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TYPE RT REED TRACK CIRCUIT EQUIPMENT

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PRODUCT SAFETY

To ensure that the equipment described in this manual continues to meet its design specification the necessary preventive and corrective maintenance must be carried out as specified. Inadequate or lack of proper maintenance may result in a reduction of safety standards. At all times attention must be given to safety hazard warnings which are mounted upon the equipment, or, where applicable, given in this manual.

Where the maintenance is not carried out by GEC-General Signal Ltd. the maintenance instructions should be followed by the user or his designated maintaining authority. The user should ensure that all the relevant parts of his organisation are aware of the maintenance actions required.

Maintenance work should be recorded formally. This will provide a reference to the user in performing preventive maintenance routines and provide historical data for subsequent analysis should failures occur.

In order to help the user set up or strengthen his maintenance organisation GEC-General Signal Ltd. is able to offer a service to assist in formulating such an organisation and in training personnel. The Company will also advise on the type and quantity of spares that should be held.

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1.0 PRINCIPLES.

1.1 General

1.1.1. The design of all type RT track circuits is based on the use of the reed filter, which is also used in type RR remote-control equipment. It is a filter which uses a pair of mechanically tuned vibrating reeds to provide a band-pass characteristic with a narrow bandwidth and a stable centre frequency.

1.1.2. In the feed end equipment, the reed filter and oscillator amplifier form a single unit, conforming generally to the module size of British Railways' standard miniature relays, which acts as an audio-frequency tone generator. The tone frequency is determined by the reed filter, and is chosen to lie in one of two groups, between harmonic frequencies of the mains supply. Sets of frequencies are provided for applications in 50Hz and 60Hz areas. For details of frequencies used, see section 5.

1.1.3. The tone is fed to the track via a power amplifier and a track filter. The latter unit eliminates harmonics and also protects the feed equipment from electric traction interference. The feed equipment takes its power supply via a constant-voltage transformer from a mains supply at 110V, 50 or 60Hz (other supply arrangements can be provided if required).

1.1.4. A high-power version of the feed end equipment is also available. This uses equipment in the same configuration, but has a larger power amplifier and track filter in order to feed a higher current to the rails. A large constant-voltage transformer supplies one feed end only.

1.1.5 At the receiver end, the reed filter is used again, to ensure that the receiver responds only to a tone of the correct frequency. The narrow bandwidth of the reed filter makes the close spacing of the tone frequencies possible. The reed filter and receiver amplifier again form a composite unit of standard module size, which drives a standard Reed follower relay of type ZS2411. This is a British Railways' standard miniature relay having a special coil to suit the receiver output. The relay is identical to that used in the type RR remote-control equipment, and has six front and three back contacts; in track circuit equipment it is normally used in conjunction with a separate slow pick-up track repeater relay. The receiver is powered from 110V mains, 50 or 60Hz, via a constant-voltage Reed power supply unit (again, other supply arrangements can be provided if required).

1.1.6 All the equipment is designed to be fitted in relay rooms or location cases, on mounting bars or frames suitable for British Railways' standard miniature relays. It is fully protected against the hazards of tropical environments, and is suitable for an ambient temperature range of -20 to 70 deg.C.

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1.2 Single and double-rail jointed track circuits.

1.2.1. Type RT equipment can be used for single and double-rail track circuits with insulating block joints, centre or end fed. At the receiver end, the connection from the rails is via a second track filter, identical to that in the equipment at the feed end, which protects the receiver against interference from electric traction.

1.2.2. The standard feed equipment may be used for single-rail track circuits up to 1000m in length.
It may also be used for single or double-rail track circuits up to 1200m (end fed) or 2000m (centre-fed).

1.2.3. The high-power feed equipment may also be used for track circuits with joints. The higher power is used to overcome low ballast resistance, and this arrangement has found particular application in long tunnels. Standard receiver equipment is used with the addition of an attenuator unit (see 3.1.1.). Double-rail high-power track circuits may be up to 2km long (end-fed) or 3 km long (centre-fed).

1.2.4. Resonated impedance bonds are available for use with these track circuits in their double-rail versions. Type DF2001 is a high-current bond for use on d.c. electrified lines, and also on a.c. lines with exceptionally high traction current levels. Type DG1001 is a smaller bond, mainly for other a.c. electrified lines.

1.3 Reed Jointless track circuit.

1.3.1. The Reed jointless track circuit is a centre-fed track circuit using receiver loops placed between the rails to define the ends of the section. There is an immune version for all a.c. and d.c. electrified lines as well as a non-immune version for non-electrified lines. The standard feed equipment is used. At each receiver end, the track circuit energy is detected by means of a rectangular pick-up loop formed from multicore cable which is laid between the rails, on the sleepers and in the webs of the rails. All but one of the cores in the cable are connected in series to form a multi-turn coil, and the remaining core is connected between the rails via the reactive shunt. The voltage induced in the multi-turn coil feeds the Reed receiver via an attenuator/filter, which provides for adjustment of the overall sensitivity.

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1.3.2. In its standard form the Reed jointless track circuit can be set to give a drop shunt of 0.5 ohm at any value of ballast resistance between 2 Ωkm and infinity. Each receiver must be between 300m and 1500m from its feed and the ratio of the lengths of the two halves must not exceed 1·2:1.

The signalling must be arranged so that vehicles occupying adjacent track circuit block sections may not approach one another closer than 300m; otherwise a low value of train shunt may result. This may be achieved by overlapping the receiver loops by this distance or by controls.

1.3.3. The non-immune version of the jointless track circuit equipment is simplified by replacement of the track filter at the feed by a resistor and by the use of the resistive shunt rather than the reactive shunt in the loop circuit at the receiver. Details are given in sections 2 and 3.

1.3.4. For a.c. electrified lines with exceptionally high traction current level (greater than 1000A), a high-power version of the immune jointless track circuit is available, using the high-power feed end equipment. The receiver end equipment is standard, except that the number of turns in the loop is reduced. By this means, the signal-to-noise ratio is maintained in the presence of very high levels of interference, and the performance of the track circuit is unchanged.

1.4 The remainder of this manual describes the various features of the type RT system in detail, as follows; section 2 describes the standard and high-power versions of the feed end equipment, and section 3 the jointed and jointless receiver and equipment, with technical details and installation instructions in each case. Section 4 gives fault-finding procedures, and section 5 gives a brief description of all the units available in the type RT system.

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2.0. THE FEED END EQUIPMENT.

2.1 The standard feed equipment.

2.1.1. A diagram of the standard feed arrangement is shown in figure 2. The following equipment is required:-

constant-voltage transformer, type NT1202 (50Hz) or NT1212 (60Hz);
transmitter reed filter, RT5XX0 series;
oscillator amplifier type RT5001;
power amplifier type RT7112 track filter (see below) or feed resistor type PA0111;
surge diverter, AEI type 16A, with base; 26A
surge protection unit type RT7501 (optional).

2.1.2. The equipment is supplied from 110V mains via the constant-voltage transformer, which may be used to supply up to four sets of equipment provided they are all of different frequencies. It draws 40VA when supplying one set of equipment, plus 20VA for each additional set. It provides a stabilised a.c. output at 15V rms for the power amplifier. The latter unit contains a rectifier and provides a d.c. supply at 15V for the reed transmitter in addition to its own supply. The reed transmitter (see 1.1.2) generates a tone at the required frequency, and drives the power amplifier.

2.1.3. The RT7112 power amplifier has a square wave output which is fed to the track via the track filter, a series tuned L-C filter. This removes unwanted harmonics from the track circuit current so that the waveform of the current to the rails is sinusoidal, as well as protecting the equipment from the effects of traction currents in the rails. The type reference of the track filter used depends upon the frequency in use, as shown in section 5.4.2.

2.1.4. For non-electrified lines the feed resistor type PA0112 is used in place of the track filter. This provides a standard resistance of 7.2 ohm, and a reduced resistance of 3.6 ohm for poor track conditions. When the feed resistor is used, the track circuit current has a square waveform.

2.1.5. Surge protection unit type RT7501 contains a pair of surge suppressor diodes, and may be connected in parallel with the output of the power amplifier to give additional protection against lightning in regions where there are frequent electric storms, as a back-up for the gas-discharge surge diverter type ~~16A~~. 26A

2.1.6. The RT7112 p ower amplifier supersedes both RT7101 and RT7111.

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2.2. The high-power feed equipment.

2.2.1. The high-power feed equipment has the same configuration as the standard type. A block diagram is shown in figure 3. The following items are required;

power supply unit, type NT1302 (50 Hz) of RT9201 (60 Hz);

power amplifier type RT7131;

{transmitter reed filter, RT 5XXO series;

{Oscillator amplifier type RT5001;

track filter (see below);

surge diverter, AEI type 16A, with base.

2.2.2. A single set of equipment only is supplied from 110V mains by the power supply unit, which draws 200VA, and provides both 15V d.c. for the reed transmitter and 24V d.c. for the power amplifier. The reed transmitter (see 1.1.2) generates a tone at the required frequency, and drives the power amplifier: the output from the power amplifier is fed to the track via the track filter, which is similar to that used in the standard feed equipment, but bigger in order to handle the higher track feed current. The type reference of the track filter depends upon the frequencies in use, as shown in section 5.

2.2.3. The maximum track feed current is of the order of 5A. Track fuses rated at less than 10A should not therefore be used with this type of feed.

2.2.4 Full lightning protection is built into the power amplifier type RT7131 as a standard feature, and no additional equipment is required other than the gas-discharge surge diverter type 16A

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2.3 Installation instructions for feed and equipment.

2.3.1. Figures 2 and 3 give the wiring diagrams for the standard and high-power transmitters respectively and must be followed.

2.3.2. The equipment is designed for mounting in standard location cupboards or on standard relay racks in relay rooms. The layouts of units given in figures 4 and 5 must be followed.

2.3.3. The track feed cables from the track filter to the rails must have as low a resistance as possible. For track circuits longer than 600m the loop resistance, including that of the fuse and link, must be less than 1 ohm. For standard track circuits less that 600m long the resistance may be increased, up to a maximum of 2 ohm.

2.3.4. The wiring between the power amplifier, the surge diverter and the fuse links at the bottom of the location case should be carried out in twisted pairs. These connections should be kept as short as possible and should be run straight down the side of the location case from the relay mounting bars to the fuses at the bottom.

2.3.5. The feed end must be set up correctly as described in the next section.

2.4. Setting-up procedure.

2.4.1. Equipment required: multi purpose meter (SEI Selectest super 50 or equivalent, having ranges up to 10A.). If there are impedance bonds to be tuned, an a.c. voltmeter having 1V and 10V ranges is also necessary.

2.4.2. Before units are plugged in, the equipment layout and wiring should be checked carefully, particular attention being paid to the magnitudes and polarities of supply voltages. Time spent in this checking can avoid damage to the electronic units.

2.4.3. a. Check that **one** flying lead on the track filter is connected to the terminal marked with the channel number in use, **and the other to terminal 21.**

b. Measure the mains supply voltage. It must be between 95 and 127V rms.

c. Measure the output voltage from the power supply, using the multi-purpose meter on 25 volt range. On types NT 1202 and NT1212, the output voltage must lie between 15.0 and 17.0V a.c. On types NT1302 and RT 9201 there are two d.c. outputs; they must be between 15.0 and 17.0V (terminals 5 (positive) and 6), and between 23.0 and 26.0V (terminals 3(positive) and 4) respectively.

d. Measure the supply voltage appearing on the plugboard for the oscillator amplifier type RT 5001. It should lie between 15.0 and 17.0V d.c., between terminals A1 (positive) and A2 (negative).

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e. Check that the track filter is set to terminal 21 (or feed resistor set to terminals 1 and 3). Remove the track link and connect the meter, on 2.5A or 10A range, in its place. Connect a short circuit between the rails at the feed point, and note the meter reading, which should be within the following limits.

Amplifier type	Meter range	Current
RT7101 or 7112 Terminals 10/12	2.5A	1.2 to 1.5A
RT7111 or 7112 Terminals 11/12	2.5A	1.1 to 1.4A
RT7131	10A	5A (see below)

In high-power feed equipment (amplifier type RT7131) the amplifier output tapping (terminals 2 to 5) should be adjusted to give a meter reading as close to 5A as possible. Finally, remove the short circuit.

f. In the case of a long standard power track circuit with low ballast, when setting up the receiver end (3.1.3.3.d or 3.2.3.4.e) it may be found that insufficient energisation can be obtained. In this case it will be necessary to move the flying lead from terminal 21 of the track filter to 22 or 23, or if a feed resistor is fitted, from terminal 3 to 2.

Note: if the feed equipment is energised, a high back emf may appear momentarily when the link is disconnected.

g. If there are impedance bonds in the track circuit, they should be tuned at this stage, as follows. Remove all connections from the centre tap of the bond. Connect the multimeter on a.c. amps range in series with the track winding, and the voltmeter between the ends of the track winding. Adjust the tuning capacitor so as to obtain the maximum value of the ratio volts; amps, which is the effective impedance of the bond. (A calculator or slide rule will be useful for this). Note that the maximum impedance is not obtained when the voltage is at a maximum.

h. In high-power feed equipment (with power amplifier type RT 7131) only, it may now be found that an increase in feed current, as measured with the meter connected in place of the track link, can be obtained by moving the track filter flying lead to an adjacent tap. The flying lead should therefore be set for maximum current (after the tuning of impedance bonds, if any).

j. The setting up of the feed end is now complete.

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3.0 THE RECEIVER END EQUIPMENT.

3.1 RECEIVER EQUIPMENT FOR USE AT JOINTS.

3.1.1. Description.

3.1.1.1. A diagram of the receiver equipment for use where there are insulated block joints is shown in figure 6. The following equipment is required;-

Power supply unit, type RR9121 (50Hz) or RR9181 (60Hz)
reed filter, RT6XX0 series,
receiver amplifier type RR2002;
track filter (see below);
reed follower relay type ZS2411;
surge diverter, AEI type 16A with base;
attenuator type RT7312 (with high-power feed only).

3.1.1.2. The equipment is supplied from 110V a.c. mains via the power supply unit, which draws 25VA. One power supply unit may feed two sets of receiver end equipment provided they are not of the same frequency (in this case, the leads to the second receiver must be less than 3m long). The connections from the rails go to the track filter, which is identical to that used in the standard feed equipment but connected so as to act as a band-pass filter. The track filter passes the frequency of operation of the track circuit but rejects the traction supply frequency, and thus prevents the input circuit of the reed receiver being damaged by high voltages at the traction supply frequency. The output of the track filter drives the reed receiver (see 1.1.5), which in turn drives the relay. When the feed equipment is of the high-power type, an attenuator type RT7312 is required between the track filter and the reed receiver so as to allow for a wider range of adjustment. Otherwise, the track filter output is taken directly to the Reed receiver input.

3.1.1.3. The type reference of the track filter required depends upon the track-circuit frequency in use, as shown in section 5.4.2. below.

3.1.1.4. This form of receiver end equipment is used in all track circuits with joints. It is also used in jointless track circuits at the ends of sections having continuously welded rails, in the case where the last track circuit in the section has a receiver end at the block joint.

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3.1.1.5. The reed follower relay is a standard BRB miniature relay to BR930. The contact arrangement is shown in figure 9. The relay has six front and three back contacts, being identical to that used for Reed remote-control equipment, but a slow-pick-up track repeater relay should always be provided in normal applications. (If the track relay is repeated by a vital Reed FDM channel, this provides an adequately slow pick-up, and in this case the separate TPR may be dispensed with).

3.1.2 Installation instructions for receiver at joint

3.1.2.1. Figure 6 gives the wiring diagram and must be followed.

3.1.2.2. The equipment is designed for mounting in standard location cupboards and on standard relay racks in relay rooms. The layout of equipment given in figure 7 must be followed.

3.1.2.3. The cables from the track to the receiver equipment must have as low a resistance as possible. For all track circuits longer than 600m the loop resistance, including that of the fuse and link, must be less than 1 ohm. For standard track circuits less than 600m long the resistance may be increased up to a maximum of 2 ohm.

3.1.2.4. The wiring between the track filter and the track fuses should be carried out in twisted pairs. These connections should be kept as short as possible, and should run straight down the side of the location case to the fuses at the bottom.

3.1.2.5. The equipment must be set up correctly as described in the next section.

3.1.3 Setting-up procedure

3.1.3.1. Equipment required:

multi-purpose meter (SEI Selectest super 50 or equivalent);
transistor voltmeter;
shunt box.

3.1.3.2. Before units are plugged in, the equipment layout and wiring should be checked carefully particular attention being paid to the magnitudes and polarities of supply voltages. Time spent in this checking can avoid damage to the electronic units.

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

b. Measure the mains supply voltage. It must be between 93 and 127 volts.

c. Measure the output voltage from the power supply unit (RR9121 or RR9181). It should lie between 12.0 and 13.8 volts when measured between terminals D2 (positive) and A3 (negative) on the receiver amplifier plugboard.

d. Measure the a.c. output voltage between terminals 11 and 12 of the track filter; this should be between 150 and 400 mV when measured with the transistor voltmeter. If the level is greater than 400 mV, adjust the input lead so as to connect to either terminal 22 or 21, instead of 23. By this means it should be possible to reduce the output below 400 mV.

If the level is less than 150 mV with the input lead connected to 23, it will be necessary to increase the feed end track filter tapping to 22 or 23 as necessary, or feed resistor tapping from 3 to 2 (see 2.4.3.f).

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5.1.3.3. e. If an attenuator type RT 7312 is fitted, it should now be adjusted as follows. Remove the receiver amplifier type RR 2002 and replace it with a dummy amplifier type XV1020. Measure the voltage between the dummy amplifier terminals (i.e. the reed filter output voltage).
Adjust the attenuation to make this voltage as close to 75 mV as possible. The attenuation is adjusted by selecting both primary and secondary taps on the transformer in the RT 7312. Finally, replace the receiver amplifier RR 2002.

f. Measure the voltage across the Reed follower relay type ZS 2411 between terminals R1 and R2 of the plugboard; this should be between 11.5 and 18.0 volts when measured with the multi-purpose meter on the 25V d.c. range.

g. Measure the drop shunt at any point within the track circuit. It should be greater than 0.5 ohm.

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3.2 JOINTLESS RECEIVER EQUIPMENT.

3.2.1. Description.

3.2.1.1. A diagram of the jointless receiver equipment is shown in figure B. The following equipment is required:-

power supply unit, type RR9121 (50Hz) or RR9181 (60Hz);
(reed filter, RT6XX0 series.
(receiver amplifier type RR2002;
attenuator/filter type RT7302;
reed follower relay type ZS2411;
reactive shunt, or resistive shunt
type RT7412;
surge diverter, AEI type 16A with base.

