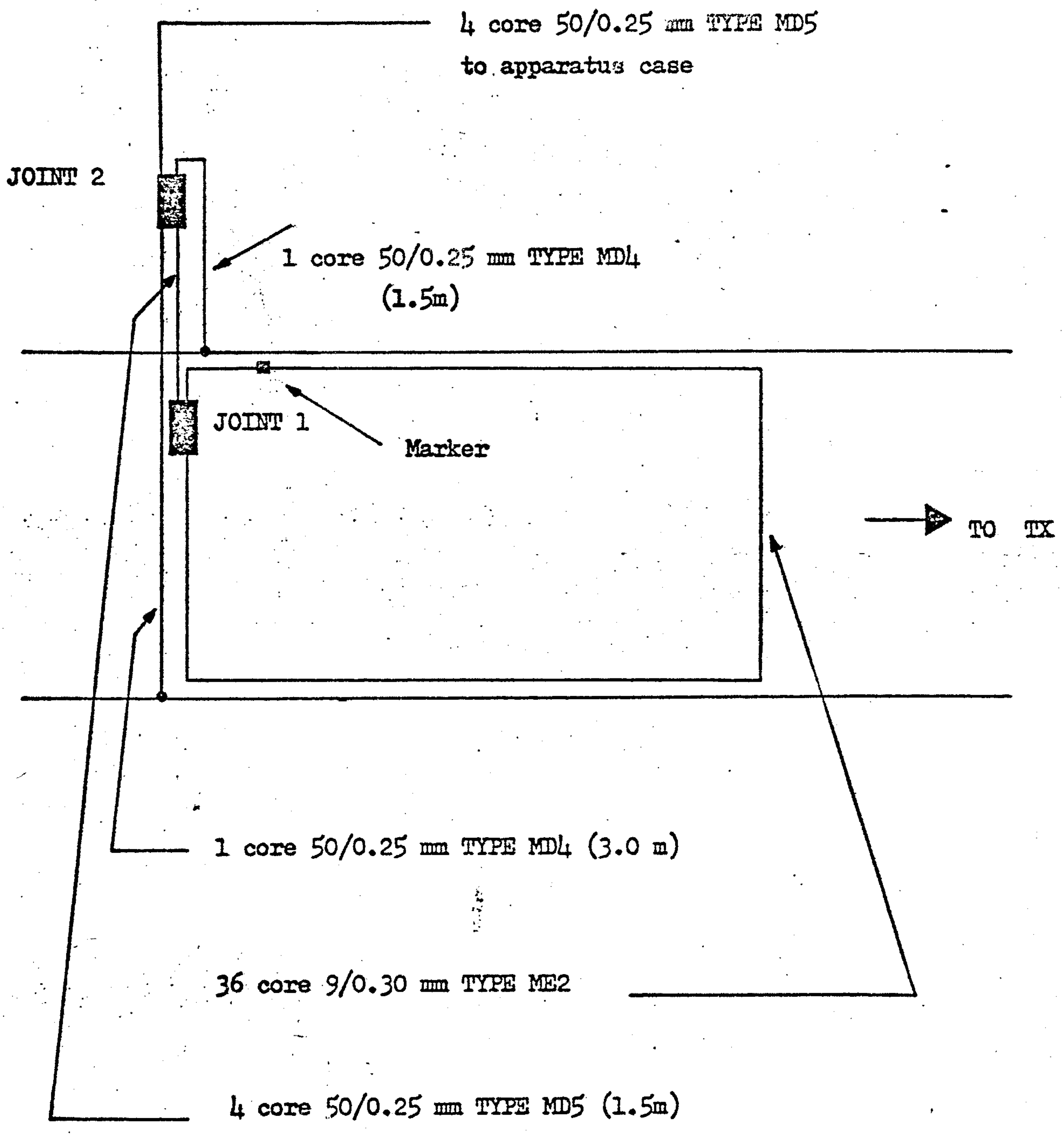
fig.32



Using a 4 core cable from the loop joint means that a simple loop can be converted to a compound loop without altering the loop jointing.

JOINT NO.2 WIRING DIAGRAM (WITHOUT SHUNT)

fig.33



GENERAL SCHEMATIC DIAGRAM OF JOINTLESS REED TRACK DETECTION LOOP

fig. 34