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AUTOMATIC KEYING DEVICES, TYPE I, IA, IB, and IC

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Chapter I

AUTOMATIC KEYING DEVICES, TYPE I, IB and IC

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INTRODUCTION

General

1. The automatic keying devices, Type 1, 1 B, and 1 C (Stores Ref. 10G/15694), have been designed for use with beacon transmitters. The function of the keying device is to provide a mechanical means of keying the beacon transmitters, periods of transmission of beacon signals being interrupted at regular intervals for a predetermined short time period. During the period of interruption the device will cause an identification signal, normally consisting of a three-letter morse code, to be radiated.

2. During the period in which the code signalling is to take place, the speed of the keying device has to be very carefully adjusted. When discussing the setting-up of a call-sign and spacings on a coded impulse sender, it is necessary to define code transmission speed with greater accuracy than the arbitary term *words per minute* permits. In signalling, a unit known as a *baud* is used and this unit is defined as the time duration of the shortest element used in the code employed. Thus in the case of the morse code, a baud is the time duration of a *dot* this being the shortest element used for both keying and subsequently stopped, at the same position from which it started, when one revolution has been completed. The morse wheel revolves in an anti-clockwise direction (as viewed from above) being driven by the motor, through gearing.

Wiper arm assembly

6. Two split pillars, supporting silver contact screws, are mounted on a paxolin base. To a third pillar is bolted the spring-loaded wiper arm, carrying silver contacts on the free end of the flat spring and having Tufnol wipers on the extremity of the wiper arm. The spring-loaded contacts register with the fixed contacts to form a morse key of which the normally closed *back*, or *space*, contact is on the left and the normally open *front* or *mark*, contact is on the right, the *tongue* being the moving wiper arm. The paxolin base is rigidly secured to a cast mounting which, in turn, is bolted to the top panel of the keying device. The position of the wipers relative to the morse disc is critical and may be adjusted by swinging the complete wiper arm assembly about its front fixing bolt, the rear fixing hole of the mounting being slotted. An eccentric, with slotted head, is mounted adjacent to the base of the assembly to provide a fine control of this adjustment which is fully described in *para. 48*.

7. The function of the morse wheel bauds and the associated wiper arm assembly is to cause the transmission of the required identification signals during the coding period. During rotation of the morse wheel, the bauds, all being equally dimensioned, are passing the wiper at a constant speed. Each baud may therefore be considered to be equivalent to the time duration of the shortest element, which in the case of the morse code is the *dot*. The wiper arm contacts are wired to the terminal block as follows.—

(1) Mark contact to terminal to Z1,

(2) tongue contact to Z2,

(3) space contact to Z3.

Terminal Z4 is the earth terminal. Since the morse disc revolves in an anti-clockwise direction, the code is set up, by working in a clockwise direction round the periphery of the morse disc. The code can be read back for checking purposes by viewing the morse wheel from above. The code transmission speed will of course depend on the speed of rotation of the morse wheel, and the relevant data for transmission speeds within the range of the keying device is shown in Table 1.

8. Every marking element must begin and end with an upper baud, and this condition **must** be observed whenever code is set up on the morse wheel. Upper bauds are therefore referred to as *marking bauds,* and the lower bauds are, generally, *spacing bauds,* but may also be used as marking bauds so long as they are **preceded by and followed** by upper OUT bauds, e.g. in a *dash.* The reason for this lies in the design of the Tufnol wiper, the upper section of which, being chisel-headed, will follow the contour of an upper OUT baud exactly and immediately. The lower section of the wiper however, has a broad face and its leading edge is advanced relative to the upper section. When therefore a *dash* has been set and is travelling past the wipers, the wiper arm will be operated to *mark* by

TABLE 1

Code transmission speed		Bauds per signal duration		Morse disc wheel speed	
Words per Minute (1)	Bauds per Second (2)	One second (3)	Two seconds (4)	Seconds per revolution (5)	Revolutions per per minute (6)
5	4·0	3	7	20·0	3·0
6	4·8	5	9	16·7	3·6
7	5·6	5	11	14·3	4·2
7½	6·0	5	11	13·3	4·5
8	6·4	7	13	12·5	4·8
9	7·2	7	15	11·1	5·4
10	8·0	7	15	10·0	6·0
11	8·8	9	17	9·1	6·6
12	9·6	9	19	8·3	7·2
13	10·4	11	21	7·7	7·8
14	11·2	11	23	7·1	8·4
15	12·0	11	23	6·7	9·0

incorporates the electromagnet, EM 1, the rectifier, RECT.1, and the resistor, R 3.

Motor, Type 63, (MTR 1)

13. This induction motor is designed to operate from a 200/250V. 50/60 c/s AC supply. The field magnet laminations are riveted together and bolted on to the front of the main casting, the bolt heads being visible through a hole in the cast end plate. The end plate protects the field coils and its fixing bolts pass through the laminations at each corner to hold the field magnet system rigidly in position. The field coil connections are brought out through a grommet and terminate on two tags eyeletted on to a paxolin panel which is mounted on the right-hand side of the motor. The 2,500-ohm resistor, R 4, and the 0·25 mfd. condenser, C 1, in series, are mounted on this paxolin panel and are connected across the field winding to provide power factor correction for the motor. The armature rotates between the field magnets and is immovably secured to the armature shaft, the main bearing of which is located immediately behind the armature. Lubricant is carried to this plain bearing by a felt wick from an oil hole, situated in the motor top plate directly above the bearing. The main end thrust is taken by a steel insert in the centre of a thrust plate which is bolted to the main end plate. The end thrust bearing is accessible for cleaning and for repacking with grease by removing the thrust plate, the main end plate being unbolted only if the field magnet system requires recentring around the armature. The shaft end, remote from the armature, rotates in a plain bearing which is a sliding fit in the main casting. A bolt, the head of which is accessible through a hole in the motor top plate, is secured down on to a "flat" on this movable bearing to lock it in the required position, With the end plate and thrust plate bolts tightened down, all residual end-play in the shaft is thus taken up by readjusting the position of this rear end bearing. Although it is necessary to have no apparent end-play, the shaft must still rotate freely in its bearing.

14. The rotation of the armature shaft is transmitted to the vertical motor spindle through a worm and worm wheel drive giving a reduction ratio of 14:1. A ball bearing let into the lower end of the spindle bears on a circular steel plate bolted into the bottom of the main casing, the plate being removed for cleaning and greasing of the bearing surface. The upper plain bearing of the spindle is carried by the motor top plate, and the 20-tooth motor drive pinion is pinned on to the upper end of the spindle. The motor top plate is located on the main casting by two projections on the top plate which register with the two corresponding holes in the casting, the top plate then being secured to the casting by four bolts. The top plate is removed for greasing of the worm drive and for the better observation of the governor gear. For speed regulation the centrifugal type of governor is employed, but without the normal friction control. A weight is fixed at the centre point of each of three flat springs, and one end of each spring is secured to a collar which is made fast by grub screws to the armature shaft, near to the worm. The other end of each spring is attached to the boss of the governor disc, the disc otherwise being free on the shaft. Rotation of the shaft causes the weights to swing outwards against the action of the governor springs, and the governor disc is thus drawn along the shaft, in the direction, away from the armature, for a distance which is proportional to the speed of rotation of the armature shaft. Access to the governor disc for cleaning purposes is provided by a hole in the bottom of the main casting, the motor name plate acting as a cover for this inspection point.

Spring set, Type 18 (K 1)

15. This component has one pair of normally closed heavy duty silver contacts, the required contact pressure being approximately 30 grammes. The fixed contact is mounted at each end of a rigid blade. The moving contact is mounted on a longer flexible blade, the end of which carries a brass stub on the same side of the blade. A felt pad of cylindrical form, lightly impregnated with oil, fits tightly over the stub, but is easily rotated or reversed on the stub, or replaced by a new felt pad, as and when wear occurs. The spring set, K 1, is fitted to the left-hand side of the motor on a carrier, the front member of which is bolted to the side of the main casting. A single fixing bolt passes through the spring set and secures it horizontally in a recess provided on the rear member of the carrier. The rear member is movable along guide pins attached to the front member, the relative lateral positions of the members being varied by rotation of a lead screw. The head of the lead screw motor winding. The voltage across the field windings is consequently appreciably lower than the normal value of 230 volts, and is only just sufficient to maintain rotation of the armature at a very low speed, i.e. below 200 r.p.m. In operation, assuming the motor speed regulator is set at some intermediate position and the AC supply is made available, the motor armature quickly attains the speed at which the contacts of K 1 are caused to open. The series resistance is then introduced and the armature speed begins to fall, but immediately it does so R 1 is cut out of circuit again by the contact K 1 and the armature speed picks up, only to be checked as before. This cycle is repeated indefinitely while the mains supply is available, the armature being unable to rotate at a high or lower speed than that desired. A condenser, C 1, and resistor, R 4, increase the power factor of the circuit to a value which eliminates sparking at the continuously operating contacts of K 1. Disconnection or failure of either of these components would be shown by the consequent pitted condition of the contacts which should, therefore, regularly be examined and wiped clean. For this purpose the single fixing bolt of the spring set is removed and the spring set is withdrawn from the motor, the mains isolating switch, S 1, having first been operated to the "off" position. Since the spring set, K 1, forms part of the mains supply circuit and is working in close proximity to the earthed motor governor gear, it is essential that the moving blade of the spring set be directly connected, through the switching to the "neutral" mains conductor. There exists, otherwise, the possibility of the governor springs burning through and snapping, and of the face of the governor disc becoming burnt and scored, causing excessive wear of the felt pad. It is, therefore, important that the mains supply be connected with the neutral lead to terminal Z 5, and, when fitting a replacement spring set, Type 18, the moving (rear) blade be connected towards the terminal Z 6. To assist in this and similar operations, all leads are colour-coded to agree with the circuit diagram which is fitted in the lid of the keying device.

Gear train for morse wheel drive

18. It is necessary that the motor, MTR 1 should drive the morse wheel spindle at chosen speeds varying between 3 r.p.m. and 9 r.p.m. (*Table 1*) a speed range of ratio 1:3. This speed range can be covered by the motor speed regulator, but the control then becomes critical at the lower speeds, and alternative drive ratios are therefore provided. The motor is thus enabled to rotate at a speed sufficiently high to ensure satisfactory speed regulation and adequate torque at all morse disc speeds. A 200-tooth gear wheel is pinned on to the morse wheel spindle and meshes constantly with an auxiliary gear train, driving the idling pinion of the gear train at a speed 20 times that of the morse wheel spindle. The gear train and the motor, Type 63, are mounted in such a manner that the 20-tooth motor pinion may engage either with the 200-tooth gear wheel or with the 20-tooth idling pinion, at will. In the first place, in which MTR 1 is said to be in POSITION 1, a step-down motor pinion morse wheel drive ratio is obtained, this being suitable for code transmission speeds above 7·5 w.p.m. In the second place, in which MTR 1 is said to be in POSITION 2, the step-down motor pinion/morse wheel drive ratio is 20:1 and this ratio is to be employed for code transmission speeds of 7·5 w.p.m. and below.

19. The method of mounting the motor, Type 63, on to the keying device to provide these alternative drive ratios is as follows. At the rear, the motor top plate is located on a rigid shouldered collar which projects from the underside of the keying device sub-panel. Locknuts, with plain and spring washers, hold the motor firmly on to this pivoting point. Towards the front, the motor is similarly located on two collars, but these collars are rigidly mounted on a sliding flat bar which is sprung to the underside of the sub-panel. When moving the motor from one position to another, the gear teeth must be gently eased into full mesh which is obtained when the sliding bar comes against its appropriate end stop. A pointer, held under a motor top plate fixing bolt, indicates on a panel the motor "position" in use. For inspection or substitution, the motor, Type 63, is dropped away from the sub-panel after removing the nuts which secure the motor top plate to the locating collars. Alternatively, at the front, the lock nuts securing the sliding bar to the sub-panel are removed, the bar being left attached to the motor. For re-assembly, in the first event, the motor is more easily re-secured to the collars if the spring set, Type 18, is temporarily removed from the motor. In the second instance, the rear fixing is re-secured first, the bar then being tightened up to the sub-panel equally on both sides until

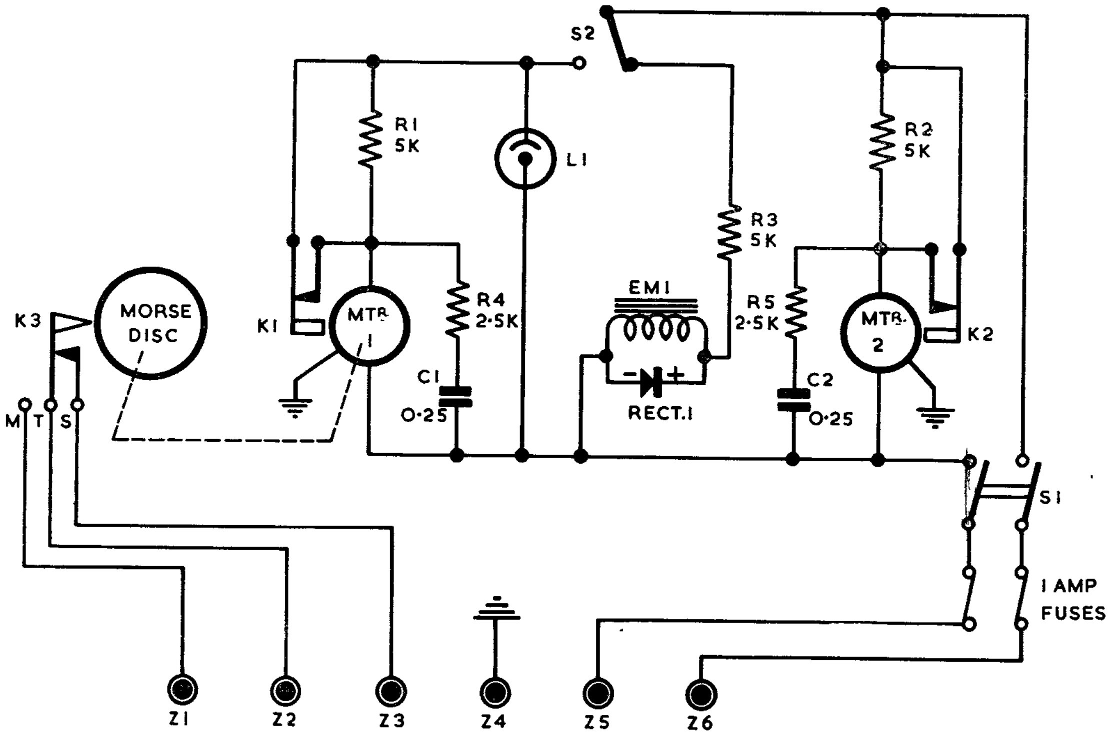


Fig. 8. Circuit diagram

panel control is not calibrated, but, instead, a stroboscopic timing device is provided to give an exact visual indication of six standard code transmission speeds, namely:—5, 6, 7·5, 10, 12 and 15 w.p.m. The stroboscope disc revolves below the top panel at a speed 40 times that of the morse wheel, being driven through the gear train which is bolted on the sub-panel to the left of the 200-tooth morse wheel gear. Below the stroboscope disc there is positioned the 0·5 W. neon lamp, L 1, which is connected in parallel with the power supply to MTR 1. Above the stroboscope disc, in which six circular rows of holes are drilled concentrically, an engraved sector place is mounted. Each of the six sectors of the sector plate may be viewed, in turn, through an aperture in the top panel, by rotating a milled knob located at the right of the aperture. In each sector a slot is cut to coincide with one of the circular rows of holes in the stroboscope disc. When the morse wheel is rotating at a speed equivalent to the code transmission speed (engraved on the exposed sector) the light of the lamp, L 1, appears in the aperture as a series of "stationary dashes". It must be noted that the *stationary dash* effect will also be obtained at morse speeds which are equivalent to *sub-harmonics* of the indicated fundamental speed. Since, however, the physical length of the *dash* produced is proportional to the morse disc speed no difficulty in selecting the correct (fundamental) speed will be experienced if:—

(1) the motor MTR 1 is placed in the position indicated on the exposed sector;

(2) the morse speed knob is then adjusted until *stationary dashes* of the **greatest length obtainable** are reproduced.

The stroboscopic indications are true when the keying device is operated from a 50 c/s. AC power supply. If a supply of this periodicity is not available, or a temporary failure of the lamp L 1 occurs, the checking of the code transmission speed is effected by referring to Table 1, columns (1) and (5) and then timing a complete revolution of the morse disc. It will be appreciated that, apart from its primary purposes, the lamp L 1, since it is switched on and off with the motor MTR 1, provides a check indication of the correct electrical functioning of the change-over switch S 2.

Brake assembly

21. At the completion of each revolution of the morse disc the power supply to MTR 1 is cut off. The momentum acquired by the moving parts of the system will, however, cause the continued rotation of the morse wheel through an angle which would vary with the code transmission speed and would approach 90 degrees at 15 w.p.m. This effect, termed *over-run*, would, of course, result in incorrect code transmission. Such excessive over-run is therefore prevented by the provision of a friction brake which is applied to the rim of the stroboscope disc when the supply to MTR 1 is cut off. The brake is operated from the motor power supply to which it is connected through the change-over switch, S 2 (*para. 10*). The power supply being available at the brake assembly, the voltage is dropped to a suitable value by the resistor, R 3, and is then applied to a parallel circuit comprising the half-wave metal rectifier, RECT.1, and the coil of the electro-magnet, EM 1. Uni-directional current is thus passed through the coil of EM 1, and the armature is permanently attracted to the pole face. The armature is normally held away from the pole face by the action of a flat spring on the free end of which is mounted the replaceable felt brake pad. Consequently, attraction of the armature causes the felt pad to be moved towards the rim of the stroboscope disc, the armature just touching the pole face as the felt pad is firmly applied to the disc. The resistor, R 3, and the rectifier RECT.1 are mounted upon a paxolin panel which is bolted to the front and the electro-magnet to the rear, of the L-shaped bracket for the assembly. The bracket is secured to the underside of the sub-panel by two bolts. Slots cut in the bracket for these bolts allow the complete assembly to be withdrawn for inspection, or re-positioning on the sub-panel, by which means the efficiency of the braking action may be varied. In operation, a small amount of over-run is essential since the morse disc spindle striker pin must always be allowed to clear its bell crank to provide for the subsequent operation of the change-over switch, S 2, by the cycle-timing wheel striker pin. At a code transmission speed of 15 w.p.m. the over-run should not be less than 9 degrees (=2 bauds) and not more than 22·5 degrees (=5 bauds). Thus adjusted, the run-over allowed will be satisfactory at all other code transmission speeds. It will be noticed that a small braking force is constantly applied to the 200-tooth gear wheel by the spring-loaded felt pad which is supported from the right-hand gear train. This constant braking force assists in the smooth and steady rotation of the morse wheel.

Drive unit for cycle-timing wheel

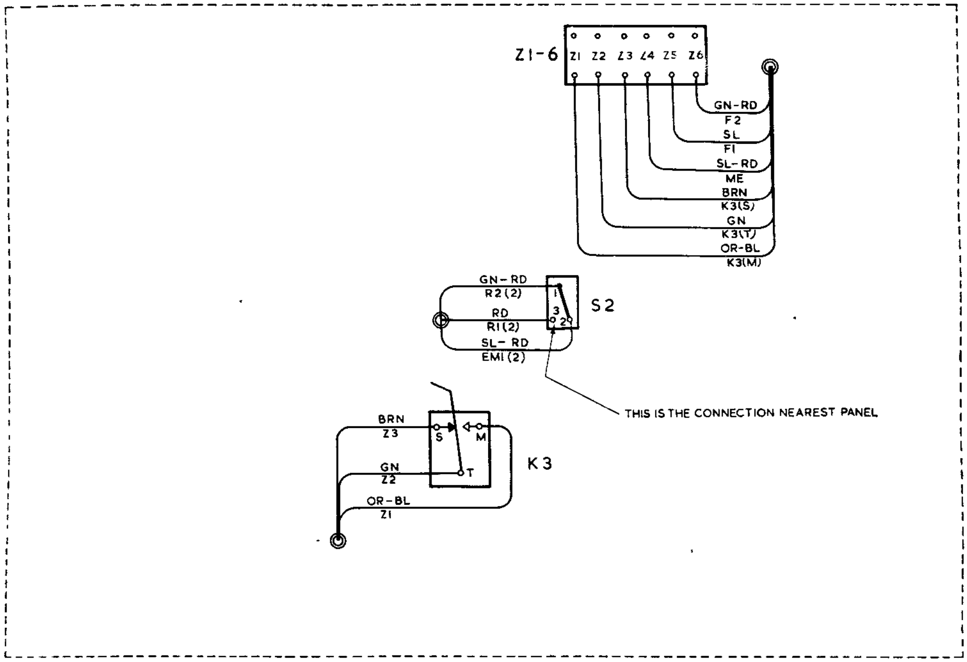
22. This unit comprises:—the motor, Type 63 (MTR 2) which is fitted with the spring set, Type 18 (K 2) resistor R 5, condenser C 2, resistor R 5 and the gear train for friction plate drive.

23. This unit is essentially a duplicate of the morse wheel drive unit. The motors MTR 1 and MTR 2, spring sets K1 and K 2, resistors R 1 and R 2, resistors R 4 and R 5, and condensers C 1 and C 2, are, respectively, interchangeable, performing exactly similar functions in the two drive units. The brake assembly, stroboscope speed indicator and panel control for motor speed regulator are not provided for the cycle timing drive unit. The motor, MTR 2, mounted in the same manner as is MTR 1, drives the friction plate spindle either directly, giving a step-down ratio of 10:1 (POSITION 1) or through the auxiliary gear train, giving a step-down ration of 40:1 (POSITION 2). By adjustment of the motor speed regulator, the screw-driver slot being employed for this purpose, the motor pinion is timed to revolve continuously at a speed of 70 r.p.m. The motor MTR 2 thus causes the friction plate to revolve at the required speed of 7 r.p.m. and 1·75 r.p.m. when it is placed in POSITION 1 and POSITION 2 respectively. The friction plate and motor pinion speeds are those which normally produce an accurately calibrated cycle timing scale. Since factors such as the amount of wear of the friction tyre affect the calculated results, the speed of MTR 2 is preferably adjusted by observation of the speed of the cycle timing wheel, rather than the friction plate. The re-timing of MTR 2, normally unnecessary unless the spring set, K 2 has been disturbed, is therefore effected by first setting the pointer to any convenient scale mark and placing the motor in the appropriate position. The motor speed regulator is then adjusted until the cycle timing wheel makes one complete revolution in the period of time indicated by the pointer **when the keying device top panel is horizontal.** The correct motor speed having thus been obtained, all subsequent cycle timing operations are carried out by choice of motor position and by rotation of the control knob on the cycle timing carriage.

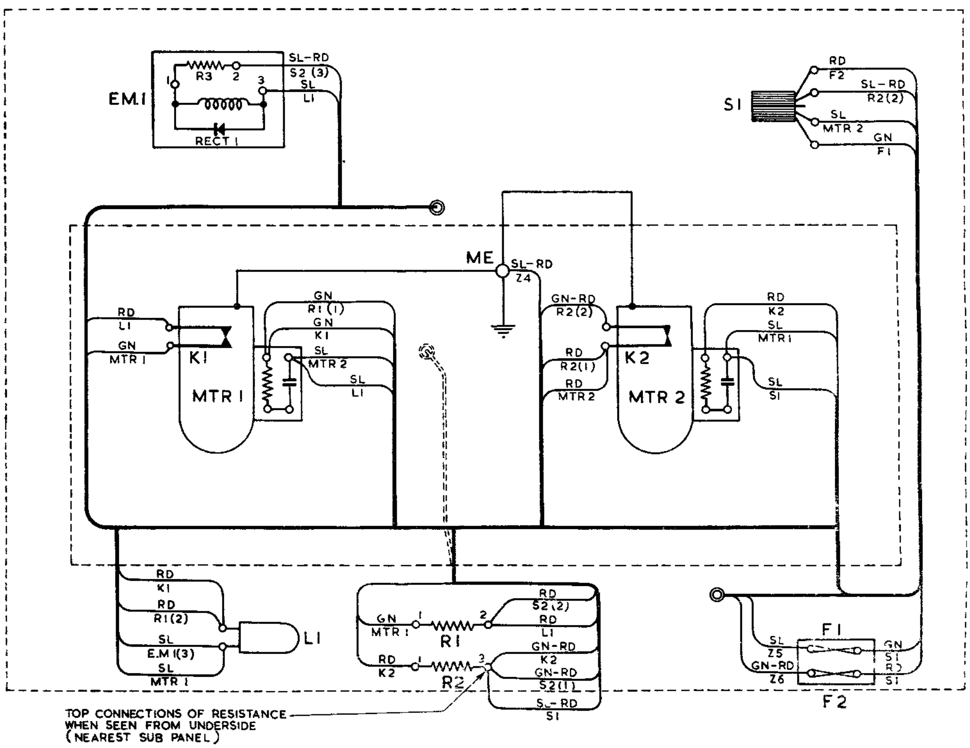
SETTING-UP MORSE DISC

"Mark" and "space" signals

24. As stated previously (*para. 8*) the following conditions apply:—



TOPSIDE VIEW



UNDERSIDE VIEW

Fig. 9. Bench wiring diagram

TABLE II

Morse signal	Relative Time value	Obtained by
Dot	1 unit	1 upper baud OUT
Space betwen elements of a letter	1 unit	1 lower baud IN
Dash	3 units	3 adjacent bauds OUT (2 upper and intermediate lower)
Space between letters of a group	3 units	3 adjacent bauds IN (2 lower and intermediate upper)

(1) Bauds in the OUT position produce *mark* signals and bauds in the IN position produce *space* signals.

(2) Every morse element set up must commence and finish with an upper baud.

Morse characters

25. For the correct setting-up of morse characters the time values in Table II must hold, and, from *para. 24* (*1*) and (*2*), will be given only by the combination of bauds shown.

The illustration, *fig. 7*, shows how a specimen call-sign DTA is correctly set up to satisfy the foregoing conditions. It will be noted that this example occupies a total of 21 bauds. The reason for the condition (2) of *para. 24* will be the more clearly appreciated if two adjacent bauds, one upper and one lower, are placed in the OUT position.

The resulting *mark* signal will have a time-value **not** of $2 \times 1 = 2$ units, but of $2\frac{1}{2}$ units approximately.

26. Even with correctly set-up bauds, a wiper arm incorrectly positioned relative to the morse disc will cause incorrect morse to be sent by upsetting the equal time relationship that should exist between unit *mark* and *space* signals. If the arm is too close to the disc, *mark* signals will be longer and equivalent *space* signals correspondingly shorter than their correct (that is, equal) values. Procedure for checking this is set out in *para. 47*.

SETTING-UP "LONG-MARK" AND "SPACE" SIGNALS

27. Bauds remaining unused after any chosen call-sign has been set up, are utilized to produce the *long-mark* signal and also the *space* signals separating the call-sign from the *long-mark*. For standard morse spacing, seven IN bauds will be required at each end of the call-sign, but alternatively, to produce a space signal of an approximate given duration at any specified w.p.m. speed, the number of IN bauds required is to be calculated from column (2) of Table 1, practical examples derived from this are shown in columns (3) and (4) of that Table. It will be noted that these are invariably given to the nearest **odd** number of bauds, to comply with the condition (2) of *para. 24* It will also be noted that references to numbers of bauds greater than one always imply a block of adjacent (that is, upper plus-lower) bauds.

28. Having determined the numbers required for each *space* signal, these two blocks of IN bauds are set up immediately before and after the call-sign. An arc of bauds will then remain still unallocated and all these are placed in the OUT position to produce a *continuous-mark* signal. For example, if a two-second space is specified before the call-sign shown in *fig. 7* and a one-second space after it, and the sending speed is to be $7\frac{1}{2}$ w.p.m. then eleven IN bauds will appear on the anti-clockwise or leading side of call-sign and five IN bauds on the clockwise, or trailing side. Consequently the *long-mark* block will occupy a total of $80-(11+21+5)=43$ OUT bauds. Thus the timing of this example will be:—

Signal	Bauds occupied	Duration of signal at $7\frac{1}{2}$ w.p.m.
Space before call-sign	11	$1\frac{5}{6}$ seconds
Call-sign	21	$3\frac{1}{2}$ seconds
Space after call-sign	5	$\frac{5}{6}$ seconds
Long-mark	43	$7\frac{1}{6}$ seconds
Totals (1 revolution of morse disc)	80	$13\frac{1}{3}$ seconds

29. It is impossible to obtain a cycle-time less than $13\frac{1}{3}$ seconds at $7\frac{1}{2}$ w.p.m., and minima for other call-sign speeds are also shown in Table 1 column (5); but, by halting the morse disc each time it completes one revolution, with wiper arm resting on the *long-mark* block, and subsequently restarting the disc after a predetermined interval, cycle-times greater than the minima (within the limits of 15 and 240 seconds approximately) are obtained, and the correct increased duration of the *long-mark* signal is automatically provided without calculation. For, assuming that a cycle-time of one minute is called for in the example being worked out, then the cycle-timing wheel is adjusted to revolve (and so to trigger the morse disc) once every 60 seconds. The wheel and disc are thus revolving simultaneously for $13\frac{1}{3}$ seconds and the wheel alone for $(60\text{-}13\frac{1}{3})=46\frac{2}{3}$ seconds. The duration of long mark is, therefore, the original $7\frac{1}{6}$ seconds plus the added $46\frac{2}{3}$ seconds $=53\frac{5}{6}$ seconds, which with $3\frac{1}{2}$ seconds for call-sign and $2\frac{2}{3}$ seconds for spacings makes up the required cycle-length of 60 seconds.

Setting-up identification call-sign

30. Slacken off milled nut securing morse wheel and with both hands lift disc slightly, with an anti-clockwise motion, out of engagement with locating pin on spindle giving access to all bauds.

Note . . .

In an anti-clockwise direction ONLY, to avoid damage to wiper arm, etc.

Having first put all bauds IN commence setting-up required call-sign at the upper baud indicated by engraved line on morse disc, proceeding in accordance with *para. 25* and working round the disc in a clockwise direction. Next provide for the space signals as described in *para. 27*. Continue turning morse wheel anti-clockwise until it falls into engagement once more with locating pin and tighten down centre nut. The device should now be switched on, and a check made that each time the morse wheel comes to rest, the wiper arm is held to mark by some part of the *long-mark* block of OUT bauds, but it may so happen that the wiper arm travels off the *long-mark* and into *space* when the disc stops, and if this is not due to faulty electro-magnet brake adjustment, the setting-up must be effected again. In repeating this setting-up, however, the call-sign must start, not at the engraved line on the morse disc, but at some other upper baud removed from it in anti-clockwise direction, at a distance rather greater than that which the wiper travels into the *space* block. Thus, it is not essential to commence setting-up at the engraved line, but it will usually be found more convenient to do so.

Adjustment of speed controls

31. The device should be brought to its normal working temperature as follows:—

(1) Set morse disc motor to POSITION 2, and adjust speed to $7\frac{1}{2}$ w.p.m.

(2) Set cycle-timing motor to POSITION 1, and pointer to 15 seconds.

(3) Switch on and allow to run for 20-30 minutes.

Having brought the device to its normal working temperature, set up motor positions, stroboscopic sector plate and cycle-timing pointer, as required for operational purposes. Check cycle-duration by direct timing and call-sign speed by stroboscope if possible, otherwise by direct timing. It will not be necessary to go through this lengthy procedure to ensure correct timing each time the device is brought into use, but if large mains voltage variations are to be expected or wide variations in atmospheric temperature are encountered, it will be advisable to make frequent timing checks.

PRECAUTIONS AND SERVICING

General Precautions

32. At all times, except when making adjustments, the lid of the cabinet is to be kept closed to protect the components from dust and damage. The periodically necessary removal of dust is only to be effected by means of a soft brush, since the use of dusting cloths is liable to cause damage to, or misalignment of, working parts.

Note . . .

The morse disc is never, for any reason, to be rotated in a clockwise direction.