3.2.1.2. The track circuit signal in the rails is detected by means of a loop formed of multicore cable, laid across the sleepers and in the web of the rail. The standard compound loop incorporates a connection between the rails, which is taken via the reasonant or resistive shunt. The compound loop is directional; it must be aligned correctly with respect to the transmitter which is feeding it, with the joint at the end of the loop remote from the transmitter (see fig. 8).

3.2.1.3. Two pairs of wires are required between the loop and the location cupboard or relay room housing the equipment. One pair forms the shunt circuit connected to the rails, and must have a loop resistance of less than 1 ohm. The other brings the output from the multi-turn coil to the equipment; this is a high-impedance circuit, and may have a loop impedance of up to 20 ohm.

3.2.1.4. The output from the multi-turn loop is passed to the Reed receiver via the attenuator/filter, which provides a mean of adjusting the sensitivity of the receiver to obtain the desired value of train shunt, and also protects the reed filter from damage due to high interference voltages. The reed receiver (see 1.1.5) drives the reed follower relay, which is a standard BRB miniature relay to BR930. The contact arrangement is shown in figure 9. The relay has six front and three back contacts, being identical to that used for Reed remote-control equipment, but a slow-pick-up track repeater relay should always be provided in normal applications. In the standard centre-fed arrangement, a single TPR is energised over contacts of the track relays of the two receivers. (If the track relay is repeated by a vital Reed FDM channel, this provides an adequately slow pick-up, and in this case the separate TPR may be dispensed with).

3.2.1.5. The last jointless track circuit in a section has insulated block joint(s) at one end. In this case, the transmitter may be connected to the rails near the joint(s), so that the track circuit is single-ended, with only one receiver. There is no limitation on the minimum length in this case.

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If a long track circuit is required it must be centre-fed, as in the standard arrangement, so that it then has a receiver at the block joint(s). This receiver should be of the jointed form, as in section 3.1

3.2.1.6. When the standard feed equipment is used, the loops should normally be formed of 3 -core cable.

When the high-power feed equipment is used, the loops should normally be formed of 12-core cable, with taps at 7 and 9 turns if required.

Cables used for loops must not be screened. If local standards do not include the sizes called for above, the nearest larger size should be employed. Only the number of cores called for above should be used, and the innermost cores should be left unused.

For further details of the loops, see the Appendix. Track-plan symbols for the loops are shown in figure 13.

3.2.1.7. An additional receiver may be provided within a track circuit when an additional indication such as the strike-in point for a level crossing or approach control of a signal is required. The loop for such a receiver may be placed anywhere within the track circuit, and should normally be of the simple type; that is, it should consist only of the multi-turn coil, and should have no rail connections or resonant or reactive shunt. A typical example is shown in figure 11.

3.2.1.8. The jointless track circuit may be used as an overlay on d.c. and other track circuits. Compound loops should be used with reactive shunts even on non-electrified lines, because the 2.2 ohm of the resistive shunt, being connected between the rails, would tend to drop the berth track circuit. It may be necessary to take steps to prevent the feed and relay end equipment loading the overlay reed track circuit; on d.c. track circuits this is done by connecting the special inductor, type RT7601 to RT7611, in series with the track connections. In very long d.c. tracks, the special inductor is not required in any connections more than 2km away from the reed track circuit. A typical arrangement is shown in figure 12.

3.2.1.9. The resistive shunt provides a resistance of approximately 2.2 ohm in the shunt circuit of the compound loop, and is used in track circuit on non-electrified lines. On electrified lines the reactive shunt is used in its place; this is a tuned device providing the same impedance at the operating frequency, but presenting a high impedance to a.c. and d.c. traction current. For the type reference of the reactive shunt, see section 5.9.

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3.2.2. Installation instructions for jointless receiver.

3.2.2.1. Figure 8 shows the wiring diagram for a jointless receiver, and must be followed. The diagram shows the connections for a standard compound loop feeding one receiver. The wiring from the reactive or resistive shunt to the track fuses, and from the attenuator/filter to the track fuses, should be run in twisted pairs. Note that the reactive or resistive shunt circuit has a 4A fuse, whereas the circuit from the loop to the attenuator/filter has a 2A fuse (because it is not connected directly to the rails). The leads from the reactive or resistive shunt to the track fuses should be run directly down the side of the location case if the shunt is mounted on the relay mounting bars.

3.2.2.2. The equipment is designed for mounting in standard location cases or on relay racks in relay rooms. The layout of the equipment must be as shown in figures 14 and 15.

3.2.2.3. The receiver loop must be installed correctly, following the instructions given in the Appendix. Note that the joint in the cable forming the loop must be at the end of the loop remote from the transmitter which feeds it. Also, the cross-connection between the rails must be run so that it crosses over itself, so that the voltages induced by the currents in the rails and in the cross-connection augment each other, rather than bucking each other off, as shown in figures 16.

3.2.2.4. Positioning the loop; on jointless track there are no joints to indicate the positions of feed ends and receiver loops, and their positions must therefore be measured. Correct positioning of the loops in particular is essential, because this determines the effective end of the track circuit. On track plans, loops are indicated by flag-shaped symbols (see figure 13). On the plan, the dimension is to the tail of the symbol. On the ground, the loop must be positioned with its centre at the measured point. The compound loop must be laid so that the cable joint is at the end indicated by the tail of the symbol. The position of the feed connections to the rails is shown on the plan by an arrow (see figure 13).

3.2.2.5. The track circuit must be set up correctly, as described in the next section.

3.2.3. Setting-up procedure for jointless receiver

3.2.3.1. Equipment required:

multi-purpose meter; (SEI Selectest Super 50 or equivalent);
transistor voltmeter;
shunt box.

3.2.3.2. Before units are plugged in, the layout and wiring should be checked carefully, particular attention being paid to the magnitude and polarity of supply voltages. Time spent in this way may avoid damage to the electronic units. Measurements should only be attempted when there are no trains within 1km of the receiver end.

3.2.3.3. In the standard arrangement of jointless track circuits, adjacent track circuits each have a separate compound receiver loop, arranged so that the track circuits overlap. Two signals of different frequencies are present in the rails in the vicinity of the pair of loops, and traction interference may also be present. Hence it is not normally possible to take accurate meter readings between the rails at the relay end, or at the output of the loop. Accurate readings must therefore be taken at the output of the reed filter, using the Dummy Amplifier type XV 1020. An electronic voltmeter having ranges down to 100mV full-scale is necessary for this purpose (see below).

3.2.3.4. a) If the equipment includes a reactive shunt, make sure that the flying lead is connected to the terminal appropriate for the channel in use.

b) Measure the mains supply voltage. It must lie between 93 and 127V.

c) Measure the output voltage from the power supply unit (RR9121 or RR9181). It should lie between 12.0 and 13.8V d.c. when measured between terminals D2 (positive) and A3 (negative) on the receiver amplifier plugboard.

d) Remove all track and shunt fuses. Using the multimeter on ohms range, measure the resistance looking into each pair of track tails, to check that the loop and shunt connections have not been interchanged. The loop will give a reading typically of the order of 15 ohm, whereas the shunt circuit will give a reading of less than 1 ohm.

e) Replace the receiver amplifier type RR 2002 with a dummy amplifier type XV1020, and measure the voltage appearing between the two terminals on the front of the dummy amplifier with an electronic voltmeter. Adjust the attenuation on the attenuator/filter unit type RT 7302 until this voltage is approximately 75mV; this is done by moving the two flying leads on the RT 7302 to select two series resistors. Start with both leads at the bottom of the terminal block, and move first one up to obtain an approximate setting, and then the second for a finer adjustment.

If the level is less than 75mV with the minimum resistance in circuit it will be necessary to increase the feed end track filter tapping to 22 or 23, or feed resistor tapping from 3 to 2 (see 2.4.3.f).

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f) Withdraw a fuse from the shunt circuit. The meter reading should now decrease. If it increases, the polarity of the loop is wrong. (An incorrect loop will normally give a low output voltage as well. The maximum voltage available from a loop of correct polarity will normally be well in excess of 75mV). Replace the fuse. (Note that the polarity of the loop can be changed by turning it over about an axis parallel to the rails, i.e. so that the joint remains at the same end).

g) Remove the Dummy Amplifier and replace the Receiver amplifier. The track relay should then energise. Measure the voltage across the Reed follower relay type ZS 2411 between terminals R1 and R2; it should be between 11.5 and 18.0 volts when measured with the multimeter on 25V d.c. range. Measure the drop shunt; a value greater than 0.5 ohm should be obtained. Do not attempt to take a drop shunt over the loop. It should be taken at a point on the feed side of the loop (for example, between the track connections of the other loop).

h) After both relay ends have been set up in this way, apply a short-circuit, such as the shunt box set to zero, between the rails at each of the three positions XX, YY and ZZ in turn (XX and ZZ are any points outside the pair of loops, and YY is a point between them). Check that the sequence of operation is correct, as follows:

shunt at	'A' track relay	'B' track relay
XX	down	up
YY	down	down
ZZ	up	down

This test checks that each loop is connected to the correct relay end. If both relays are dropped in all three positions, repeat tests (d) and (f).

3.2.3.5 A simple loop may feed either one or two relay ends. It has no shunt connection. Set up the relay end(s) as in (a) to (e) and (g) above. If there are two relay ends, the position of the feed determines on which side of the loop each relay end will shunt.

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4.0 FAULT FINDING PROCEDURES.

4.1 The equipment is designed for maintenance on a unit replacement basis, faulty units being replaced in the field and returned to the workshops or manufacturers for repair. It is therefore only necessary to decide which unit is faulty and to replace it.

4.2.0 Important notes on fault-finding.

4.2.1 It is very important that any fault causing a low output from the transmitter is not corrected for by re-setting the track circuit.

4.2.2. When changing a Reed filter it is important to ensure that the replacement is of the correct channel number. (A filter of the wrong channel cannot be inserted into the plugboard because of the registration pins).

4.2.3. If a track filter or reactive shunt is changed, it must be set to the correct frequency. Care must be taken, as it is possible that a high voltage may be present across the inductor or capacitor inside the unit. A charge may be retained on the capacitor after the unit has been disconnected, and should be discharged by connecting a multimeter on 300V d.c. range across its output. It must not be discharged with a short-circuit.

4.2.4. Attention must be given to the security and cleanliness of all connections.

4.2.5. It is necessary to set up the track circuit again as described above if any unit has been changed in rectifying the fault.

4.2.6. In each case after the fault has been cleared the drop shunt of the track circuit should be checked. It should be greater than 0.5 ohm.

4.2.7 It is not possible to measure signal levels between the running rails in electrified areas as the traction supply causes interference.

4.2.8. Equipment required :

multimeter (SEI Selectest super 50 or equivalent).
electronic voltmeter with 100 and 1000mV a.c. ranges;
dummy amplifier type XV 1020 (jointless receiver end only);
shunt box.

4.3.0 Standard feed end.

4.3.1 Figure 2 shows the standard feed equipment.

4.3.2 Remove the track link, and connect a multimeter on 2.5 or 10A a.c. range between the equipment terminals, to measure the short-circuited current. The correct value depends upon the amplifier as follows :

Track filter terml.	Min. current for RT 7101 or RT 7112 terml.10/12	RT 7111 or RT 7112 terml. 11/12.
21	1.2A	1.0A
22	1.5A	1.3A
23	1.8A	1.5A
or feed resistor termls.		
1/3	1.5A	1.2A
1/2	2.0A	2.0A

If it is correct, the feed end equipment may be assumed to be operating normally. If there are impedance bonds within the track circuit under investigation, the tuning of each one should be checked (see 2.4.3f). The receiver end(s) should then be investigated.

If the short-circuit current is not correct, continue as follows.

4.3.3. With the track link removed, measure the a.c. output voltage of the power amplifier RT 7101 or RT 7111 (terminals 11 and 12).* It should be about 17V (RT 7101) or 13V (RT 7111) measured with a multimeter.

If it is correct, change the track filter. (Ensure that the flying lead in the new track filter is set to the same tap as that on the one replaced).

If wrong, continue as follows :

4.3.4 Measure the a.c. output voltage from the oscillator amplifier RT 5001 (plugboard terminals D1 and D3). It should be about 3V.

If it is correct, change the power amplifier.

If wrong continue as follows :-

* Terminals 11 and 12 with RT 7112
(Con. BN/Ken Howe (GEC) 14/8/84.
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4.3.5 Measure the d.c. supply voltage to the oscillator amplifier between A1 (positive) and A2; it should lie between 15.0 and 17.0V.

If correct, change the oscillator amplifier RT 5001 and/or the reed filter.

If wrong continue as follows :

4.3.6 Measure the voltage of the a.c. output from the constant-voltage transformer. It should lie between 15.0 and 17.0V rms.

If it is correct, change the power amplifier.

If it is wrong, remove the plug-coupler from the power amplifier and repeat the test. If it is still wrong, check the mains supply voltage, which should lie between 93 and 127V. If the mains voltage is between these limits, change the constant-voltage transformer, NT 1202 or NT 1212.

Note : A short circuit fault in a power amplifier can cause the output voltage of the constant-voltage transformer to be reduced to a low value. Where several power amplifiers are fed by one constant-voltage transformer, it may be necessary to find the faulty amplifier by disconnecting them one at a time.

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4.4.0. High-power feed end

4.4.1. Figure 3 shows the high-power feed equipment.

4.4.2. Remove the track link, and connect a multimeter on 10A a.c. range between the equipment terminals so as to measure the short-circuit current. Make a note of the number (2, 3, 4 or 5) of the terminal on the RT 7151 to which the output flying lead is connected; if it is 3, 4 or 5, move the lead to terminal 2. The meter reading should now be at least 4.5A.

If it is correct, the feed end equipment may be assumed to be operating normally, and the flying lead should be returned to the original terminal on the RT 7151. The tuning of any impedance bonds should be checked (see 2.4.3f), and then the receiver end(s) should be investigated.

If the short-circuit current is less than 4.5A, continue as follows.

4.4.3. Measure the a.c. output voltage of the power amplifier RT 7151 (terminals 1 and 2). It should be at least 11V.

If it is correct, change the track filter. (Ensure that the flying lead on the new track filter is set to the same tap as that on the one replaced). Restore the flying lead on the RT 7151 to its original terminal.

If the amplifier output is incorrect, continue as follows.

4.4.4. Check the two d.c. supplies from the power supply unit NT 1302 or RT 9201 to the power amplifier. The voltages should be 24V between terminals 5 (positive) and 4, and 15V between terminals 5 (positive) and 6, on the power supply unit.

If both are correct, measure the a.c. output voltage from the oscillator amplifier RT 5001 (plugboard terminals D1 and D3, or 6 and 7 on the RT 7151). It should be about 5V.

If this is also correct, change the power amplifier. Set the flying lead on the amplifier to the terminal previously noted (see 4.4.2).

If it is wrong, check that the 15V d.c. supply from the NT 1302 or RT 9201 is present between plugboard terminals A1 (positive) and A2. If it is, change the oscillator amplifier RT 5001 and/or the reed filter.

4.5.0 Receiver end at joint.

4.5.1 Figure 6 shows the receiver equipment used at a block joint.

4.5.2 Check that a voltage of between 150 and 400mV a.c. is present between terminals 11 and 12 of the track filter, using an electronic voltmeter. If not, and if the track fuses and leads are in order, then either the track filter is faulty, or the fault is at the feed end. Check the track filter by replacing it with a substitute (ensure that the leads to the new track filter are connected to the correct terminals).

If the voltage is correct, continue as follows :-

4.5.3 Measure the voltage across the coil of the Reed follower relay ZS2411 (terminals R1 and R4), using a multimeter on d.c. range. It should be at least 9V d.c.

If this voltage is wrong, continue as follows :-

4.5.4 Check the d.c. supply voltage to the receiver amplifier RR2002, between plugboard terminals D2 (positive) and A3. It should be 12.5V approximately. If the upply voltage is correct, change the receiver amplifier RR2002 and/or the receiver reed filter. If this does not clear the fault, change the transmitter reed filter at the feed end of the track circuit.

If the supply voltage is incorrect, check the mains voltage, which should lie between 93 and 127V rms. If the mains voltage is correct, change the power supply unit RR9121 or RR9181.

4.6.0 Jointless receiver end.

4.6.1 Figure 8 shows the jointless receiver equipment.

4.6.2 Check that a voltage greater than 0.2V a.c. from the receiver loop in the track is present at the track terminals; if not, the loop itself must be faulty and should be checked for continuity. Note that, as measured with the multimeter, the shunt circuit in the loop appears as a short circuit approximately, whereas the multiturn coil has a significant resistance of several ohms (see also sections 3.2.3.4.)

4.6.3 Replace the receiver amplifier RR2002 with a dummy amplifier XV1020, and measure the voltage between the terminals of the XV1020 (this is the reed filter output voltage), using an electronic voltmeter. It should be greater than 42mV.

If it is not, first reduce the setting on the attenuator/filter type RT7302 to zero resistance (as in section 3.2.3.4.). If the voltage measured is still less than 42mV, short out the attenuator/filter between its terminals T1 and T2. If this has the effect of bringing the voltage up to a level greater than 42mV, replace the RT7302. If not, replace the resonant shunt, or the resistive shunt RT7411 as appropriate. If this does not bring the voltage up, replace the receiver reed filter.

If the XV1020 output voltage is greater than 42mV, continue as follows :-

4.6.4. Restore the receiver amplifier RR2002, and measure the voltage across the coil of the Reed follower relay ZS2411 (terminals R1 and R4), using a multimeter on d.c. range. It should be at least 9V d.c.

If this voltage is wrong, continue as follows.

4.6.5. Check the d.c. supply voltage to the receiver amplifier RR2002, between plugboard terminals D2 (positive) and A3. It should be 12.5V approximately.

If it is correct, change the receiver amplifier RR2002. If this does not clear the fault, change the transmitter reed filter at the feed end of the track circuit.

If the supply voltage is incorrect, check the mains voltage, which should lie between 93 and 127V rms. If the mains voltage is correct, change the power supply unit RR9121 or RR9181.

4.7.0. Drop Shunt

4.7.1. After clearing any fault, always check the drop shunt. It should be at least 0.5 ohm.

4.7.2. On jointless track circuits, check the drop shunt at a point just on the feed side of the receiver loop. On centre-fed track circuits clearing a fault in one receiver will not affect theother receiver, except on short track circuits in cases where a resonant or resistiv shunt has been changed; nevertheless, the drop shunt should be checked at both ends of centre-fed tracks.

4.7.3. At intermediate jointless receivers using simple loops, the setting operation described in section 3.2.3.4. above will be found to give a drop shunt value in the region of 2.5 ohm. This relatively high figure is a consequence of the electrical parameters of the simple loop, and does not indicate excessive sensitivity.

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5.0 DESCRIPTION OF EQUIPMENT.

5.1 This section gives a brief description of all the units available in the type RT system for jointed and jointless track circuits of the various kinds described above. Most of the units are designed to be fixed on mounting bars for standard miniature relays in location cupboards, or on relay racks in relay rooms.
Units with a suffix letter to the type reference number (e.g. RT5001A) are internally modified or updated but are functionally interchangeable with other units with a different or no suffix.

5.2. Reed transmitters.

5.2.1. The reed transmitter consists of two separate parts, an oscillator amplifier and a transmitter reed filter. They clip together to form a single unit which mounts on a BRB standard miniature relay plugboard and whose dimensions conform generally to the miniature relay module size except that the depth is 22mm greater. The combined unit acts as a feedback oscillator whose frequency is determined by the reed filter.

Oscillator amplifier type RT5001 is the upper part of the Reed transmitter. It has a red anodised cover, and is used only in Reed track circuits. It is common to all the frequencies used.

Transmitter reed filter, type RT5XXO series is the lower part of the Reed transmitter. The middle two digits of the type reference number indicate the frequency to which the filter is tuned; for example; type RT5130 is a transmitter reed filter for channel number f213 (369 Hz). The reed filter is fitted with registration code pins, which prevent a unit of the wrong frequency being plugged in. The frequency used and other details are shown in the table in 5.12 below.

5.2.2. In the standard feed equipment, the power supply to the reed transmitter must be obtained from the power amplifier (see below). In the high-power feed equipment, it must be obtained from the power supply unit, type NT 1302 or RT9201.

5.3 Power amplifiers.

Power Amplifier RT7112 is used for all standard power track circuits. It occupies a single miniature relay space and must be supplied from a constant voltage transformer type NT1202 (50Hz) or NT1212 (60Hz).

Power Amplifier type RT7131 is used in high power feed equipment. It occupies three miniature relay module speces. It must be fed from a power supply unit type NT1302 (50Hz) or RT 9201 (60Hz).

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5.4 Track Filters.

5.4.1. At the feed end, the track filter removes harmonics from the feed current and also protects the feed equipment from high voltages on the track due to traction etc. At the receiver end of track circuits with joints, the track filter is used again and acts as a filter, rejecting traction supply frequencies and passing only the Reed frequencies.

5.4.2. The type reference number of the track filter depends upon the channel in use. The type references are as shown below. The standard track filters are for use in standard feeds, and in all receivers of jointed tracks; the high-power track filters are for use in high-power feeds.

Channels:	Standard Type	High-Power Type.
f211 - f216	RT 7202	RT 7221
f217 - f221	RT 7212	(RT 7271)
A, B, C,	RT 7241	RT 7261
D to H	RT 7231	RT 7251

5.4.3. All the track filters require three miniature relay module spaces. They have tappings which must be selected according to the frequency in use, the terminals being labelled accordingly.

5.4.4. The standard track filters incorporate two resistors which are normally in series with the track connections (see figures 2 and 6), with a total resistance of 4 ohm. These resistors may be omitted in order to compensate for the resistance of long track leads by making connection to terminal 22 or 23 rather than 21.

5.5. Reed receivers.

5.5.1. Like the reed transmitter, the Reed receiver consists of two parts forming a single unit which plugs into a standard miniature plugboard.

Receiver amplifier type RR 2002 is the upper part of the Reed receiver. It has silver anodised cover, and is used only in Reed track circuits. It is common to all the frequencies used.

Receiver amplifiers type RR2002B and RR2002C are fitted with RF interference suppression components, but are otherwise interchangeable with RR2002.

Receiver reed filter of the RT6XXC series is the lower part. The middle two digits of the type reference number indicate the channel number, as in the case of the transmitter reed filters; details are given in the table in 5.12 below. The reed filter is fitted with registration code pins.

5.5.2. The power supply to the reed receiver must be obtained from a reed power supply unit type RR 9121 or RR 9181.

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5.6. Attenuators.

Attenuator/filter type RT7302 is used in jointless receivers only. It provides for adjustment of the receiver by means of series resistors, which are selected by means of two flying leads, and also incorporates a filter which stands off traction interference picked up by the loop. It requires two miniature relay module spaces.

Attenuator panel type RT7312 is used in receivers at joints in track circuits with high-power feeds. It is a transformer having sets of adjustable taps for coarse and fine adjustment of the receiver. It requires two miniature relay module spaces.

5.7 Follower relay.

Reed follower relay type ZS2411 is the track relay in all Reed track circuits. It is a standard miniature relay to BR930, fitted with a special coil to match the output from the receiver amplifier. It has a maximum pick-up voltage of 8.8V, and a minimum drop away of 5.7V. The contact arrangement is shown in figure 9. It mounts on plugboard type ZY0133.

5.8 Power Supply Units.

Constant-voltage transformers types NT1202 and NT1212 are used in the standard feed equipment with power amplifiers type RT7112. One constant-voltage transformer can feed up to four power amplifiers The power consumption from 110V a.c. mains is 40VA when supplying one power amplifier, plus 20VA for each additional power amplifier. Type NT1202 is for 50 Hz mains, and type NT1212 for 60Hz mains. Each requires five miniature relay module spaces.

Power supply units types NT1302 and RT9201 are used in the high-power feed equipment with the power amplifier type RT7131. Each set of feed equipment must have its own power supply unit. The power consumption from 110V a.c. mains is 200VA. Type NT1302 is for 50Hz mains, and type RT9201 for 60Hz mains. They are intended for backboard mounting, and measure 370 x 180 x 170mm.

Reed power supply units type RR9121 and RR9181 are used to feed the receiver equipment in all cases. Each draws 25VA from 110V a.c. mains, and requires two miniature relay module spaces. Type RR9121 is for 50Hz mains and type RR 9181 for 60Hz mains. One power supply unit may supply two sets of receiver end equipment, provided they are of different frequencies. In this case the leads to the second receiver should be less than 3m long.

5.9 Reactive and Resistive Shunts.

The reactive shunt is used in conjunction with the compound receiver loop in jointless relay ends on electrified lines (see section 3.2).

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5.9 (cont.) Types RT7701 and RT7711 are used in 50 Hz areas and cater for channels f211 to f218 and f219 to f221 respectively. They occupy three miniature relay spaces.

Types RT7431 and RT7441 are used in 60 Hz areas, and they cater for the following channels:-

RT 7431 - channels D to H;
RT 7441 - channels A,B and C.

They have tappings which must be selected according to the frequency in use, the terminals being labelled with the appropriate letters.

Resistive shunt type RT 7412 replaces the reasonant shunt on non-electrified lines. It consists of a resistor of 2.2 ohm of suitable design on a plate requiring two miniature relay module spaces.

5.10 Miscellaneous Items.

Surge protection unit type RT7501 is used in standard feed equipment to provide additional protection in regions where there are frequent electric storms. It mounts in a single miniature relay module space.

Special inductors type RT7601 and RT7611 are for use when a Reed jointless track circuit is overlaid on a d.c. track circuit (see figure 12). The d.c. resistance is 0.06 ohm nominally, and the inductance is 8mH. Type RT7611 requires two miniature relay module spaces, and type RT7601 is mounted on a plate of the GRS B2 size.

Dummy amplifier type XV1020 is used in testing and setting-up as a convenient means of measuring the output voltage from the reed filter in the receiver. It resembles the receiver amplifier type RR2002 physically, but it only contains connections to the reed filter output, which are brought to a pair of terminals on the front of the unit. For taking readings, it is attached to the reed filter in place of the RR2002, and the combined unit is put back on to its plugboard.

Dummy Amplifier type XV2002 provides a similar function to XV1020 but incorporates a digital millivoltmeter, thus avoiding the need for a separate meter.

5.11.1. Impedance Bonds for use with Reed Track Circuits.

Impedance bond type DF 2001 is a high-current bond having the following ratings:

d.c. : 1000A per rail.
50 or 60 Hz : 500A per rail

Impedance bond type DG1001 is a smaller bond, primarily for a.c. lines, with a rating at 50 or 60 Hz of 200A per rail.

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5.11.2. Resonating Capacitors for Impedance Bonds.

Capacitor type NR1251 is used for resonating either of the bonds described in 5.11. It is fitted with sliding links which enable the capacitance in circuit to be adjusted between 3.0 and 12.5 microfarads. It is intended to be mounted in a location cupboard.

When Reed track circuits are installed on lines already electrified, it may be a requirement that existing impedance bonds be retained. Non-adjustable resonating capacitors are available for use with a number of standard types of impedance bond for this purpose. They are designed to fit inside the secondary terminal-chamber of the impedance bond itself, and are of a suitably robust construction. The types available currently are shown in the following table.

Type - for use with bond type	Nominal capacitance
NR 1811 DD (SGE. Rly. Signal Co.)	180nF
NR 2201 DE (GEC-General Signal)	220nF
NR 1802 P3 (Westinghouse B. & S. Co,)	180nF
NR 1821 S (Westinghouse B. & S. Co.)	180nF

5.12. Operating Frequencies.

5.12.1. There are two standard sets of operating frequencies, one for use where the mains supply, including the supply to the traction system (if any), is at 50 Hz, and one for use where it is at 60 Hz. The two sets of frequencies must never be mixed. The frequency of operation is determined by the reed filters used in the feed and receiver equipment

5.12.2. Frequencies for 50 Hz areas are identified by a channel number; for example, f214 denotes an operating frequency of 372 Hz. The middle two digits of the type reference number for the reed filter indicate the channel numbers; for example, transmitter and receiver reed filters for f214 are types RT 5140 and RT 6140 respectively.

5.12.3. Frequencies for 60 Hz areas are identified by a letter; for example, letter A denotes an operating frequency of 506Hz

5.12.4. The tables on the next two pages list all the frequencies used, and give details of the reed filters and plugboards required for each. Note that only the reed filters and the track filter (see section 5.4 above) vary from one operating frequency to another: all the rest of the equipment is common to all the frequencies.

5.12.5 For track circuits with joints, a rotation of three frequencies should be used on each line so as to protect against short-circuit failure of insulated block joints: that is, two track circuits of the same frequency should always be separated by two track circuits of other frequencies. Separate sets of three frequencies should in general be used on adjacent lines. A typical example is shown in figure 17.

5.12.6. For jointless track circuits seven (or more) frequencies in rotation must be used on each line. On adjacent parallel lines a stagger of two (or more) frequencies should be adopted. If there are four roads this will require the use of eight frequencies as shown in fig. 17.

Channel No.	Frequency	Transmitter filter Type	Pin-code	Plug-board*	Receiver filter Type	Pin-code	Plug-board*
f211	363 Hz	RT 5110	ACGHM	RY 0391	RT 6110	ACGJM	RY 0392
f212	366 Hz	RT 5120	ACGKM	RY 0393	RT 6120	ACGLM	RY 0394
f213	369 Hz	RT 5130	ACHJM	RY 0395	RT 6130	ACHKM	RY 0396
f214	372 Hz	RT 5140	ACHLM	RY 0397	RT 6140	ACJKM	RY 0398
f215	375 Hz	RT 5150	ACJLM	RY 0399	RT 6150	ACKLM	RY 0400
f216	378 Hz	RT 5160	ADEFM	RY 0401	RT 6160	ADEGM	RY 0402
f217	381 Hz	RT 5170	ADEHM	RY 0403	RT 6170	ADEJM	RY 0404
f218	384 Hz	RT 5180	ADEKM	RY 0405	RT 6180	ADELM	RY 0406
f219	408 Hz	RT 5190	ADFGM	RY 0407	RT 6190	ADFHM	RY 0408
f220	417 Hz	RT 5200	ADFJM	RY 0409	RT 6200	ADFKM	RY 0410
f221	423 Hz	RT 5210	ADFLM	RY 0411	RT 6210	ADGHM	RY 0412

Channels for use in areas with 50 Hz mains supply

* Phenolic (black) plugboards. For epoxy (blue) plugboards, change the prefix letters from RY to RW.

Channel	Frequency	Transmitter filter			Receiver filter		
		Type	Pin-code	Plug-board	Type	Pin-code	Plugboard
A	506 Hz	RT 5310	AEHJM	RY 0431	RT 6310	AEHKM	RY 0432
B	503 Hz	RT 5300	AEGKM	RY 0429	RT 6300	AEGLM	RY 0430
C	500 Hz	RT 5290	AEGHM	RY 0427	RT 6290	AEGJM	RY 0428
D	387 Hz	RT 5320	AEJLM	RY 0435	RT 6320	AEKLM	RY 0436
E	384 Hz	RT 5180	ADEKM	RY 0405	RT 6180	ADELM	RY 0406
F	381 Hz	RT 5170	ADEHM	RY 0403	RT 6170	ADEJM	RY 0404
G	378 Hz	RT 5160	ADEFM	RY 0401	RT 6160	ADEGM	RY 0402
H	375 Hz	RT 5150	ACJLM	RY 0399	RT 6150	ACKLM	RY 0400

Channels for use in areas with 60 Hz mains supply

• Phenolic (black) plugboards. For epoxy (blue) plugboards, change the prefix letters from RY to RW.

APPENDIX

Installation of Receiver Loops for Jointless Track Circuits

1. The standard compound receiver loop is formed from 37 core cable. For certain applications different numbers of turns may be specified, either for technical reasons or to suit local standards. For high-power jointless track circuits 12-core cable should be used. Where particularly wide variations in track conditions are anticipated an intermediate tapping may be brought out of the multiturn coil to provide a coarse stage of receiver setting. This should be between the 50 and 70% points (at 20 turns when 37-core cable is used).

2. Figure 20 shows a typical connection method for a loop formed from 37-core cable. Cores 1 to 36 are connected in series to form a 36-turn coil, whose ends are brought out to the receiver. Core 37 forms the shunt circuit which runs between the two rails, and the correct end must be connected to each rail as shown in the figure (see also fig. 16). The types of cable used and the jointing method may be varied to suit local standards; the figure shows the standards adopted for British Railways' Scottish Region. A disconnection box may be provided in the leads between the loop and the location cupboard to facilitate changing loops in the event of a fault.

3. The loop should be so laid out that its length along the track is approximately 5m. However, the transverse parts should be run along sleepers, as shown in figure 20, and so this dimension is to the nearest sleeper position only. Hence all loops may not be exactly the same length, particularly on track with wooden sleepers, and if they are to be pre-assembled in the workshop it may be necessary to measure the exact sleeper spacing.

4. The loop must always be laid so that the joint is at the end remote from the feed of the same track circuit, as shown in fig. 20. Each relay end normally has its own loop, and they are always arranged so that there is an overlap of the adjacent track circuits. Hence the arrangement of loops on the ground should be as shown in one of the two standard layouts, figs. 18 and 19.

5. The arrangement shown in fig. 18 provides an inclusive overlap. The two loops are laid one on each side of the measured overlap point as shown, with a single sleeper between them. The nominal end point of each track circuit is the centre point of its own receiver loop, as shown.

6. The arrangement shown in figure 19 provides first-axle replacement of the signal, because the loop for the track circuit ahead (RT) is brought back to the signal so that the two track circuits overlap by 300m. The loop for the track circuit in rear is placed so that its centre lies at the measured overlap point.

7. For some purposes a 'simple' receiver loop is used. This is a loop which does not include the shunt circuit between the rails. All the cores in the cable are connected in series to form the coil. Such a loop may be used for an additional receiver at an intermediate point in a track circuit for various purposes such as approach control. It should be made up as shown in fig. 20 with the omission of the rail connections, core 37 being included in the coil instead. It should be placed on the track with its centre at the measured position.

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APPENDIX 2

Mounting Reed track circuit and vital remote control equipment together

1. When type RT Reed track circuit equipment and vital type RR Reed remote control equipment are mounted in proximity to each other, it is necessary to take certain precautions to ensure that the relatively high currents flowing in the track circuit equipment cannot give rise to interference in the remote control equipment.

2. When the equipment is housed in lineside apparatus cases, wherever possible type RR receivers should be mounted in separate cases from type RT feed end equipment or from Reactive Shunts (type RT7701 etc.; see section 5.9). Where type RR receivers must be mounted in the same case as type RT feed end equipment or Reactive Shunts, the RR receivers should be separated by at least two rows from the RT equipment.

3. When Reactive Shunts are mounted on a mesh or backboard in an apparatus case, no Reed receiver (type RR or type RT) should be mounted within 300mm of them. This is most simply achieved by ensuring that Reactive Shunts are always mounted at least 300mm below the top of the mesh or backboard.

4. When the equipment is housed in relay rooms, type RR receivers should again be separated by at least two rows from type RT feed end equipment or Reactive Shunts. Where possible, it is desirable to keep type RR and type RT equipment to separate racks.

5. The standard layouts of type RT track circuit equipment must be kept to at all times (see sections 2.3.1., 3.1.2.2., and 3.2.2.2), and twisted pairs must be used for local wiring as shown in figures 2,3,6 and 8.