33. Before the morse disc is lifted from its spindle, or replaced thereon, all bauds must be placed in the IN position. After replacing the morse disc it should be rotated by hand until the groove in the boss locates with the pin in the spindle.

Daily | Servicing – First line

34. Lubricate the points indicated on the lid chart, applying one drop of oil to each point. A container for oil, complete with "dropper", is fixed to the front left-hand corner-block of the cabinet. Take particular care, when lubricating parts of the cycle-timing carriage, to keep the friction tyre wheel, and the face of the friction plate, completely free from oil. The locating fork and the groove in the friction tyre wheel, are to be ***greased,*** not oiled. Similarly, a protective grease film is to be maintained on the surfaces of the keyed shaft and the lead screws.

35. Make a superficial examination of the drive from MTR1 pinion to the morse disc, from MTR2 pinion to the friction plate and from the friction plate to the cycle-timing wheel. See that the motors are fully home in their correct positions. Lift the cycle-timing carriage, and rotate the cycle-timing wheel by placing a finger in the striker pin, to check for smooth and free rotation.

36. Run the keying and check the morse speed and the cycle-timing. Observe a couple of operations, noting the satisfactory mechanical operation of S2. Check the morse disc brake, EM1, by noting that the morse disc wheel "overrun" (*para.* 21) is not excessive.

Weekly servicing—second line

37. Operate the isolating switch, S1 to the OFF position, and then withdraw K1 from MTR1. Clean the contacts and the felt pad, using carbon tetrachloride and re-lubricate the felt pad, altering its position on the stub if this appears to be desirable from considerations of wear (*para.* 15). Clean off all oil from the face of the motor governor disc, to which access is obtained through the hole in the bottom of the motor casting (*para.* 14). Bolt K1 in position again, and then carry out a similar cleaning operation on K2 and on the governor disc of MTR2.

38. Lubricate the keying device in accordance with *para.* 34.

39. Effect the operations detailed in *para.* 35, particularly examining the friction tyre for signs of wear. The friction tyre can be changed, when this becomes necessary, by withdrawing the screw which is tapped into the right-hand end of the keyed shaft. The shaft can then be moved a small distance to the left, so that the old tyre can be taken off the shaft and the new tyre subtituted. If the complete friction-tyre wheel has been removed from the keyed shaft (this is unnecessary if tyre changing only is required) remember, in replacing, that the groove for the locating fork is to be on the left side of the wheel. The shaft is then moved back to the right, and the screw, with its plain washer, is screwed home into the right-hand of the shaft.

Note . . .

When withdrawing and replacing this screw, on no account should the friction tyre wheel be held as a means of preventing the rotation of the keyed shaft, otherwise the pin which keys the wheel on to the shaft may be sheared. The shaft itself, or the pinion on its left-hand end, should be gripped.

40. Whether the friction tyre is to be changed or not, ensure that adequate working clearances are provided between the friction tyre and the top panel, between the cycle-timing carriage and the top panel, and between the cycle-timing control knob and the 4 B.A. bolt which acts as its "lock". Check also that the bolts which secure the carriage and its bracket are secure, and that the carriage hinges freely at its working position.

◀**41.** Check the adjustment of the morse wheel brake as follows:—

(1) After operating the right-hand bell crank of S2, slowly rotate the morse wheel by hand and arrest the rotation as soon as the switch blade of S2 is heard to move to the right-hand contact. At this point make a distinguishing pencil mark on the periphery of the morse wheel to register with the reference pointer (upper wiper of K3).

(2) Rotate the morse wheel further by a small amount to clear the left-hand bell crank of S2.

(3) Then place MTR1 in POSITION 1, switch on the device and cause the morse wheel to make one complete revolution at a speed of "15 w.p.m.". When the morse wheel has been automatically halted, count the number of bauds by which the distinguishing mark has passed the reference pointer. If this is less than 2 bauds or more than 5 bauds, re-adjust the position of the brake assembly (*para.* 21) re-test with the top panel horizontal, until the permissible amount of overrun is obtained.

WARNING

Before handling the brake assembly, always place the switch S1 in the OFF position.

Monthly servicing—second line

42. The following will be required for monthly servicing:—

Testmeter Type D	10S/10610
or	
Testmeter Type F	10S/1
Gauges feeler English	1B/4299
Pins adjusting small	1B/3589

43. Ensuring that the switch S1 is in the OFF position:—

(1) Withdraw the fuse carrier with the fuses, F1 and F2.

(2) Disconnect the flexible speed regulator drive cable from both bosses, and withdraw K1 from MTR1.

(3) Drop MTR1 away from its fixings by either of the methods detailed in para. 19.

(4) Remove the motor top plate and the vertical drive spindle from the motor casting.

(5) Clean and repack with grease the two end bearings of the armature shaft.

(6) Replace the front end-plate.

(7) Replace the rear end bearing, adjusting and locking its position so that all armature shaft play is taken up.

(8) Clean the face of the governor disc.

(9) Spin the armature shaft by hand to test for free rotary movement and for clearance between armature and pole faces.

(10) Clean and re-grease the worm and worm wheel and the lower bearing of the vertical spindle. Replace the spindle.

(11) Clean the contacts and the felt pad of K1 with carbon tetrachloride, relubricate the felt pad and bolt K1 in position.

(12) Spin the vertical spindle and note the satisfactory operation of the governor gear.

(13) Clean and lubricate the upper bearing of the spindle, locate and bolt down the top plate on the casting.

(14) Refit the motor to the keying device.

(15) Reconnect the flexible speed regulator drive cable. (The construction of the motor is described in *para.* 13 *and* 14.)

44. Withdraw K2 from MTR2 and drop the motor away from its fixings. Effect the same operations as previously performed on K1 and MTR1.

45. Lubricate in accordance with instructions in *para.* 34.

46. Clean and adjust the wiper arm assembly as follows:—

(1) Remove morse disc, slacken off the split pillar screws sufficiently to unlock the contact screws, and screw the space and mark contacts away from the tongue.

(2) Clean all contact surfaces with carbon tetrachloride.

(3) Screw the space contact towards the tongue until contact is just established.

(4) Then secure the space contact in this position by retightening the split pillar screw.

(5) Insert the 0·004 in. feeler gauge (packed with the kit of "minor spares") between the tongue and mark contacts.

(6) Screw up the mark contact until the feeler gauge is lightly gripped and lock the mark contact in this position.

(7) Check the contact gap after locking.

(8) Replace morse disc and set up continuous dots by placing all upper bauds **OUT** and all lower bauds **IN.**

(9) Move MTR1 into POSITION 1.

(10) Rotate the morse speed control knob fully counter-clockwise.

(11) Replace fuses F1 and F2 and raise the cycle-timing carriage right back.

(12) Unsolder the lead from the mark contact pillar and move it out of position.

(13) Set a testmeter to its lowest DC ohms range and connect across the tongue and mark contacts of K3.

(14) Switch on the keying device and cause the morse disc wheel to rotate continuously at its maximum speed (over 15 w.p.m.) by steady but light hand operations of the right-hand bell crank of S2. A pulsating reading will be observed on the testmeter. Note the maximum and minimum readings over several revolutions.

(15) Repeat the processes detailed in (14) above with the testmeter connected across the tongue and space contacts. The readings should be the same as those obtained in sub-para. 14.

(16) If the readings are dissimilar slightly slacken the bolts which secure the bracket of K3 to the top panel.

(17) Move the bracket by slightly rotating the provided eccentric counter-clockwise with a large screwdriver, while at the same time note the comparative readings obtained across each side of the key K3 as the morse disc rotates.

(18) If the two sets of readings are not approaching each other in value, rotate the eccentric fully clockwise, draw back the bracket by hand and commence adjustment as detailed in sub-para. 17 above.

(19) When the correct position has been found tighten down the bolts which secure the bracket and make a final comparative test.

(20) Disconnect the testmeter, resolder the lead removed in the operation detailed in sub-para. (12) and restore all bauds to the IN position.

Three-monthly servicing—second line

47. The following will be required for three-monthly servicing:—

Testmeter Type D	10S/10610
or	
Testmeter Type F	10S/1
Gauges feeler English	1B/4299
Pins adjusting small	1B/3589

48. Effect the operations detailed in paras. 34 to 45 then proceed as follows:—

(1) Remove the morse disc from its spindle and take off the cover of the switch assembly S2.

(2) See that the upper bearing of the morse wheel spindle is rigidly secured to the panel.

(3) Place MTR1 in neutral gear by slackening off the lock nuts either side of the 200 tooth gear wheel and moving it to a position intermediate between POSITION 1 and POSITION 2.

(4) Support the top panel with a 2 in. block placed centrally underneath it.

(5) Using the stroboscopic disc as a *fine control* rotate the morse disc spindle by hand to fully operate the left hand bell crank of the switch assembly.

(6) Check that the clearance between the back stop and the bell crank is $\frac{1}{16}$ in. If this is not so adjust the eccentric back stop so that the correct clearance is obtained.

(7) Operate the bell crank by hand to the right till the limit of travel governed by the internal switch blade of S2 is reached.

(8) Hold the bell crank lightly in this position and cause the spindle striker pin to pass the bell crank.

(9) Vary the overall length of the push rod until the striker pin can **just** pass the bell crank without causing the rod to travel further to the right. The length of the push rod is varied by altering the projection of the screw tapped into its right-hand end, a cranked pin being inserted in a hole drilled in the rod to enable the locking nut to be loosened and re-tightened after adjustment.

(10) Allow the bell crank to return to its back stop and operate the right-hand bell crank.

(11) Slowly rotate the morse disc wheel spindle past the switch operating point. The switch blade should be heard to move to the right-hand contact when the push rod has completed half its normal travel of $\frac{1}{16}$ in. After prolonged wear full push rod travel will be unobtainable even though the back stop is at its maximum left-hand position. When this occurs rotate the back stop 180 degrees to its maximum right-hand position, then reduce the overall length of the push rod until the required travel of $\frac{1}{16}$ in. is obtained when the bell crank is operated by hand.

(12) Slightly loosen the three bolts which secure the top of the assembly to the panel and vary the position of the assembly relative to the morse wheel spindle until, with the bell crank held over to the right, it is just possible for the striker pin to pass the bell crank.

(13) Re-secure the assembly to the top panel and check the adjustment as described.

49. Examine the connections to micro-switch S2 and check with a testmeter that contact resistance is negligible.

Note . . .

To renew the micro-switch S2 unsolder the three connections, noting their positions, and remove the two 4 B.A. securing nuts. After renewal replace connections as found.

50. Place MTR2 in neutral gear and proceed as follows:—

(1) Check that switch S2 is operated by the right-hand bell crank when the friction plate is operated manually.

(2) Hold the right-hand bell crank by hand so that the plunger is moved to the left as far as the internal switch blade allows.

(3) Rotate the friction plate by hand and note that the striker pin is just able to pass the bell crank without causing a further movement.

(4) If necessary vary the projection of the striker pin from the cycle-timing wheel to obtain this position, relocking with the nut provided.

(5) Release the right-hand bell crank and operate the left-hand bell crank by hand.

(6) Rotate the friction plate by hand and check that the switch blade is heard to move to the left-hand contact before the angular movement of the bell crank is complete.

(7) Lubricate the push rod and bell crank bearings then replace the switch assembly top cover securing it with the two 4 B.A. securing nuts.

51. Secure MTR1 and MTR2 in their normal operating positions and replace the morse disc spindle.

RENEWAL OF COMPONENTS

General

52. No difficulty should be experienced mechanically or electrically, in changing any unserviceable component if reference is made to the appropriate section of the general description and the servicing schedules. In some cases it will be obvious that the change of a component or portion thereof will necessitate the re-adjustment of the complete assembly of which the changed item forms part. As an example the replacement of the "tongue" of K3 (springs, contact, Ref. No. 10G/13046) necessitates the re-adjustment of the wiper arm assembly (*para.* 45) before the keying device is once more ready for service. Again when renewing either K1 or K2 tests are to be made to ensure that the spring set functions as described in *para.* 15.

53. A schedule of replaceable components is given in the appendix A. Certain of these components are supplied, as a kit of minor spares, with the keying device. The kit comprises:—

Item	*Ref. No.*	*Nomenclature*	*Qty.*
1	10G/13050	Contact screw	2
2	10H/9613	Fuse Type 5	2
3	10F/1621	Spring set Type 18	1
4	10F/–	Pad felt (for 10F/1621)	4
5	10G/13046	Spring contact (wiper arm)	1
6	10F/13101	Switch Type 807	1
7	10F/2669	Switch Type 1549	1
8	10G/4100	Band friction	3

Fault location

54. In the event of complete failure of the equipment the most probable cause will be a defective fuse F1 or F2 (*fig.* 8). Erratic operation of motors MTR1 or MTR2 will result if the contacts of spring sets K1 or K2, as appropriate, are functioning incorrectly. Defective braking will result from failure of components EM1, Rect 1, R3 or S2 (*fig.* 8). If the motor MTR1 fails to operate but motor MTR2 functions normally then failure of switch S2 is the most likely fault. ▶

APPENDIX A

Schedule of replaceable components—automatic keying device, Type 1 (10G/13033)

Ref. No.	Nomenclature	Detail	Position
10G/4100	Band friction	1 in. dia. × $\frac{1}{8}$ in. × $\frac{1}{8}$ in.	Friction tyre (cycle-timing drive)
10G/3557	Brake, electro-magnetic	—	EM1
10G/13050	Contact, screw	Fitted with gold-silver contact	Mark and space contacts of K3
10H/9613	Fuse, Type 5	1-amp. glass cartridge, $1\frac{1}{4}$ in.	F1, F2
10G/13250	Gear train, 4:1	—	Friction plate drive and stroboscope drive
10G/13251	Gear train, 2:1	—	Cam wheel drive
5LX/964104	Lamp, neon	200/260V 0·5 W BC	L1 (stroboscope)
10K/13102	Motor, Type 63 *including:—*	200/250V AC with 20-tooth pinion	MTR1, MTR2
10CZ/115510	1 condenser	0·25 m/f, 500V DC. wkg. tubular	C1, C2
10W/1215	1 resistor, Type 1215	2,500-ohms, 6-W, vitreous enamel	R4, R5
10F/1621	1 spring, set, Type 18	1 break complete with felt pad	K1, K2
10D/1521	Rectifier, metal, Type 153	Half-wave, rod type	Rect. 1
10W/8865	Resistor Type 2294	5,000-ohm, 10W with holder	R1, R2
10W/10795	Resistor Type 3580	5,000-ohm, 10W wire-wound	R3
10G/13046	Spring, contact	Arm, contacts and spring, complete	Tongue of K3
10F/2669	Switch Type 1594	D-P, on/off, toggle, 250V	S1
10F/13101	Switch Type 807	S-P, c/o, 3-way	S2
10G/13044	Wheel, gear, large	200-teeth	Cam wheel, drive, friction plate drive, cycle-timing wheel
10G/13045	Wheel, gear, small	20 teeth	Motor pinion. Cycle-timing pinion
10G/13047	Wipers	Tufnol, $\frac{3}{8}$ in. wide × $\frac{3}{16}$ in. thick	Bolted to tongue of K3

Chapter 2

AUTOMATIC KEYING DEVICE, TYPE 1A

(Stores Ref. No. 10G/1881)

AND REMOTE CONTROL, TYPE T

(10J/100)

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LIST OF ILLUSTRATIONS

INTRODUCTION

General

1. The automatic keying device, Type 1A, has been designed for use with radio track guide and beam approach main beacon transmitters, Types T.1122, T.1254, T.1345 and T.1451. The function of the keying device is to interrupt the transmission of track guide and beam approach signals at regular long intervals for a pre-determined short time period. During the period of interruption the device will cause an identification signal, normally consisting of a two-letter morse code, to be radiated in accordance with either of the two accepted systems of identification signalling applicable to those types of installations, viz. the *omni-directional* and the *alternate sector* system.

2. Both systems of identification signalling require that the 1150 c/s tone modulator of the transmitter be placed under the control of the keying device. The device must then provide for:—

(1) a continuous 1150 c/s tone during periods of track guide or beam approach signal radiation,

(2) cutting off the tone at the conclusion of these periods, and

(3) restoration in code rhythm during the time available for identification signalling.

It is principally in the control of the reflector relays during the period of code transmission that the two systems differ, as is explained in the following two paragraphs.

Omni-directional coding

3. During code transmission, the circuits of the normal keying contacts and of the normally-open *dot* (or "A") reflector relay-must be open, and the circuit of the normally closed *dash* (or "N") reflector relay must be closed. Both reflectors are thus inoperative and, the 1150 c/s tone having been cut off immediately prior to effecting the above changes in the reflector relay circuits, a high frequency unmodulated carrier wave with no selective directional properties is radiated by the main beacon transmitter. The unmodulated radiation should be maintained for a minimum period of one second before modulation in code rhythm is impressed on the carrier wave. This obviates confusion between the last radiated element of the approach signals and the first radiated element of the identification code. The selected identification signal may be radiated once or twice during each coding period, according to operational requirements, but, irrespective of whether a single or a repeated call sign is transmitted, both reflectors must be open throughout the total coding period.

Alternate sector coding

4. In this system, the selected call sign is invariably repeated during each code transmission period, one of the call signs being radiated in the *dot* (or "A") sector and the other in the *dash* (or "N") sector. Depending on operational requirements, the call sign may be required to be radiated either in the *dot* sector first, or in the *dash* sector first. It is normal to specify that the total two-call-sign coding period should occupy one-eighth of a minute (7½ secs.) irrespective of the length of the call sign. The keying device provides alternate sector coding service in accordance with the requirements outlined herein. The 1150 c/s tone will be controlled as described for omni-directional coding, and, similarly, the circuit of the normal reflector-keying contact will be broken throughout the complete coding period. The energizing circuits both of the normally-open *dot* reflector relay and of the normally-closed *dash* reflector relay will now, however, be open throughout the transmission of one call sign, and closed throughout the transmission of the other call sign. Thus, one call sign (not necessarily the *first* call sign) will be radiated with the reflectors held at "dash closed, dot open"; and the other call sign will be radiated with the reflectors held at "dot closed, dash open". The change-over of reflector relay conditions from *both open* to *both closed*, or vice-versa, is made to occur during the period of unmodulated carrier wave radiation which occurs between the transmission of the first and the second call signs.

5. From *para. 3* and *4* it will be appreciated that the omni-directional system has an advantage in that the duration of the coding period, being dependent only upon the length of the call sign and spacings required and the morse transmission speed employed, may be reduced to a minimum, particularly if the call sign is radiated once only. This system is consequently of value when applied to beam approach installations, where a long interruption of approach path signals may be considered prejudicial to air safety. The alternate sector system gives, however, additional navigational information. For example, the relative signal strengths at which the two call signs are received is a guide to the angular displacement, that is, relative to the main beacon site, of the aircraft with respect to the *QTE* or the *QDR*. Along the *QTE* and *QDR* the two call signs are, of course, received at equal intensities.

6. A remote control, Type T, operates in conjunction with either of the beam approach main remote control units, Type 35 and Type K, and gives the following facilities:—

(1) Starting and stopping the keying device, by which means either beam approach signals periodically interrupted by identification signals, or continuous beam approach signals without interruption may be obtained.

(2) Visual indication of the type of transmission actually being radiated by the main beacon transmitter, i.e. approach path (*beam*) or identification (*coding*) signals.

(3) Visual and audible warning of the occurrence of certain types of fault in the keying device itself or on the remote control lines over which it is operated.

(4) Open circuiting the main beacon fault alarm during coding periods.

Operation (4) is desirable since, when the transmission of beam approach signals is interrupted, no 1150 c/s tone indication is received by the main remote control unit and, normally, the fault alarm would therefore sound. Except as stated later, the keying device may still be operated, without modification, if its remote control unit Type T is not installed or, if installed, is unserviceable; in these circumstances intermittent sounding of the fault alarm may occur during each coding period. The remote control unit, Type T, *must* be installed *and* must be serviceable to the extent of performing operation (4) above if the beam approach installation is controlled by a main remote control, Type K, which has been modified to close down the main beacon transmitter automatically if the 1150 c/s tone return falls below a predetermined value.

7. The keying device, Type 1A, comprises essentially a mechanical impulse sender with associated cam plates and switch units for performing the various transmitter control functions. Thermal and magnetic relays are incorporated in the keying device but are employed only in connection with the remote control of the device. The mechanical impulse sender consists of a cam wheel which revolves at predetermined intervals, the interval being decided by the speed of rotation of a continuously revolving cycle-timing wheel. Within limits, which are indicated in *para. 177, 181* and *184*, any desired morse call sign may be set up on the morse wheel. The morse cam wheel and the cycle-timing wheel are separately driven by 200/250 volts 50/60 c/s, induction motors. Independent controls are provided whereby the morse transmission speed may be varied between 5 and 15 words per minute, and the cycle timing between ¼-min. and 3-minutes. The term *cycle timing* denotes that period of time in which a complete cycle of events takes place, the cycle comprising the periods during which is radiated:—

(1) The normal approach path signals.

(2) The unmodulated carrier wave, denoting that identification signalling is about to commence.

(3) The identification call sign or call signs.

(4) The unmodulated carrier wave, denoting that the full identification has been sent.

The *coding period* or *code sending period* is taken as being *not* period (3) alone but the total period of time occupied by (2), (3) and (4) together.

8. When discussing the setting-up of call signs and spacings on a coded impulse sender, it is necessary to define code transmission speed with greater accuracy that the arbitrary term *words per minute* permits. In signalling codes a unit known as a *baud* is therefore used, and this unit is defined as the *time duration of the shortest element used in the code employed*. Thus, in the case of the morse code, a baud is the time duration of a *dot* this being the shortest element used for both keying and spacing. It will be realized that if no code transmission speed is specified the time duration of a baud has a purely arbitrary value and use of the term in this sense simplifies the preliminary work involved in setting-up the code. When the code transmission speed is decided upon, the time duration of the baud will acquire a fixed value, but the value will be different for each different code transmission speed. The agreed relationship between code transmission speed and baud value is shown in TABLE II, *column* (*1*), (*2*) and (*3*).

GENERAL DESCRIPTION

General

9. The keying device (*fig. 1*) is contained in a wooden cabinet measuring approximately 1 ft. 4 in. in length and 10 in. in height and breadth, the metal-cased relay unit projecting a further 2½ in. to the front. The top of the cabinet is hinged to form a lid 4 in. deep, on the inside of which is affixed the lid chart, giving circuit and lubrication diagrams of the device. The sheet metal top panel of the keying device supports, either directly or through the sub-panel, all the components of the device. The top panel is hinged on to the back of the cabinet and is raised by means of a captive ring. It may be supported in the raised position by resting the struts, placed at each end of the sub-panel, against the corner blocks of the cabinet. The top panel should never be supported by one strut alone, and before the panel is lowered again, the struts should be folded right back against the sub-panel. Two terminal blocks are provided along the rear of the top panel, and the lid is slotted to allow the external connections from the transmitter to be made off on to these blocks. The keying device may be considered to comprise a number of simple independent units assembled together and working in a certain sequence. To arrive at a more comprehensive understanding of the operation of the keying device it is essential first to appreciate the purpose and function of each unit separately.

Morse wheel unit

10. This unit (*fig. 2*) comprises the following components:—morse wheel (8), wiper arm assembly, K3 (5), switch unit, Type 150, K1 (6), switch unit, Type 151, K2 (11), cam plates (10).

Morse wheel

11. The periphery of the morse wheel is divided into 80 equal parts, each part containing a radial metal slider which is referred to as a baud. From constructional considerations the bauds are arranged alternately in the upper and lower sections of the morse wheel. A pin is attached to each baud for use as a handle in placing it in one of two alternative positions, viz. projecting from, or withdrawn into, the edge of the morse wheel. The former is termed the *out* position and the latter the *in* position of the baud. The two positions must be positively located and a ball bearing is therefore pressed into indentations, formed in the baud, by the action of a flat spring extending from the centre of the morse wheel. The morse wheel should not in any circumstances be dismantled, as its assembly is essentially a factory operation. The morse wheel is rigidly secured to the morse wheel spindle by tightening down a milled nut on the spindle, after a groove in the boss of the morse wheel has been registered with a locating pin on the spindle. At intervals, the morse wheel is rotated at a predetermined constant speed and is subsequently stopped, at the same position from which it started, when one revolution has been completed. The morse wheel revolves in an anti-clockwise direction as viewed from above, being driven by the motor, MRT 1, through gearing.

The correct setting-up of a specimen call sign—*AJ*—is illustrated in *fig. 3* and *4*. Since the morse wheel revolves in an anti-clockwise direction, the code is set up by working in a *clockwise* direction round the periphery of the morse wheel. The code can be read back for checking purposes by viewing the morse wheel from above, as shown in *fig. 3*. The code transmission speed will, of course, depend upon the speed of rotation of the morse wheel, and the relevant data for transmission speeds within the range of the keying device is shown in TABLE II.

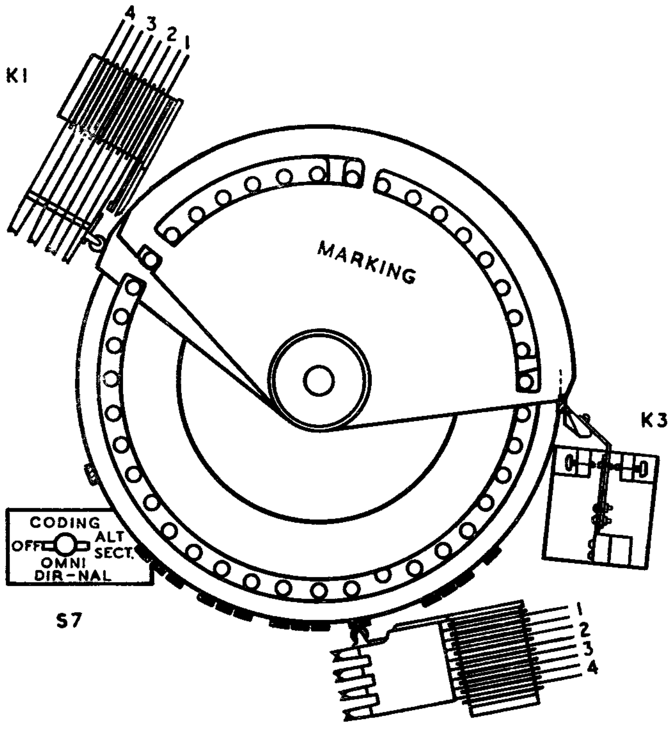


Fig. 3. Morse wheel

14. Referring to *para. 13* it will be noticed that every marking element is shown as beginning and ending with an upper baud, and this condition must be observed whenever code is set up on the morse wheel. Upper bauds are therefore referred to as *marking bauds* and lower bauds are, generally spacing bauds but may also be used as marking bauds so long as they are immediately preceded, and followed, by upper *out* bauds, for example, in a *dash*. The reason for this lies in the design of the Tufnol wiper, the upper section of which, being chisel-headed, will follow the contour of an upper *out* baud exactly and immediately. The lower section of the wiper however, has a broad face and its leading edge is advanced relative to the upper wiper. When, therefore, a *dash* has been set up and is travelling past the wipers, the wiper arm will be operated to *mark* by the leading edge of the first upper *out* baud. Before the upper wiper has travelled off this baud the leading edge of the lower wiper will have ridden on to the intermediate lower *out* baud. The lower wiper will continue to ride on the intermediate baud until the upper wiper has ridden on to the next upper *out* baud. Finally, the upper wiper will ride off the trailing edge of this baud and so allow the

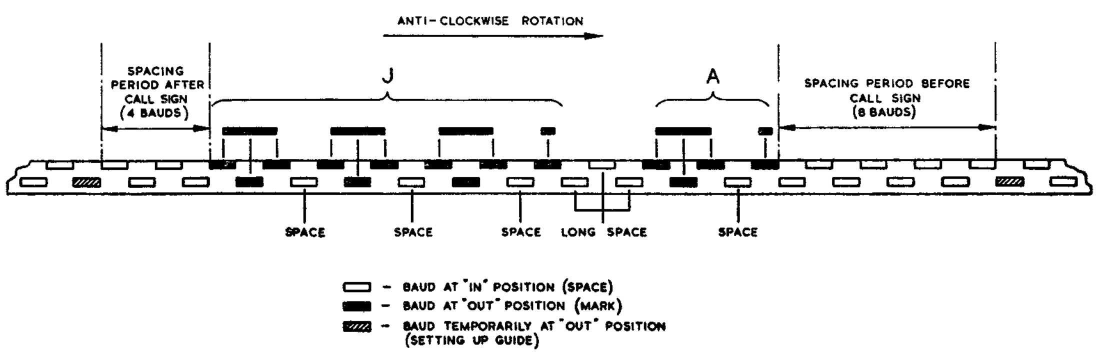


Fig. 4. Signal "AJ"

wiper arm to be restored to *space*, having been operated to *mark* for three complete baud lengths. The design of the wipers ensures a smooth "carry-over" between adjacent upper and lower *out* bauds. It is important to realise that the upper wiper is thus the "master" wiper, and the chisel point of this wiper is therefore used as a reference pointer when carrying out timing operations and tests.

TABLE II

Code transmission speed		Time duration of one baud in milli-seconds (3)	Morse wheel speed	
Words per minute (1)	Bauds per second (2)		Seconds per revolution (4)	Revolutions per minute (5)
5	4·0	250	20·0	3·0
6	4·8	208	16·7	3·6
7	5·6	179	14·3	4·2
7½	6·0	167	13·3	4·5
8	6·4	156	12·5	4·8
9	7·2	139	11·1	5·4
10	8·0	125	10·0	6·0
11	8·8	114	9·1	6·6
12	9·6	104	8·3	7·2
13	10·4	96	7·7	7·8
14	11·2	89	7·1	8·4
15	12·0	83	6·7	9·0

Switch units, Type 150 (K1) and Type 151 (K2)

15. The switch units each comprise an assembly of four contact pairs mounted upon a bracket which is bolted to the keying device top panel. The mounting positions of the switch units K1 and K2 are shown in *fig. 1* and *3* and the method of numbering their contact pairs for reference purposes is also indicated therein: for example, the designation "K1.4" indicates that pair of contacts on K1 which is farthest from the morse wheel. The four pairs of contacts of each switch unit all operate from their normal condition, in a certain sequence, when a Tufnol roller which is attached to the inner-most spring rides up the leading edge of the cam plate (*para. 18*).

16. The contact pairs return, in the reverse sequence, to their respective normal conditions when the roller rides down the trailing edge of the cam plate. The following are the functions performed by each contact pair of the switch unit K1, in the sequence in which the contact pairs operate, that is, when the roller rides up the leading edge of the cam plate:—

(1) Contact pair 1 (normally open)—operates a relay REL 2(Z) (*fig. 5*) and, hence, gives remote coding indication and provides a motor supply holding circuit, as described in *para. 101.*

(2) Contact pair 4 (normally closed)—cuts off the continuous 1150 c/s tone source, the contacts being, in effect, connected across the *tongue* and *mark* terminals of the wiper arm assembly K3.

(3) Contact pair 3 (normally closed)—opens the negative lead to the complete reflector relay DC circuit, thus rendering the normal reflector keying contacts ineffective and also allowing the *dot* reflector to open and the *dash* reflector to close.