6. Wiring for type RR systems and type RT track connections must always be run separately.

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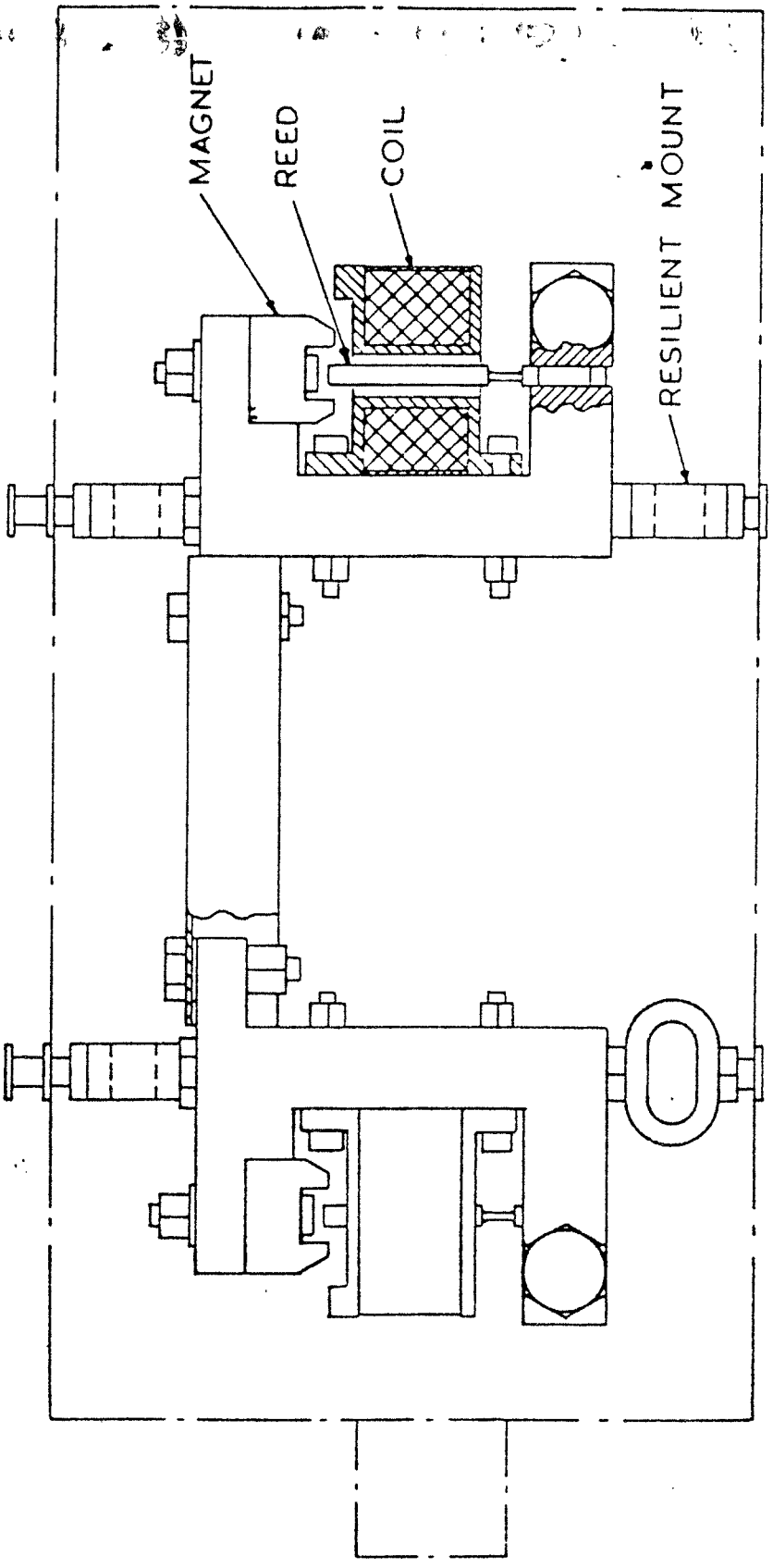
10	1
11	2
12	1
13	3
14	3
15	3
16	3
17	3
18	2
19	2
19A	1
20	2
21	3
22	2
23	2
24	3
25	3
26	3
27	3
28	3
29	3
30	3
31	2
32	1
33	2
34	3

Figure	Issue
1	2
2	3
3	3
4	3
5	3
6	3
7	3
8	3
9	1
10	3
11	2
12	3
13	1
14	3
15	3
16	2
17	2
18	2
19	2
20	1



GENERAL ARRANGEMENT OF REED FILTER

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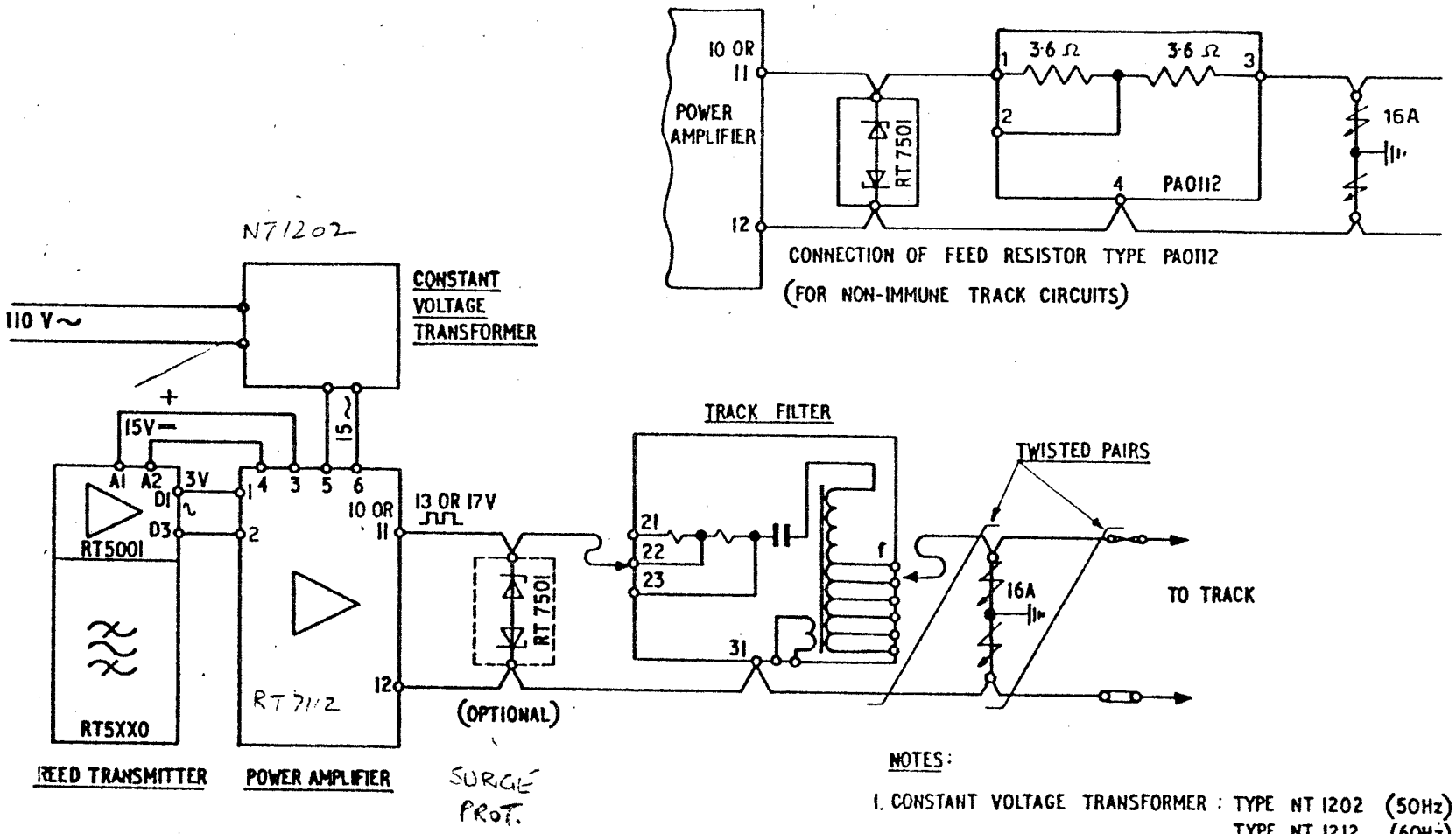
APP'D	DHS	18 VII 79		
TRACED				
CHECKED				

A4	PRINT ISSUED ISS 1. 18/7/78 ISS 2 1-3-79	GEC-General Signal Ltd. London, England	TITLE GENERAL ARRANGEMENT OF REED FILTER	4SKD074 IB147 FIG.1.



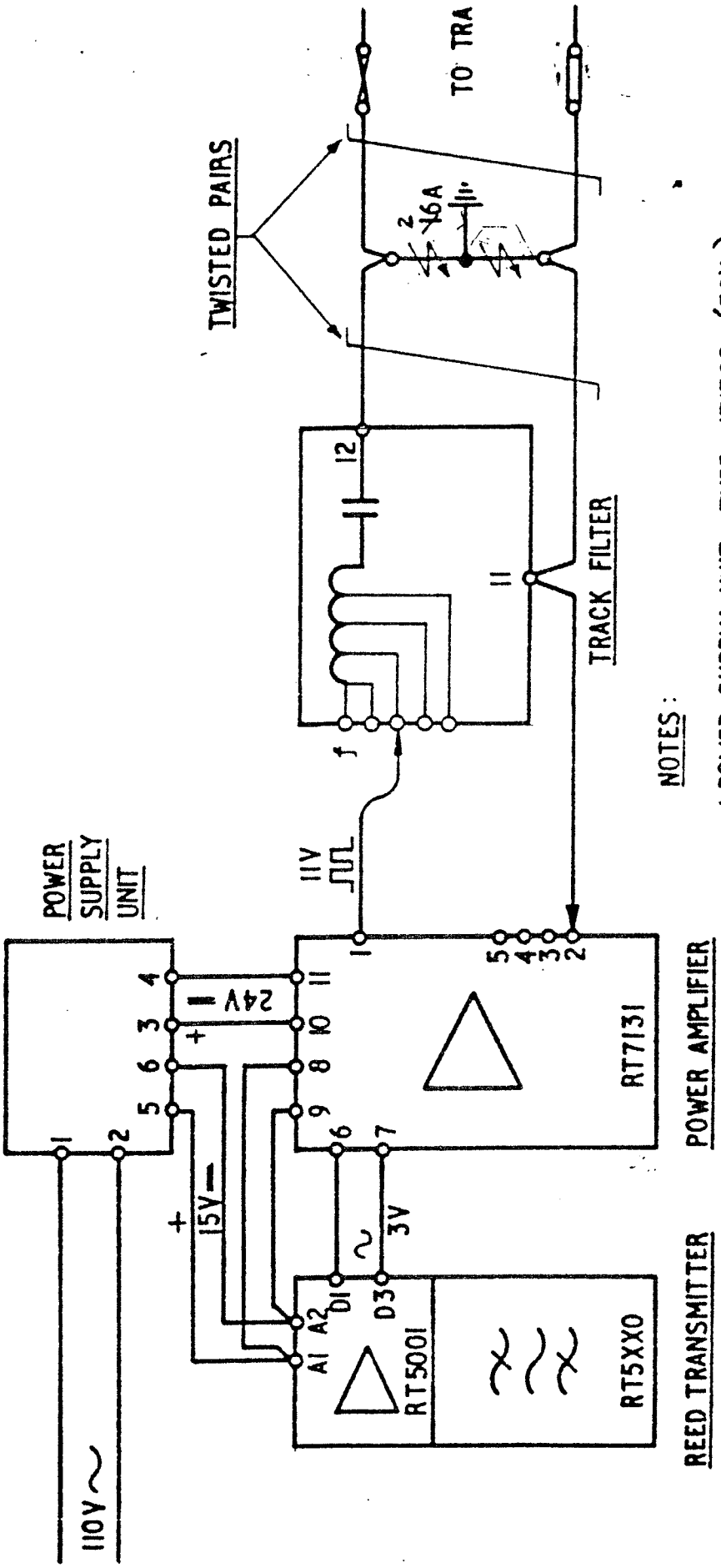
NOTES:

1. CONSTANT VOLTAGE TRANSFORMER : TYPE NT 1202 (50Hz)
   TYPE NT 1212 (60Hz)

2. POWER AMPLIFIER : TYPE RT7112

3. TRACK FILTER : TYPE RT7202 OR RT7212 (50Hz)
   RT7231 OR RT7241 (60Hz).
   DEPENDING ON FREQUENCY OF OPERATION
   USED FOR IMMUNE TRACK CIRCUITS ONLY.

A3	ISSUE 2	DATE 4.12.79 CHKD CLL APPD DHS	ISS 3	DATE 9.7.82 CL CHKD SRH APPD		DRAWN CLL 4.12.79	GEC-General Signal Ltd. London, England. © 1979	PRINT ISSUED	REED TRACK CIRCUITS	3SK0105
	WAS 4SK0105 PA0111 INSET ADDED		REVISED			CHECKED APP'D DHS TRACED CHECKED			STANDARD FEED END	IB 147 FIG 2



NOTES:

1 POWER SUPPLY UNIT : TYPE NT1302 (50Hz)
TYPE RT9201 (60Hz)

2 TRACK FILTER : TYPE RT7221 OR RT7271 (50Hz)
TYPE RT7251 OR RT7261 (60Hz)
—DEPENDING ON FREQUENCY OF OPERATION

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3	CHK'D GRM
	APP'D
REVISED	
ISS 2	DATE 4-12-79
	CHK'D
	APP'D DHS
REDRAWN	

A4	PRINT ISSUED	GEC-General Signal Ltd. London, England. © 1979	REED TRACK CIRCUITS HIGH-POWER FEED EQUIPMENT	4SK0131 IB 147 FIG. 3 0

7679E 7682E

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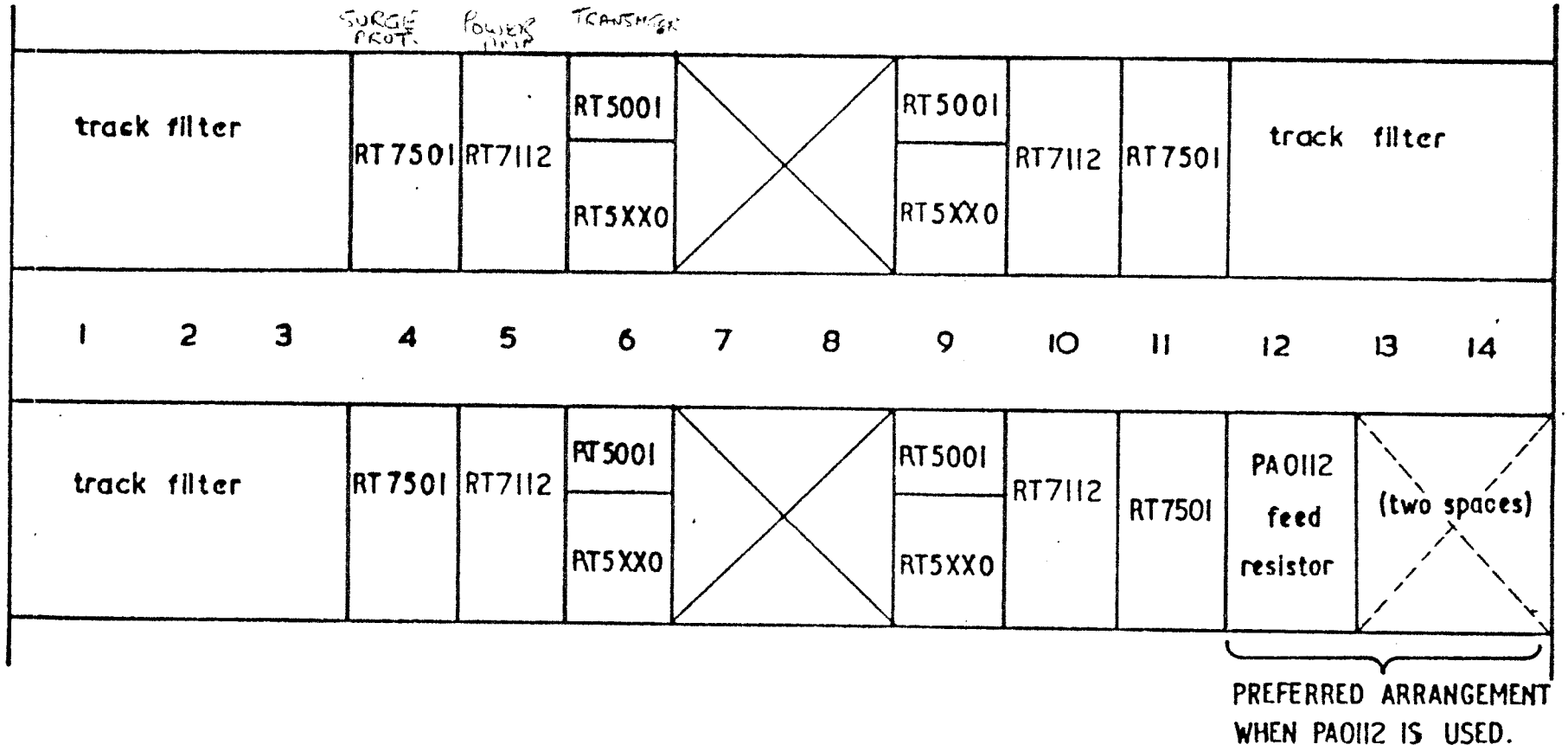
DATE
APP'D
DES.ENG



STANDARD LAYOUT OF UP TO FOUR STANDARD FEEDS

Constant-voltage transformer (NT1202 or NT1212) is mounted on a separate row.

Note : If feeds and receivers are mounted in the same case, none of the receivers may be of the same frequency as any of the transmitters.

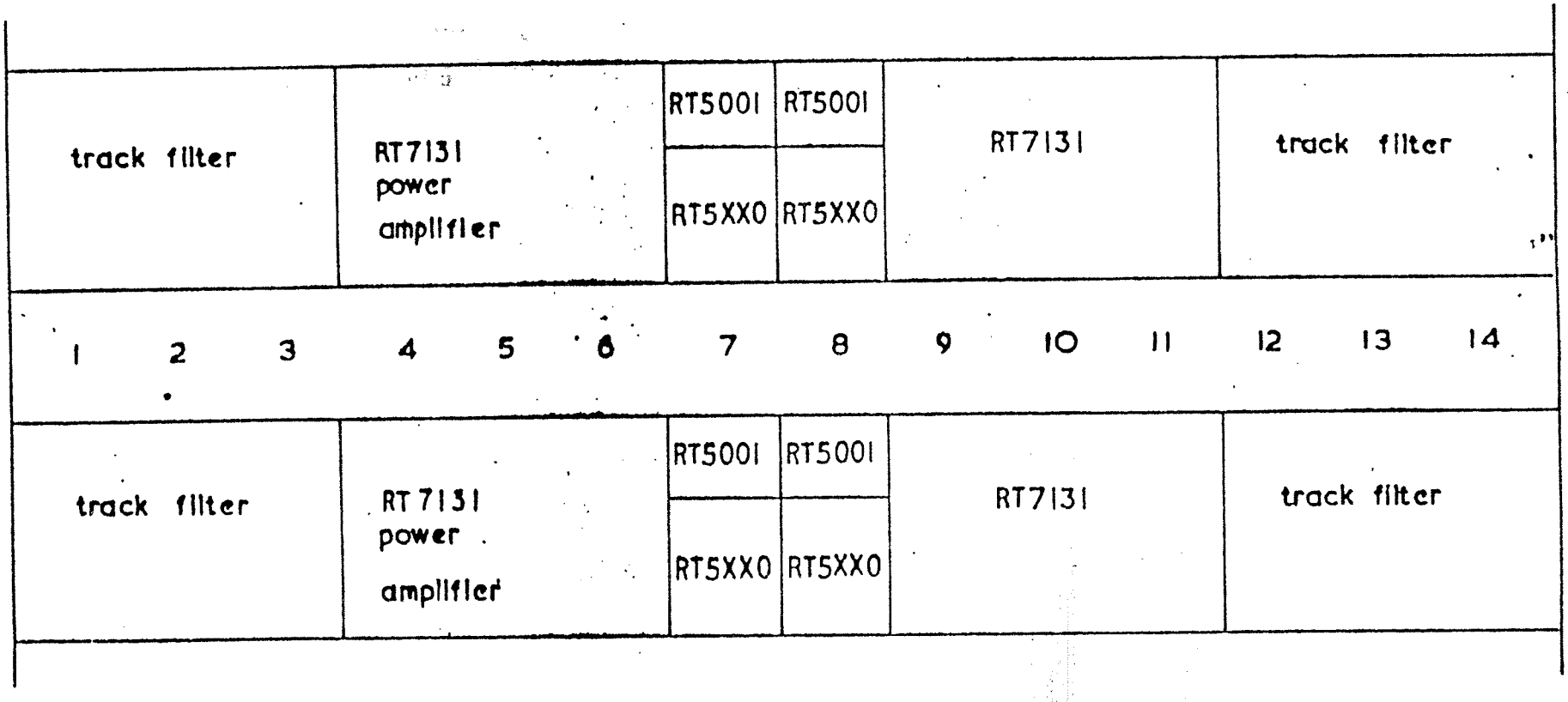


Figure 5

STANDARD LAYOUT OF UP TO FOUR HIGH POWER FEEDS

Power supply units (NT1332 or NT3221) are not mounted on the rack mounting panels.