(4) Contact pair 2 (normally open)—provides effects which are dependent upon the system of code sending in use, viz.—

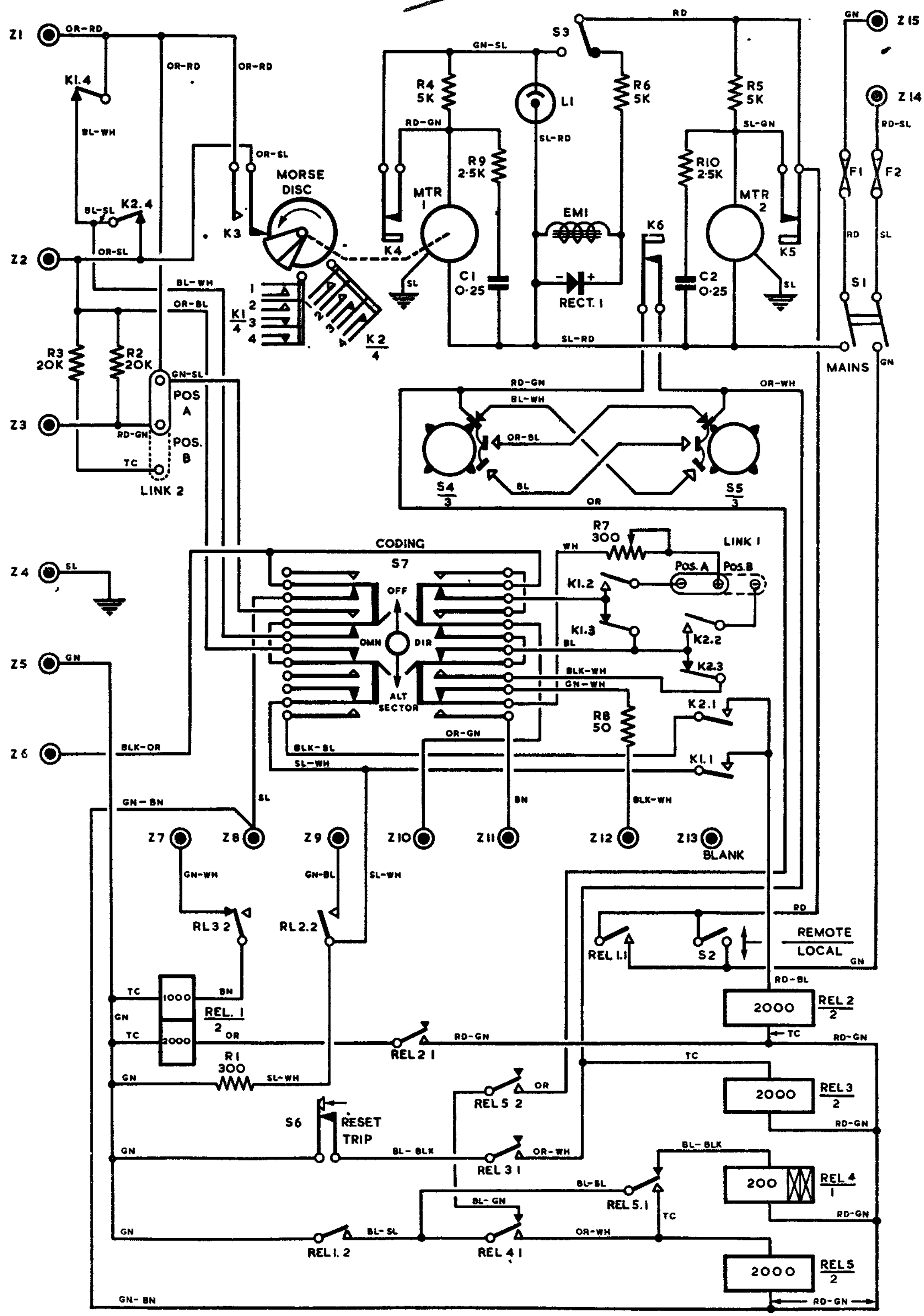
  (a) Omni-directional—provides a circuit for the normally closed *dash* reflector relay only, thus opening this reflector.

  (b) Alternate sector, first call sign in *dot* sector—provides a circuit for both the reflector relays, thus closing the *dot* reflector and opening the *dash* reflector.

  (c) Alternate sector, first call sign in *dash* sector—is electrically ineffective so that, since K1.3 is open, the *dash* reflector closes and the *dot* reflector opens.

The reasons for the transmitter circuits being affected in the sequence given will be self-evident, but the reason for the prior operation of the first contact pair is the necessity of introducing a time lag effect between the release of the fourth and first contact pairs upon the resumption of approach path signals. Reference to this effect is made in *para. 107.*

17. The function of the switch unit K2 (*fig. 5*) is to prepare for and then to hold the transmitter circuits in the condition required for the transmission of the second call sign when the alternate sector coding system is employed. All the contact pairs of this switch unit are electrically ineffective unless the coding switch, S7 (*fig. 5*) (*para. 24–27*) is in the ALTERNATE SECTOR position. Assuming this position of S7 to have been selected and the switch unit K1 still to be operated, Radio 4B.



T C. = TINNED COPPER WIRE

Fig. 5. Automatic Keying Device, Type 1A—Circuit Diagram

the contact pairs of K2 upon being operated from their normal positions perform the following functions in the order stated:—

(1) Contact pair 1 (normally open) provides a second circuit for the relay REL2(Z) which therefore remains operated after K1.1 has released, so maintaining the remote indication of the coding period and the motor supply holding circuit.

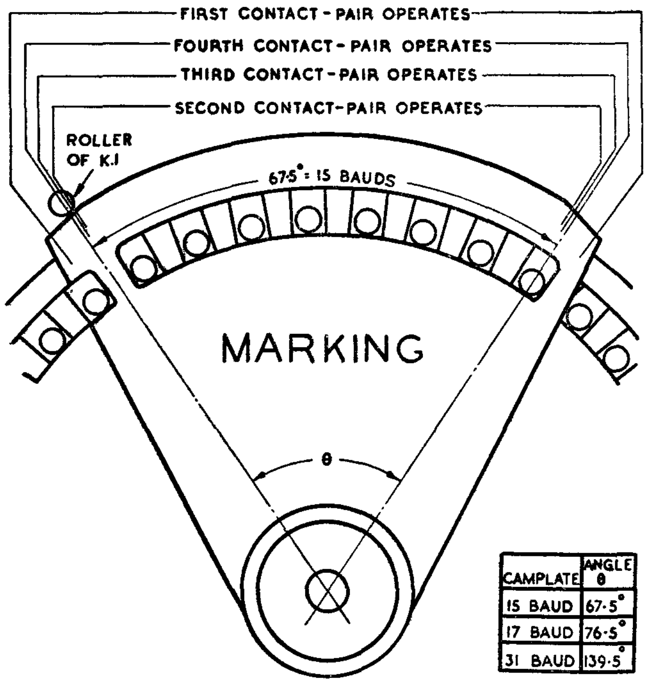
(2) Contact pair 4 (normally closed)—maintains the open circuit provided by K1.4 since the contact pairs K1.4 and K2.4 are now connected in series across the tongue and mark terminals of K3. The continuous 1150 c/s tone thus remains cut off even after the release of K1.4.

(3) Contact pair 3 (normally closed)—maintains the open circuit provided by K1.3 since the contact pairs K1.3 and K2.3 are now both connected in series with the negative lead to the complete reflector relay DC circuit.

(4) Contact pair 2 (normally open)—is electrically ineffective if the first call sign has been radiated in the "A" sector and, since K2.3 is open, it thus allows the second call sign to be radiated with the "N" reflector closed and the "A" reflector open. If however the first call sign has been radiated in the "N" sector, then the contact pair K2.2 will prepare a circuit for the two reflector relays. This prepared circuit will be completed when K1·3 releases; the "A" reflector will then close and the "N" reflector will open.

Cam plates

18. One 15-baud, one 17-baud and two 31-baud cam plates are provided with the keying device, the 15-baud cam plate being shown in position on the morse wheel in *fig. 6*. The cam plate is centred by passing the boss of the milled nut through the circular hole in the cam plate and is rigidly secured, after being located between the desired baud pins, by tightening down the milled nut. The cam plate rests on a loose distance piece, fitted in a recess in the centre of the morse wheel, which raises the rim of the cam plate to the level of the rollers of K1 and K2. Assuming



CAMPLATE	ANGLE θ
15 BAUD	67·5°
17 BAUD	76·5°
31 BAUD	139·5°

Fig. 6. Cam plates

the cam plate to be so secured, rotation of the morse wheel anti-clockwise brings the leading edge of the cam plate to the roller of K1. Further rotation of the morse wheel will cause the respective contact pairs of K1 to operate as the roller reaches the positions on the bevelled leading edge of the cam plate indicated in *fig. 6* which shows the roller in the position at which the fourth contact pair operates. The contact pairs will remain operated until the roller begins to run down the trailing edge, when they will be released to their respective normally-open or normally-closed conditions at the roller positions indicated. It will be seen that K1.4 is held *open* while the morse wheel rotates through an angle of 67·5 degrees which angle is equivalent to $\frac{67{\cdot}5 \times 80}{360} = 15$ complete bauds Thus, the transmitter modulation circuit is cut off while 15 complete bauds travel past the chisel-head of the upper wiper of K3, that is, for a time duration of 15 bauds.

19. The 17-baud and 31-baud cam plates will cause the operation of the contact pairs of K1 in precisely the same manner as described in *para. 18*, but the modulation circuit will be cut off for time durations of 17 bauds and 31 bauds, respectively. Each cam plate operates the switch unit K2 in exactly the same manner as K1, the contact operating

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positions shown in *fig. 6* applying equally to both switch units. Since, however, the roller of K1 *leads* the roller of K2 by an angle of 130·5 degrees (measured at the centre of the morse wheel) the operation of the contact pairs of K2 always lags behind the operation of the corresponding contact pairs of K1 by a time duration of $\frac{130 \cdot 5 \times 80}{360} = 29$ bauds.

20. The cam plates are engraved MARKING on the one face and SPACING on the other face. With the marking side uppermost, assuming K1 and K3 to be correctly positioned, the modulation will always be cut off (at leading edge of cam plate) and restored (at trailing edge of cam plate) by K1.4 at the moment when the upper wiper of K3 points to the leading edge and the trailing edge, respectively, of upper (i.e. *marking*) bauds. With the *spacing* side uppermost the modulation will always be cut off (at leading edge of cam plate) and restored (at trailing edge of cam plate) by K1.4 at the moment when the upper wiper of K3 points to the leading edge, and to the trailing edge, respectively, of lower (i.e. *spacing*) bauds.

Note . . .

It must not be inferred that the use of a cam plate with "marking" *side uppermost provides a marking signal. The terms engraved on the cam plates are not used in this sense or for this purpose but are solely intended to indicate the correct position of the reference pointer, relative to the "marking" and "spacing" bauds, at the operating or releasing positions of K1.4.*

21. The function of the switch units K1 and K2 and of the associated cam plates is to cause the interruption of the normal approach path signals for the complete coding period, and, during this period, to hold the reflectors in the condition required by the system of code sending in use. Further functions described in *para. 97–109* provide facilities

(1) for the coding period to be remotely indicated,
(2) for the main beacon fault circuit to be rendered inoperative, and
(3) for the power supply to the driving motors to be maintained throughout the coding period.

The interruption of the approach path signals is considered to begin at the moment when K1.4 is opened, and to end when K1.4 (for omni-directional coding) or K2.4 (for alternate sector coding) is allowed to close.

22. For the omni-directional coding systems the total period of interruption, which is variable according to the length of the call sign, etc., is first calculated in bauds. A cam plate which will hold K1.4 operated for this number of bauds, is made up by employing two suitable cam plates and overlapping them to the necessary extent. For an interruption of 15-baud lengths the 15-baud cam plate is used alone. For interruption periods between 17 and 30 baud lengths the 15-baud and 17-baud cam plates are used together. For interruption periods between 31 and 61 baud lengths the two 31-baud cam plates are used together. The cam plates must be employed in this manner to prevent the unequal wearing of the upper and lower halves of the Tufnol rollers of K1 and K2. By suitable positioning of the reversible cam plates on the baud pins, the interruption and restoration of the approach path signals can be made to occur as the upper wiper points to the leading, or the trailing, edge of selected bauds. Operating points would, of course, be selected with regard to the chosen position of the call sign on the morse wheel and the number of baud lengths of spacing desired before and after the call sign.

23. The requirements of alternate sector coding can only be met by employing a 31-baud cam plate (composed of the two 31-baud cam plates, completely overlapped) in conjunction with the two switch units K1 and K2. Assuming this cam plate to be rigidly located on the morse wheel and a revolution of the wheel begun, the approach path signals are interrupted as the leading edge of the cam plate reaches the operating position of K1.4. The rotation being continued for the equivalent of 29 bauds, the leading edge of the cam plate is now at the operating position of K2.4 and preparation for the necessary change in reflector conditions for the second call sign is then begun. A further rotation equivalent to two bauds brings the trailing edge of the cam plate to the position at which K1.4 is restored to its normal condition, when the new circuit arrangement prepared by K2 has just become effective. After revolving the morse wheel a further amount, equivalent to 29 bauds, the trailing edge of the cam plate reaches the position at which K2.4 closes, and the normal approach path signals are then restored. Completion of the revolution releases K2.1, and the cam plate leaves the roller. The conditions required for the transmission of the first call sign are thus held for the first $29 + 2 = 31$ bauds and those for the second call sign are held for the subsequent 29 bauds. The total period of interruption is equivalent to $31 + 29 = 60$ bauds, the time duration of which, at a code transmission speed of 10 words per minute, is 7·5 seconds, calculated from TABLE II.

Associated components

24. Associated components not forming part of the morse wheel unit, but in direct electrical association with its components are:—

(1) the coding system selector switch, S7,

(2) the two position links, LINK 1 and LINK 2,

(3) the resistors, R2, R3, R7 and R8.

The *coding switch*, S7, is a key-switch having four locking change-over contact sets on each side. It is secured to the top panel in the position indicated in *fig. 1* and *3* by four screws passed through the engraved mounting plate. Removal of these screws allows the key-switch to be drawn away from the top panel to the left, and all contacts are then accessible. The link, LINK 1, and the variable resistor, R7, are mounted on a paxolin panel which is bolted to the underside of the top panel, directly below the contact springs of the switch unit, K2. The link, LINK 2, and the fixed resistors, R2, R3 and R8, are mounted on another paxolin panel which is located in the bottom left-hand corner of the keying device. The link, LINK 2, and the resistors, R2 and R3, are associated with the modulation control circuits of the keying device, the purpose of the link being to connect the resistors in circuit in the manner appropriate for the control of any of the four beam-approach main beacon transmitters. The different modulation control circuit arrangements are dealt with in *para. 81–83, 88, 91* and *93–95*.

25. The coding switch, S7, in its right-hand position connects the contact pairs of K1 and K2 so that they perform the functions applicable to the alternate sector system of code sending, these functions being described in *para. 16*, (1), (2), (3) and (4 b/c), and *para. 17*, (1), (2), (3) and (4). With the link, LINK 1, bolted in POSITION A the switch, S7, in its centre position renders the four contact pairs of K2 electrically ineffective and connects the contact pairs of K1 so that they perform the functions applicable to the omnidirectional system of code sending, these functions being described in *para. 16*, (1), (2), (3) and (4a).

26. The required position of the link, LINK 2, may be tabulated as follows:—

TABLE III

Link I position

System of code sending	Required position of LINK I
Omni-directional	Position A
Alternate sector—	
First call sign in *dash* or N sector	Position B
First call sign in *dot* or A sector	Position A

In its left-hand or OFF position the switch, S7, renders the morse key, K3, and the contact pairs of K2 and K1 electrically ineffective, and provides permanent circuits for the normal reflector keying contacts and for the 1150 c/s tone source. The keying device may therefore be adjusted and serviced, and may be run up locally to observe its complete mechanical operation without causing any interruption of the normal approach-path signals radiated by the main beacon transmitter. In this CODING OFF position the switch, S7, also permanently breaks the negative supply lead to all the relays incorporated in the keying device and in the remote control, Type T, for the following main reasons:—

(1) The keying device being in an operationally ineffective state, it is necessary to indicate this fact remotely and also to withhold the remote control facilities.

(2) As it is inconvenient to set up the cam plates with the motor supply holding circuit connected, it is necessary to render this circuit inoperative.

27. During coding periods one or other of the two contact pairs K1.2 and K2.2 provides a circuit which permanently energizes one or both of the reflector relays. Depending upon the position of the coding switch, S7, this circuit includes:- the resistor R7; *either* the dot reflector relay *or* the resistor, R8 (each having a DC resistance of 50 ohms) and the dash reflector relay. The resistor, R7, is adjusted to allow a current of 150 mA. to flow through this circuit, the adjustment being independent of the working position of the switch, S7. The timing characteristics of the reflector relays are thereby not impaired, and the change-over of reflector conditions during coding periods is accomplished with the minimum of "key-click".

28. From the foregoing description it will be realized that the morse wheel unit, taken as a whole, performs all the transmitter control functions necessary to provide a service of identification signalling. The ultimate function of the remainder of the units and components of the keying device is either the control of the morse wheel speed and of the frequency of rotation or the provision of remote indications and on/off control.

Cycle timing unit

29. This unit comprises the friction plate and the hinged cycle timing carriage, on which is mounted the cycle timing wheel and the calibrated cycle timing control. The friction plate, which is seven inches in diameter, revolves continuously at one or the other of two constant speeds, viz.:—7 r.p.m. or 1·75 r.p.m., being driven by the motor, MTR2, through dual ratio gearing. The face of the friction plate is approximately one-quarter inch below the level of the keying device top panel, a portion of which is cut away to expose a radius of the friction plate. A keyed shaft on the cycle-timing carriage is located immediately above this exposed radius. Keyed on to the shaft is the friction wheel; this is faced with a replaceable soft friction tyre one-eighth inch wide and has an external diameter of one inch. A 20-tooth pinion on the end of the keyed shaft meshes constantly with the 200-tooth cycle timing wheel. The friction tyre rests on the friction plate by which it is driven at a speed directly proportional to the "drive radius", i.e. the distance between the resting position of the friction tyre and the centre of the friction plate.

30. Rotation of the control knob on the right-hand side of the carriage causes a fork, working in a groove out in the friction wheel, to displace the friction wheel laterally along the keyed shaft thereby varying the drive radius. A pointer moves with the fork and indicates on two calibrated scales the position it should take up to cause the cycle timing wheel to make one complete revolution in the period of time indicated. The calibration will only be true if the motor, MTR2, is driving the friction plate at the required speeds of 7 r.p.m. for the upper scale markings and 1·75 r.p.m. for the lower scale markings. The cycle timing control being continuously variable, slight inaccuracies can be corrected by small adjustments of the control knob. A locking effect for the control knob is provided by the 4-B.A. bolt which projects from the top panel towards the octagonal knob and prevents its rotation through an angle greater than 30 degrees approximately. To rotate the control knob through greater angles than this, the carriage is lifted slightly; this action also raises the friction tyre from the friction plate so preventing the formation of *flats* on the tyre. For inspection of the friction wheel, and other components, the carriage is lifted right back, care being taken to rest the teeth of the cycle timing wheel very gently against the switch, S5.

Motor switch unit

31. Mechanically associated with both the cycle timing and the morse wheel units is the motor switch assembly, comprising the single-pole change-over switch, Type 807 (S3), the right-hand and the left-hand bell cranks, and the push rod. These components are mounted on a flat plate which is bolted to the keying device top panel between the cycle timing wheel and the cam wheel spindle, the assembly being protected by a removable metal cover. On the completion of each revolution of the cycle timing wheel, a striking pin, tapped into and projecting from this wheel, operates the right-hand bell crank. The right-hand plunger of the switch, S3, is thus depressed and the blade of the switch moves from the right-hand to the left-hand contact. This breaks a circuit to the electro-magnetic brake assembly (*para. 54*) and completes a circuit for the motor, MTR1; the morse wheel therefore rotates.

32. A striking pin extends from and rotates with the morse wheel spindle and this pin in due course operates the left-hand bell crank, moving the push rod to the right and so depressing the left-hand plunger of the switch, S3. The blade of the switch then moves from the left-hand to the right-hand contact which breaks the circuit for the motor, MTR1, and re-establishes the circuit for the electro-magnetic brake. Means of adjustment are provided to compensate for wear of the working parts of the assembly and to allow for possible slight differences in operating characteristics of a replacement motor switch. Adjustment on the right-hand side of the switch is effected by varying the projection of the striking pin from the cycle timing wheel. On the left-hand side two complementary means of adjustment are provided, viz.:—

(1) an eccentrically mounted back stop for the bell crank, and

(2) an extension piece tapped into the right-hand end of the push rod.

The adjustments are described in *para. 199 (6)* and *(7)*.

33. The function of the cycle timing unit and the associated motor switch assembly is to cause the transmission of the desired identification signals at the predetermined regular time intervals. This will occur, since each revolution of the cycle timing wheel causes one revolution of the morse wheel. It is to be noted that the starting of the morse wheel does not signify that a code sending period has begun. Normal approach path signals are still radiated, even though the morse wheel is revolving, until the switch unit K1 is operated by the cam plates. It will be appreciated that, since the cycle timing wheel is revolved continuously and independently of the morse wheel, the frequency of repetition of the coding periods, i.e. the *cycle timing*, is not affected by variations in the code transmission speed or in the time duration of the coding period, except for the special cases quoted in *para. 34*.

34. The design of the keying device is such that the morse wheel must always complete its revolution and operate the motor-switch, S3, in a period of time less than that taken by the cycle timing wheel to complete a revolution. Thus, referring to TABLE II, the cycle timing selected must always be greater than the time period shown in column (4) against the code transmission speed it is desired to use. For example, at a code transmission speed of 7·5 w.p.m. or above, a cycle time of 15 seconds can be employed. If it is now desired to reduce the transmission speed to 5 w.p.m. the cycle time must be increased to a value *greater than 20 seconds*. It can be shown that, assuming the cycle timing were to be left set at 15 seconds in this instance, the actual cycle timing obtained would be $15 \times 2 = 30$ seconds. Only in the event of a quick repetition frequency being employed with a slow code transmission speed can it happen that variation of code transmission speed has an effect upon cycle timing.

Drive unit for morse wheel

35. This unit comprises:—the motor, Type 63 (MTR1) which is fitted with the spring set, Type 18 (K4), the resistor R9, and the condenser, C1; the resistor, R4; the gear trains for morse wheel and stroboscope disc drive; the stroboscopic speed indicator, with the lamp, L1; the brake assembly, which incorporates the electromagnet, EM1, the rectifier, RECT1, and the resistor, R6.

Motor, Type 63 (MTR 1)

36. This induction motor is designed to operate from a 200/250 volt, 50/60 c/s. AC supply. The field magnet laminations are riveted together and bolted on to the front of the main casting, the bolt heads being visible through a hole in the cast end plate. The end plate protects the field coils and its fixing bolts pass through the laminations at each corner to hold the field magnet system rigidly in position. The field coil connections are brought out through a grommet and terminate on two tags eyeletted on to a paxolin panel which is mounted on the right-hand side of the motor. The 2,500-ohm resistor, R9, and the 0·25 μF condenser, C1, in series, are mounted on this paxolin panel and are connected across the field winding to provide power factor correction for the motor.

37. The armature rotates between the field magnets and is immovably secured to the armature shaft, the main bearing of which is located immediately behind the armature. Lubricant is carried to this plain bearing by a felt wick from an oil hole, situated directly above the bearing in the motor top plate. The main end thrust is taken by a steel insert in the centre of a thrust plate which is bolted to the main end plate. The end thrust bearing is accessible for cleaning and repacking with grease by removing the thrust plate, the main end plate being unbolted only if the field magnet system requires recentring around the armature. The end of the shaft remote from the armature rotates in a plain bearing which is a sliding fit in the main casting. A bolt, the head of which is accessible through a hole in the motor top plate, is screwed down on to a "flat" on this movable bearing to lock it in the required position. With the end plate and thrust plate bolts tightened down, all residual end-play in the shaft is taken up by readjusting the position of this rear end bearing. Although it is necessary to have no apparent end-play, the shaft must still rotate freely in its bearings.

38. The rotation of the armature shaft is transmitted to the vertical motor spindle through a worm and worm-wheel drive giving a reduction ratio of 14:1. A ball bearing let into the lower end of the spindle bears on a circular steel plate bolted on to the bottom of the main casting, the plate being removed for cleaning and greasing of the bearing surface. The upper plain bearing of the spindle is carried by the motor top plate, and the 20-tooth motor drive pinion is pinned on to the upper end of the spindle. The motor top plate is located on the main casting by two projections on the top plate which register with two corresponding holes in the casting, the top plate then being secured to the casting by four bolts. The top plate is removed for the greasing of the worm drive and for better observation of the action of the governor gear.

39. For speed regulation the centrifugal type of governor is employed, but without the normal friction control. The governor controls a series resistance in the field circuit of the motor (*para. 44*). A weight is fixed at the centre point of each of three flat springs, and one end of each spring is secured to a collar which is made fast by grub screws to the armature shaft, near to the worm. The opposite end of each spring is attached to the boss of the governor disc, the disc otherwise being free on the shaft. Rotation of the shaft causes the weights to swing outwards against the action of the governor springs, and the governor disc is thus drawn along the shaft, in a direction away from the armature, for a distance which is proportional to the speed of rotation of the armature shaft. Access to the governor disc for cleaning purposes is provided by a hole in the bottom of the main casting, the motor name plate acting as a cover for this inspection point.

Spring set, Type 18 (K4)

40. This component (*fig. 5*) has one pair of normally closed heavy duty silver contacts, the required contact pressure being approximately 30 grammes. The fixed contact is mounted at the end of a rigid blade. The moving contact is mounted on a longer flexible blade, the end of which carries a brass stub on the same side of the blade. A felt pad of cylindrical form, lightly impregnated with oil, fits tightly over this stub, but is easily rotated or reversed on the stub, or replaced by a new felt pad, as and when wear occurs. The spring set, K4, is fitted to the left-hand side of the motor on a carrier, the front member of which is bolted to the side of the main casting. A single fixing bolt passes through the spring set and secures it horizontally in a recess provided on the rear member of the carrier. The rear member is movable along guide pins attached to the front member, the relative lateral positions of the members being varied by rotation of a lead screw. The head of the lead screw projects forward from the front member, and is provided with a screwdriver slot and a collar in which a flexible remote-drive cable may be secured. The contact blades of the spring set, K4, thus project into the motor casting, the rigid blade being to the fore and the felt pad extending beyond it towards the face of the governor disc.

41. With the armature at rest, and having a new felt pad in position on the spring set, rotation of the carrier lead screw fully clockwise should press the felt pad against the governor disc just sufficiently to cause the contact to open. If necessary, a slight alteration of the "set" of the fixed blade is made to obtain this condition, a corresponding correction of the moving blade being made, if necessary, to restore the contact pressure to the required value of 30 grammes. Having obtained these conditions at the clockwise position, rotation of the carrier lead screw fully anti-clockwise will draw the felt pad away from the governor disc a sufficient amount to allow the armature to rotate at its maximum speed without opening of the contacts by the governor disc. The motor top plate having been removed to observe these adjustments, it will be noted also that any deviation of the spring set, K4, from its correct horizontal position will result in one of two undesirable effects. It will either displace the felt pad upwards so that only a small part of its area registers with the face of the governor disc, or it will displace it downwards causing the governor springs to touch the moving blade of the spring set as the armature shaft rotates at its maximum speed.

42. It will be understood that the function of the carrier lead screw control on the motor, MTR1, is to set the felt pad of the spring set, K4, in such a position as to cause the operation of the spring set contacts at any desired armature speed below its maximum. The contacts of K4 will be open at all speeds above that desired and closed at all speeds below it. Regular cleaning of the governor disc, removing from it the oil which in due course becomes carbonized by the heat developed in the motor, maintains a low co-efficient of friction between the felt pad and the governor disc. The arrangement is thus considered solely as an electrical, and not as a frictional, speed controller and hence will be self-compensating within satisfactory limits. The carrier lead screw control is referred to as the "speed regulator" of the motor.

Power limiting resistor (R4)

43. This resistor is mounted in its holder at the back of the keying device to the left of centre, the holder being bolted to the underside of the top panel. The resistor, R4, is used in conjunction with the spring set, K4, in the control of the armature speed of the motor, MTR1. The circuit employed and the principle of operation is as follows.

44. The spring set K4 is connected in parallel with the resistor R4, which is then wired in series with the field windings of the motor MTR1 across the source of supply. Two circuit conditions are thus available. With the contacts of the spring set K4 assumed to be permanently closed, the resistor R4 is ineffective and the full supply voltage, nominally 230 volts, is available across the field windings. The motor armature therefore rotates at its maximum speed. With the contacts of the spring set K4 assumed to be permanently open, the 5,000-ohm resistor R4 appears in series with the motor winding. The voltage available across the field windings is consequently appreciably lower than the nominal value of 230 volts, and is only just sufficient to maintain rotation of the armature at a very low speed, that is, below 200 r.p.m.

45. In operation, assuming that the motor speed regulator is set at some intermediate position and that AC supply is available, the motor armature quickly attains the speed at which the contacts of K4 are caused to open. The series resistor R4 is then introduced and the armature speed begins to fall but immediately it does so the resistor R4 is cut out of circuit again by the contact K4 and the armature speed picks up, only to be checked as before. This cycle is repeated indefinitely while the mains supply is available, the armature being unable to rotate at a higher or a lower speed than at that desired. The condenser C1 and the resistor R9 increase the power factor of the circuit to a value which eliminates sparking at the continuously operating contacts of K4. Disconnection or failure of either of these components would be shown by the pitted condition of the contacts which should, therefore, be regularly examined and wiped clean. For this purpose the single fixing bolt of the spring set is removed and the spring set is withdrawn from the motor, the mains isolating switch S1(Z) having first been operated to the *off* position.

46. Since the spring set K4 forms part of the mains supply circuit and is working in close proximity to the earthed motor governor gear, it is essential that the moving blade of the spring set be directly connected, through the switching, to the *neutral* mains conductor. Otherwise there exists the possibility of the governor springs burning through and snapping, and of the face of the governor disc becoming burnt and scored, causing excessive wear of the felt pad. It is therefore important that the mains supply be connected to the keying device in the manner described under "installation", and that when fitting a replacement spring set, Type 18, the moving (rear) blade be connected towards the terminal Z14. To assist in this and similar operations, all leads are colour-coded to agree with the circuit diagram which is fitted in the lid of the keying device.

Gear train for morse wheel drive

47. It is necessary for the motor MTR1 to drive the morse wheel spindle at chosen speeds varying between 3 r.p.m. and 9 r.p.m. (TABLE II), a speed range ratio of 1:3. This speed ratio can be covered by the motor speed regulator but the control then becomes critical at the lower speeds, and alternative drive ratios are therefore provided. The motor is thus enabled to rotate at a speed sufficiently high to ensure satisfactory speed regulation and adequate torque at all morse wheel speeds. A 200-tooth gear wheel is pinned on to the morse wheel spindle and meshes constantly with an auxiliary gear train, driving the idling pinion of the gear train at a speed 20 times that of the morse wheel spindle. The gear train and the motor, Type 63, are mounted in such a manner that the 20-tooth motor pinion may engage at will either with the 200-tooth gear wheel or with the 20-tooth idling pinion. In the first place, in which MTR1 is said to be in POSITION 1, a step-down motor pinion/morse wheel drive ratio of 10:1 is obtained, this being suitable for code transmission speeds above 7·5 w.p.m. In the second place, in which MTR1 is said to be in POSITION 2, the step-down motor pinion/morse wheel drive ratio is 20:1 and this ratio is to be employed for code transmission speeds of 7·5 w.p.m. and below.

48. The method of mounting the motor, Type 63, on the keying device to provide these alternative drive ratios is as follows. At the rear, the motor top plate is located on a rigid shouldered collar which projects from the underside of the keying device sub-panel. Locknuts, with plain and spring washers, hold the motor firmly on to this pivoting point. Towards the front, the motor top plate is similarly located on two collars, but these collars are rigidly mounted on a sliding flat bar which is sprung to the underside of the sub-panel. When moving the motor from one position to the other, the gear teeth must be gently eased into full mesh, which is obtained when the sliding bar comes against its appropriate end stop. A pointer, held under a motor top plate fixing bolt, indicates on a panel the motor *position* in use.

49. For inspection or replacement, the motor, Type 63, is dropped away from the sub-panel after removing the nuts which secure the motor top plate to the locating collars. Alternatively, at the front, the locknuts securing the sliding bar to the sub-panel are removed, the bar being left attached to the motor. For re-assembly in the first instance the motor is more easily re-secured to the collars if the spring set, Type 18, is temporarily removed from the motor. In the second instance, the rear fixing is re-secured first, the bar then being tightened to the sub-panel equally on either side until the sliding movement becomes reasonably stiff in operation. The nuts should never be tightened to such an extent as to make sliding movement impossible. During re-assembly all nuts, and plain and spring washers, must be replaced exactly as found, and the rear locating collar must remain rigidly secured to the sub-panel, otherwise incorrect gear meshing may result.