Note: All feeds are identical and in the same case, none of the receivers may be of the same frequency as any of the transmitters

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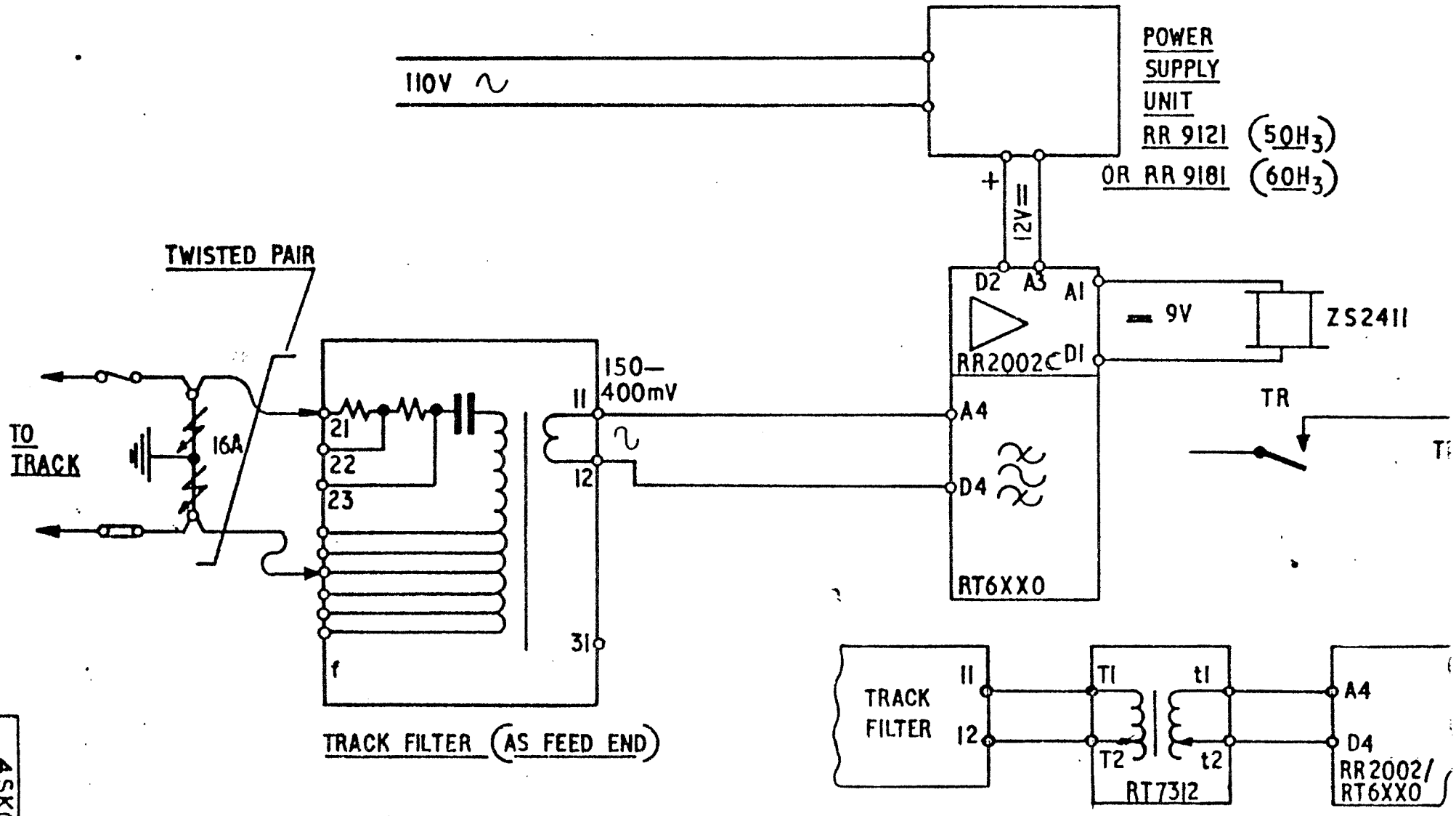
FIGURE 6

IB 147

4SKOI04



RELAY END AT JOINT

CONNECTION OF ATTENUATOR TYPE RT7312
(HIGH-POWER TRACK CIRCUITS ONLY; SEE SECTION 3.1

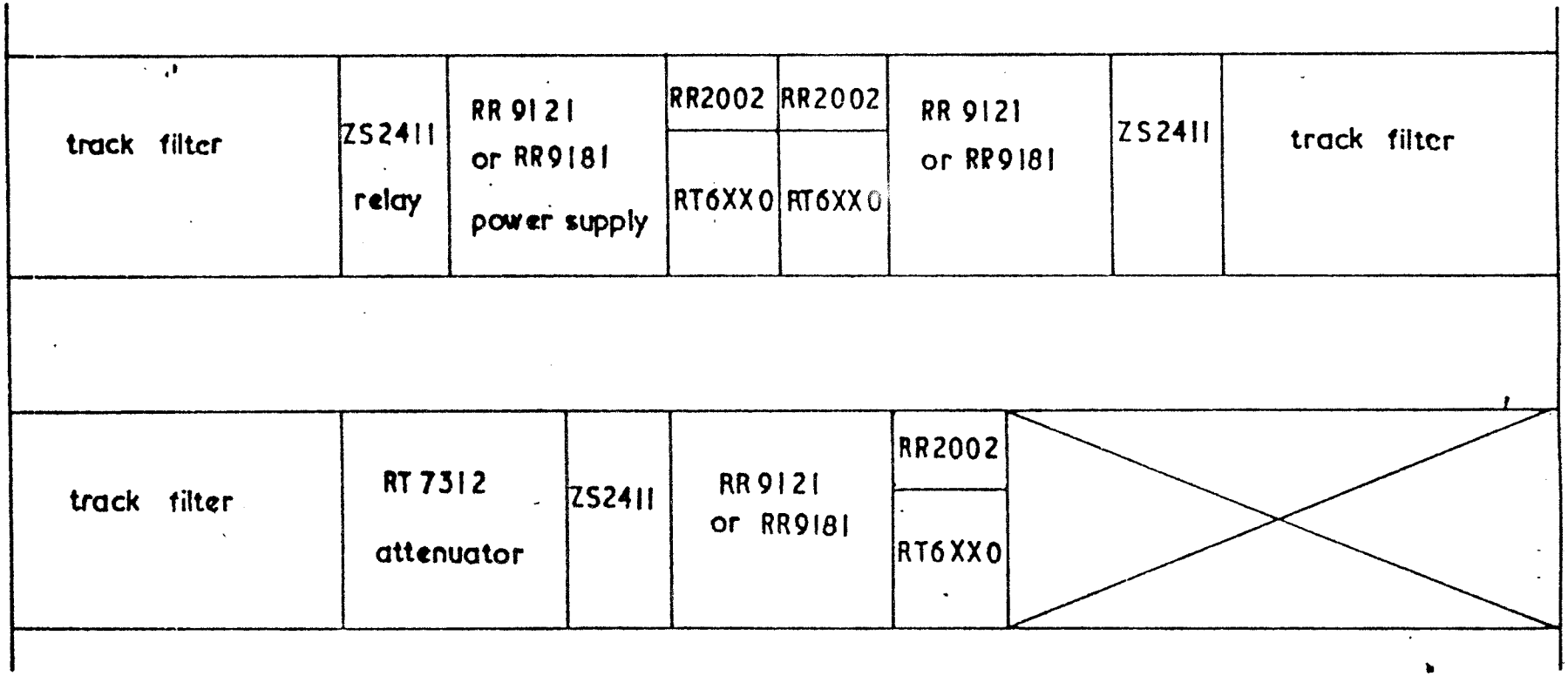
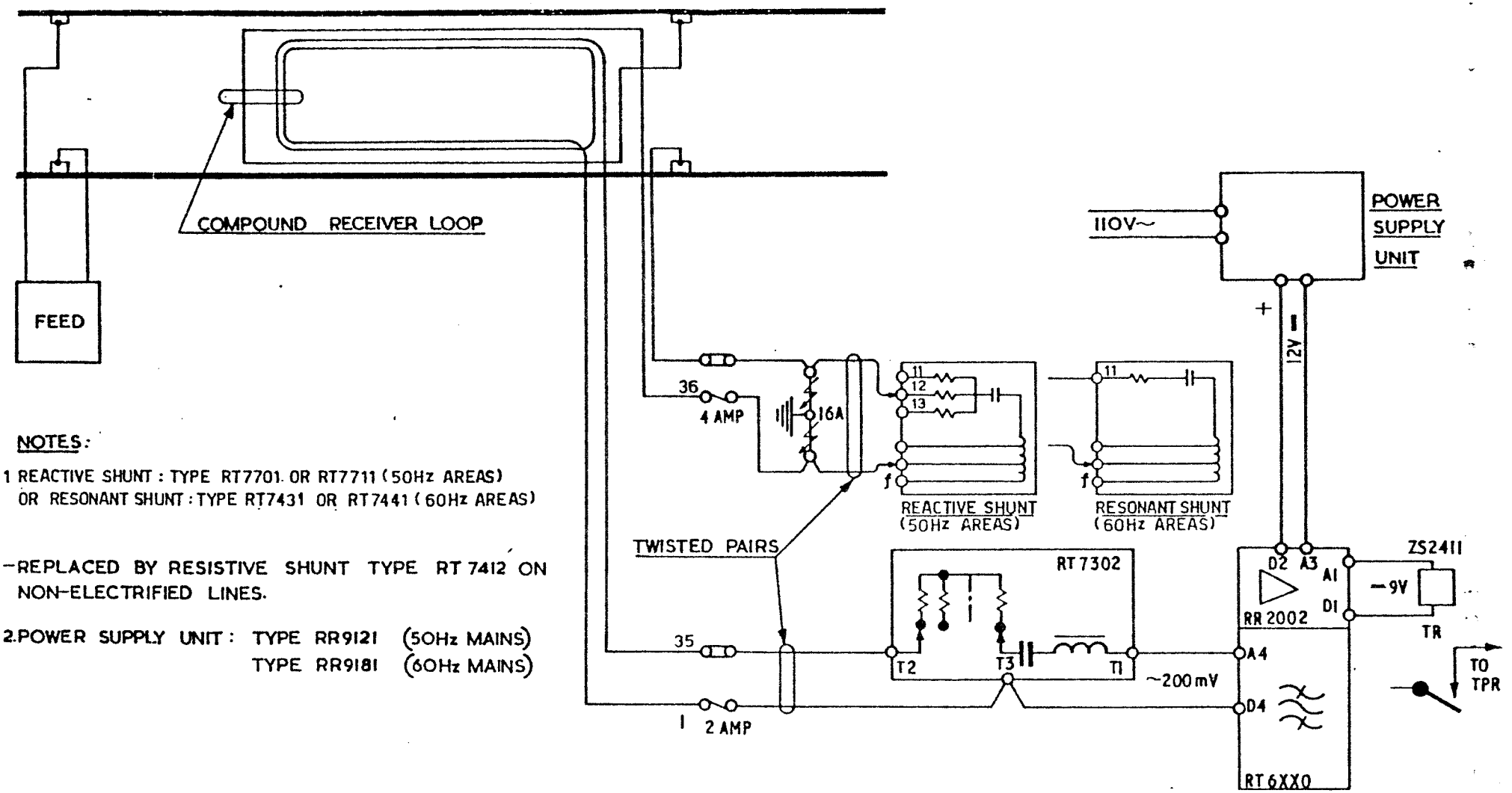


Figure 7

STANDARD LAYOUT OF RECEIVERS

—with and without attenuator type RT7312 (see 3.1.1.2.).

If two receivers are of the same frequency, they must be diagonally opposite each other.



NOTES:

1 REACTIVE SHUNT : TYPE RT7701 OR RT7711 (50Hz AREAS)
OR RESONANT SHUNT : TYPE RT7431 OR RT7441 (60Hz AREAS)

-REPLACED BY RESISTIVE SHUNT TYPE RT 7412 ON NON-ELECTRIFIED LINES.

2.POWER SUPPLY UNIT : TYPE RR9121 (50Hz MAINS)
TYPE RR9181 (60Hz MAINS)

A0	ISSUE 2	DATE 30.11.79 CHKD CLL. APPD	ISSUE 3	DATE 9.7.82 CL CHKD APPD	DRAWN	CLL.	30-11-79	GEC-General Signal Ltd. London, England. © 1979	PRINT ISSUED	REED JOINTLESS TRACK CIRCUIT JOINTLESS RELAY END WITH COMPOUND LOOP.	3SK0125 IB 147 FIG 8
	REDRAWN		REVISED		CHECKED						
					APP'D	IS	30xi79				
					TRACED						
					CHECKED						

ICC No

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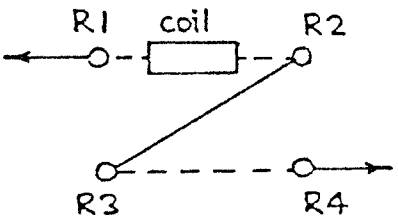
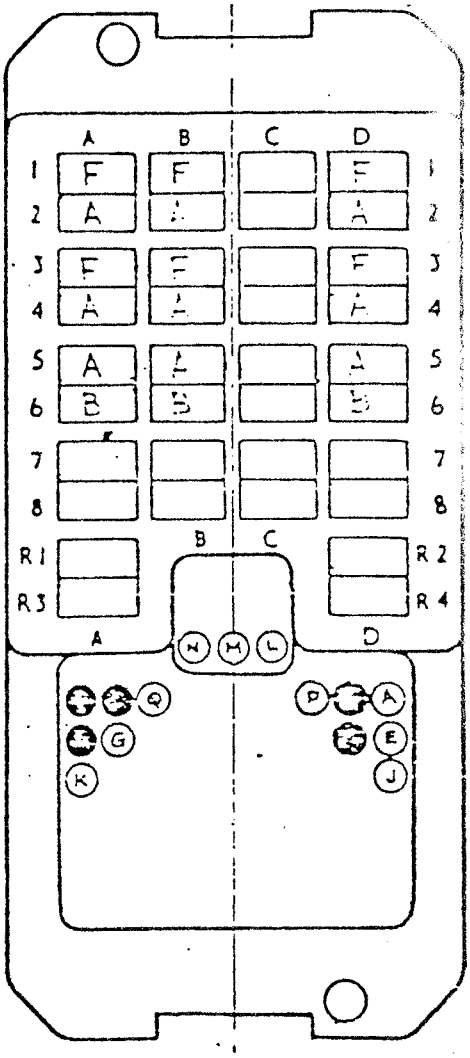
DES. ENG

CONTACTS	6F 5B
PIN CODE	133
PINS	ACDFH
PLUGBOARD TYPE	RY133

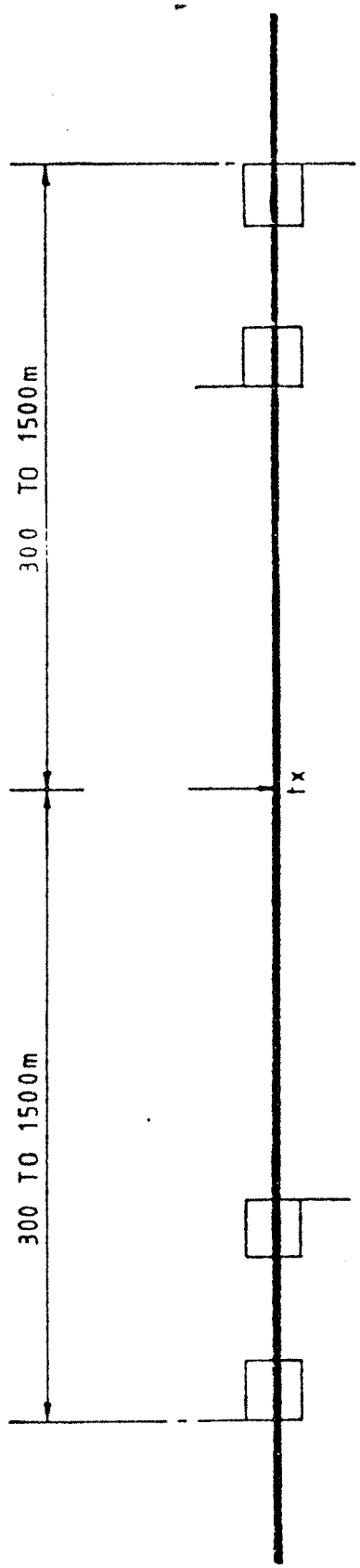




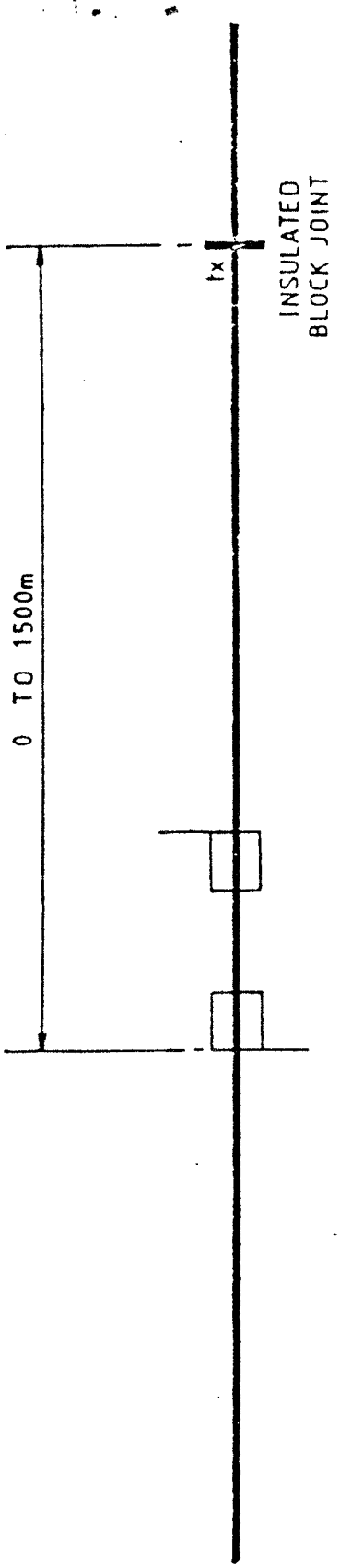
REAR VIEW

COIL RESISTANCE	(440 ohms)	
	MAX.	MIN.
Full OPERATE	5.8 v.	
Full Release	-	

The Reed follower relay type ZS 2411. The diagram shows a view of the plugboard. The coil is connected between R1 and R2 and R3 and R4 are linked inside the relay. If compatibility with the earlier type 32'10 relay, which had the same pin-code, is essential, then the connections from the Reed receiver must be made to R1 and R4, and a link must be fitted between R2 and R3. Otherwise, they may be made directly to R1 and R3.



MAXIMUM AND MINIMUM LENGTHS OF REED JOINTLESS TRACK CIRCUITS UNDER BRITISH CONDITIONS.



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	APPD DHS

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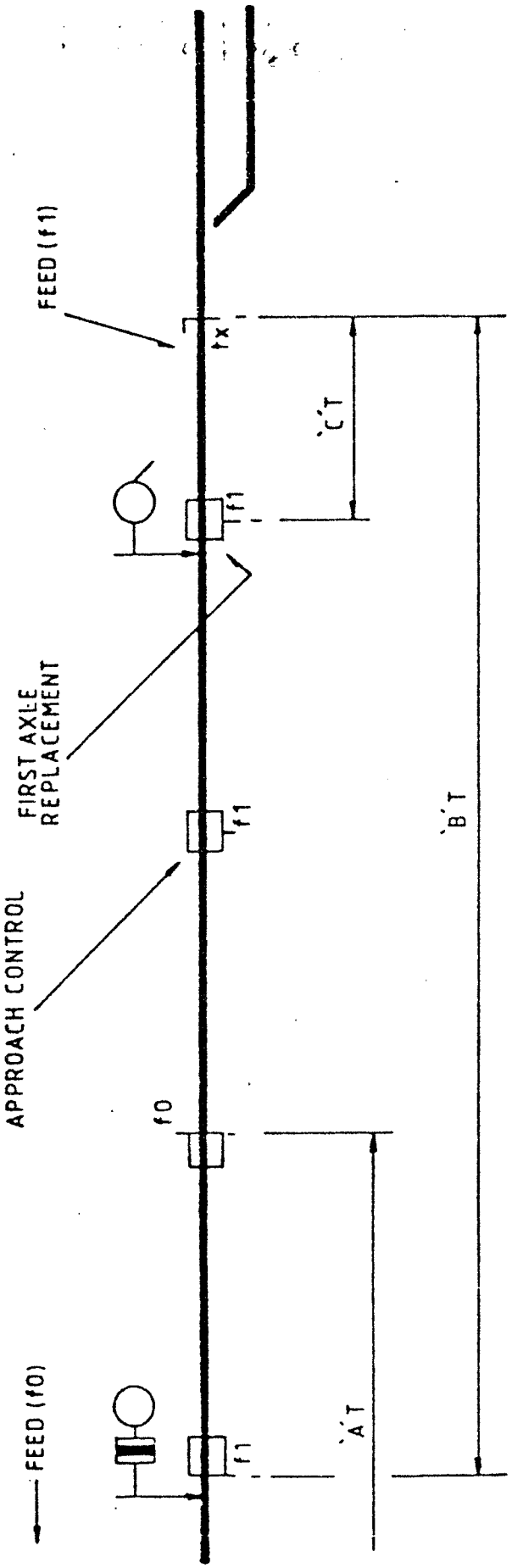
REED JOINTLESS TRACK CIRCUITS.
(BRITISH PRACTICE)

4SK 0120 X

IB 147 FIG 10



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ISSUE	DATE NOV 79
2	CHKD
	APPD DHS
REDRAWN	

A4	PRINT ISSUED	GEC-General Signal Ltd. London, England © 19	REED JOINTLESS TRACK CIRCUIT - USE OF FEED AT BLOCK JOINTS AND OF INTERMEDIATE LOOPS	4SK 0121 X
				18 147 fig 11

A		DRAWN	ATKINSON	NOV '79	CHECKED			APP'D	DHS	23/11/79	TRACED			CHECKED			

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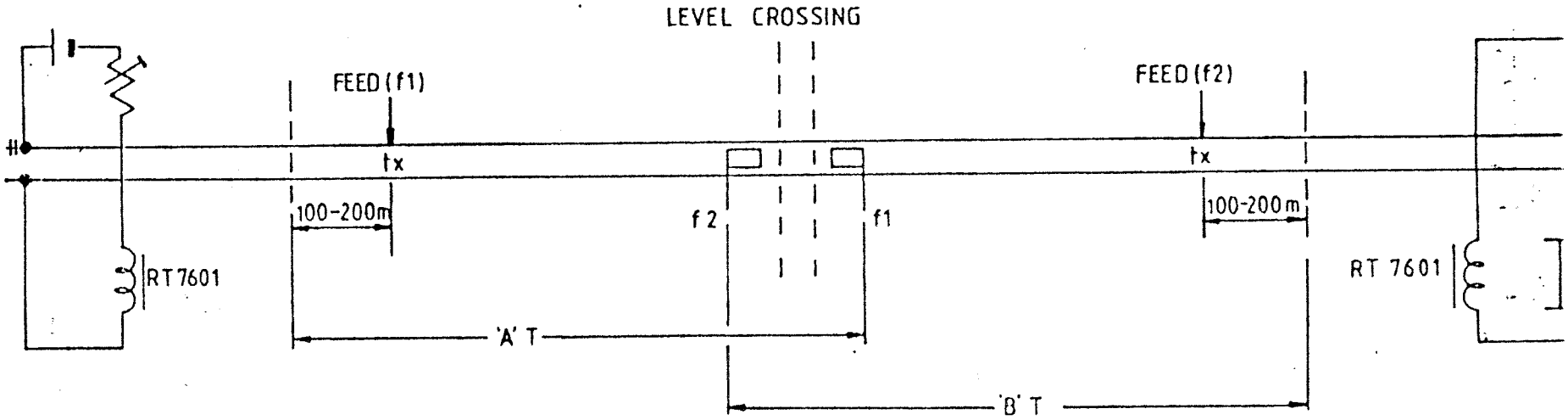
London, England.

REED JOINTLESS TRACK CIRCUIT

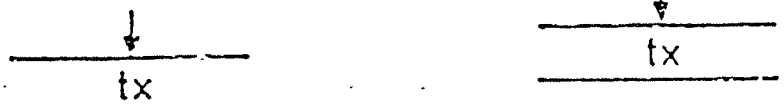
EXAMPLE OF APPLICATION AS AN OVERLAY TRACK CIRCUIT



USE OF SYSTEM [illegible] (SEE SECTION 3.2.1.8.)

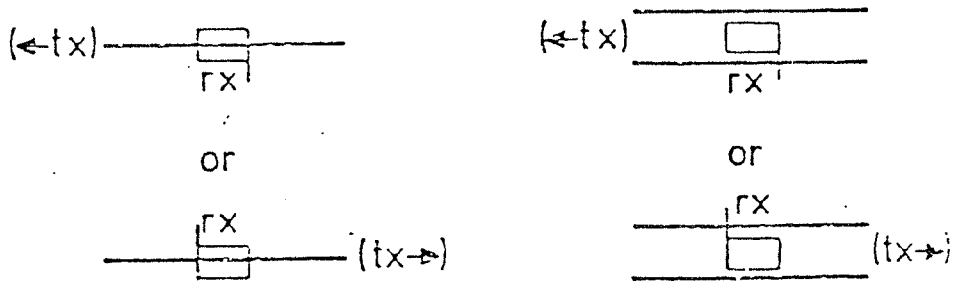
NOT TO SCALE

TRANSMITTER



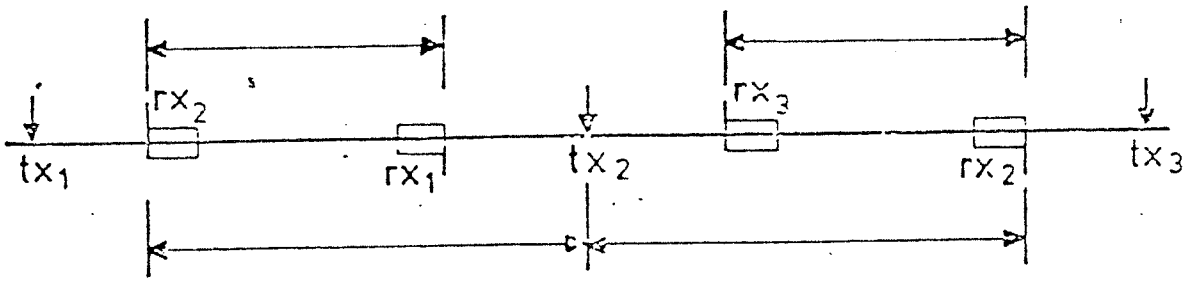
JOINTED RECEIVER

STANDARD RECEIVER WITH COMPOUND LOOP



SIMPLE LOOP (CUT SECTIONS ETC.)

POSITIONS OF TRANSMITTERS AND JOINTLESS RECEIVERS MUST BE SPECIFIED PRECISELY, FOR EXAMPLE:



Standard symbols for jointless track circuits.

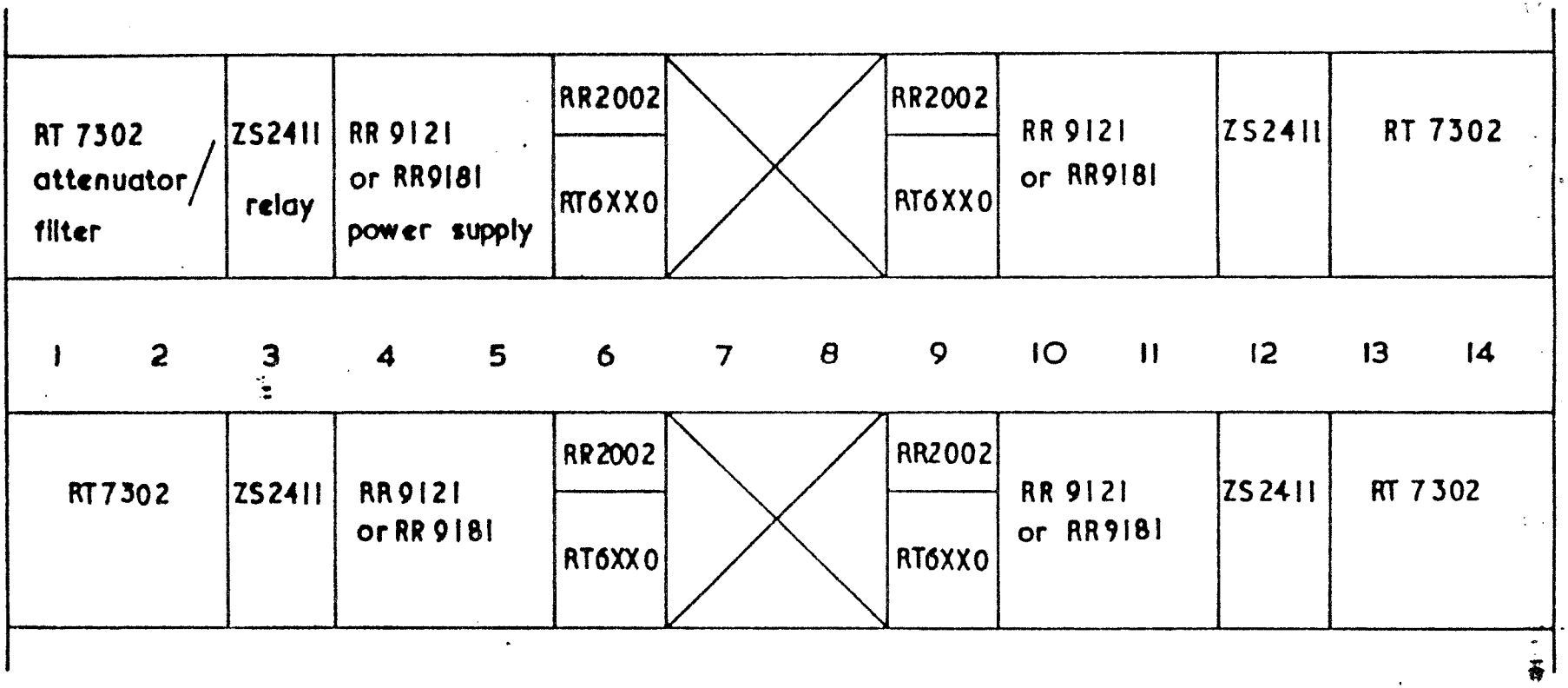
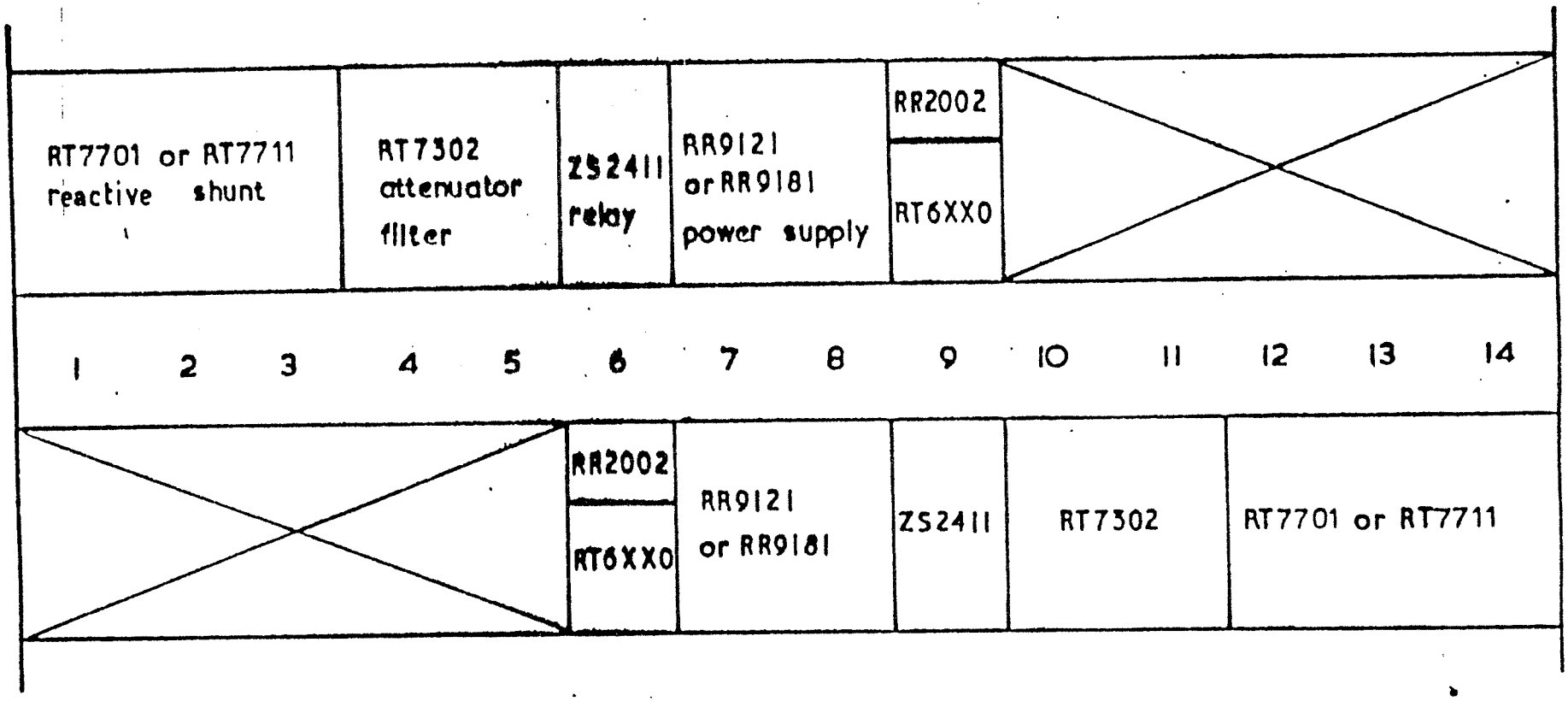


Figure 14

STANDARD LAYOUT OF UP TO FOUR JOINTLESS RECEIVERS

If two receivers are of the same frequency, they must be diagonally opposite each other.

This layout assumes resistive/reactive shunts mounted at bottom of case (or not fitted; see 3.2.1.7.)



STANDARD LAYOUT OF ONE OR TWO JOINTLESS RECEIVERS

Resistive/reactive shunts mounted on relay rack.
The receivers must be of different frequencies.