Stroboscope and gear train

50. As particular code transmission speeds are obtainable, after appropriate positioning of the motor, by adjustment of the speed regulator of MTR1, a panel knob engraved MORSE SPEED is provided for this purpose. This control knob is connected to the speed regulator by a flexible spiral drive rod secured at each end by a grub screw. The panel control is not calibrated, but instead a stroboscopic timing device is provided to give an exact visual indication of six standard code transmission speeds, viz.:—5, 6, 7·5, 10, 12 and 15 w.p.m. The stroboscope disc revolves below the top panel at a speed 40 times that of the morse wheel, being driven through the gear train which is bolted on the sub-panel to the left of the 200-tooth morse wheel gear.

51. Below the stroboscope disc is positioned the 0·5 watt neon lamp, L1, connected in parallel with the power supply to MTR1. Above the stroboscope disc, in which are drilled, concentrically, six circular rows of holes, an engraved sector plate is mounted. Each of the six sectors of the sector plate may be viewed, in turn, through an aperture in the top panel by rotating a milled knob, located at the right of the aperture. In each sector there is cut a slot which coincides with one of the circular rows of holes in the stroboscope disc. When the morse wheel is rotating at a speed equivalent to the code transmission speed engraved on the exposed sector, the light of the lamp, L1, appears in the aperture as a series of "stationary dashes".

52. It must be noted that the *stationary dash* effect will also be obtained at morse wheel speeds which are equivalent to *sub-harmonics* of the indicated fundamental speed. Since, however, the physical length of the *dash* produced is proportional to morse wheel speed, no difficulty in selecting the correct (fundamental) speed will be experienced if

(1) the motor MTR1 is placed in the position indicated on the exposed sector;

(2) the morse speed knob is then adjusted until *stationary dashes* of the *greatest length obtainable* are produced.

The stroboscopic speed indications are true when the keying device is operated from a 50 c/s AC power supply. If a supply of this periodicity is not available, or a temporary failure of the lamp, L1, occurs, the checking of the code transmission is effected by referring to TABLE II, columns (1) and (4), and then timing a complete revolution of the morse wheel. It will be appreciated that, apart from its primary purpose, the lamp L1, since it is switched on and off with the motor, MTR1, provides a check indication of the correct electrical functioning of the motor switch, S3.

Brake assembly

53. At the completion of each revolution of the morse wheel the power supply to MTR1 is cut off. The momentum acquired by the moving parts of the system will, however, cause the continued rotation of the morse wheel through an angle which would vary with the code transmission speed and would approach 90 degrees at 15 w.p.m. This effect, termed *over-run*, would, of course, result in the permanent suppression of normal approach path signals throughout the greater part of each cycle, were the morse wheel finally to come to rest with the switch unit K1 operated by the cam plates; such excessive over-run is therefore prevented by the provision of a friction brake which is applied to the rim of the stroboscope disc when the supply to MTR1 is cut off.

54. The brake is operated from the motor power supply to which it is connected through the switch, S3 (*para. 31*). The power supply being available at the brake assembly, the voltage is dropped to a suitable value by the resistor, R6, and is then applied to a parallel circuit comprising the half-wave metal rectifier, RECT1, and the coil of the electro-magnet, EM1. Uni-directional current is then passed through the coil of EM1, and the armature is permanently attracted to the pole face. The armature is normally held away from the pole face by the action of a flat spring on the free end of which is mounted the replaceable felt brake pad. Consequently, attraction of the armature causes the felt pad to be moved towards the rim of the stroboscope disc, the armature just touching the pole face as the felt pad is firmly applied to the disc.

55. The resistor R6 and the rectifier RECT1 are mounted upon a paxolin panel which is bolted to the front, and the electro-magnet to the rear, of the **L**-shaped bracket for the assembly. The bracket is secured to the underside of the sub-panel by two bolts. Slots cut in the bracket for these bolts allow the complete assembly to be withdrawn for inspection, or re-positioned on the sub-panel, by which means the efficiency of the braking action may be varied. In operation, a small amount of over-run is essential since the morse wheel spindle striker pin must always be allowed to *clear* its bell crank to prepare for the subsequent operation of the switch, S3, by the cycle timing wheel striker pin. At a code transmission speed of 15 w.p.m. the over-run should be not less than 9 degrees (= 2 bauds) and not more than 22·5 degrees (= 5 bauds). Adjusted thus, the over-run allowed will be satisfactory at all other code transmission speeds. It will be noticed that a small braking force is constantly applied to the 200-tooth gear wheel by the spring-loaded felt pad which is supported from the right-hand gear train. This constant braking force assists in the smooth and steady rotation of the morse wheel.

Drive unit for cycle timing wheel

56. This unit comprises:—the motor, Type 63 (MTR2), which is fitted with the spring set, Type 18 (K5), resistor R10, condenser C2, auxiliary spring set, Type 19 (K6), resistor R5, and the gear trains for friction plate drive. This unit is in its essentials a duplicate of the morse wheel drive unit. The motors MTR1 and MTR2, spring sets K4 and K5, resistors R4 and R5, resistors R9 and R10, and condensers C1 and C2 are respectively interchangeable, performing exactly similar functions in the two drive units. The brake assembly, stroboscopic speed indicator and panel control for motor speed regulator are not provided for the cycle timing drive unit.

57. The motor MTR2, mounted in the same manner as is MTR1, drives the friction plate spindle either directly, giving a step-down drive ratio of 10:1 (POSITION 1), or through the auxiliary gear train, giving a step-down drive ratio of 40:1 (POSITION 2). By adjustment of the motor speed regulator, a screwdriver slot being employed for this purpose, the motor pinion is timed to revolve continuously at a speed of 70 r.p.m. The motor MTR2 thus causes the friction plate to rotate at the required speeds of 7 r.p.m. and 1·75 r.p.m. when placed in POSITION 1 and POSITION 2, respectively. The friction plate and motor pinion speeds quoted are those which normally produce an accurately calibrated cycle timing scale. Since factors such as the amount of wear of the friction tyre affect the calculated results, the speed of MTR2 is preferably adjusted by observation of the speed of the cycle timing wheel, rather than of the friction plate.

58. The re-timing of MTR2, normally unnecessary unless the spring set K5 has been disturbed, is effected by first setting the pointer to any convenient scale mark and the placing the motor in the appropriate position. The motor speed regulator is next adjusted until the cycle timing wheel makes one complete revolution in the period of time indicated by the pointer *when the keying device top panel is horizontal*. The correct fixed motor speed having thus been obtained, all subsequent cycle timing adjustments are effected by choice of motor position and by rotation of the control knob on the cycle timing carriage.

after a further delay of approximately 25 seconds. Both the keying device and the remote control, Type T, incorporate components which are annotated "REL1" and "REL2". These in the keying device are therefore identified by the suffix "(Z)" and those in the remote control, Type T (*fig. 16*), by the suffix "(ZR)".

Switches

62. The switch, Type 241 (S2) is a single-pole on-off toggle switch, mounted on the front of the relay unit. The switch contacts are open at the position engraved REMOTF and closed at the position engraved LOCAL. The *reset-trip* switch, Type 1188 (S6), also mounted at the front of the relay unit, has one pair of contacts which are normally closed, the operating toggle being spring-loaded. The contacts are open only while the toggle is held depressed. The switch, Type 1189, two of which are used in the keying device in the positions annotated S4 and S5, has three normally open contact pairs mounted against a rotatable drum, the direction of rotation being non-reversible. In one revolution the drum passes through 12 positively-located positions at each of which one of the contact pairs is caused to close. A *set* pointer is radially secured to one end of the drum and from this end the contact pairs are numbered, in order, for reference purposes. The contact pairs are also closed in this same order, continuously repeated, as the drum is rotated. One side of each of the three contact pairs is connected to a common point, and the switch thus becomes a single-pole three-way continuously rotary switch. In its *set* position, at which the pointer registers with a white-tipped reference pillar, the first contact is connected to the common point.

63. The switch, S4, is mounted horizontally on the top panel, beneath the morse wheel. At each revolution of the morse wheel S4 is advanced one step by the striker pin of the morse wheel spindle. The switch S5 is vertically mounted on the top panel to the rear of the cycle timing wheel, the striker pin of which advances S5 one step at each revolution. A mounting position for the switch S5 must be maintained which ensures that no possibility exists of the carriage being forced up as the striker pin is operating this switch. Such a *lifting* action would cause the loss of the drive from the friction plate to the friction tyre. The switches S4 and S5 are used in a monitoring capacity as described in the following paragraph.

Keying device failure provision

64. The free contact springs of the switches S4 and S5 are interconnected in the manner shown in *fig. 5*. The electrically-equivalent circuit appears more clearly in *fig. 19* (*e*) to which reference should now be made for an understanding of the function of the arrangement. The keying device being in operation and a revolution of the morse wheel having just been completed, the switches S4 and S5 are placed in their "set" positions when it will be seen that no circuit exists through the switches between the common contacts of S4 and the common contacts of S5.

65. The operation of the keying device now being continued, the correct mechanical cycle of events is as follows:—

(1) the striker pin of the cycle timing wheel advances S5 one step and then

(2) operates S3, which causes the morse wheel to rotate;

(3) the striker pin on the morse wheel spindle advances S4 one step and then

(4) operates S3, so causing the morse wheel rotation to cease.

This cycle is repeated indefinitely so long as the correct mechanical operation of the keying device continues, and it will be observed that at no period will a circuit be provided through the switches. However, any electrical or mechanical fault which results either in the failure of the morse wheel to rotate when it should do so, or alternatively, in its failure to switch itself off when it has completed one revolution, will cause S4 and S5 to become *out of step*. In the first instance, i.e. when no coding periods are provided or, when the morse wheel stops during a coding period, S4 is not operated and thus S5 will be advanced a further step on the following revolution of the cycle timing wheel. In the second event, i.e. when normal beam approach signals are constantly being interrupted at intervals of a few seconds, S4 operates at a greater frequency than does S5 since the morse wheel speed is always greater than the cycle timing wheel speed (*para. 33* and *34*).

66. Reference to *fig. 19* (*e*) will make it clear that in both the instances quoted a circuit is provided through the switches S4 and S5 between their common contacts. In the first it had to be assumed that the cycle timing wheel did in fact continue to revolve even though the morse wheel failed to do so. The assumption would not be realized in the event of a fault which affected both drive units simultaneously, for example, the complete failure of the motor power supply. This variation would, therefore, *not* result in a circuit being made through the switches S4 and S5. To provide for such a contingency a second means of establishing a circuit across the switches is provided by the spring set K6. The components S4, S5 and S6, thus provide a *monitoring circuit* which will be open when the keying device is running correctly.

67. If the cycle timing wheel continues to revolve, but the morse wheel for any reason fails to start, or fails to stop, when required to do so, then the monitoring circuit will be closed. It will also be closed if the cycle timing wheel itself fails to revolve because MTR2 is not rotating for any reason. Thus, this monitoring circuit is simple, yet reasonably comprehensive, particularly if at daily inspections careful attention is paid to the maintenance of a firm drive between the armature shaft of MTR2 and the cycle timing wheel. A loss of drive between these points is not shown up by the monitoring system. It will be realized that, to obtain the correct electrical operation of the switches S4 and S5 it is essential to check, after inspections, that the switches, having been placed in their *set* positions, the mechanical cycle of events begins with the operation of S5 by the striker pin of the cycle timing wheel.

68. The various functions of the relay unit components may be stated in general terms. The control of the motor power supply of the keying device is effected locally by the switch S2 and, remotely, by the relay REL1(Z). The relay REL2(Z) causes the remote indication of the coding periods and the maintenance of the motor power supply during these periods. The correct running of the keying device is monitored by the switches S4 and S5 and by the spring set K6, all of which are connected into circuit approximately 35 seconds after the keying device has been switched on remotely. This time delay is provided by the relays REL4 and REL5 together. If keying device failure, monitored by S4 and S5, or by K6, then occurs, these components complete a circuit which operates the relay REL3. Operation of REL3 causes the remote indication of the failure and the tripping of the keying device, so preventing its further operation from the remote point until the tripping circuit is re-set by depression of the switch S6. The resistor R1, value 300 ohms, limits the current flow should accidental contact occur between certain contact springs on each of the components K1, K2 or REL2(Z), during adjustments, or should a short-circuit develop on the remote control lines. The contact springs referred to are those which are connected to opposite poles of the relay operating supply. A detailed description of the operation of the relay circuits is provided in *para. 96–135.*

REMOTE CONTROL, TYPE T

General

69. This comprises a metal box, $6\frac{1}{2}$ in. by $6\frac{1}{2}$ in. by $3\frac{1}{4}$ in., the square front cover of which supports all the components of the control, viz.:—the control switch, S1(ZR); the indicating lamps, P1(ZR), P2 and P3; the relays, REL1(ZR) and REL2(ZR). A terminal block is not provided. Instead, the external connections are brought out through a numbered and colour-coded cable-form of sufficient length to allow direct connection into either of the main beam approach control units. A circuit diagram of the remote control, Type T, is included in its metal box, the circuit also being shown in *fig. 16.*

70. The switch S1(ZR) is a key switch having three locking change-over contact sets on one side only. The switch is used as a three-pole on-off switch, the operating handle being horizontal at its OFF position. As the handle is operated to the ON position the contact numbered 1 is closed before those numbered 2 and 3. The relays REL1(ZR) and REL2(ZR) are of the same type, each being a P.O. 3,000 type relay with single 1,000-ohms coil winding and two change-over contact sets. All but one of the change-over contact sets are used as normally-closed contact pairs.

71. The 12-volt P.O. No. 2 lamps P1(ZR), P2 and P3 are supplied through the switch and relay contacts from the 12-volt lamp transformer in the main remote control unit. The functions performed by the remote control, Type T, have already been described in *para. 6.* A detailed description of the operation of the various circuits is provided in *para. 96–135.*

CIRCUIT DESCRIPTION

Transmitter control circuits

72. Although both the modulation circuit and the reflector relay control circuit of the keying device are taken through the switch units, K1 and K2, and the coding switch S7, at no point are they interconnected electrically. The two control circuits can thus be considered and traced out quite independently and to facilitate this, circuit diagrams are included in this Publication. These diagrams show, in full, the following:— Relevant circuits of each of the four transmitters; necessary modifications to these circuits; interconnections between the transmitters and the keying device; and the relevant control circuits of the keying device. Identical annotation of the keying device components and of their contacts is maintained throughout all the illustrations which may therefore be used, in conjunction with the text, to understand the manner in which the desired effects upon the various transmitters are obtained.

Use with transmitter, Type T.1122

73. The complete reflector keying circuit is shown in *fig. 8*. With the coding switch S7 in the OFF position, the terminals Z6 and Z10 are permanently bridged, and the keying device circuits connected to the terminals Z11 and Z12 are both open whatever the position of the link LINK 1 and of the switch units K1 and K2. The original reflector keying circuit is therefore maintained while the keying device is run locally for servicing or for adjustment purposes.

74. With the switch S7 in the OMNI-DIRECTIONAL position and link LINK 1 in position A, the reflector relay control circuits of the keying device are arranged for omnidirectional coding. Thus, at the beginning of a coding period, the contact pair K1.3 opens, breaking the complete reflector keying circuit at the terminals Z6 and Z10, that is, at the transmitter terminals E8 and D8. The contacts K1.2 then close and provide a permanent alternative path for the *dash* reflector relay, the resistor R7 taking the place of the relay REL3(D) and of the resistor R6(D), and the resistor R8 taking the place of the *dot* reflector relay. These circuit changes, which are maintained throughout the coding period, thus hold the *dash* reflector inoperative and, by isolating the *dot* reflector relay and the complete keying unit "D" from the negative supply at the contacts K1.3, ensure also that the *dot* reflector and the normal keying contacts also remain ineffective.

75. Upon the completion of the coding period, the contacts K1.2 open to release the *dash* reflector relay locking circuit, and the contacts K1.3 then close to restore the negative supply to the terminal D8 and so re-establish the normal reflector keying circuit. During some part of the revolution of the morse wheel the contacts K2.3 and K2.2 will be operated but, these being out of circuit, no effect will be produced thereby on the reflector relays.

76. With the coding switch S7 in the ALTERNATIVE SECTOR position, the reflector relay control circuits of the keying device are re-arranged in accordance with the requirements of this system of code sending. At the beginning of a coding period, the contacts K1.3 open to render ineffective the normal reflector keying unit D, as before. The contacts K1.2 then close and, assuming LINK 1 to be in position A, a permanent alternative path through the equivalent resistor R7 (*but not through R8*) is provided for both the *dot* and the *dash* reflector relays. The *dot* reflector therefore closes and the *dash* reflector opens. After a time period equivalent to 29 baud lengths, the contacts K2.3 open and then the contacts K2.2 close. No reflector change results at this point, K2.3 breaking a circuit which is already open at the contacts K1.3 and K2.2 being ineffective since one side is connected to the open contacts K1.3 and the opposite side to the unused B position of LINK 1.

77. After a further time period equivalent to (*nearly*) 2 baud lengths, the contacts K1.2 open to release the locking circuit for the two reflector relays. The contacts K1.3 then close but without effect since the circuit to the terminal Z10 has just previously been opened at the contacts K2.3. Hence the *dash* reflector is closed, and the *dot* reflector is open, for the final 29 baud lengths of the coding period. This period having been completed, the ineffective contacts K2.2 and the effective contacts K2.3 restore to their normal conditions, and normal reflector keying is re-established. Thus, with the link, LINK 1 in position A, the first call sign is radiated in the *dot* sector, and the second call sign is radiated in the *dash* sector.

78. With LINK 1 in position B the conditions quoted in *para. 77* are reversed, in the following manner. At the beginning of the coding period, the contacts K1.3 open to break the complete reflector relay circuit and to isolate the normal keying circuit, unit D, as before. The contacts K1.2 then close but no circuit change results from this since this contact is connected to the now unused A position of the link LINK 1. The reflectors

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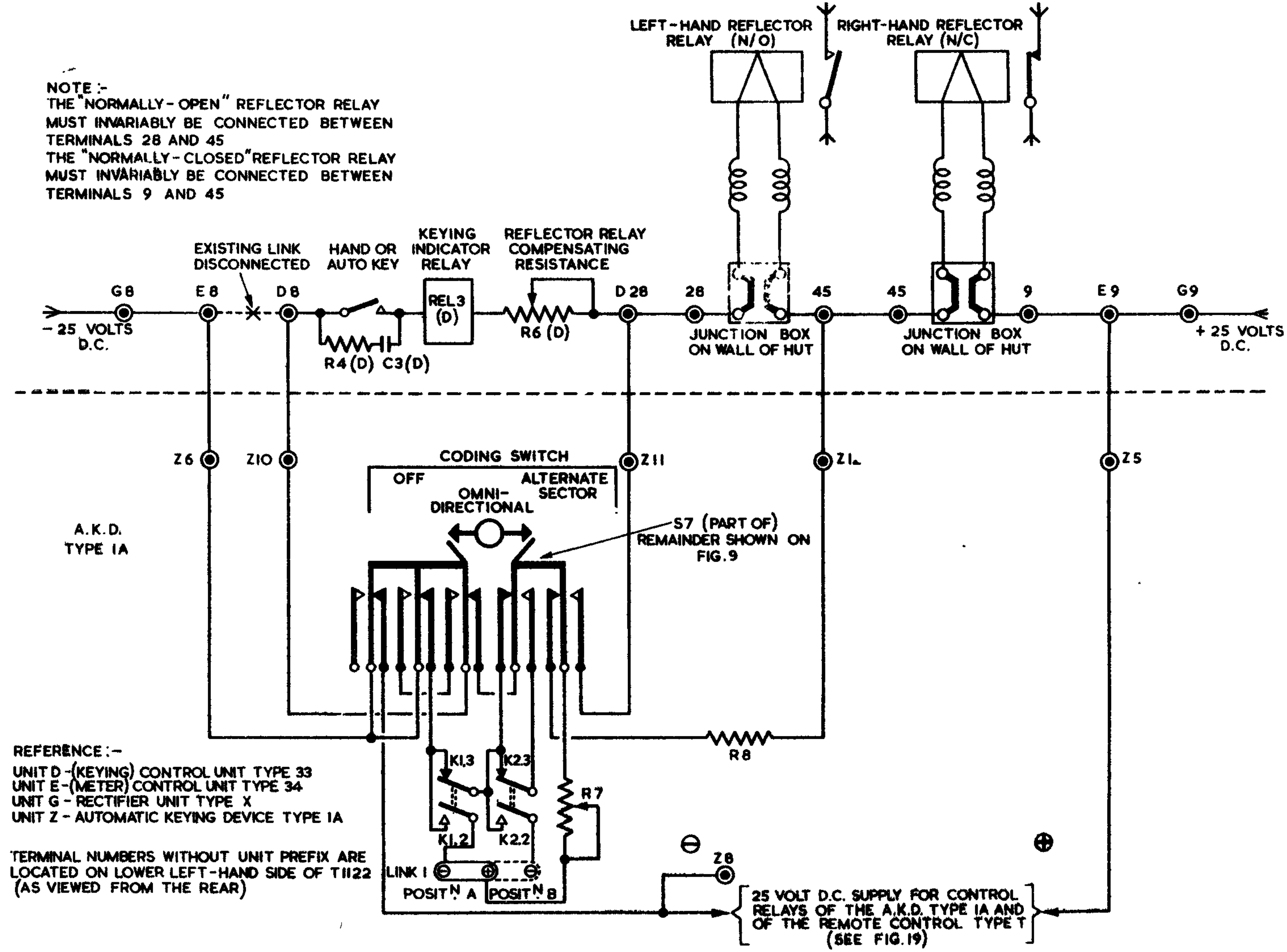

FIG. 8. INTERCONNECTION WITH TRANSMITTER, T.1122 – REFLECTOR RELAY UNIT

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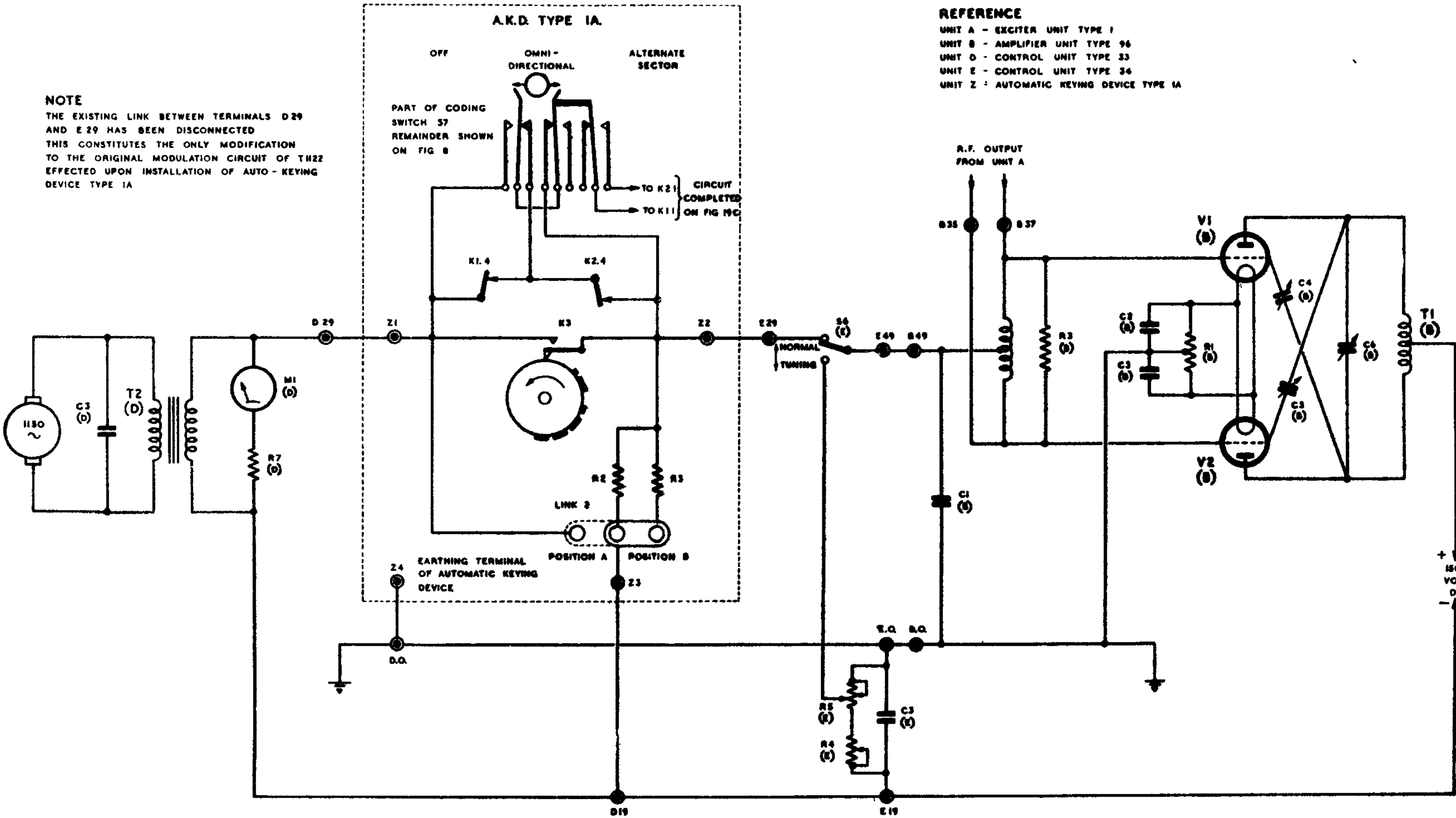


FIG. 9. INTERCONNECTION WITH TRANSMITTER T1122-MODULATOR UNIT

thus remain in their static positions, the *dash* reflector being closed and the *dot* reflector being open.

79. After a time period equivalent to 29 baud lengths, the contacts K2.3 open and then the contacts K2.2 close. No effect is produced upon the existing static reflector conditions by the operation of these contacts, since their negative feed point is already broken at the open contacts K1.3. After the further time period equivalent to 2 baud lengths, the ineffective contacts K1.2 open and the effective contacts K1.3 close, the latter completing a circuit, through the now closed contacts K2.2 and the resistor R7, for the *dot* and the *dash* reflector relays.

80. Meanwhile, when K1.3 closes, the open circuit across the terminals Z6 and Z10 first provided by K1.3 is maintained by the now open contacts K2.3. Thus, for the final 29 baud lengths of the coding period the *dot* reflector is closed and the *dash* reflector is open. At the completion of the coding period the contacts K2.2 open and so release the steadily held reflector relays, and the contacts K2.3 then close to restore the reflector keying circuit to normal.

81. The modulation control circuits are shown in *fig. 13*. It will be seen that the link LINK 2 is placed in position B to connect the keying device resistors, R2 and R3, in parallel, producing an equivalent resistance of 10,000 ohms, 10-watts, across the terminals Z2 and Z3. These resistors are then permanently connected in the grid circuit of the first modulator stage valves V1 and V2 unit B, in place of the secondary winding of the tone transformer, T2, unit D. The upper end of this winding is taken to the terminal Z1 which is normally connected, through the switch S7 or through the contacts K1.4, K2.4 to the terminal Z2. Thus, the secondary winding of the tone transformer T2(D) is reconnected into its original position in the circuit but can be isolated from the grid circuit at the contacts K1.4, K2.4 to cut off the modulation.

82. Meanwhile, the resistors R2 and R3 maintain a permanent DC path for the grid circuits of the valves V1(B) and V2(B). These contact sets of the coding switch S7 which are not shown in *fig. 8* appear in *fig. 9*. Of the three contact sets shown in the latter, the two sets adjacent to the switch arm have a controlling effect upon the transmitter modulation circuits. The third (right-hand) set is associated with the control relay circuits of the keying device, and is referred to in *para. 109*. Referring to *fig. 9* it will be seen that, with S7 in the OFF position, a permanent circuit is provided through the switch S7 between the terminals Z1 and Z2. The contacts K1.4, K2.4 and K3, can thus be opened or closed as desired without causing the modulation to be cut off.

83. In the OMNI-DIRECTIONAL position, the permanent circuit is broken, the contacts K1.4 are introduced, and the contacts K2.4 are short-circuited. Hence, at the beginning of the coding period the contacts K1.4 are opened, and the modulation is cut off. An alternative path between the terminals Z1 and Z2 being available through the contacts of the morse key K3, modulation is restored in code rhythm as the *out* bauds operate the wiper arm on which the contacts K3 are mounted. The code pulses and the final spacing having been ended, the coding period is completed and the contacts K1.4 return to their normal closed condition. Continuous modulation for the normal beam approach signals is accordingly restored. The contacts K2.4 will be held open during part of the revolution of the morse wheel but these contacts, being bridged in the coding switch S7, have no control over the modulation.

84. With the coding switch S7 in the ALTERNATE SECTOR position, the short-circuit across the contacts K2.4 is removed, the contacts K1.4 and K2.4 then being connected, in series, between the terminals Z1 and Z2. At the beginning of an alternate sector coding period, therefore, the contacts K1.4 are opened to cut off the modulat on, and the first call sign is then pulsed on the morse key K3.

85. At a time period equivalent to 29 baud lengths after the opening of contacts K1.4, the contacts K2.4 are opened, and after a further time period of 2 baud lengths the contacts K1.4 are closed. The necessary open-circuit through the contacts K1.4 and K2.4 is thus maintained between the terminals Z1 and Z2 while the switch unit K2 is operated and the switch unit K1 is released. The release of K1 having re-arranged the reflector conditions as required, the second call sign is pulsed on the morse key K3.

86. Finally, 29 baud lengths after the contacts K1.4 are closed, the contacts K2.4 are closed also, and this completes the coding period. The contacts K2.4, in closing, restore the continuous modulated tone for the normal beam approach signals. From *fig. 9* it will be noted that keying device contacts and components in direct electrical connection with the terminals Z1, Z2 and Z3 are at a potential which is negative with respect to the earthed metal of the keying device. The value of this potential is determined by the steady voltage drop across the biasing resistors, R4 and R5, unit E, and by the alternating voltage available across the secondary winding of the tone transformer T2, unit D.

Use with transmitter, Type T.1254

87. The complete reflector keying control circuits are given in *fig. 10*. The keying device controls the operation of the reflectors in the same way as has been described in *para. 73* and *80*. It will be noted that the installation of the keying device, Type 1A, does not necessitate any change being made in the circuit or the functioning of the monitoring and test panel, unit W. The test link on this panel remains in the *normal* position for normal beam approach transmission with or without code sending. Similarly, for aerial alignment, the link, unit W, is placed in the *test* position, the short-circuited hand-key sockets are switched into circuit, and the *dead/alive* switches on unit W are operated, all in the usual manner. The keying device may conveniently be switched off during aerial testing by operating the coding switch S7 to the OFF position.

88. The complete modulator stage, unit G, of the transmitter, Type T.1254, as modified for low power working and for the operating of the keying device, is shown in *fig. 11*. The modulation control circuits of the keying device are also given, and it will be seen that the link LINK 2 is placed in position A to connect the resistor R2 across the terminals Z1 and Z2. The terminal Z3 and the resistor R3 are not used. The contacts, K1.4. K2.4 and K3, and the coding switch S7 operate in the manner described in *para. 81* to *86* to provide an open-circuit or short-circuit across the terminals Z1 and Z2, that is, across the resistor R2. This resistor of 20,000-ohms is thus introduced as an additional bias resistance in the cathode circuit of the tone oscillator stage valves, V1(G) and V2(G), when the modulation is required to be cut off. The anode current of this stage, measured on the meter M1, then falls to 3 mA. approximately, and the stage is therefore prevented from oscillating until the resistor R2(Z) is once more short-circuited in code rhythm, or continuously. It should be noted that the terminal Z1, contacts and other components in direct electrical connection therewith, are at a potential of 60 volts (nominal) above earth during spacings in the coding periods, but are at earth potential during continuous or coded marking periods.

89. When the keying device is employed in conjunction with transmitter, Type T.1254, it is necessary to modify the modulator unit, Type 41. The time-constant of the original oscillator feedback circuit (C5, R5 and C6, R4) is too great to permit of rapid modulation keying. The modulation is cut off immediately the resistor R2(Z) is introduced; but, on short-circuiting this resistor, the oscillations *build up* to their normal amplitude comparatively slowly, the time usually being of the order of 100 milliseconds. *Clipping* of the call sign elements, especially of the *dot* elements, therefore occurs. To overcome this defect, the anode-to-grid coupling of the oscillator stage is increased by taking the 100,000 ohms resistors R4 and R5, out of circuit or alternatively, by substituting resistors of greatly reduced ohmic value. In consequence, the *build up* time is reduced to a satisfactorily low value but the grid drive is then excessive. The excess voltage developed across the audio tuned circuit C1(G), C2(G) and CH1(G), is therefore absorbed by additional resistance connected across the capacitive component of the tuned circuit.

90. The modulation depth control, resistor R2(G), which introduces damping into one leg of the tuned circuit, is sometimes found to have little effect since only the one side of the balanced oscillator is damped. The addition of a fixed resistor, value between 200-ohms and 500-ohms, in the other leg of the tuned circuit, as shown, serves to restore a measure of modulation depth control to the variable resistor R2(G). This resistor, R2, may have either of two maximum values, 75 ohms and 500 ohms. If of 500 ohm, the parallel resistor R11 is taken out of circuit, and if of 75 ohms a small additional fixed resistor in series with R2(G) may be required. The oscillator stage grid drive having been increased, the anode current of this stage is also increased, a value of 75 mA., as against

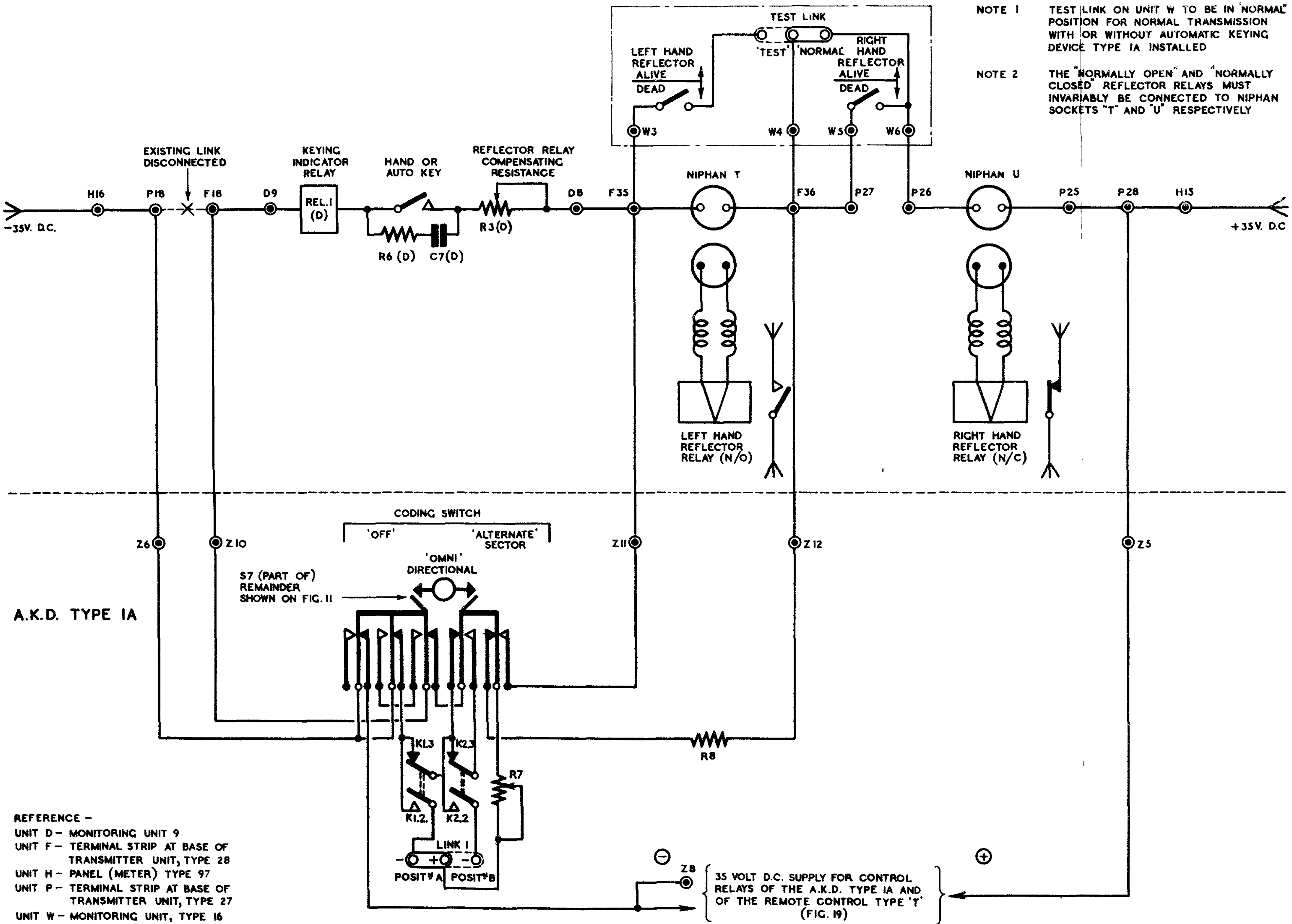


FIG. 10.— INTERCONNECTION WITH TRANSMITTER T.1254 REFLECTOR RELAY UNIT

PP5013 M41586 G1475 11/47 495 C&P Gp. 959 (4)

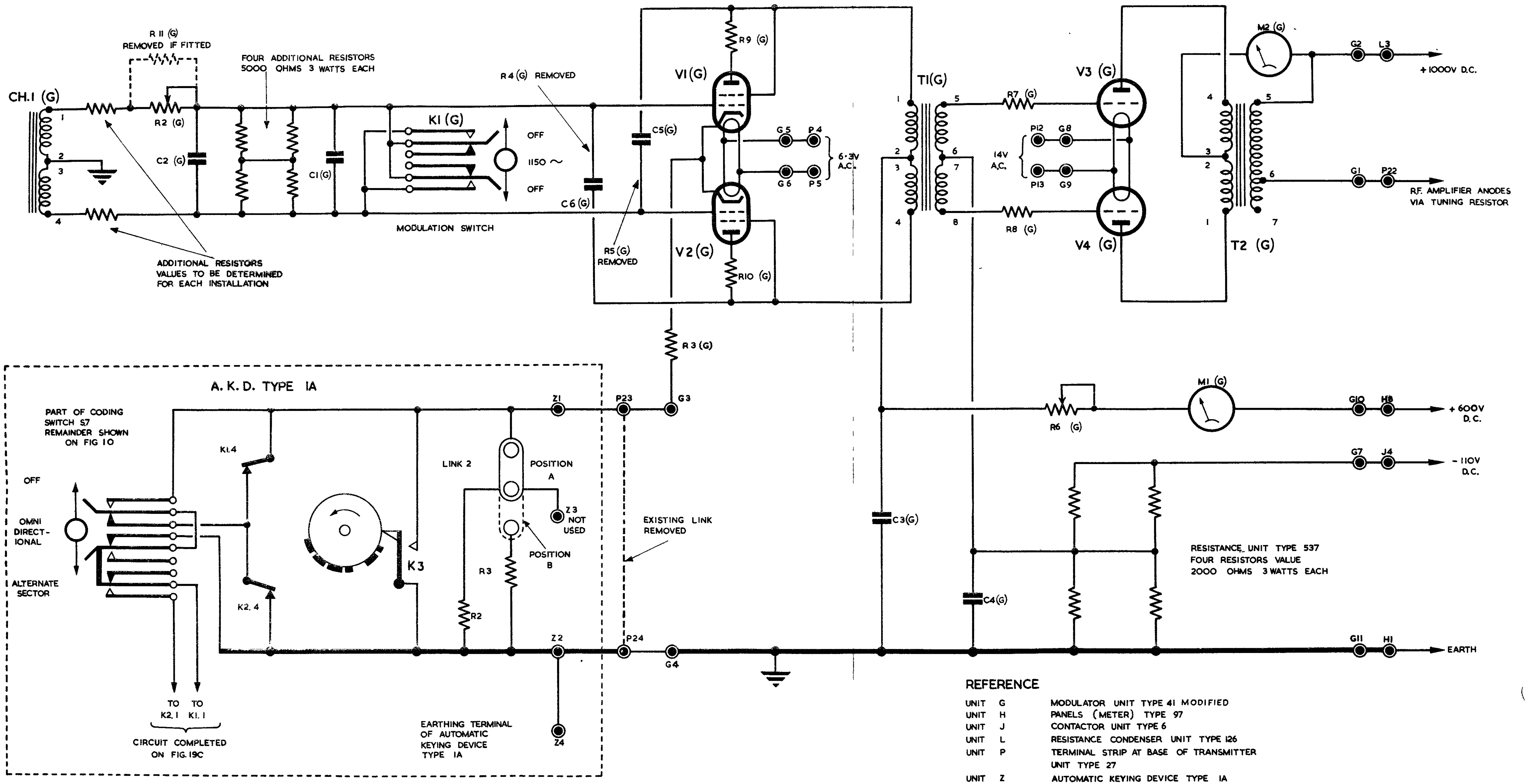


FIG. 11. INTERCONNECTION WITH TRANSMITTER T1254-MODULATOR UNIT

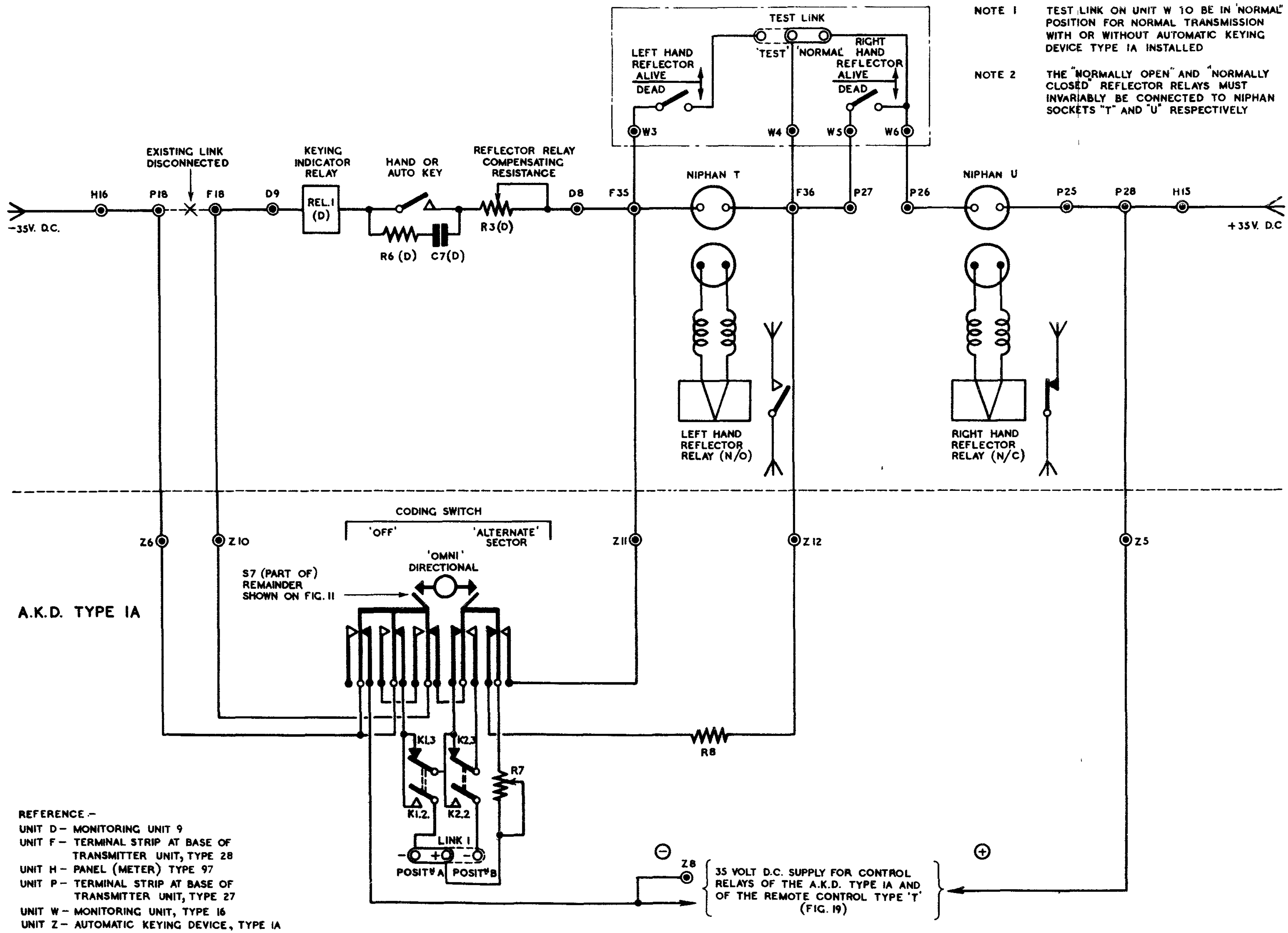


FIG. 10.— INTERCONNECTION WITH TRANSMITTER T.1254 REFLECTOR RELAY UNIT

PP5013 M41586 G1475 11/47 495 C&P Gp. 959 (4)

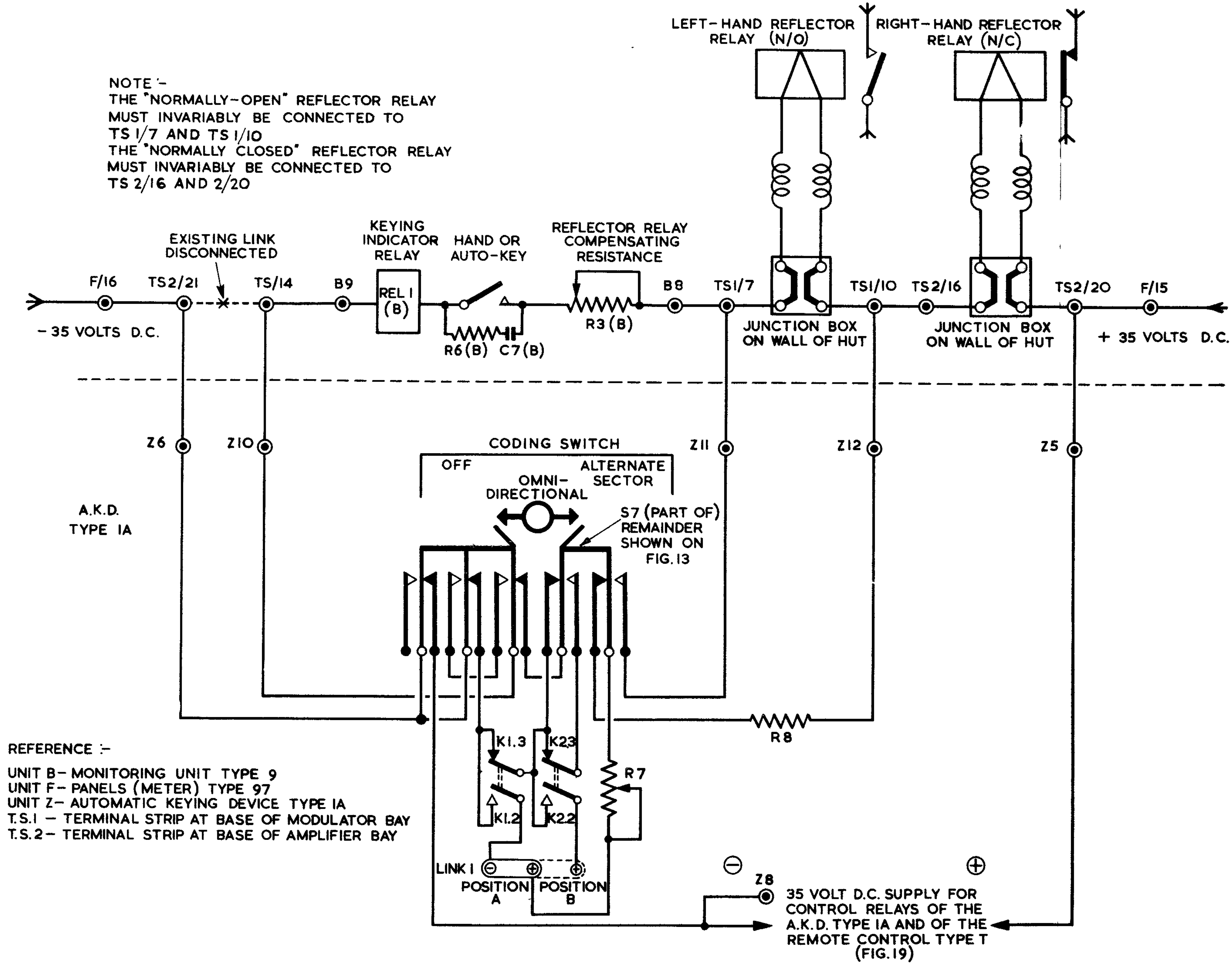


FIG. 12 - INTERCONNECTION WITH TRANSMITTER T1345 - REFLECTOR RELAY UNIT

PP5013 M41586 G1475 11/47 495 C&P Gp. 959 (4)

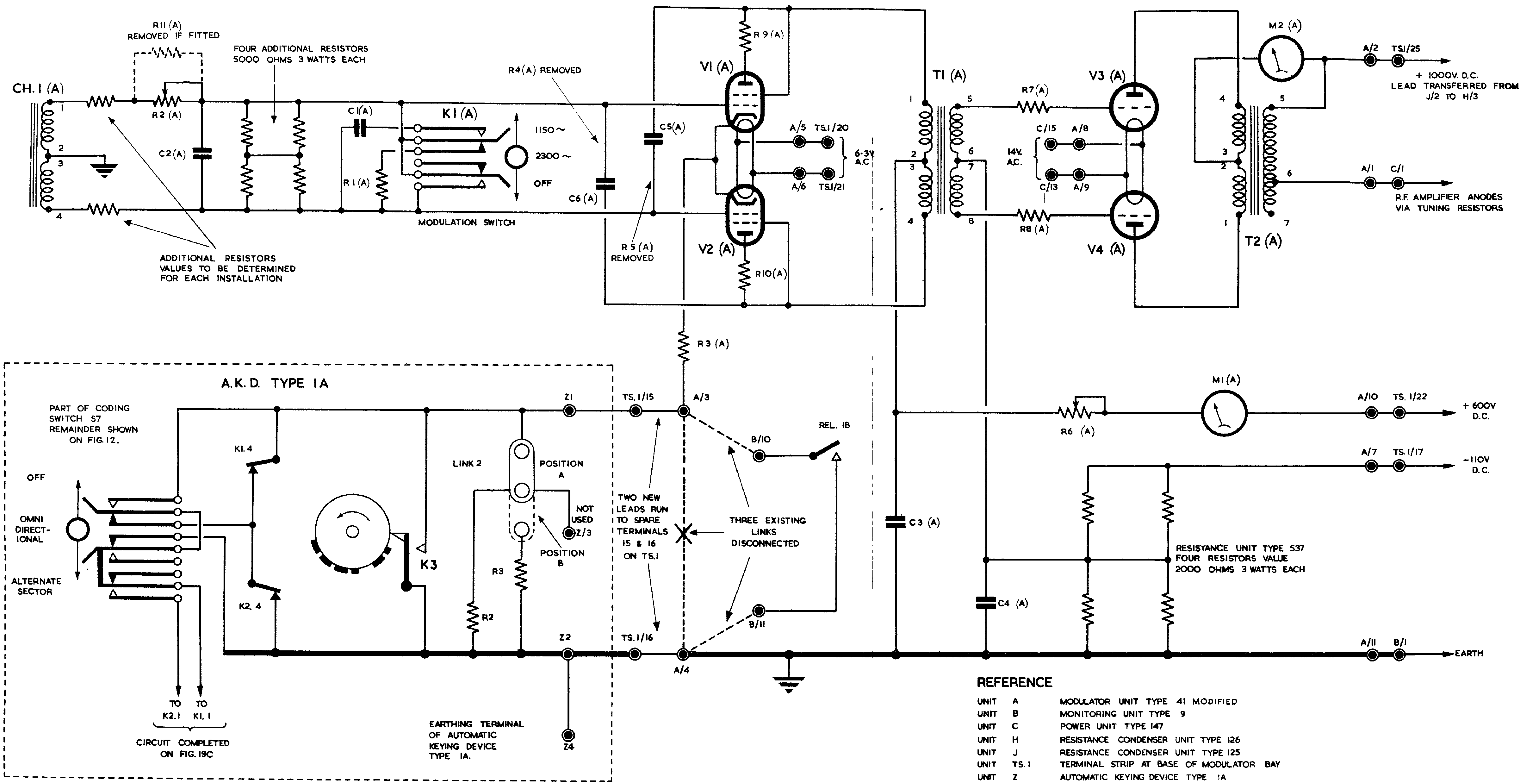


FIG.13. INTERCONNECTION WITH TRANSMITTER T1345 - MODULATOR UNIT

This leaf issued with A.L. No. 2, Nov. 1947

NOTE –
1. THE "NORMALLY-OPEN" REFLECTOR RELAY MUST INVARIABLY BE CONNECTED BETWEEN TERMINALS J4 AND J5
2. THE "NORMALLY-CLOSED" REFLECTOR RELAY MUST INVARIABLY BE CONNECTED BETWEEN TERMINALS J2 AND J3
3. TO MAINTAIN NORMAL OPERATION OF THE REFLECTOR KEYING CIRCUIT IF THE KEYING DEVICE IS DISCONNECTED AND REMOVED, LINK THE TERMINALS C9 AND C10

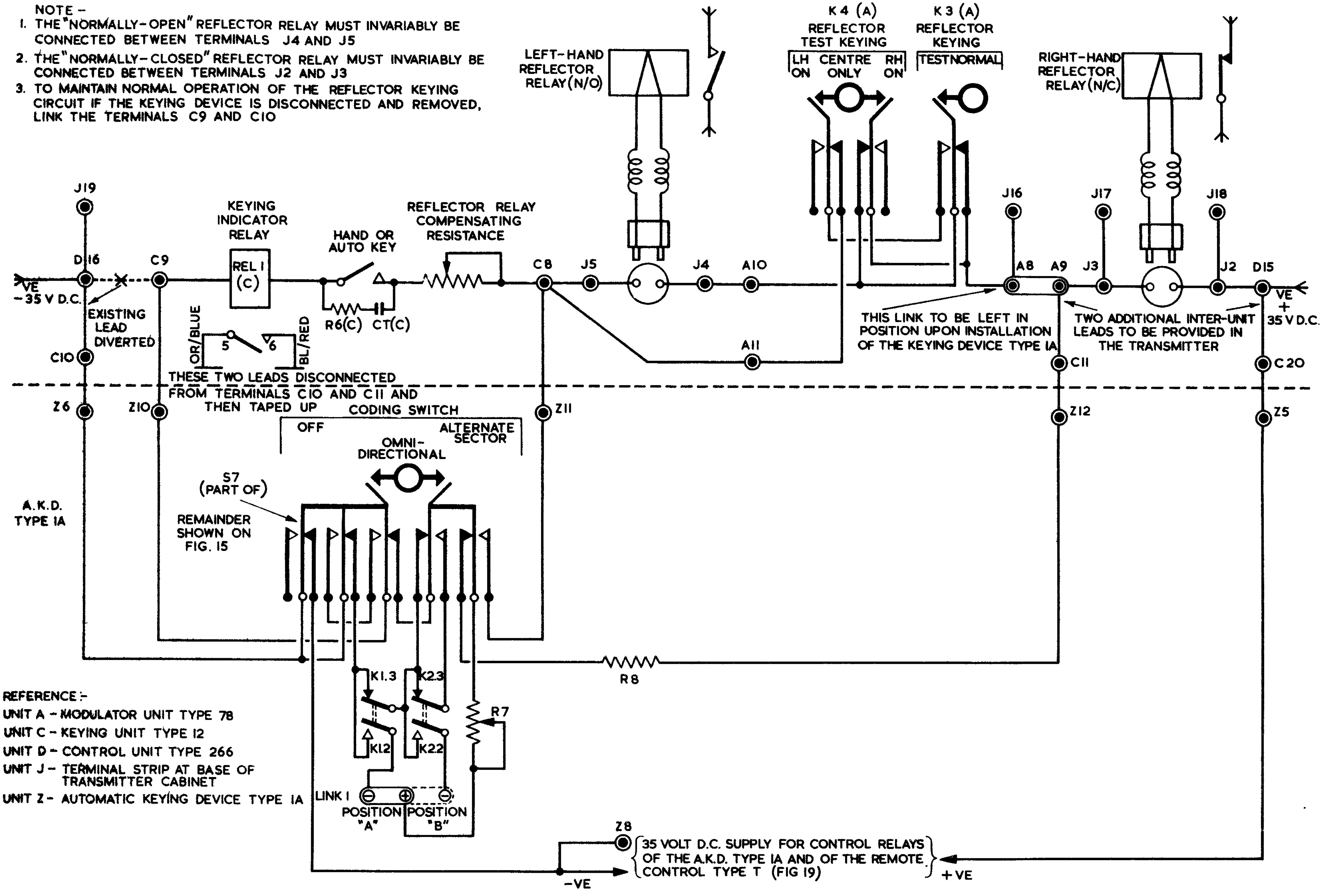


FIG. 14 – INTERCONNECTION WITH TRANSMITTER T.1451 – REFLECTOR RELAY UNIT

PP5013 M41586 G1475 11 47 495 C&P Gp. 959 (4)