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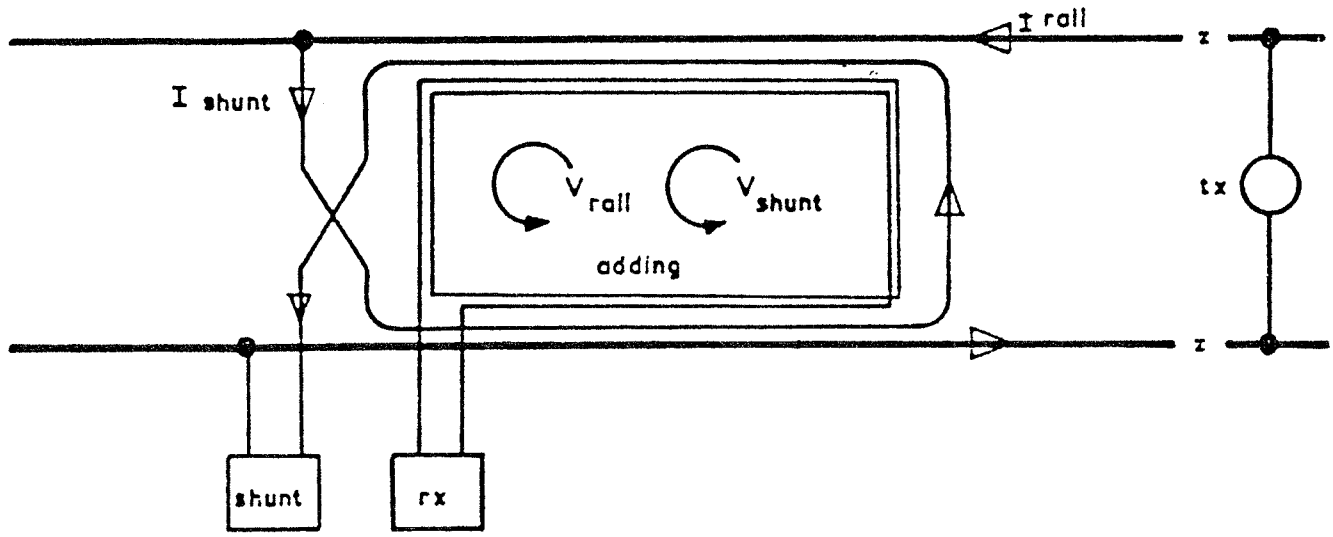
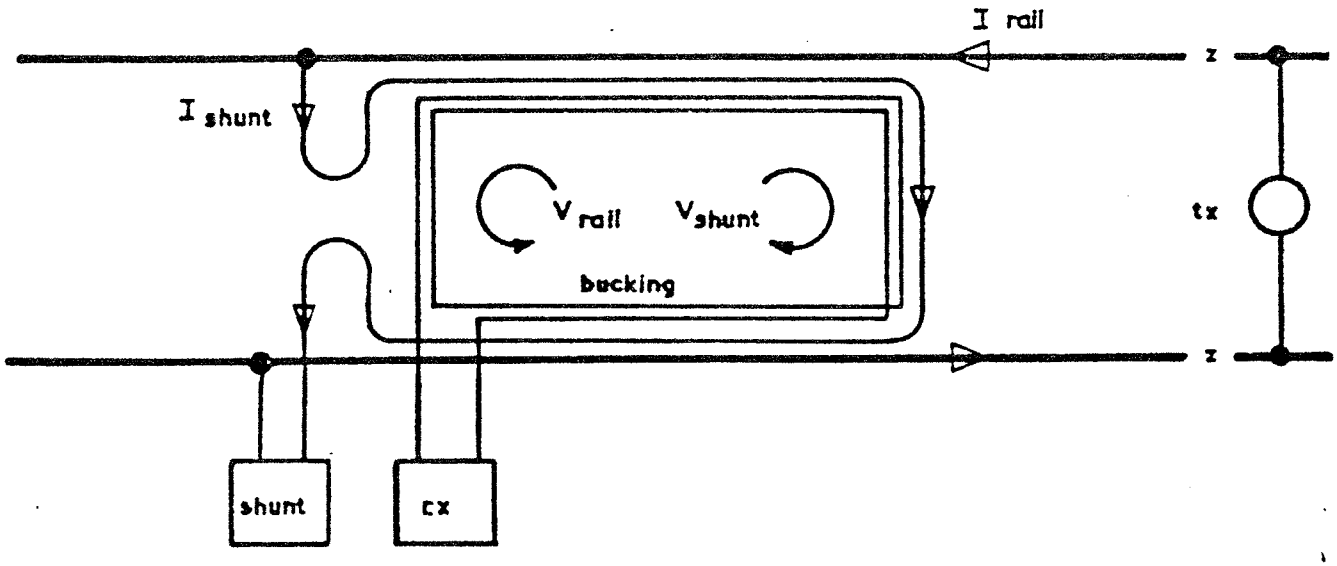
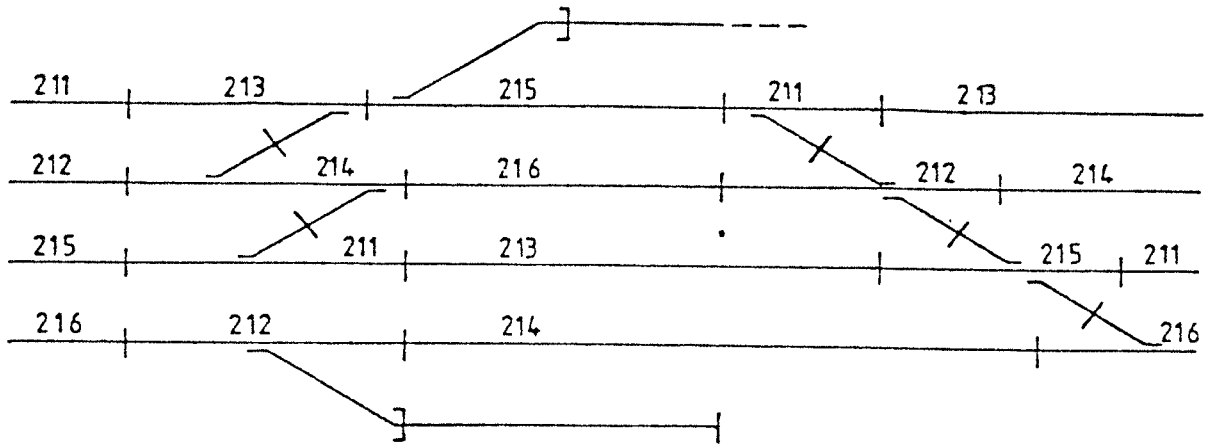


CORRECT

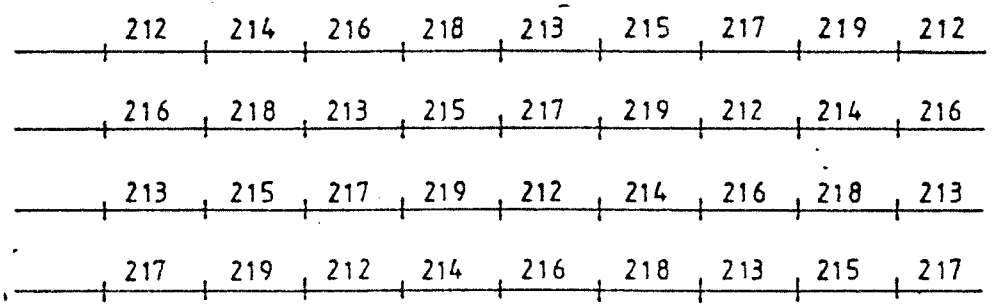


INCORRECT

Installation of receiver loop showing correct and incorrect arrangments of the shunt connection between the rails.



WITH JOINTS - THREE FREQUENCIES ON EACH LINE



JOINTLESS - EIGHT FREQUENCIES ON EACH LINE

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	APPD
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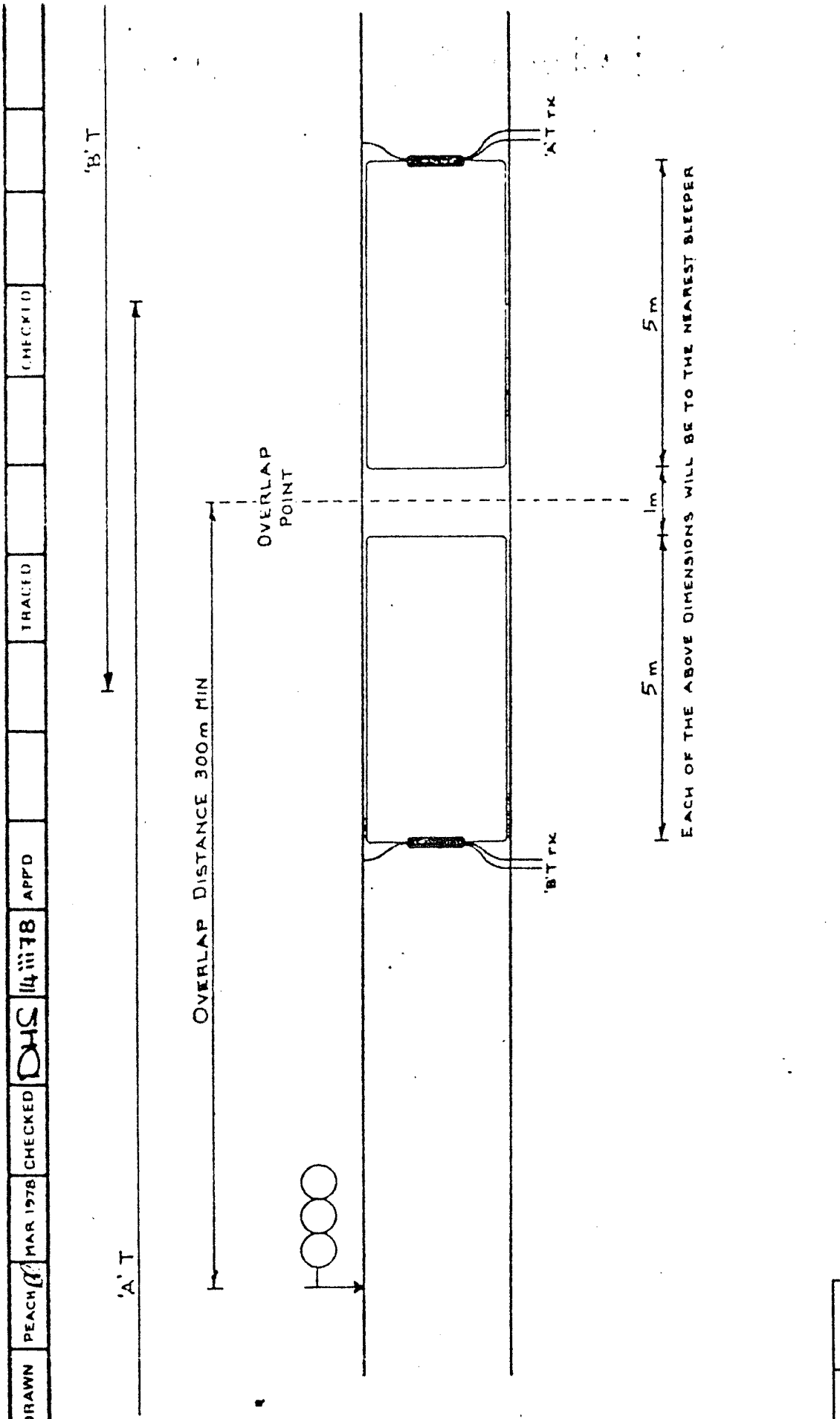
A4	PRINT ISSUED	GEC-General Signal Ltd. London England © 1979	REED TRACK CIRCUITS EXAMPLES OF USE OF FREQUENCIES IN ROTATION	4SK 0119 IB 147 FIG 17



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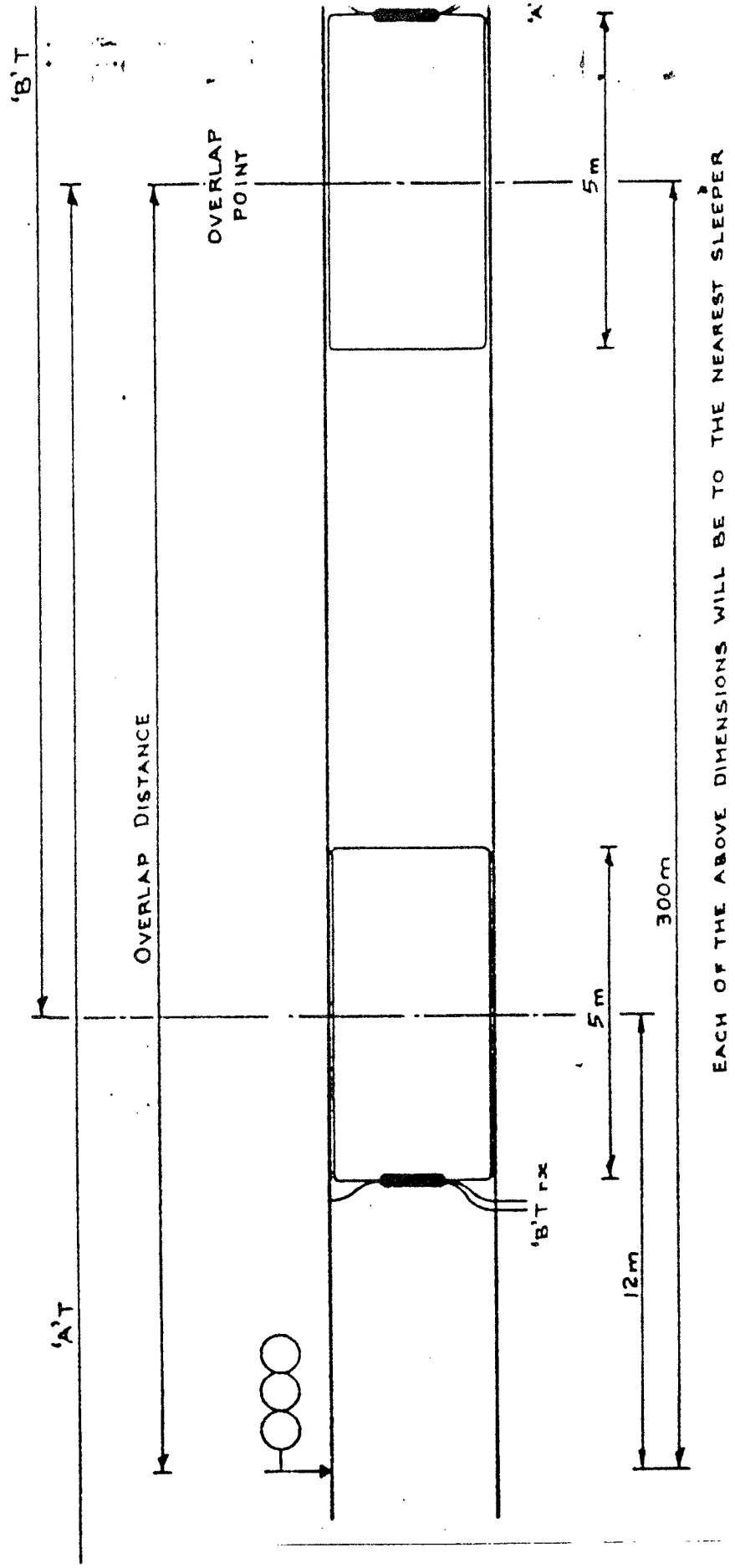
ISS 2	DATE 13-7-82 CL			
	CHK'D RM			
	APP'D			
REVISED				

A 4	PRINT ISSUED	GEC-General Signal Ltd. London, England. © 1978	REED JOINTLESS TRACK CIRCUIT ARRANGEMENT OF RECEIVER LOOPS AT OVERLAP POINT OF SIGNALS, WITH 1METRE SEPARATION	4SK0069
				IB 147 FIG 18



EACH OF THE ABOVE DIMENSIONS WILL BE TO THE NEAREST SLEEPER

POSITION OF OVERLAP POINT WILL HAVE BEEN MEASURED AND MARKED ON THE TRACK.

SKETCH NOT TO SCALE

DRAWN	PEACH	MAR 1978	CHECKED	DHS	28 IX 78	APP'D	TRACED			CHECKED	

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2	13 7 82 CL
	CHK'D GRM
	APP'D

REVISED

A 4	PRINT ISSUED	GEC-General Signal Ltd. London, England. © 1978	REED JOINTLESS TRACK CIRCUIT ARRANGEMENT OF RECEIVER LOOPS AT SIGNAL, WITH 200 METRE OVERLAP OF TRACK CIRCUITS	4SK 0070
				1B 147 FIG 19

7679E 768

User Information

Outline drawing: 4A 56017.

The Receiver amplifier type RR 2002C is the standard receiver amplifier for type RT track circuits. It supersedes RR2002B and is functionally interchangeable with it, but incorporates updated components. It is suitable for ambient temperatures between -20 and 70°C, and for use in tropical environments. Radio interference suppression is incorporated.

The Receiver amplifier is used in conjunction with a Receiver filter of the RR6XX0 series, the two parts clipping together to form a single unit which mounts on a BRB standard miniature relay plugboard and whose dimensions conform generally to the miniature relay module size (but see the outline drawing). The combined unit forms the receiver for type RT track circuits. The receiver amplifier is common to all frequencies and the contacts which make electrical connections to the plugboard are mounted on it; the Receiver filter, which is a standard Reed filter, determines the frequency of the unit, and has the plugboard coding pins attached to it.

The combined unit requires a power supply at a nominal 12V d.c. which must be obtained from a Reed power supply unit RR 9121; the power supply terminals are D2 (positive) and A3. The input terminals are A4 and D4, and the output appears between terminals D1 (positive) and A1, and feeds a Reed follower relay type ZS 2411, which is a standard BRB miniature relay having six front and three back contacts.(See Note 1).

For further applications details, see the Type RT Track Circuits Handbook (IB 147).

Weight: 0.4 Kg.

Colour: Silver

Note 1: There are some early RR2002C units in existence where the positive relay output terminal is identified by a red dot (A1 or D1). In this case the statement above that D1 is the positive terminal may not be correct. The operation of the equipment is not affected by the relay polarity.

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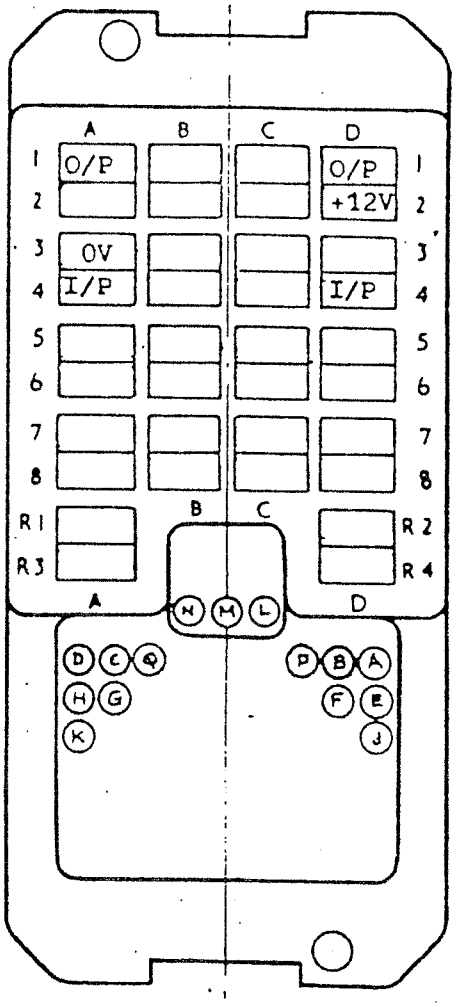
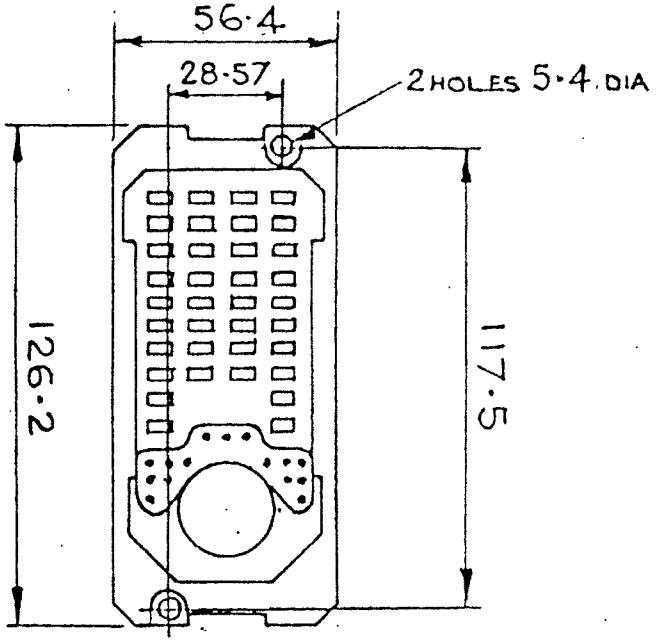
CONTACTS
PIN CODE
PINS
PLUGBOARD

The code pins are fitted on the receiver filter, RR6XX0 series. Details are given in the Data Sheet for that series.