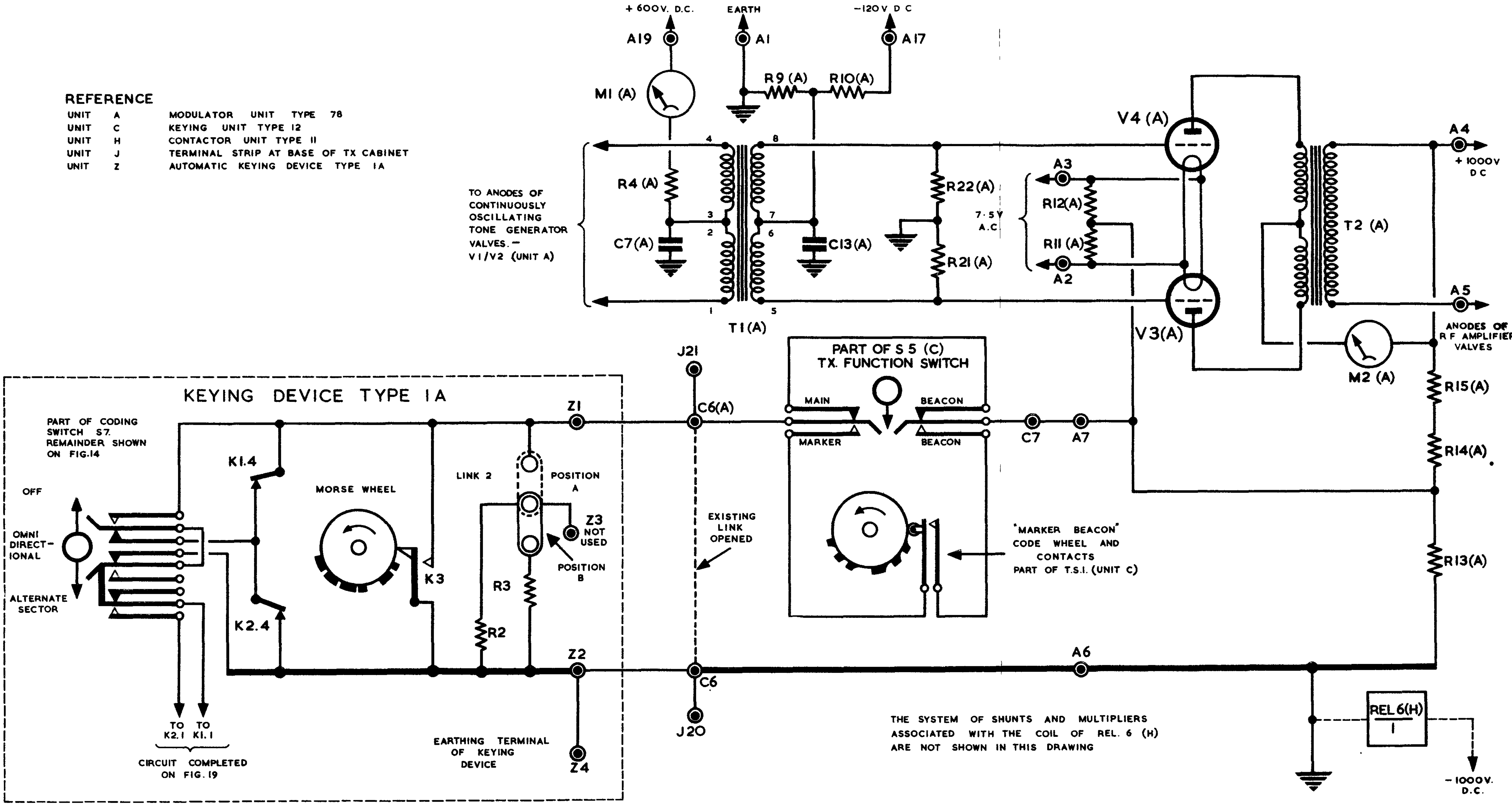


FIG. 15. — INTERCONNECTION WITH TRANSMITTER T. 1451 MODULATOR UNIT

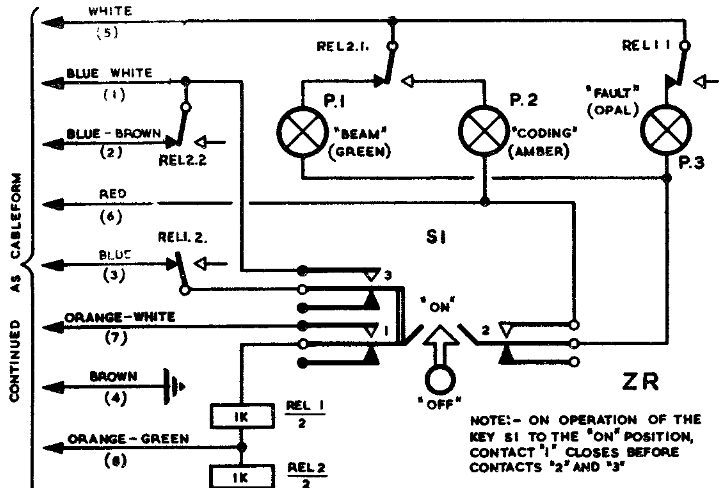


FIG. 16. - CIRCUIT DIAGRAM

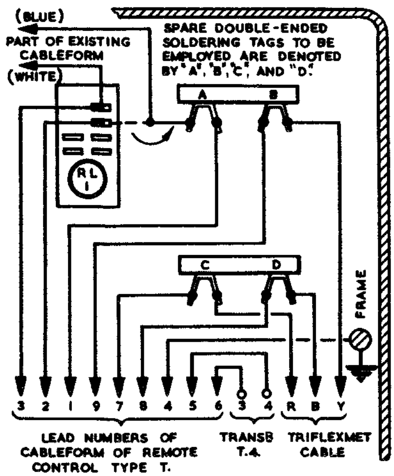


FIG. 16A. CONTROL UNIT, TYPE 35

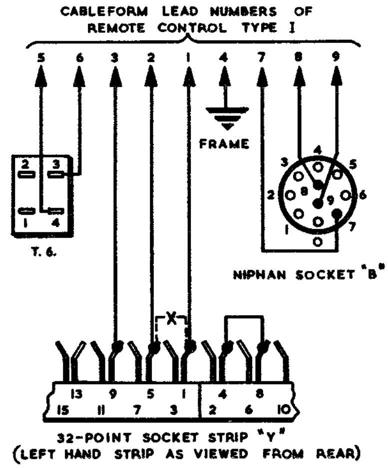


FIG. 16B - REMOTE CONTROL TYPE K

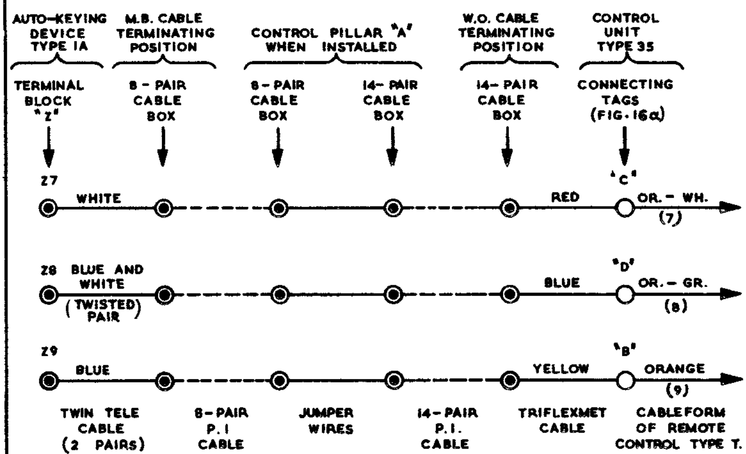


FIG. 16C - INTERCONNECTION USING SPARE REMOTE CONTROL LINES FOR S.B.A., T.1122 AND T.1345

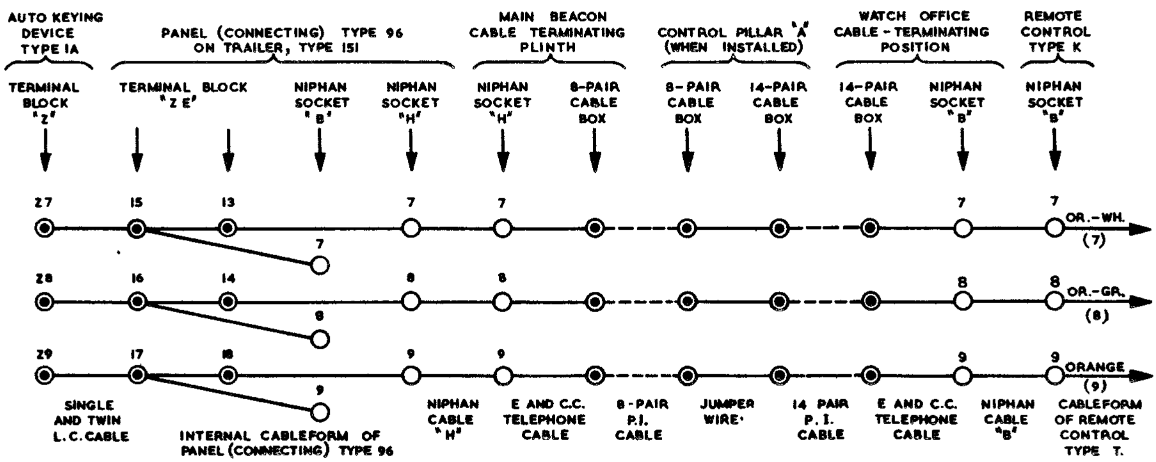
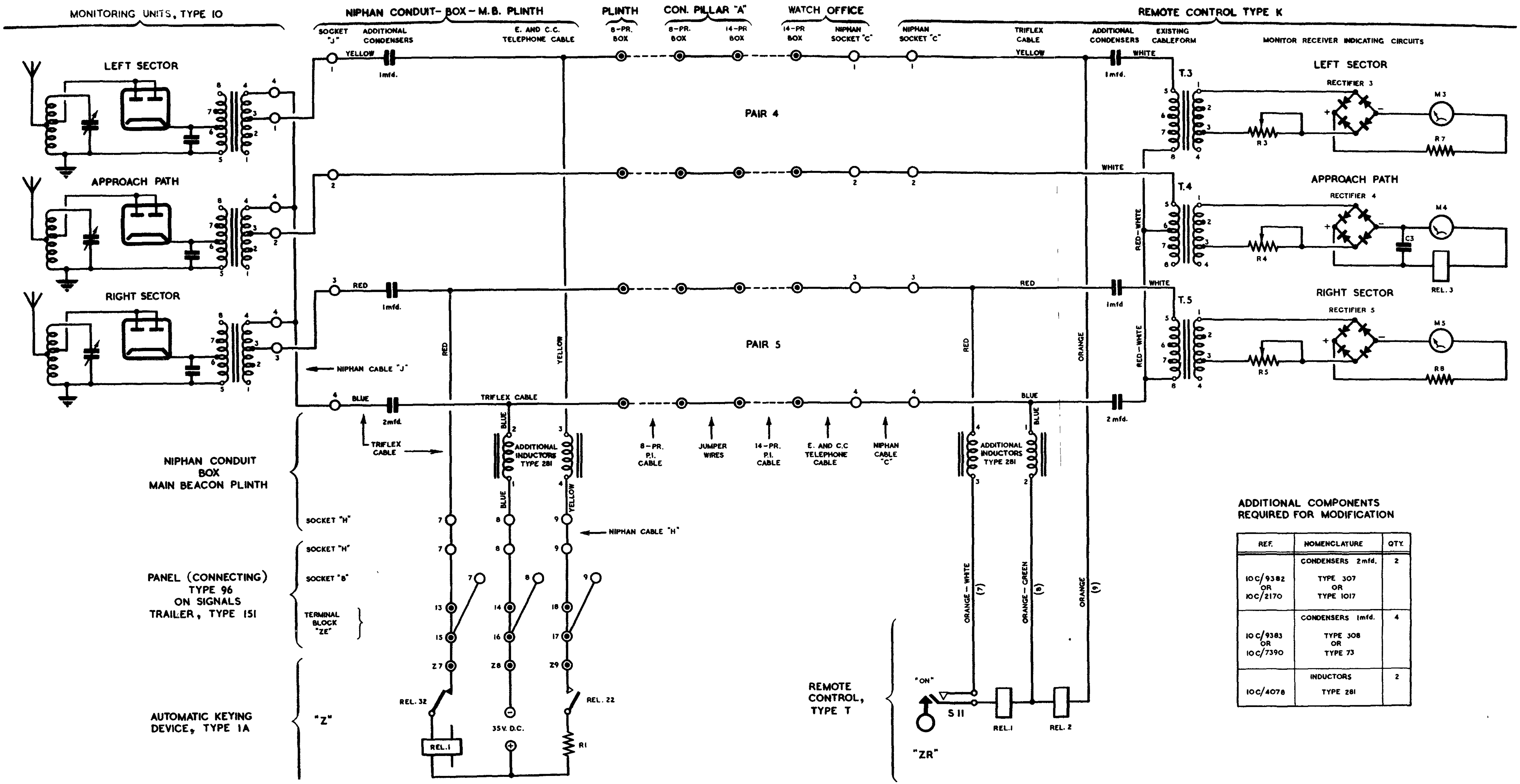


FIG. 16 d. - INTERCONNECTION USING SPARE REMOTE CONTROL LINES FOR S.B.A., T.1254 AND T.1451



ADDITIONAL COMPONENTS REQUIRED FOR MODIFICATION

REF.	NOMENCLATURE	QTY.
	CONDENSERS 2mfd.	2
10C/9382 OR 10C/2170	TYPE 307 OR TYPE 1017	
	CONDENSERS 1mfd.	4
10C/9383 OR 10C/7390	TYPE 308 OR TYPE 73	
	INDUCTORS	2
10C/4078	TYPE 281	

FIG. 17.—INTERCONNECTION WITH REMOTE CONTROL, TYPE T., USING MODIFIED MONITOR RECEIVER LINES (FOR TRANSMITTERS T.1254 AND T.1451 ONLY)—CIRCUIT DIAGRAM

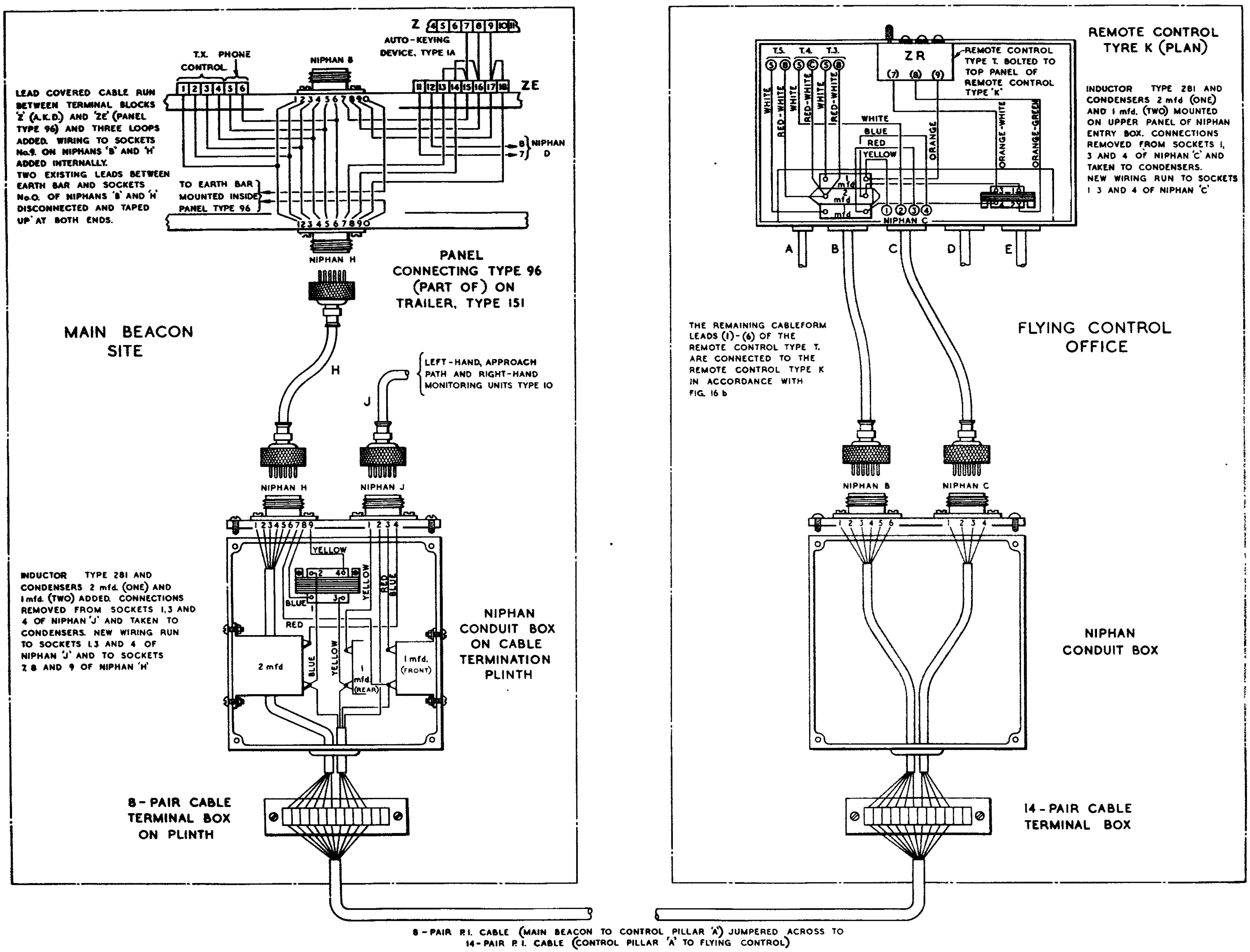


FIG. 18. — INTERCONNECTION WITH REMOTE CONTROL TYPE T. USING MODIFIED MONITOR RECEIVER LINES (FOR TRANSMITTERS T. 1254 AND T. 1451 ONLY) — WIRING DIAGRAM

PP5013 M41586 G1475 11/47 495 C & P Gp. 959 (4)

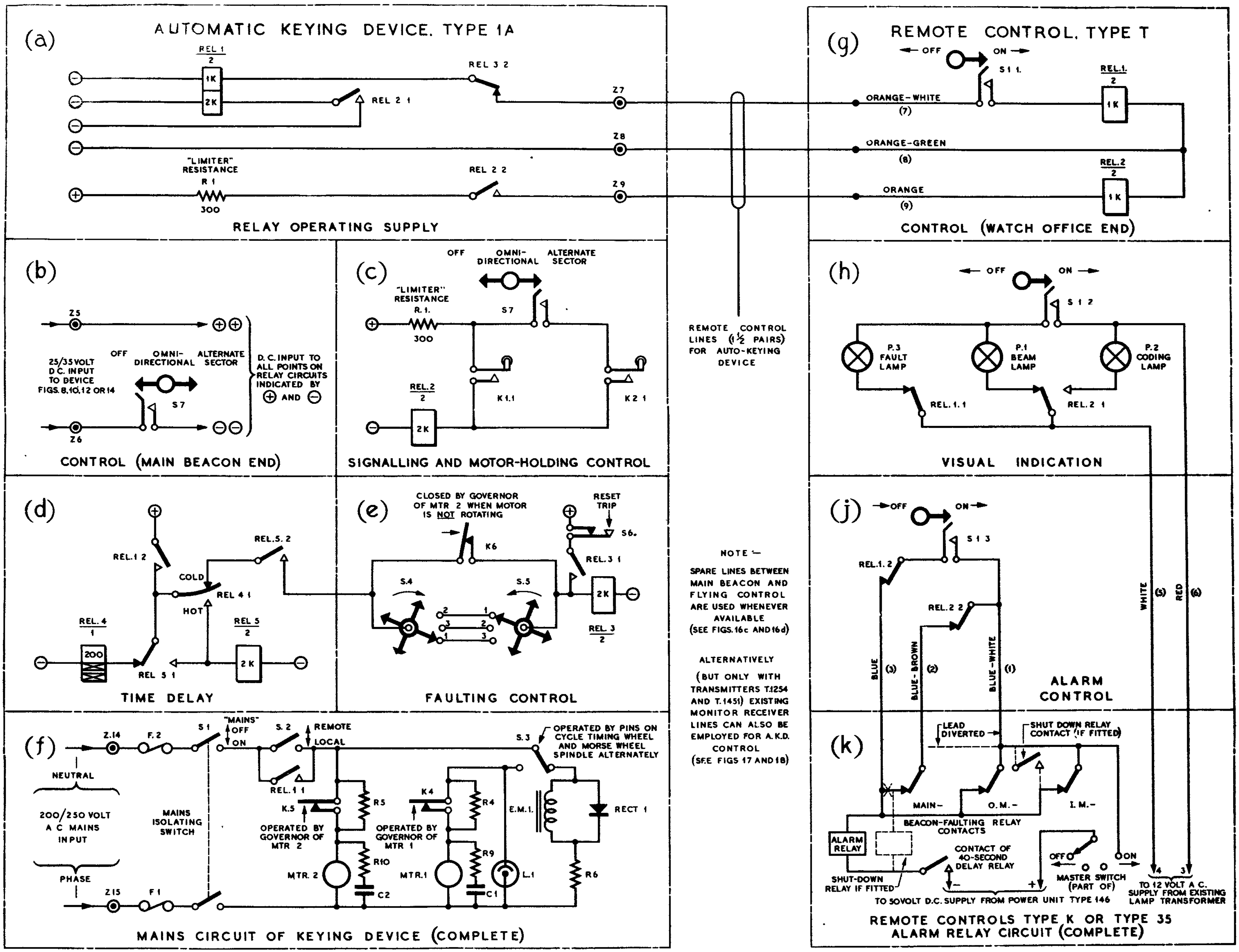


FIG. 19. REMOTE CONTROL FAULT INDICATION AND MAINS CIRCUITS (ANALYSED)

40 mA, being normal. The voltage drop across the resistor R6(G) is increased proportionally, and the voltage available at the anodes of V1 and V2 is correspondingly reduced. The increased grid drive and reduced anode voltage may cause grid current to flow through the tuned choke, CH1(G), and the waveform of the tone may be impaired as a result. This may be corrected by varying the value of R6(G) and, if necessary, of the additional resistor.

Use with transmitter, Type T.1345

91. The complete reflector keying control circuits are shown in *fig. 12* and the keying device controls the operation of the reflector relays in the same way as has been described in *para. 73* to *80*. The modulation control circuits, as applied to the modified modulator unit, Type 41, are given in *fig. 13*. The keying device controls the modulation, and the modulator unit A is modified, in the same way as has been described in *para. 88* to *90*.

Use with transmitter, Type T.1451

92. The complete reflector keying control circuits are shown in *fig. 14* and the keying device controls the operation of the reflector relays in the same way as has been described in *para. 73* to *80*. It will be noted that aerial testing facilities, provided by the test keys K3 and K4 in unit A, are available in the normal manner when the keying device is switched off at the remote point or, alternatively, at the coding switch S7.

93. The method of modulation control is shown in *fig. 15*. In the transmitter, Type T.1451, the tone oscillator stage drives the modulator stage continuously and the modulator stage is then keyed by the cut-off biasing method, instantaneous keying response thereby being achieved. A steady value of bias voltage, tapped off a potentiometer across the 120-volt DC bias supply, is applied to the grids of the modulator stage valves, V3 and V4, unit A. Additional grid bias is provided in the cathode circuit, between the filament centre-point and HT negative, by the voltage drop across the resistor R13(A) which, with the resistors R14(A) and R15(A), form a potentiometer across the 1,000-volt anode supply. The voltage thus developed across R13, nominally 166 volts, augments the steady value of bias provided in the grid circuit to a value which entirely prevents the flow of modulator stage anode current.

94. To restore the modulation the resistor R13(A) is short-circuited, the voltage drop (i.e. the additional grid bias) then becoming zero, and the filament centre-point being connected directly to earth and so to negative HT supply. Referring to the keying device circuits, it will be seen that the link, LINK 2, is placed in position B and that the terminal Z3 and resistors R2 and R3 are not used. An open circuit or a closed circuit is thus provided in the same manner as has been described in *para. 81* to *86*, across the terminals Z1 and Z2 which are connected, through the switch S5(C), across the resistor R13(A) to control the modulation.

95. The operation of the *transmitter function* switch S5, unit C, is not affected by the installation of the keying device so long as the device is switched off, for example, at the coding switch, during *marker beacon operation*. It should be observed that during spacings in the coding periods, the terminal Z1, and contacts and other components in direct electrical connection therewith, are at a potential of 166 volts (nominal) above the keying device chassis and other earthed objects. During continuous or coded marking periods, however, these points are at earth potential.

Relay circuits

96. The complete relay circuits comprise a number of distinct functional circuits. These separate circuits are shown, with their functions, in *fig. 19*. Standard conventions are maintained throughout the diagrams. The coil and contact sets of each relay are *divorced* in order that each coil and contact set may appear the more clearly in its own functional circuit. Identification between any particular relay coil and its physically associated contact sets is then made by appropriate annotation. For example, the expression $\frac{\text{REL 1 (Z)}}{2}$ (*fig. 19a*) indicates that the component part so annotated is the coil of the relay, REL1(Z) which has two sets of contacts as is denoted by the divisor. One of these contact sets is annotated REL1(Z)1 (*fig. 19f*) and the other REL1(Z)2 (*fig. 19d*). All relay contact sets are shown in their normal non-operated positions; and normally closed fixed contacts are drawn "solid" while normally open fixed contacts are drawn "open".

97. Referring to *fig. 19* (*a*) and (*g*) it will be seen that the remote control, Type T, is connected to the keying device over three remote control lines ($1\frac{1}{2}$ pairs). For clarity the various jumper points, and chokes, if used, which will exist between the keying device terminal block and the cable-form of the remote control are not shown here, being given in full in *fig. 16* (*c*) or (*d*) or *fig. 17* and *18*. However, all these schemes of connections are basically similar inasmuch as terminal Z7 of the keying device is always ultimately connected to lead 7 of the remote control, terminal Z8 is always connected to lead 8, and terminal Z9 to lead 9.

98. On *fig. 19* (*k*) the existing fault alarm circuit of the main control unit (both types) is re-drawn to show the necessary interconnections between it and the faulting control circuits (*fig. 19j*) of the remote control, Type T. The modification is shown whereby the main-beacon alarm-sounding contact is connected, not directly, but through the relay contacts REL2(ZR)2, to positive 50 volts. Further, a fourth circuit for the operation of the alarm relay is provided by the relay contacts REL1(ZR)2 in series with the switch section, S1(ZR)3.

99. From *fig. 19* (*a*) it is apparent that a DC supply for all the functional circuits shown in *fig. 19* (*a*), (*c*), (*d*), (*e*) and (*g*) is continuously available so long as:—

(1) the main beacon transmitter is operating and is delivering a 25/35-volt DC supply to the terminals Z5 and Z6;

(2) the coding switch S7 is at either the OMNI-DIRECTIONAL or the ALTERNATE SECTOR position.

100. Reference to *fig. 19* (*f*) shows that the keying device can be set in operation locally by closing the switch S2 and remotely by closure of the relay contacts REL1(Z)1 so long as:—

(1) the 200/250-volts AC supply is available at the terminals Z14 and Z15;

(2) the 1-amp. cartridge fuses, F1 and F2, are in position in their holder and are intact;

(3) the double-pole isolating switch, S1(Z), is in its normal "on" position.

Assuming that these five conditions are obtained, and that the complete beam approach installation is operating normally, then, upon switching on the previously set-up keying device from the remote control, Type T, the following relay circuit conditions will be produced.

101. Operation of the control switch, S1(ZR), to the ON position closes its three pairs of contacts. The switch contacts, S1(ZR)1, which make first, close a circuit as follows [*fig. 19* (*a*) and (*g*)]:—

> Positive relay supply, 1,000-ohms winding of REL1(Z), closed relay contacts REL3·2, terminal Z7, upper GO remote control line, cableform lead 7, switch contacts S1(ZR)1, winding of REL1(ZR), cableform lead 8, along the *negative return* line to terminal Z8 and so to negative relay supply.

The two relays, REL1(Z) and REL1(ZR), therefore operate, the former starting up the keying device by closing its contact pair REL1(Z)1, (*fig. 19f*). The cycle timing wheel thus begins to rotate.

102. At the remote control, the relay REL1(ZR) in operating opens its contacts REL1(ZR)1 (*fig. 19h*) while at the same time the switch contacts S1(ZR)2 are being closed. Thus the *fault* lamp P3 will remain extinguished, but the *beam* lamp P1(ZR) will be lighted through a circuit which includes the back contacts of the changeover set REL2(ZR)1. Similarly (*fig. 19d*), the relay contacts REL1(ZR)2 are opened as the switch contacts S1(ZR)3 are being closed. Hence, an open circuit will still be maintained between the alarm relay and the positive 50 volts supply (*fig. 19k*), and the alarm relay will remain unoperated. (In the main control it is, of course, already assumed that the master switch is at its final ON position, that the contact of the 40-second delay relay is closed, and that tone returns from the three beacons are causing their respective paralleled alarm-sounding contacts to be held open.)

103. Switching on the keying device from the remote control, Type T, has therefore caused:—the keying device to start up, the *beam* lamp to be lit, and additional circuits for the main aural alarm and for the keying device *fault* lamp to be prepared. These conditions will be steadily held, pending further developments at the keying device which will only occur after the cycle timing wheel has revolved sufficiently to cause the operation of the switch S3 (*fig. 19f*).

104. Operation of the switch S3 having taken place, the friction brake on the stroboscope disc is released, power is applied to the morse wheel motor MTR1 and to the stroboscope lamp P1(Z), and the morse wheel begins its revolution. At a certain point, the switch unit K1 is operated by the leading edge of the cam plate, and, first, the contact pair K1.1 closes (*fig. 19c*). This completes a circuit across the relay supply which includes the resistor R1 and the winding of REL2(Z). The relay REL2(Z) therefore operates and its contact pair REL2(Z)1 closes (*fig. 19a*), connecting the 2,000-ohm winding of the relay REL1(Z) directly across the relay supply. No further circuit change arises here since the relay REL1(Z) is already operated through its 1,000-ohm winding. However, if the circuit through the 1,000 ohm winding were now to be opened, for example, by moving the control switch S1(ZR) to its OFF position, the mains circuit to the motors through the relay contacts REL1(Z)1 (*fig. 19f*) would be maintained until the contacts REL2(Z)1 were released (*fig. 19a*). It will be appreciated that such releasing would not take place until contacts K1.1 and K2.1, if in circuit, had themselves been released (*fig. 19c*) and this would only occur when the complete coding period had ended.

105. Returning to the operation of the relay REL2(Z) through the contacts K1.1, the other contact pair REL2(Z)2, of this relay also closes and this provides a circuit [*fig. 19* (*a*) and (*g*)] as follows:—

> Positive relay supply, resistor R1, contacts REL2(E)2, terminal Z9, lower *go* line, cable form lead 9, winding of relay REL2(ZR), cableform lead 8, back along the common *negative return* line to terminal Z8 and so to negative relay supply.

The relay REL2(ZR) therefore operates and, at its changeover contacts REL2(ZR)1 (*fig. 19h*) causes the *beam* lamp P1(ZR) to be extinguished and the *coding* lamp P2 to be lighted. At the same time its other contact pair REL2(ZR)2 opens (*fig. 19j*) and so (*fig. 19k*) disconnects positive 50 volts from the main beacon alarm-sounding contact rendering this contact electrically ineffective.

106. The closing of the switch unit contacts K1.1 preliminary to the start of an *omni-directional* or an *alternate sector* coding period, has therefore caused:—

(1) a precautionary motor supply holding circuit to be provided,

(2) the remote visual indication to be changed from *beam* to *coding*, and

(3) the main beacon alarm-sounding contact to be made electrically ineffective.

These three conditions will be steadily maintained throughout the complete code sending period.

107. Continued rotation of the morse wheel, from the position at which K1.1 closed, causes the operation of the contacts K1.4, K1.3 and K1.2. Contact K1.4 cuts off the modulation, and, after the release lag delay of approximately 250 milliseconds, the now ineffective main beacon alarm-sounding contact closes (*fig. 19k*). The contacts K1.3 and K1.2 cause the reflectors to be locked in their appropriate conditions.

108. The initial spacing period having been completed, the modulation is restored in code rhythm by the contacts K3, and the still ineffective main beacon alarm-sounding relay operates in sympathy so far as its release lag of 250 milliseconds allows. The completion of the code sending period occurs at the closing point of K1.4 for omni-directional coding, but at the later closing point of K2.4 for alternate sector coding, there being the intermediate period in the latter system during which the switch units K1 and K2 are operated simultaneously.

109. From *fig. 19* (*c*) it will be seen that the section of the coding switch S7 similarly provides that a circuit is maintained for the winding of the relay REL2(Z) until the opening point of K1.1 or the later opening point of K2.1 is reached. Thus, irrespective of the system of code sending in use, the restoration of continuous modulation for the normal beam approach signals is always followed 0·75 baud later by the opening of the circuit through the relay winding REL2(Z). This delay of 0·75 baud is, of course, obtained by virtue of the different operating points, on the cam plate trailing edge, of the fourth and first contact pairs of the switch units K1 and K2 (*fig. 3* and *6*). The equivalent time value of this delay will vary with the code transmission speed employed but cannot be less than 60 milliseconds approximately (TABLE II) since the maximum transmission speed of the keying device is 15 w.p.m. Based on this minimum delay of 60 milliseconds, the circuit changes which occur on the completion of a coding period are as follows.

110. Referring to *fig. 15*, the morse wheel having revolved to the point at which, after normal reflector keying has been re-established, the continuous modulation is restored by the closing of K1.4 or K2.4; this latter causes the main beacon alarm-sounding contact to open (*fig. 19k*). Continued rotation of the morse wheel then causes the contacts K1.1 or K2.1 to open (*fig. 19c*) thus breaking the circuit of the relay winding REL2(Z). The relay REL2(Z) therefore releases and opens its two contact pairs (*fig. 19b*) the one, REL2(Z)1, releasing the holding circuit on the motor-supply relay REL1(Z), and the other, REL2(Z)2, breaking the positive supply to the relay REL2(ZR) (*fig 19g*). The relay REL2(ZR) thus releases and at its changeover contacts REL2(ZR)1 (*fig. 19h*) causes the *coding* lamp P2 to be extinguished and the *beam* lamp P1(ZR) to be lit. At the same time its other contact pair REL2(ZR)2 closes (*fig. 19j*) and this brings the main beacon alarm-sounding contact into circuit again.

111. The timing of the circuits is as follows:—

(1) From the closing of K1.4 or K2.4 to the opening of the main beacon alarm-sounding contact a time period of 50–100 milliseconds will elapse, due to the varying *build-up* times of different 1,150 c/s oscillators and to the operate lags of the polarized and double-wound main beacon alarm relays.

(2) From the same point, that is the closing of K1.4 or K2.4 to the closing of the relay contacts REL2(ZR)2, a time period of at least 123 milliseconds will elapse, due in part to the provided minimum period of 60 milliseconds between closing of K1.4 or K2.4 and opening of K1.1 or K2.1, and in part to the following release lags of the relay REL2(Z) and then of the relay REL2(ZR).

Hence, under the worst conditions the relay contact REL2(ZR)2 is not closed until 20 milliseconds after the main beacon alarm-sounding contact has opened. A circuit path for the alarm relay, or for the auto shut-down relay if this is fitted, is thus never provided at the conclusion of code sending periods, so long as the respective contact pairs of K1 and K2 are operating at their correct points on the cam leads.

112. The morse wheel rotation continues until, at the end of its revolution, it causes the operation of the switch S3 to the right (*fig. 19f*). The AC supply is thus disconnected from the motor MTR1 and from the stroboscope lamp L1(Z), and is applied to the electro-magnetic brake EM2. The rotation of the morse wheel then ceases, and will not be resumed until the next coding period is almost due, when the cycle timing wheel will again reach the point at which it causes the operation of S3. The cycle of events from this point, described in the foregoing paragraphs, will then be repeated. The keying device will normally operate in this manner indefinitely unless switched off by operation of the control switch S1(ZR) or, alternatively, a keying device fault develops. The former condition will be considered first.

113. When normal beam approach signals are being radiated, operation of the switch S1(ZR) to its OFF position first breaks the keying device alarm-sounding circuit (*fig. 19j*) and the *beam* and *fault* lamp circuits (*fig. 19h*) at its respective contacts S1(ZR)3 and S1(ZR)2. The *beam* lamp is therefore extinguished. The switch contact S1(ZR) then opens (*fig. 19g*) breaking the circuit of the series-connected relays REL1(ZR) and REL1(Z) which both release. The relay REL1(ZR) in releasing closes the keying device alarm-sounding contacts REL1(ZR)2 (*fig. 19j*) and closes the *fault* lamp contacts REL1(ZR)1 (*fig. 19h*) but both these circuits have just previously been opened by the switch contacts S1(ZR)3 and S1(ZR)2, respectively. The alarm, therefore, does not sound and the *fault* lamp does not light. The relay REL1(Z) in releasing opens its contacts REL1(Z)1 (*fig. 19f*), the motor power supply is cut off, and the keying device ceases to operate.

114. If the switch S1(ZR) is operated to the OFF position either during a coding period, or at the instant that a coding period is beginning, then the three switch contacts open, and the relay REL1(ZR) releases, to perform the same functions as previously described. At the keying device, however, the coding period proceeds normally since the motor power supply relay REL1(Z) is held operated, through its 2,000-ohms winding, by the relay contacts REL2(Z)1 (*fig. 19a*). It will be noticed that no section of the switch S1(ZR) controls the circuit of the relay winding REL2(ZR) (*fig. 19g*) of the *coding* lamp P2 (*fig. 19h*) or of the main beacon fault holding-off contacts REL2(ZR)2 (*fig. 19j*). Hence, the coding period also proceeds normally at the remote control position, the relay REL2(ZR) remaining operated, the *coding* lamp remaining lighted, and the main beacon alarm-sounding contact (*fig. 19k*) remaining ineffective.

115. After the completion of the coding period all keying device contacts and relays restore to their non-operated positions, and the keying device stops. Similarly, at the remote control, the relay REL2(ZR) releases and the *coding* lamp is extinguished but the *beam* lamp, having been open-circuited, does not light. The contact REL2(ZR)2 also closes and this restores the normal circuit for the now-opened main beacon alarm-sounding contact.

116. The operation of the keying device failure provision circuits will now be discussed. The *monitoring circuit* (*fig. 19e*), comprising the spring set K6 in parallel with the series-connected switches S4 and S5, is *open* when the keying device is running correctly but provides a closed circuit in the fault conditions detailed in *para. 64* to *67*. However, a closed circuit is also provided whenever the keying device is switched off normally, since the contact K6 is closed as soon as the motor MTR2 ceases to rotate for any reason. Further, the contact K6 does not open immediately power is applied to the field windings of the motor MTR2, the inertia of the armature having first to be overcome.

117. For the reason stated in the foregcing paragraph, it is necessary that the monitoring circuit be made effective only *after* MTR2 has had sufficient time to attain its normal running speed, but that the circuit be made ineffective *immediately* the keying device is switched off, that is, before the speed of MTR2 has dropped sufficiently to cause K6 to close. These requirements are met by the circuit shown at *fig. 19* (*d*).

118. When the keying device is switched on remotely the relay REL1(Z) operates and closes its two pairs of contacts. The second contact pair, REL1(Z)2, extends the positive relay supply, through the *cold* contact of the thermal relay changeover set REL4.1 to the contacts REL5.2. These latter are, however, open, the relay REL5 not yet having operated.

119. The positive relay supply is also extended through the back contact of the changeover set REL5.1, to the heater coil of the thermal relay REL4, the opposite side of which is connected to negative relay supply. The thermal strip therefore heats up and in approximately 10 seconds operates its changeover set REL4.1, the moving contact now resting on the *hot* contact. This provides a circuit:—

> Positive relay supply, made contacts REL1(Z)2, thermal relay *hot* contact REL4.1, winding of relay REL5, to negative relay supply.

The relay REL5 therefore operates and, through its changeover contacts REL5.1, the positive relay supply is withdrawn from the thermal relay heater coil and is connected instead to the winding of REL5. The relay REL5 is thus locked on through a circuit which includes the contacts REL1(Z)2 and its own front contact REL5.1.

120. At the same time the thermal heater coil is steadily isolated from the positive supply, and the thermal strip is thus allowed to cool. As the contact set REL5.1 operates, so the contact pair REL5.2 closes to prepare for the subsequent return of the thermal relay changeover set REL4.1 to its *cold* position. The contacts REL4.1 are accordingly restored approximately 25 seconds after the relay REL5 has operated, and a circuit is then provided from positive relay supply,

> through made contact REL1(Z) 2, cold contact of the changeover set REL4.1, and made contact REL5.2, to one side of K6 and of S4 (fig. 19*e*).

Hence, 35 seconds after the keying device has been switched on remotely, the monitoring circuit is connected to positive relay supply.

121. No further circuit changes will result from this if the keying device is running normally since, although S5 and S4 are regularly being operated in turn, the monitoring circuit will remain *open*. The keying device then being switched off remotely, the relay REL1(Z) releases, simultaneously isolating the motors from their power supply at its contact REL1(Z)1 (*fig. 19f*), and the monitoring circuit from the relay supply at its contact REL1(Z)2 (*fig. 19d*).

122. As a further result of the opening of the contact REL1(Z)2, the locking circuit of the relay REL5 is broken and REL5 therefore releases. The moving contact of the changeover set REL5.1 returns to its back contact and the contact pair REL5.2 opens. The delay circuit is thus re-set so that, upon subsequently switching on the keying device remotely, the monitoring circuit remains ineffective for the initial period of 35 seconds.

123. Upon the occurrence, during remote operation of the keying device, of a fault which causes the monitoring circuit to close, the following circuit changes take place. The positive relay supply, being available as above at one side of K6 and of S4 (*fig. 19e*) passes through the monitoring circuit to the winding of the relay REL3. The opposite end of this winding is connected to negative relay supply and the relay REL3 therefore operates.

124. Having operated, this relay locks itself on to positive relay supply through the closed contacts of S6 and its own made contact REL3.1. At the same time, its second contact pair REL3.2 is permanently opened (*fig. 19a*). The terminal Z7 and the upper remote control line, which normally have a steady positive potential, are isolated from the positive relay supply, and the circuit of the series-connected relays, REL1(Z) and REL1(ZR), is now broken. The remote relay REL1(ZR) releases immediately and its contact pairs close, the first, REL1(ZR)1, completing a circuit through the closed switch contacts S1.2 for the keying device *fault* lamp P3 (*fig. 19h*) which then lights.

125. The second contact pair, REL1(ZR)2, provides a circuit (*fig. 19j*) through the closed switch contacts S1.3 for the alarm relay (*fig. 19k*) which therefore operates, causing the normal aural and visual alarms to be given. The aural alarm can, as usual, be suppressed by operating the button provided for this purpose on the main remote control.

126. At the keying device, when the contacts REL3.2 are opened, the relay REL1(Z) also releases immediately. Alternatively, this relay releases at the completion of the coding period if coding is in progress when the fault occurs. REL1(Z) being released, its contact pair REL1(Z)1 opens to cut off the power supply (*fig. 19f*). The keying device therefore stops, preventing further repetition of the fault condition which caused the monitoring circuit to close, and allowing the normal beam approach signals to be radiated uninterruptedly. The contact pair REL1(Z)2 also opens (*fig. 19d*) to re-set the 35-second time delay circuit, but the relay REL5 does not release at this point. It is held operated through the same locking circuit as is REL3, since the closing of the monitoring circuit effectively connected the windings of the relays REL3 and REL5 in parallel.

127. Thus, the closing of the monitoring circuit causes the permanent closing down or *tripping* of the keying device, and the state of unserviceability is indicated remotely by aural and visual alarm. The keying device cannot then be controlled from the remote position until the device has been examined and the RE-SET TRIP switch S6 depressed.

128. Operation of the switch S6 (*fig. 19e*) disconnects the positive relay supply from the relay windings REL3 and REL5 and these two relays release. The relay REL5 in releasing (*fig. 19d*) restores its two contact sets to normal, and this completes the re-setting of the 35-second time delay circuit. The relay REL3 in releasing, opens its contact pair REL3.1 (*fig. 19e*), so re-setting the locking circuit, and this relay will therefore not operate again when S6 returns to its normally closed condition.

129. The release of REL 3 also results in the closing of its contact pair REL3.2 (*fig. 19a*) and this re-establishes the original circuit for the relays REL1(Z) and REL1(ZR). If, therefore, the control switch S1(ZR) is still in its ON position, the relays REL1(Z) and REL1(ZR) both operate when the RE-SET TRIP switch S6 is depressed. As a result, the keying device starts up, as does the 35-second delay circuit, and at the remote control all the fault indications are cleared. It is, of course, necessary to investigate the cause of the monitoring circuit having been closed and to apply the appropriate remedial faction, otherwise the keying device will again be tripped, and the remote alarm indications given, as soon as the 35-second delay period has elapsed.

130. It will be appreciated that, when the remote switch S1(ZR) is ON, remote aural and visual fault alarms are given if any break occurs in the circuit which includes the relays REL1(Z) and REL1(ZR). In certain circumstances such a break is intentionally provided by the relay contacts REL3.2, controlled by the monitoring circuit, or by the contacts of the coding switch S7, when this is operated to its OFF position (*fig. 19b*).

131. Other circumstances covered by the system of fault indication employed include the failure at the transmitter of the 25/35-volt reflector keying supply, or the development of an open-circuit in the remote control lines 7 and/or 8 including any plug-and-socket or other connecting point associated therewith. Although such faults are not due to faulty operation of the keying device itself they do, of course, prevent the operation of the keying device and this is indicated remotely by aural and visual means. Obviously, depression of the RE-SET TRIP switch S6 has no clearing effect in these instances.

132. Some examples of other line faults and the efferts produced are detailed:—

(1) A short circuit across the lines 7 and 8 at any point maintains operation of the keying device, but by shorting the coil of the relay REL1(ZR) gives continuous fault indication at the remote position. The continued operation of the keying device would be shown remotely by the lighting of the coding lamp at the usual regular intervals.

(2) An open-circuit in the line 9, or a short-circuit across the lines 8 and 9, does not affect the control of the keying device from the remote point, but prevents the operation of the remote relay REL2(ZR). The coding lamp therefore does not light, and intermittent sounding of the aural alarm occurs, during coding periods. Alternatively where the main beacon automatic shut-down modification has been provided, the main beacon and, hence, the keying device both close down as the next coding period commences. Continuous aural and visual alarm is then given at the remote position.

133. Other fault conditions, and the indications to which they give rise, can be deduced from a study of the *fig. 19*.

134. For local control of the keying device the switch S2 is used (*fig. 19f*), the mains isolating switch S1(Z) remaining in its normal ON position, and the remote switch S1(ZR) being OFF. Upon operating the switch S2 to the LOCAL position, the keying device starts up. Since the relay REL1(Z) is not operated, the relays REL4, REL5 and REL3 also do not operate and so the fault monitoring circuit is not effective when the keying device is controlled locally. Otherwise, however, the relay circuits of the keying device function normally. Thus, at the beginning of a coding period (*fig. 19c*) the relay REL2(Z) operates and its contacts close (*fig. 19b*) to operate the local relay REL1(Z) and, if connected, (*fig. 19g*), the remote relay REL2(ZR). If the switch S2 were then to be moved to the LOCAL OFF (i.e. the REMOTE position), the keying device would continue to operate until the coding period had been completed.

Note . . .

The contacts REL1(Z)2, being closed during coding periods, cause (fig. 19d) *the thermal delay circuit to be started up. The circuit is however, re-set when REL1(Z) is released at the end of each coding period, and this will occur before the monitoring circuit is made alive since a coding duration of 35 seconds lies outside the limits of the device.*

135. If the remote control, Type T, is installed and connected when the keying device is operated by local control, remote visual indication of the coding periods is obtained, and the main beacon alarm-sounding contact is rendered ineffective during these periods, in the standard manner.

INSTALLATION

136. The keying device is installed in the main beacon hut in installations equipped with the transmitters, Types T.1122 and T.1345, and in the main beacon trailer with the transmitter, Type T.1254. When used with the transmitter, Type T.1451, the keying device is located in the transmitter keying unit C after redisposition of the components comprising this unit. The necessary changes in, and additions to, the original circuits of each of the four transmitters and of each of the two main control units, consequent upon the installation of the keying device, are described in subsequent paragraphs. The interconnections between the keying device and the four transmitters are given in TABLE IV, the required position of the keying device link, LINK 2, also being tabulated therein.

For transmitter, Type T.1122

137. The following circuit changes are made in the transmitter on the installation of the keying device:—

(1) The link between terminals D29 and E29 is disconnected.

(2) The link between terminals D8 and E8 is disconnected.

(3) The connections of the reflector relays are checked and, if necessary, are altered so that the *dot* reflector relay is connected between the terminals 28 and 45 and the *dash* reflector relay is connected between the terminals 45 and 9.

138. The keying device is mounted on a bracket secured to the left-hand side of the transmitter casing, connections to the transmitter being made by means of a cableform between the terminals indicated in TABLE IV and in *fig. 8* and *9*. Cables are also run from the keying device terminals Z7, Z8 and Z9, to spare terminals on the remote control cable terminating box in the main beacon hut, as indicated in *fig. 16* (*c*).

139. The keying device AC power input terminals, Z14 and Z15, may be connected to any two of the transmitter terminals D1, D2 and D3, the pair selected being those from which the higher voltage reading is obtained. 220 volts (nominal) AC is then available at the terminals Z14 and Z15 so long as the two rotary switches on the power switchboard (unit M) are ON, the circuit breaker CB1 on the voltage regulator (unit N) is closed, and the transmitter isolating switch S1 (unit F) is ON.

140. If the remote control, Type T, is to be installed, it is bolted on to the existing control unit, Type 35, which will normally be situated in the airfield control office. As the front panel is square the remote control, Type T, can be mounted on the top, bottom or side of the control unit, Type 35, at a convenient operating height. The cableform is led into the control unit, Type 35, through a bushed hole which should be drilled in a suitable position in the casing of the control unit. The cableform is then connected to the points indicated on the wiring diagram, *fig. 16* (*a*), which gives a rear view of the appropriate portion of the control unit, Type 35. It will be found that the cableform leads are of more than adequate in length to reach the appropriate points of connection but none of the leads should on this account be cut short. Instead, the cableform slack should be neatly coiled and taped.

141. The method of breaking the circuit of the main beacon alarm-sounding contacts (REL1 in the control unit, Type 35) is clearly indicated in the diagram, the existing *blue* lead being transferred from the middle upper spring of REL1 to the spare tag annotated A. The three control lines connected at the main beacon hut to the terminals Z7, Z8 and Z9, having been identified on the terminating cable box in the control office, a single length of triflexmet cable is run from this box alongside the existing breeze cable into the control unit, Type 35. The ends of the triflexmet cable having been made off to the points indicated in *fig. 16* (*c*), this connects the remote control, Type T, to the keying device in the required manner.

For transmitter, Type T.1254

142. The following circuit changes are made in the transmitter on the installation of the keying device:—

(1) The link between terminals P23 and P24 is removed.

(2) The link between terminals P18 and F18 is disconnected.

(3) The connections of the reflector relays are checked and, if necessary, are altered so that the *dot* reflector relay is connected between the terminals F35 and F36 and the *dash* reflector relay is connected between the terminals P25 and P26.

(4) The modulator unit, Type 41, is modified in accordance with *para. 56*.

143. The keying device is mounted on a bracket secured to the trailer walls behind the amplifier bay. Cables are run against the wall to connect the keying device to the transmitter in accordance with TABLE IV and *fig. 10* and *11*. Cables are similarly run, from terminals Z7, Z8 and Z9, to the terminal block (ZE) on the connecting panel, Type 96, above which panel the keying device is positioned.

144. The internal wiring of the connecting panel, Type 96, is modified on the installation of the keying device, as follows:—

(1) A wire is run between terminal ZE17 and socket 9 of Niphan socket B.

(2) A wire is run between terminal ZE18 and socket 9 of Niphan socket H.

(3) The earth lead is removed from socket O of Niphan socket B.

(4) The earth lead is removed from socket O of Niphan socket H.

These modifications are shown at the upper left-hand corner of the wiring diagram, *fig. 18*, which also gives the external connections between the terminal blocks Z and ZE.

145. A circuit diagram of these connections appears in *fig. 16* (*d*) from which it will be observed that terminal Z7 is taken to the sockets 7 on the internal Niphan socket B and on the external Niphan socket H. Similarly, terminal Z8 is taken to the sockets 8, and terminal Z9 to the sockets 9. Thus, it has been arranged for convenience that the keying device control circuits are available at the *main beacon* Niphan sockets both inside the trailer (for local tests) and outside the trailer (for normal working), and then the Niphan pin and socket numbers correspond with the keying device terminal numbers.

146. Connectors, Type 700 (*Niphan cable H*), used to connect between the connecting panel Type 96 and the cable terminating standard on the main beacon plinth, comprise eight

TABLE IV

Keying device inter-connections, and link 2 position

Terminal on keying device Type 1A	Terminal on T.1122	Terminal on T.1254	Terminal on T.1345	Terminal on T.1451	Function
Z1	D29	P23	TS 1/15	C6a	Modulation keying (high potential side)
Z2	E29	P24	TS 1/16	C6	Modulation keying (earthed side—except with T.112)
Z3	D19	(Z3 not used)	(Z3 not used)	(Z3 not used)	Permanent grid circuit for modulator stage (L.1122 only)
Z4	D0	(looped to Z2)	(looped to Z2)	(looped to Z2)	Earth for keying device chassis
Z5	E9	P28	TS 2/20	C20	Positive 25/35 volts
Z6	E8	P18	TS 2/21	C10	Negative 25/35 volts
Z7	(1st spare control line)	ZE15 and ZE13	(1st spare control line)	Niphan H or M Socket 7	Remote control—"on/off" and fault indication
Z8	(2nd spare control line)	ZE16 and ZE14	(2nd spare control line)	Niphan H or M Socket 8	Remote control—common negative return
Z9	(3rd spare control line)	ZE17 and ZE18	(3rd spare control line)	Niphan H or M Socket 9	Remote control—coding indication
Z10	D8	F18	TS1/4	C9	Control of normal reflector keying
Z11	D28	F35	TS1/7	C8	Control of reflectors-alternate sector coding
Z12	45	F36	TS1/10	C11	Control of R-H reflector omni-directional coding
Z13	—	—	—	—	(Z13) spare terminal
Z14	D1–D2 or	F37–F38 or alternatively F39–F40	TS1/2–TS1/3	C2–C3	200/250 volts AC supply—"neutral" side
Z15	D1–D3 or D2–D3				200/250 volts AC supply—"phase" side
LINK 2	Position B	Position A	Position A	Position B	Modulation control—arrangement of keying device circuit

insulated wires connected between the two 10-pin plugs and brought out to the pins 1–8. Uninsulated strain wires, running through the centre of the connector from end to end, are terminated on the pins 9 and 0, on each plug, and it now, therefore, becomes necessary to employ these strain wires as the ninth connecting lead between trailer and cable terminating standard. This is permissible if certain precautions are carefully observed on installing the keying device and thereafter, since the strain wires are surrounded by the eight insulated wires, and the complete connector is then protected by the insulated and waterproofed covering provided.

147. It will be realised that, since the pins 9 and 0 are solidly linked in the connector through the strain wires, a connection is provided between *sockets 9* and *0* on any Niphan socket into which the connector is plugged. It is for this reason that the earth connection must be removed from sockets *0* of Niphan sockets B and H, for otherwise the reflector keying supply would be earthed through the relay coil REL2(ZR) and, when they were closed, through the contacts REL2(Z)2 also.

148. Further, the undermentioned tests are to be made on the connector, which must be rejected unless a satisfactory result is obtained for each test. (It is pointed out that, if rejection is necessary, connectors, Type 700, are also used for the inner and outer marker beacon installations and these other connectors should then be tested. If one is found suitable, it should be used at the main beacon position, the rejected cable usually being suitable for employment at the marker beacon position where leads 1–6 only are used.) The connector tests are as follows:—

(1) A continuity test between each of the pins 1–9, in turn, on one plug and the correspondingly numbered pin on the other plug.

(2) An insulation test between each of the pins 1–9, in turn, and all other pins.

(3) An insulation test between each of the pins 1–9, in turn, and the metal flanges of both plugs.

Further reference is made to the earthing of the reflector relay keying supply in *para. 149–152* and *169*.

149. A suitable connector, Type 700, having been obtained and each end plugged into its appropriate socket, the keying device terminals, Z7, Z8 and Z9, are now extended to the correspondingly numbered sockets on the Niphan socket which is mounted on the conduit box bolted to the cable-terminating standard. From this point two alternative schemes for the extension of these control circuits to the airfield control office are available, the scheme to be adopted depending upon the availability of spare remote control lines between these points. If three spare properly-insulated remote control lines exist, then these are utilized in the manner indicated in *fig. 16* (*d*). If three suitable spare lines are not available, then three of the four existing field-monitor return lines are used, the line connections first being re-arranged to permit the necessary simultaneous but independent working of AC and DC circuits over the same control lines.

150. The arrangement of the modification, with the required interconnections, is clearly shown on the wiring and circuit diagrams, *fig. 17* and *18*. It will be seen that the original arrangement of the monitor return indication circuits is varied only by the inclusion at each end of DC-blocking condensers in the left-sector, right-sector and common-return lines. The approach-path return line, being associated with the main beacon fault indicating circuit, is undisturbed.

151. The 1,150 c/s AC returns are prevented from being short-circuited through the circuits of the keying device and of the remote control, Type T, by the double-wound inductors, Type 281, and also by the relay windings REL1(Z) and REL2(ZR). The right-sector return line is now used, in addition, as the keying device "on/off" control and faulting indication line; while the left-sector return line is used in addition, as the coding indication line; the common-return line for the monitor returns is used, in addition, as the common-return line for the keying device control circuits.

152. It should be particularly noted that the circuit (*fig. 17*) is not earthed at any point other than the tuned circuit of each monitor receiver, the line transformers of which, being double-wound, isolate the remainder of the circuit from these earthing points. This *non-earthed* condition must be obtained upon installation, and subsequently maintained, otherwise spurious inductive "kicks", synchronizing with the normal keying of the 35-volt reflector relay supply and passed therefrom via the keying device control circuits, will be observed on the indicating meters, M3 and M5, in the remote control, Type K.

153. The remote control, Type T, when used with the remote control, Type K, is bolted on to the top panel of the latter into which the cable form leads are then led. The cableform leads 1–6 are connected to the points indicated in *fig. 16* (*b*), the link between the tags Y1 and Y5 on the relay unit multi-contact jack socket being removed.

154. It is assumed that the standard main beacon automatic shut-down modification, which makes provision for the appropriate connection of the fault control and fault-indicating circuits of the remote control, Type T (cable form leads 1, 2, 3), has already been effected. The cableform leads 7, 8 and 9 are connected in accordance with *fig. 17* and *18* if modified monitor receiver lines are used for keying device control. If, however, spare remote control lines are being employed, the cableform leads 7, 8 and 9 are connected as shown in *fig. 16* (*b*), the control circuits being extended to the remote control line termination box as indicated in *fig. 16* (*d*). Then, of the four connectors, Type 711 (Niphan cables B, C, D and E), used at the remote control position, the one selected to carry the main beacon and keying device control circuits (Niphan cable B) must fulfil all the requirements laid down for connectors, Type 700, in *para. 146* to *148*, for the reasons stated therein.

155. Considering the connection of the keying device AC power supply terminals, Z14 and Z15, to the transmitter, T.1254, it will be seen from TABLE IV that alternative pairs of transmitter terminals are stated. Although the keying device speed control circuits are reasonably independent of power supply voltage fluctuations, it is preferable to utilize a regulated supply if such is available since abnormal voltage fluctuations are sometimes encountered on supplies to main beacon sites.

156. However, if a voltage regulator is provided for the main beacon it can be wired into either one of two points in the power distribution circuits. In the one instance it can be connected between transmitter terminals F27/F28 and F29/F30, the voltage regulator then providing a regulated supply for the T.1254 power units only, the auxiliary supplies (e.g. crystal oven, lighting, heating and ventilating) being unregulated. In this event, the keying device regulated supply is to be taken from the terminals F39 and F40, which are only alive when the transmitter main switch fuse, and the isolating switch S1 and contactor REL1 (both in T.1254, unit C) are closed.

157. If the alternative connection is made the voltage regulator is joined at the point of entry into the trailer of the power supply, and thus all power circuits, including the auxiliary supplies are regulated. Advantage is taken of this fact to operate the keying device from the power sub-circuit, which supplies the crystal oven, by connecting the keying device to the transmitter terminals, F37 and F38. Then, if the crystal oven supply is continuously alive, as it should be through the *lighting* switch-fuse and the *auxiliary* distribution board, fuse-way D, the keying device power supply is continuously alive also, it being independent of the position of the transmitter isolating switch and contactor and the *transmitter* main switch-fuse. This fact should be borne in mind if it is required to isolate the keying device from the power supply more completely than is possible by normal methods, for example, by operating the switch S1(Z), or by withdrawing the fuses F1 and F2 of the keying device.

158. It will be understood that a failure of the crystal oven supply will now be indicated remotely (as a "keying device fault") through the operation of the keying device contacts K6 and relay REL3. In addition, the keying device can be run up locally, if required, without switching on the transmitter. It having been determined whether a regulated power supply for the keying device can be taken from the terminals F37/F38 or, if not, from the terminals F39/F40, then the terminal pair to be employed must be tested as indicated in *para. 159*.

159. For the reasons stated in *para. 46*, the power circuits of the keying device must be connected to the power supply in a certain manner. The appropriate pair of transmitter terminals having been identified, each terminal of this pair is therefore first tested to earth. The terminal Z14 is then to be connected to that terminal from which the lower test reading (nominally zero volts AC) is obtained; and the terminal Z15 is to be connected to that terminal from which the higher test reading (nominally 230 volts AC) is obtained.

For transmitter, Type T.1345

160. The following circuit changes are made in the transmitter on the installation of the keying device:—

(1) The link between terminals T.S.1/4 and T.S.2/21 is disconnected.

(2) The link between terminals A/3 and A/4 is removed.

(3) The link between terminals A/3 and B/10 is disconnected.

(4) The link between terminals A/4 and B/11 is disconnected.

(5) A new lead is provided from terminal A/3 to the spare terminal T.S.1/15.

(6) A new lead is provided from terminal A/4 to the spare terminal T.S.1/16.

(7) The connections of the reflector relays are checked, and, if necessary, altered so that the *dot* reflector relay is connected between the terminals T.S.1/7 and T.S.1/10 and the *dash* reflector relay is connected between the terminals T.S.2/16 and T.S.2/20.

(8) The modulator unit, Type 41, is modified in accordance with *para. 89* and *90.*

161. The keying device is mounted on a bracket secured to the cupboard enclosing the power supply and remote control line terminal boxes. Cables are run through a duct, provided below floor-level, to connect the keying device to the transmitter in accordance with TABLE IV and *fig. 12* and *13.* Cables are also run from keying device terminals Z7, Z8 and Z9 to spare terminals on the remote control cable termination box, as indicated in *fig. 16 (d).*

162. Where the control unit, Type 35, is in use with the beam approach equipment, the installation of the remote control, Type T, is effected in the manner described in *para. 140* and *141.* Where the main remote control, Type K, is in use, the remote control, Type T, is installed as specified in *para. 153* and *154,* spare remote control lines being employed.

163. The power supply voltage regulator, if fitted, is normally connected in such a way that the crystal oven supply is not regulated and the keying device is therefore not connected to this circuit. The selected pair of transmitter terminals T.S.1/2 and T.S.1/3 to be employed for the keying device supply, are only alive when the transmitter main switch-fuse, and the isolating switch S1 and contactor REL1 (both are located in T.1345, unit C) are closed. The specified pair of transmitter terminals must be tested, and the keying device connected thereto, in the manner laid down in *para. 159.*

For transmitter, Type T.1451

164. The following circuit changes are made in the transmitter on the installation of the keying device:—

(1) The *blue-red* and *blue-orange* leads from contacts 5 and 6, REL1(C), are disconnected from the terminals C10 and C11.

(2) The link D16–C9 is transferred from terminal C9 to the vacant terminal C10.

(3) A new lead is provided from terminal A9 to the vacant terminal C11, the link A8–A9 being left in position.

(4) A new lead is provided from terminal D15 to the vacant terminal C20.

(5) The link between terminals C6 and C6.A is removed.

165. Metal rails are provided in the T.1451 keying unit C, and corresponding runners are bolted to the base of the keying device which may therefore be withdrawn from the rear of the unit C, after the two securing wing nuts have temporarily been removed. After withdrawal for inspection purposes, it will be found convenient to rest the keying device on a stand of suitable height, to be provided locally. The keying device is connected to the transmitter terminals indicated in TABLE IV.

166. For convenience, all the necessary transmitter connections have been brought out on to the terminal strip of the keying unit C. Keying device connections are made by means of a flexible cableform which also includes leads from the terminals Z7, Z8 and Z9 to the correspondingly numbered sockets of the Niphan socket H or M. For the reasons stated in *para. 146* to *148,* the earth lead is removed from socket 0 of Niphan socket H or M, and in addition the connector, Type 700, employed with the T.1451 is required to pass the tests specified in those paragraphs.

167. The keying device remote control circuits are extended to the airfield control office by either of the alternative methods described in *para. 149* to *152,* the remote control, Type T, being installed and connected in the manner appropriate whichever method is employed.

168. As a power supply voltage regulator is not normally provided for the T.1451, the keying device power supply is most conveniently taken from the terminals C2 and C3, which are only alive when the circuit breaker OL3 (unit D), and the control contactor REL1 (unit H), are closed. The terminal pair, C2 and C3, must be tested as described in *para. 159*, connections then being made to the keying device terminals, Z14 and Z15, in accordance with the results of the test.

Earthing reflector relay keying supply

169. In each of the four transmitters, the original DC circuit of the 25-volt or 35-volt reflector relay keying supply is not earthed at any point. *Before the keying device is installed, therefore, this circuit should be tested for spurious earths and, if found to be present, they should be located and cleared.* Since, after installation of the keying device, the reflector relay keying supply is extended into the keying device itself and from there, along remote control lines, to the remote control Type T, additional points at which earthing of this supply can occur are now provided. *Consequently, upon the keying device being installed, and at regular intervals thereafter, the 25-volt or 35-volt DC circuit should be re-tested for insulation from earth.* This is conveniently done by testing from the keying device chassis to each of the terminals Z5–Z12, in turn, a *zero-voltage* test being made when the transmitter is switched on or, alternatively, an *infinity-resistance* test when the transmitter is switched off. The location and clearing of earths is thereby facilitated, the test results being interpreted after reference to the appropriate circuit diagram.

SETTING-UP AND OPERATION

Preliminaries

170. Before bringing the keying device into service, it should be confirmed that all the connections thereto are correctly made, that the links, LINK 1 and LINK 2, are in their required positions, and that normal approach path signals are being radiated by the main beacon. The reflector relays being delicately timed instruments, the compensating resistors provided should next be adjusted, these comprise:—

(1) The transmitter keying unit resistor R3, which is effective only during approach path signal transmission.

(2) The keying device resistor R7, which is effective only during coding periods.

Adjustment of reflector relay compensating resistors

171. The keying device should first be prepared as follows:—

(1) Remove the centre milled nut from the morse wheel and then remove all the cam plates.

(2) Operate the switch S1(Z) to ON, the switch S7 to ALT. SECTOR, and the switch S2 to LOCAL.

(3) When the morse wheel has completed a revolution and has been halted, lift the cycle timing carriage right back so that the further operation of S3, and the consequent rotation of the morse wheel, is prevented.

(4) Operate the switch S2 to REMOTE and then rotate, by hand, each of the switches S4 and S5 and its respective *set* position, at which the *set* arrow points to the white-tipped pillar.

(5) Place any one of the cam plates in position on the morse wheel, choosing a position which allows both K1 and K2 to remain fully released. Replace and tighten down the centre milled nut to secure the cam plate rigidly in position.

(6) Close the switch S1(ZR) on the remote control, Type T, so starting up the keying device by remote control.

The 35-second time delay period, provided by the relays REL4 and REL5, having elapsed, and MTR2 continuing to rotate, the keying device control circuits are now in their steady normal working conditions, and adjustment of the compensating resistances then proceeds as follows.

Adjustment of R3 in transmitter keying unit

172. This adjustment is made at the transmitter keying unit in the normal manner. A milliammeter having been connected across the hand-key sockets, the latter are switched into circuit by operating the appropriate key, and the resistor R3 is adjusted to give a circuit reading of 150 mA. The key is then restored to the *auto keying* position, and the test meter is removed from the hand-key sockets.

Adjustment of R7 in keying device

173. The operation of the keying device in the manner specified in *para. 171* being continued, the keying device top panel is raised and supported by the corner struts. Avoiding accidental contact with the rectifier RECT1 and the resistor R6 proceed as follows:—

(1) Place MTR1 midway between positions 1 and 2, so that the morse wheel and the armature of MTR1 can rotate independently.

(2) Set R7 to its maximum value by first loosening the slider and then re-setting it.

(3) Leaving the link LINK 1 in position A or B, connect a milliammeter across the vacant position. The polarity of the link terminals is marked on the panel.

(4) Leaving the cycle timing carriage lifted right back, advance the switch S5 by one step and check that MTR2 continued to rotate.

(5) Operate the right-hand bell crank of the switch assembly, S3 by hand, to release the morse wheel brake. The pinion of MTR1 will rotate, but will not drive the morse wheel.

(6) The cam plate being in position on the morse wheel, revolve the morse wheel by hand until one or the other of the following two conditions, determined by the link position in use, is obtained:—

   (a) Link 1 in position A, test meter in position B, K1 fully released, K2 fully operated, K3 spacing.

   (b) Link 1 in position B, test meter in position A, K1 fully operated, K2 fully released, K3 spacing.

(7) Adjust the value of R7 by first loosening the slider and then re-setting it, until a meter reading of 150mA. is obtained.

(8) Operate S1(ZR) and then S7 and S1(Z) to their OFF positions. Remove the meter connections, restore MTR1 to its original position and lower the keying device panel. Run the device by local control to complete the revolution of the morse wheel, then lower the cycle timing carriage to its normal operating position.