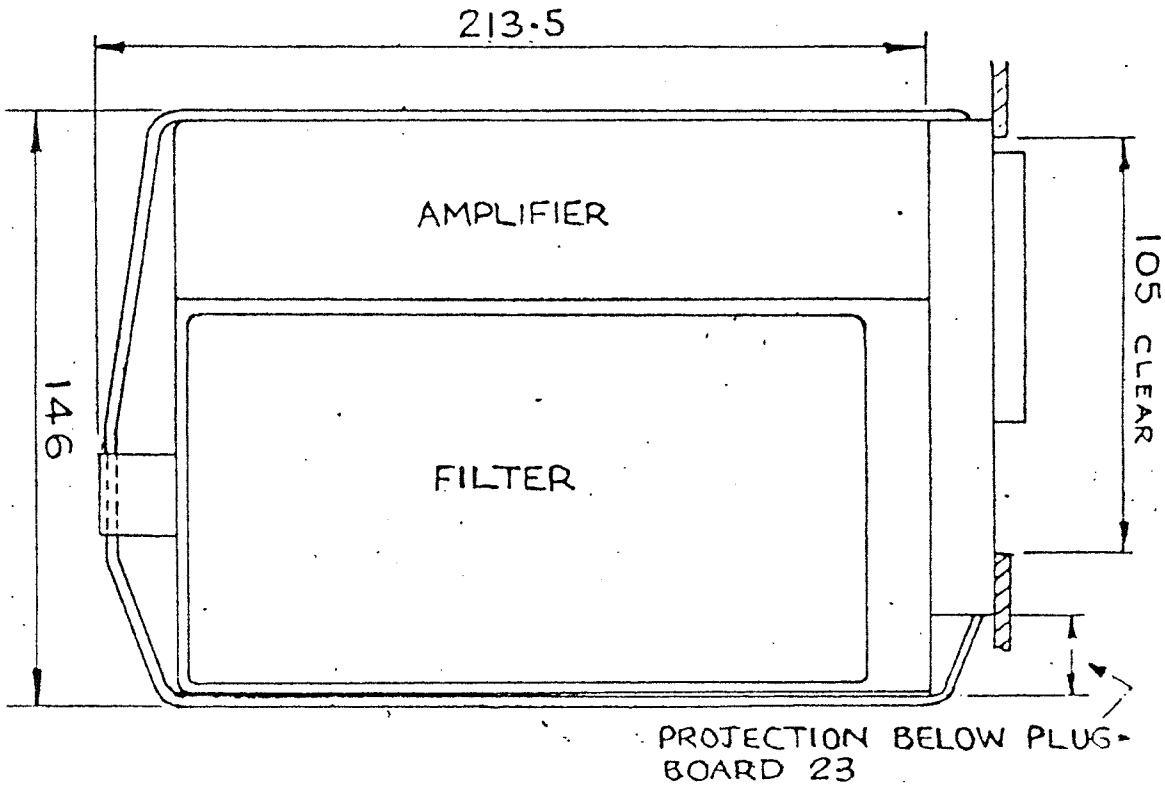


REAR VIEW

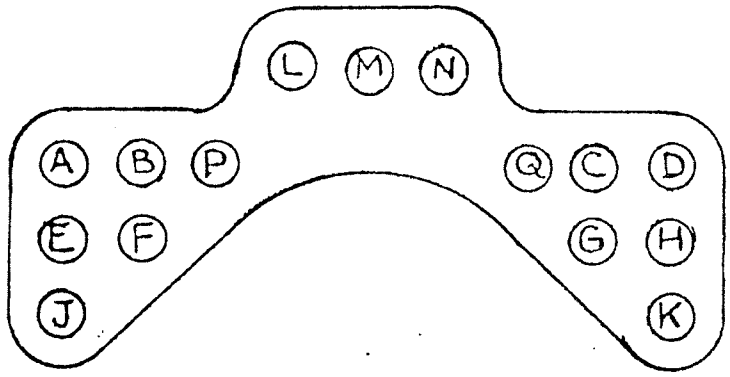
COIL RESISTANCE		
	MAX.	MIN.
OPERATE		



FRONT VIEW OF PLUGBOARD
SCALE 1:2



SIDE VIEW OF REED FILTER & AMPLIFIER COMPLETE WITH PLUGBOARD
SCALE 1:2.



PIN CODE HOLES
SCALE 2:1

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Date
Appd.
Des. Eng.

Issue 2 P'type approval added p.5 D.M.Poole 7/12/82

Issue 3 Note 1 re polarity added p2 D.M.Poole 23/3/83

Signalling Equipment Department, Manchester

DATA SHEET FOR
RECEIVER AMPLIFIER

TYPE REFERENCE
RR 2002 C

CATEGORY D

BASIC DESCRIPTION

Standard receiver amplifier for use in Type RT Reed track circuits.

Supersedes RR2002B.

MANUFACTURING INFORMATION

General Assembly & Bill of Material	:	2C50124A
Manufacturing Specification	:	MES 3037
Circuit Diagram	:	3W60084
Test Specification	:	MES 5005

		Name	Signed
Office copy Purchasing Sales; Material Control; Quality Assurance Signals Application	All pages	AUTHOR	D.M. Poole
		DESIGN ENGINEER	D.M. Poole
Supplier ----------	Pages 1–4		
Customer (when req'd)	Pages 1–4		

DATE 9.1.81

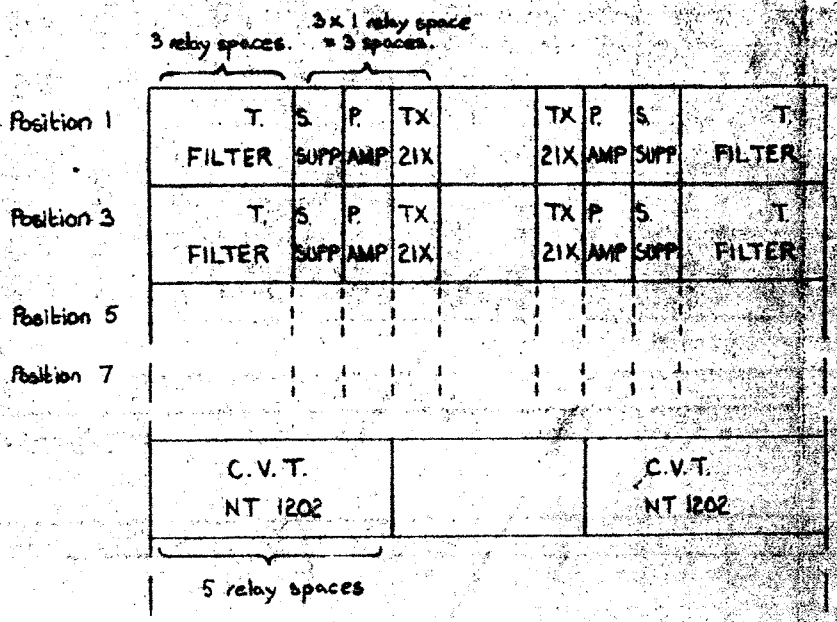
Type Reference

FEED END

T. FILTER RT 7202	S. SUPP RT 7501	P. AMP RT 7112	T. TX

T. FILTER – RT 7202
S. SUPP. – RT 7501
P. AMP. – RT 7112
TX (AMP) – RT 5001
(FILTER) – RT 51X0
X = 1 to 6 = f211 to 216 respectively.

LOCATION MOUNTING OF EQUIPMENT



C.V.T. – NT 1202 – WILL FEED 4 SETS OF TX EQUIPMENT (OF DIFFERENT FREQUENCIES)

TRACK TRANSMITTERS OF THE SAME FREQUENCY CAN BE MOUNTED TOGETHER PROVIDED THEY ARE "MIRROR IMAGED" AND NOT MOUNTED VERTICALLY ABOVE EACH OTHER.

e.g. A TX of the same frequency as one mounted at position 1 should be mounted in position 4 or alternatively in position 2. (only 2 TX's of the same frequency can be mounted in a location case).

TX's AND RX's OF THE SAME FREQUENCY MUST NOT BE HOUSED IN THE SAME LOCATION.

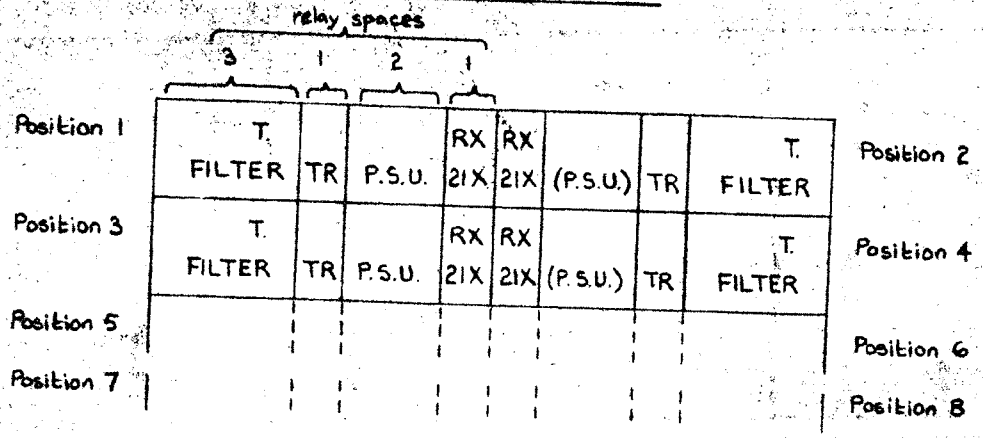
C.V.T.'s MUST BE MOUNTED A MINIMUM OF 6" BELOW ANY REED EQUIPMENT.

TX's OF THE SAME FREQUENCY MUST BE FED FROM DIFFERENT C.V.T.'s.

T. FILTER RT 7202	TR ZS2411	P.S.U. RR 9121	T. RX

T. FILTER – RT 7202
TR – 6F 3B – ZS 2411
P.S.U. – RR 9121
RX (AMP) – RR 2002 C
(FILTER) – RT 61X0.
X = 1 to 6 = f 211 to 216 respectively.

LOCATION MOUNTING OF EQUIPMENT



P.S.U. – RR 9121 – WILL FEED 2 SETS OF RX EQUIPMENT (OF DIFFERENT FREQUENCIES)

TRACK RECEIVERS OF THE SAME FREQUENCY CAN BE MOUNTED TOGETHER PROVIDED THEY ARE "MIRROR IMAGED" AND NOT MOUNTED VERTICALLY ABOVE EACH OTHER.

e.g. A RX of the same frequency as one mounted at position 1 should be mounted in position 4 or alternatively in position 2. (only 2 RX's of the same frequency can be mounted in a location case).

RX's AND TX's OF THE SAME FREQUENCY MUST NOT BE HOUSED IN THE SAME LOCATION.

RX's OF THE SAME FREQUENCY MUST BE FED FROM DIFFERENT P.S.U.'s.

POINT DETECTION

WK. RX. P.S.U.	NK RX	RK RX	IMM. UNIT.	ISOL. TRAN.	NKR	RKR		NK TX	RK TX	WK. TX. P.S.U.
RR 9121			RR85XO	RR8200	ZS2411	ZS2411				RR 9121

P.S.U. - RR9121
RX (AMP) - RR2003C
(FILTER) - RR7XXO
IMM. UNIT - RR 85XO

ISOL. TRAN - RR 8200
NKR / RKR - ZS 2411
TX (AMP) - RR1002
(FILTER) - RR 4XXO

LOCATION MOUNTING OF EQUIPMENT

WK. RX. PSU	NK RX	RK RX	IMM UNIT	ISOL TRAN	NKR	RKR		NK TX	RK TX	WK. TX. PSU
	NK RX	RK RX	IMM UNIT	ISOL TRAN	NKR	RKR		NK TX	RK TX	

P.S.U. - RR9121 - WILL FEED 2 SETS OF TX OR RX EQUIPMENT (OF DIFFERENT FREQUENCIES)

POINT DETECTION EQUIPMENT IS MOUNTED BELOW ANY TRACK CIRCUIT EQUIPMENT MOUNTED IN THE SAME CASE.

IF POSSIBLE TYPE RR DETECTION UNITS SHOULD BE IN A DIFFERENT LOCATION TO TYPE RT TRACK TX UNITS. WHERE THIS CANNOT BE ACHIEVED DETECTION EQUIPMENT MUST BE AT LEAST 2 ROWS BELOW THE TX UNITS WITH THE C.V.T. A FURTHER 6" (MIN.) BELOW THE DETECTION EQUIPMENT.

IMM. UNIT - RR 8510 IS USED WITH RX (FILTER) UNITS RR 7010 TO RR 7070.
- RR 8520 IS USED WITH RX (FILTER) UNITS RR 7080 TO RR 7160.

TRANSMITTER AND RECEIVER FILTERS ARE ALWAYS USED IN PAIRS - RR 4010 AND RR 7010. RR 4020 AND RR 7020 etc.

ALL DETECTION EQUIPMENT IN ANY ONE LOCATION CASE MUST BE OF DIFFERENT FREQUENCIES.

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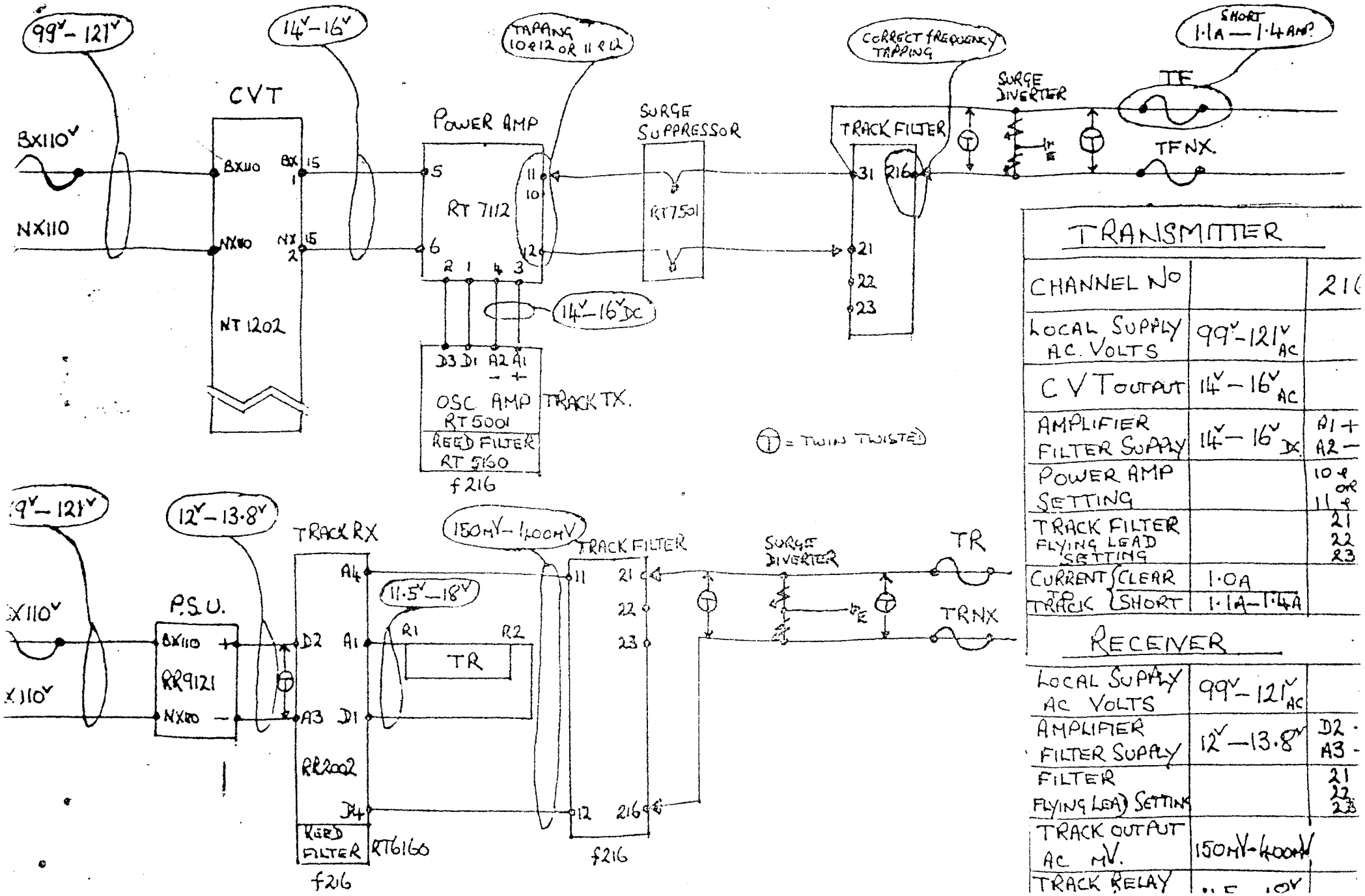

TRANSMITTER

CHANNEL NO		216
LOCAL SUPPLY A.C. VOLTS	99V – 121V AC	
C V T OUTPUT	14V – 16V AC	
AMPLIFIER FILTER SUPPLY	14V – 16V DC	A1 + A2 –
POWER AMP SETTING		10 & 12 OR 11 & 12
TRACK FILTER FLYING LEAD SETTING		21 22 23
CURRENT TO TRACK { CLEAR / SHORT }	1·0A / 1·1A – 1·4A	

RECEIVER

LOCAL SUPPLY AC VOLTS	99V – 121V AC	
AMPLIFIER FILTER SUPPLY	12V – 13·8V	D2 + A3 –
FILTER FLYING LEAD SETTING		21 22 23
TRACK OUTPUT AC mV.	150mV – 1400mV	
TRACK RELAY		