Setting-up

174. The setting-up procedure for the different systems of code sending varies in certain respects, being governed by differing limitations. The procedure applicable to each system is therefore separately explained by means of examples. It will be understood that to set up the keying device, it is necessary to know:—

(1) The call sign.

(2) The code transmission speed, in w.p.m.

(3) The system of code sending. When the *omni-directional* system is specified it is further required to know:—

   (a) Whether one or two call signs are to be transmitted in each coding period.

   (b) The duration of the spacings preceding and following the call sign(s).

(4) The repetition frequency of the coding periods, i.e. the "cycle timing".

175. Referring to *para. 174*, item (4) determines the setting-up of the cycle timing unit, whilst items (1), (2) and (3) together determine the setting-up of the morse wheel unit. To be able to perform this latter operation, it is necessary that the call sign length, the spacing lengths, and the code transmission speed, should each be referred to a common unit; the baud is employed for this purpose. The total baud length of the call sign includes the sum of the baud lengths of each character and the necessary inter-letter spacing(s). The standard inter-letter spacing is 3 baud lengths, while the baud length of the various morse characters is given in TABLE V, in which for completeness the numerals are included.

TABLE V

Morse Character	Baud Length	Morse Character	Baud Length
E	1	C, O, P, X, Z: 4, 6	11
I, T	3	J, Q, Y: 3, 7	13
A, N, S	5	2, 8	15
D, H, M, R, U	7	1, 9	17
B, F, G, K, L, V, W: 5	9	0 (zero)	19

The code transmission speed is converted from *words per minute* to *bauds per second* by reference to TABLE II, *columns* (*1*) and (*2*). The figure thus obtained from *column* (*2*) is the multiplying factor to be employed in the conversion, from *time duration in seconds* to *baud length* of the spacings which precede and follow the call sign(s).

176. For convenience, these spacings are hereafter referred to by the following terms:—

(1) *initial spacing*—i.e. that which immediately follows the interruption of normal approach path transmission.

(2) *intermediate spacing*—i.e. that which separates the first call sign from the second call sign.

(3) *final spacing*—i.e. that which immediately precedes the resumption of normal approach path transmission.

There are, obviously, only the *initial* and the *final* spacings in the event of a coding period in which the call sign is sent once only.

Omni-directional coding—one call sign per coding period

177. In this instance the following limitations apply:—First, the total coding period shall occupy not less than 15 baud lengths and not more than 61 baud lengths; second, the final spacing shall occupy not less than

3 baud lengths. In addition, it is advisable that the initial spacing should be not less than one second in duration. Subject to these limitations, a call sign and spacings of any length, and any code transmission speed between 5 w.p.m. and 15 w.p.m., can be employed. As an example, it is assumed that the call sign is "AJ", that the code transmission speed is 10 w.p.m., and that initial and final spacings of 1-sec. and ½-sec., respectively, are required. Converting these, in accordance with *para. 175*:—

(1) the call sign AJ occupies $5 + 3 + 13 = 21$ baud lengths,

(2) since 10 w.p.m. is equivalent to 8 bauds per second, then

(3) the initial spacing will occupy $1 \times 8 = 8$ baud lengths, and

(4) the final spacing will occupy $\frac{1}{2} \times 8 = 4$ baud lengths.

Fractional results for the spacing lengths should be brought to the nearest whole number. From this example it is seen that the total coding period occupies $8 + 21 + 4 = 33$ baud lengths, which is within the stated upper and lower limits. The other limitations are also observed. If desired, the total time-duration of interference caused by each coding period can be worked out, at this point, by re-conversion. In the present example, this amounts to $33 \div 8 = 4{\cdot}125$ sec.

178. The necessary preliminary calculations having been completed as detailed, the morse wheel unit is set up in the following manner. The setting-up is also illustrated in *fig. 9* and *10*.

(1) Operate the switch S2 to REMOTE, and place the switches S1(ZR), S7 and S1(Z) in the OFF position.

(2) Place MTR1 in *neutral gear*, midway between POSITIONS 1 and 2, so that the morse wheel can be rotated (anti-clockwise only) by hand, giving access both to upper and lower baud pins.

(3) From the morse wheel remove the centre milled nut and the cam plates. Place all bauds IN.

(4) If the initial spacing is an odd number of baud lengths, temporarily place OUT that baud which is indicated by an engraved line on the upper face of the morse wheel. When the initial spacing is an even number of baud lengths, as in the present example, then the lower baud, immediately in advance of that indicated, is temporarily pulled OUT instead. The trailing edge of the baud so placed OUT indicates the beginning of the initial spacing.

(5) From this point on the morse wheel, working in a clockwise direction, count off the required number of bauds for the initial spacing (in this instance eight). Starting at the following baud which will be an upper baud, set up the elements of the call sign AJ in accordance with TABLE I.

(6) From the trailing edge of the last element of this call sign, count off the number of bauds (four) required for the final spacing. Place the following baud (the *fifth*), temporarily in the OUT position so that the leading edge of the baud so placed OUT indicates the end of the final spacing.

(7) Rotate the morse wheel anti-clockwise until the starting point of the initial spacing — *sub-section* (*4*) — registers exactly with the *standard reference pointer*, the latter being the chiselled edge of the upper wiper of K3. This morse wheel position is illustrated in *fig. 3*.

(8) At this point, place a suitable cam plate in position on the morse wheel so that the leading edge will just cause the contacts K1.4 to open. In the present example, a 31-baud cam plate will be used (*para. 22*) and the *marking* side will be uppermost (*para. 20*).

(9) Continue the anti-clockwise rotation of the morse wheel until the finishing point of the final spacing—*sub-section* (*6*)—registers exactly with the reference pointer.

(10) Now place a second suitable cam plate in position over the first so that its trailing edge will just cause the contacts K1.4 to close. In the present example, the second 31-baud cam plate will be used (*para. 22*) and the *marking* side will again be uppermost (*para. 20*).

(11) Replace and tighten down the centre milled nut so that the cam plates form a single rigid cam.

(12) Check back the correctness of the cam so formed by rotating the morse wheel until the contacts K1.4 are just being opened. At this point, confirm that the reference pointer registers with the beginning of the initial spacing. Continue the revolu-

tion, noting that each contact pair of K1 remains fully operated until the trailing *lead* of the cam is reached. Arrest the rotation as the contacts K1.4 are just being closed to confirm that, at this point, the reference pointer registers with the end of the final spacing.

(13) The setting-up of the morse wheel unit having been checked, restore the two bauds, which acted as setting-up guides for the spacings, to the IN position.

179. The morse wheel speed is next set for the code transmission speed required, as follows:—

(1) Place MTR1 in the position appropriate to the specified transmission speed, this being POSITION 1 for speeds above 7·5 w.p.m. (as in the present example), and POSITION 2 for speeds of 7·5 w.p.m. and below. In addition, if the keying device power supply has an unvarying periodicity of 50 c/s, and if the transmission speed is included amongst these engraved on the stroboscope sector plate, rotate the sector plate to bring the appropriate sector into view. It is pointed out that, where a local stand-by power supply is employed, the stroboscope indications are unreliable and must not be used.

(2) Turn the morse speed knob fully anti-clockwise, lift the cycle timing carriage right back, close the isolating switch S1(Z) and operate S2 to LOCAL.

(3) Operate the right-hand bell crank of S3 by hand, and reduce the morse wheel speed from maximum, by clockwise rotation of the morse speed knob, until the *stationary dash effect* is obtained on the stroboscope. If, however, the stroboscope cannot be employed for any reason, regulate the code transmission speed either by timing a complete revolution of the morse wheel, or by counting the number of revolutions continuously performed by the morse wheel in one minute. The latter alternative, which is preferable if a stop watch is not available, necessitates the continuous but light operation by hand of the right-hand bell crank of S3. The necessary timing data is given in TABLE II, from which it is seen that, at a transmission speed of 10 w.p.m. the morse wheel makes a complete revolution in 10 seconds and so makes exactly six revolutions in one minute.

180. Having adjusted the morse wheel speed switch off by operating S2 and complete the setting-up of the keying device thus:—

(1) On the cycle timing carriage, rotate the hand wheel control to bring the pointer over the scale mark corresponding to the cycle timing required. Lower the carriage into its operating position, and place MTR2 in the position appropriate to the scale in use. Assuming that a cycle time of 2·5 min. were required, the lower scale would be used and MTR2 would be placed in POSITION 2.

(2) Switch on the device locally and check the cycle timing by noting, in the present example, that S3 is operated every 2·5 min. by the cycle timing wheel pin. Correct the timing, if necessary, by means of the hand wheel control.

(3) The cycle timing having been adjusted, allow the keying device to run until the morse wheel has completed a revolution and has been halted. Then switch off the device by operating S2, and bring the pin of the cycle timing wheel to the top of its travel.

(4) Rotate, by hand, each of the switches S4 and S5 to its respective *set position*, at which the *set* arrow points to the white-tipped pillar.

(5) Place the link, LINK 1, in position A, move the coding switch S7 to the OMNI-DIRECTIONAL position, and leave the isolating switch S1(Z) in the ON position.

The keying device is then ready for operation by local or by remote control.

Omni-directional coding—two call signs per coding period

181. In this instance the following limitations apply:—

(1) The total coding period shall occupy not more than 61 baud lengths;

(2) the intermediate spacing shall not occupy not less than 5 baud lengths and shall in any event always occupy an *odd* number of baud lengths;

(3) the final spacing shall occupy not less than 3 baud lengths.

In addition, it is advisable that the initial spacing should be not less than 1 sec. in duration.

182. Subject to the limitations mentioned, call signs and spacings of any length, and any code transmission speed between 5 w.p.m. and 15 w.p.m., can be employed. As an example, it is assumed that the call sign AJ is to be sent twice, that the code transmission speed is to be 10 w.p.m., and that the duration of the initial, intermediate and final spacings is to be 1 sec., 1 sec. and ½ sec., respectively. Conversion being carried out in the manner detailed in *para. 175*, the total coding period comprises:—

Initial spacing	$=1\times8$	= 8 baud lengths
First call sign AJ	$=5+3+13=21$	baud lengths
Intermediate spacing	$=1\times8=8$, but reduce this to	7 baud lengths
Second call sign AJ	$=5+3+13=21$	baud lengths
Final spacing	$=\frac{1}{2}\times8$	= 4 baud lengths
Therefore, total interruption of approach path signals		=61 baud lengths
		$=61\div8$
		=7·625 sec.

It will be understood that the intermediate spacing has had to be reduced in value from 1·0 sec. to 0·875 sec. so that this spacing shall be an odd number of baud lengths, and that the total coding period shall not occupy more than 61 baud lengths.

183. The necessary preliminary calculations having been completed, the keying device is set up in the following manner:—

(1) First proceed, in order, with the operations detailed in *para. 178* up to and including *sub-section (5)*. Then,

(2) from the trailing edge of the last element of the call sign just set up, count off the number of bauds (seven) required for the intermediate spacing. Starting at the following baud (the *eighth*), which will be an upper baud, set up the elements of the second call sign AJ.

(3) Perform, in order, the operations specified in *sub-section (6)* to *(13)* of *para. 178*.

(4) Set up the morse wheel speed, the cycle timing, the link, LINK 1, and the switches S1(Z), S4, S5 and S7, in the manner detailed in *para. 179* and *180*.

The keying device is then ready for operation by local or by remote control.

Alternate sector coding

184. For each coding period to occupy the standard value of 7·5 secs., a code transmission speed of 10 w.p.m. is to be employed; in these circumstances a call sign of 21 baud lengths or less can be sent twice in the coding period. If, however, it is permissible to deviate from this standard coding time of 7·5 secs., then any other transmission speed between 5 w.p.m. and 15 w.p.m. can be employed. The maximum number of baud lengths available for the call sign is then 19, 21 or 23, depending upon the selected transmission speed.

185. Whatever code transmission speed is employed, the following limitations invariably apply:—

(1) The total coding period shall always occupy 60 baud lengths precisely;

(2) the length of the initial spacing and the first call sign shall together total not more than 30 baud lengths;

(3) the intermediate spacing shall occupy not less than 5 baud lengths and shall in any case always occupy an *odd* number of baud lengths.

(4) The final spacing shall occupy not less than 3 baud lengths.

In addition, it is advisable that the initial spacing should be not less than 1 sec. in duration.

186. It is, further, desirable that the initial, intermediate and final spacings should be of equal lengths (so far as the above limitations permit) so that a balanced coding signal may be radiated in each sector. The most suitable spacing lengths to satisfy all the above requirements are given in TABLE VI, to which reference should be made after the baud length of the required call sign has been determined (*para. 175*). The spacing lengths to be employed are then read off in *columns (3)*, *(4)* and *(5)* against the appropriate code transmission speed range, *column (2)*, and call sign length, *column (1)*.

TABLE VI

Baud length of call sign (1)	Transmission speed in w.p.m. (2)	Baud length of initial spacing (3)	Baud length of inter-mediate spacing (4)	Baud length of final spacing (5)
13	5–15	12	11	11
	5–12	10	11	9
15	13–15	12	9	9
	5–11	9	9	8
17	12–15	12	7	7
	5–10	8	7	7
19	11–12	10	7	5
	13–15	11	5	6
	5– 7½	6	7	5
21	8–10	8	5	5
	11–15	Not permissible		
	5– 6	5	5	4
23	7– 7½	6	5	3
	7–15	Not permissible		

187. The equivalent time duration of each spacing is obtainable by dividing the spacing in baud lengths by the code transmission speed in bauds per second. The time duration of the complete coding period (equalling the approach path signal interruption) at any code transmission speed is obtainable directly, with the alternate sector coding system, from the formula:—

$$\text{Duration of coding period in secs.} = \frac{75}{\text{code transmission speed in w.p.m.}}$$

188. As an example, it is assumed that the call sign is AJ and that the standard code transmission speed of 10 w.p.m. is to be employed. The call sign AJ occupies 21 baud lengths (*para. 175*) and, referring to TABLE VI, it will be seen that a transmission speed of 10 w.p.m. can be employed so long as initial, intermediate and final spacings of 8, 5 and 5 baud lengths, respectively, are employed.

189. The necessary preliminary steps having been completed as indicated, the morse wheel unit is set up in the following manner:—

(1) Effect the operations detailed in *para. 178* up to and including *sub-paragraph* (*5*). Then—

(2) From the trailing edge of the last element of the call sign just set up, count off the number of bauds (five) required for the intermediate spacing. Starting at the following baud which will be an upper baud, set up the elements of the second call sign AJ.

(3) From the trailing edge of the last element of the second call sign, count off the number of bauds (five) required for the final spacing. Place the following baud temporarily in the OUT position, so that the leading edge of the baud so placed OUT indicates the end of the final spacing.

(4) Rotate the morse wheel anti-clockwise until the starting point of the initial spacing [see *para. 178* (*4*)] registers exactly with the reference pointer [*para. 178* (*7*)].

(5) Now place both the 31-baud morse plates in position on the morse wheel so that their leading edges will just cause the contacts K1.4 to open. In the present example, the *marking* side of each cam plate will be uppermost (*para. 20*).

(6) Replace and tighten down the centre milled nut so that the cam plates form a single rigid 31-baud cam of double thickness.

(7) Check back the correctness of the cam so formed by rotating the morse wheel until the contacts K1.4 are just being opened. At this point, confirm that the reference pointer registers with the beginning of the initial spacing. Continue the revolution, noting that each contact pair of K1 remains fully operated until the roller of K1 reaches the start of the trailing *lead* of the cam. At this point confirm

 (a) that each contact pair of K1 and K2 is fully operated, and

 (b) that the first call sign has completely passed, but the second call sign has not reached, the wipers of K3.

Continue with the revolution, noting that each contact pair of K2 remains fully operated until the roller of K2 reaches the start of the trailing *lead* of the cam. Arrest the rotation as the contacts K2.4 are just being closed to confirm that, at this point, the reference pointer registers with the end of the final spacing.

(8) The setting-up of the morse wheel unit having been checked, restore the two bauds which acted as setting-up guides for the initial and final spacings to the IN position.

(9) Set up the morse wheel speed in the manner detailed in *para. 179*, then switch off by operating S2.

(10) Perform, in order, the operations detailed in *para. 180* up to and including *sub-para. (4)*.

(11) Place the link, LINK 1, in position A or position B, in accordance with TABLE III.

(12) Place the coding switch S7 in the ALT. SECTOR position and leave the isolating switch (S1(Z) in the ON position.

The keying device is then ready for operation by local or by remote control.

Operation

190. The keying device having been made ready for operation as described, local control is effected by means of the switch S2. The keying device is started by moving this switch to the LOCAL position, and is stopped by restoring the switch to the REMOTE position. When the remote control, Type T, is installed and connected, the keying device can be controlled therefrom by means of the switch S1(ZR) on the remote control. The keying device is then started by moving this switch to the ON position, and is stopped by restoring the switch to the OFF position. For remote control the switch S2 is, of course, to remain in the REMOTE position, and for local control the switch S1(ZR) is to remain in the OFF position. In both cases, the mains isolating switch S1(Z) is to remain in the ON position. The complete functioning of the keying device under local and remote control is fully described in *para. 72* to *135*.

191. To avoid the possibility of radiating part only of an identification signal, the following conditions governing the switching on and off, by local and by remote control, of the main beacon transmitter and the keying device are to be observed:—

(1) The keying device is only to be switched on when
  - (a) the main beacon has been switched on, and
  - (b) normal approach path signals are actually being radiated.

(2) The main beacon transmitter is only to be switched off when
  - (a) The keying device has been switched off, and
  - (b) normal approach path signals are being radiated.

PRECAUTIONS AND SERVICING

General precautions

192. Except when making adjustments, the lid of the cabinet is to be kept closed, and the cover of the relay unit is to be in position, to protect the components from dust and damage. The periodical removal of dust is only to be carried out by means of a soft brush, since the use of dusting cloths is liable to cause damage to, or mis-alignment of, working parts.

193. *The morse wheel is never for any reason to be rotated in a clockwise direction.* Before the morse wheel is lifted from its spindle or is replaced thereon, all bauds must first be placed in the IN position. After replacing the morse wheel, it should be rotated by hand until the groove in the boss locates with the pin on the spindle.

194. Normally, it is not necessary to close down the main beacon transmitter when servicing the keying device, since the coding switch, S7, and/or the double-pole mains isolating switch, S1(Z), can, instead, be operated to the OFF position as required. Before placing S7 or S1(Z) in the OFF position, the keying device should be switched off at the remote control, Type T, otherwise the fault alarm will sound. The mains switch, S1(Z), can itself be isolated by withdrawing the double-pole fuses F1 and F2. For the complete isolation of the keying device power input terminals, Z14 and Z15, reference should be made to *para. 137–138* (for T.1122), *para. 155–158* (for T.1254), *para. 160–163* (for T.1345) or *para. 164–168* (for T.1451).

195. When servicing the keying device with the main beacon transmitter in operation, it should not be forgotten that the modulation control circuits may not be at earth potential for the reasons explained in *para. 86* (for T.1122), *para. 88* (for T.1254) and T.1345) and *para. 93–95* (for T.1451). If considered more convenient, the keying device can be removed from its bracket for major servicing, the numbered cables temporarily being disconnected from the terminals, Z1–Z15, and taped up. In this event, to maintain the normal operation of the main beacon transmitter it is only necessary to connect together the cables which ran to terminals Z1 and Z2 and also to connect together the cables which ran to terminals Z6 and Z10. The main beacon transmitter is to be switched off while the cables are being disconnected from, and reconnected to, the keying device.

196. The adjustment of relays, which calls for special tools not normally available on site, should not be attempted unless absolutely necessary. If adjustment is considered essential, the instructions given in Air Publication 2487, Vol. I, Sect. 2, Chap. 2, should be followed.

DAILY AND PERIODIC INSPECTION SCHEDULES

Daily inspection

197. At the remote control, Type T, if fitted:—

(1) Observe that beam and coding lamp indications are correct and that the aural fault alarm does not sound during coding periods.

(2) Switch off the keying device during a coding period to observe that this coding period is completed but that further coding periods do not occur.

(3) The main beacon transmitter having been switched off by means of the test key (part of the main remote control test procedure), operate the switch on the remote control, Type T, to the ON position. Observe that the *beam* and the *fault* lamps are both lit, then restore the keying device switch to the OFF position.

(4) Where the monitor return lines also carry the keying device control circuits, observe the monitor return meter readings *after* the main beacon transmitter has been switched on again by means of the test key but *before* the 1,150 c/s tone return has become available. Upward *kicks*, synchronizing with the normal reflector keying, can be disregarded if of small amplitude (below 0·05 mA). If, however, of larger amplitude this usually denotes the occurrence of an earth at some point on the reflector relay keying supply, and reference should then be made to *para. 146* to *152* and *169*.

(5) Restore the keying device control switch to the ON position.

198. At the keying device:—

(1) Operate the coding switch, S7, to the OFF position and ascertain that this has caused the aural and visual fault alarms to be given at the remote control position, and that the alarm indications are cleared when the keying device is switched off from the remote point. Leave the keying device switched off remotely, and leave the coding switch in the OFF position.

(2) Lubricate the points as indicated on the lid chart, applying one drop of clock oil to each point. A container for oil, complete with dropper, is fixed to the front left-hand corner-block of the cabinet. Take particular care, when lubricating parts of the cycle timing carriage, to keep the friction-tyre wheel, and the face of the friction plate, completely free from oil. The locating fork, and the groove in the friction-tyre wheel, are to be *greased* and not oiled. Similarly, a protective grease film is to be maintained on the surfaces of the keyed shaft and of the lead screws.

(3) Make a superficial examination of the drive from MTR1 pinion to morse wheel from MTR2 pinion to friction plate, and from friction plate to cycle timing wheel. Ensure that the motors are fully home in their correct positions. Lift the cycle timing carriage and rotate the cycle timing wheel by placing a finger on the striker pin, to check for smooth and free rotation.

(4) Run the keying device locally, and check the morse speed and the cycle timing.

(5) Observe a complete cycle of operations, noting the satisfactory mechanical operation, in turn, of:—S5, S3, K1, K3, K2, S4 and S3. Check the morse wheel brake, EM1, by noting that the morse wheel *overrun* (*para. 53*) is not excessive, then restore S2 to the REMOTE position.

(6) Temporarily link the terminals Z7 and Z8 at a convenient point, e.g. the Niphan socket B on T.1254 installations. Lift the cycle timing carriage right back, set S4 and S5 correctly, then remove the cover of the relay unit. Restore S7 to its normal operating position and so start up the keying device. When the 35-sec. delay period provided by REL4 and REL5 has elapsed, test K6 by switching S1(Z) OFF. As MTR2 comes to rest, REL3 should operate and REL1 should release. Restore S1(Z) to the ON position.

(7) Operate and release S6 and, two or three seconds after the keying device has started up again, push in the armature of REL5 by hand. Test S4/S5 by advancing S4 one position (when REL3 should operate and REL1 should release) and then advancing S5 by one position. Repeat the procedure detailed in this sub-paragraph twice more, to test the three circuits of S4/S5.

(8) Place S1 (Z) and S7 in their OFF positions, and then replace the cover of the relay unit. Lower the cycle timing carriage, and remove the temporary link between the terminals Z7 and Z8. Restore S1(Z) to ON, and S7 to the required operating position. Check that S4 and S5 are correctly set, then have the keying device switched on from the remote control, Type T.

(9) The correct functioning of the modulation control circuits of the keying device, during *beam* and *coding* periods, will then be observed when the main beacon transmitter daily meter readings are being recorded. An aural check of the quality of the modulation keying and the correctness of the identification signals will be made when the normal daily *beam* check is being effected with the test set, Type 6.

(10) The correct functioning of the reflector relay control circuits of the keying device will be checked by observing the meter readings of the test set, Type 6. When this is placed at the QDM peg, the meter reading should remain constant (apart from the expected slight decrease when the modulation is cut off) whatever system of code sending is employed. Consequently, the coding signal is also to be checked in the left and right sectors, the test set being placed on the 57-yard radius line approximately 10 yards to one side of, and then 10 yards to the other side of, the QDM peg. From observation of the meter readings obtained at each point, first from the normal *dot-dash* approach path signals, and then from the coding signals, it can be checked that the reflector relays are being controlled in the manner appropriate to the system of code sending in use.

Weekly inspection

199.

(1) Perform the tests detailed in *para. 197* and *para. 198 (1)*.

(2) Operate the isolating switch, S1(Z), to the OFF position, and then withdraw K4 from MTR1. Clean the contacts and the felt pad, using a suitable non-greasy solvent, and re-lubricate the felt pad, altering its position on the stub if this appears to be desirable from considerations of wear (*para. 40–42*). Clean off all oil from the face of the motor governor disc, to which access is obtained through the hole in the bottom of the motor casting (*para. 38–39*). Bolt K4 in position again, and then effect a similar cleaning operation on K5 and on the governor disc of MTR2.

(3) Lubricate the keying device in accordance with para. *198* (*2*).

(4) Perform the operations detailed in *para. 198* (*3*), particularly examining the friction tyre for signs of wear. The friction tyre is renewed, when this becomes necessary, by withdrawing the screw which is tapped into the right-hand end of the keyed shaft. The shaft can then be moved a small distance to the left so that the old tyre can be taken off the shaft and the new tyre substituted. If the complete friction-tyre wheel has been removed from the keyed shaft (this is unnecessary if tyre renewal only is required) remember, in replacing, that the groove for the locating fork is to be on the left side of the wheel. The shaft is then moved back to the right, and the screw, with its plain washer, is screwed home into the right-hand end of the shaft.

Note . . .

When withdrawing and replacing this screw, on no account is the friction-tyre wheel to be held as a means of preventing the rotation of the keyed shaft, otherwise the pin which keys the wheel to the shaft may be sheared. Instead, the shaft itself, or the pinion on its left-hand end, is to be gripped.

(5) Whether the friction tyre is renewed or not, ensure that adequate working clearances are provided between

(a) friction tyre and top panel,

(b) cycle timing carriage and top panel,

(c) the cycle timing control knob and the 4-B.A. bolt which acts as its *lock*,

(d) the striker pin and the sprocket of S5.

Check also that the bolts which secure the carriage and its bracket are secure, and that the carriage hinges freely at its working position.

(6) Remove the morse wheel, with its cam plates, from its spindle, and take off the cover of the switch assembly, S3. Ensure that the upper bearer of the morse wheel spindle is rigidly secure to the top panel. Place MTR1 in neutral gear, and raise the top panel a small amount with a 2-inch block placed centrally under the top panel at the front. Using the stroboscope disc as a "fine control", rotate the morse wheel spindle by hand to operate the left-hand bell crank.

(a) Adjust the eccentrically-mounted back stop until a push-rod "travel" of $\frac{1}{16}$ in. is obtained when the bell crank is operated and released by the spindle striker pin.

(b) Operate the bell crank by hand to the right until the limit of travel, governed by the internal switch blade of the switch, S3, is reached.

(c) Hold the bell crank in this position and cause the spindle striker pin to pass the bell crank.

(d) Vary the overall length of the push-rod until the striker pin can *just* pass the bell crank without causing the push-rod to travel further to the right. The length of the push-rod is varied by altering the projection of the screw tapped into its right-hand end, a cranked pin (packed with the *minor spares*) being inserted in a hole drilled in the rod in order that the locking nut may be loosened and then re-tightened after adjustment.

(e) Allow the bell crank to return to its back stop, then check the adjustment, after operating the right-hand bell crank, by slowly rotating the cam wheel spindle past the switch operating point. The switch blade should be heard to move to the right-hand contact when the push-rod has completed half of its full travel of $\frac{1}{16}$ inch. After prolonged wear, the full push-rod travel will be unobtainable even though the back stop is in its maximum left-hand position. When this occurs

(i) rotate the back stop 180 degrees to its maximum right-hand position, then

(ii) reduce the overall length of the push-rod until the required travel of $\frac{1}{16}$ inch is obtained when the bell crank is operated by hand.

(iii) Slightly loosen the three bolts which secure the switch assembly to the top panel, and vary the position of the assembly relative to the morse wheel spindle until, with the bell crank held over to the right, it is just possible for the striker pin to pass the bell crank.

(iv) Re-secure the assembly to the top panel and check the adjustment as above. The micro-switch is removable, for internal inspection or substitution, after the two securing 4-B.A. nuts have been removed, the mains supply having previously been isolated at the switch S1(Z).

(v) Replace the three switch connections exactly as found, then

(vi) adjust the right-hand operation of the switch by the second method of the two described.

(7) Check the adjustment of the switch, S3, on its right-hand side by rotating the friction plate by hand, after placing MTR2 in neutral gear and supporting the top panel as before.

(a) Hold the right-hand bell crank by hand so that the plunger is moved to the left as far as the internal switch blade allows.

(b) Rotate the friction plate and note that the striker pin is *just* able to pass the bell crank without causing a further movement of the switch plunger to the left.

(c) If necessary, vary the projection of the striker pin from the cycle timing wheel, re-locking the pin in the required position with the nut provided, to obtain this condition.

(d) Check back the adjustment, after operating the left-hand bell crank by hand, by slowly rotating the friction plate while the striker pin passes the right-hand bell crank. The switch blade should be heard to move to the left-hand contact before angular movement of the bell crank has ceased.

(e) Having adjusted the switch, S3, on the left-hand and right-hand sides,

(i) lower the top panel,

(ii) lubricate the push-rod and bell crank bearings,

(iii) replace the cover of the switch assembly securing it with the 4-B.A. nuts.

(iv) Lubricate the felt wipers.

(8) Ensure that the mechanical operation of the switch, S4, is satisfactory, then replace the morse wheel and locate it on its spindle. Place any one cam plate in any suitable position on the morse wheel and tighten down the centre milled nut. Rotate the morse wheel slowly by hand and observe the operating and releasing points of the contact pairs of K1. (Refer to *para. 20* for an explanation of the terms engraved on the cam plate.) To compensate for wear of the Tufnol roller it may be necessary to move the roller of K1 nearer to the cam plate, so as to obtain the correct operating positions shown on *fig. 6*. This is to be effected by varying the position of the top panel of the bracket of K1, the bracket fixing holes being large enough to permit of this being done. Adjustment is not to be carried out by bending the individual springs, this being unnecessary (since the springs will have been correctly set upon installation) and undesirable (since the essential relay adjusting tools will not normally be available). Check, and if necessary adjust, K2 in a similar manner, remembering, however, that the meaning of the terms *marking* and *spacing* on the cam plate will now be reversed. Remove the cam plate from the morse wheel when K1 and K2 are satisfactorily positioned.

(9) Check the adjustment of the morse wheel brake as follows:—

(a) After operating the right-hand bell crank of S3, slowly rotate the morse wheel by hand and arrest the rotation as soon as the switch blade of S3 is heard to move to the right-hand contact.

(b) At this point, make a distinguishing pencil mark on the periphery of the morse wheel to register with the reference pointer (upper wiper of K3).

(c) Rotate the morse wheel a further small amount to *clear* the left-hand bell crank of S3, then

(d) place MTR1 in POSITION 1, switch on the device locally, and

(e) cause the morse wheel to make a complete revolution at a speed of *15 w.p.m.*

(f) When the morse wheel has been automatically halted,

(g) count the number of bauds by which the distinguishing mark has passed the reference pointer. If this is less than 2 bauds or more than 5 bauds, re-adjust the position of the brake assembly (*para. 53–55*) and re-test with the top panel horizontal, until the permissible amount of over-run is obtained.

Before handling the brake assembly, always place the switch S1(Z) in the OFF position.

(10) Adjust the speed of MTR2 against any convenient cycle timing scale mark (say "½-min.") as explained in *para. 58*.

(11) Check the reflector relay operating supply for possible earths in the manner detailed in *para. 169*, locating and clearing any earths which are found. The coding switch should be in its normal working position for this test, but may be varied during the test if location is thus facilitated.

(12) Check the correct operation of K6 and of S4/S5 by performing the operations detailed in *para. 198, sub-para. (6)* and *(7)*. On completion, place S1(Z) and S7 in their OFF positions, replace the cover of the relay unit, and remove the temporary link between the terminals Z7 and Z8.

(13) Check the reflector relay operating currents under *beam* and *coding* conditions in the manner detailed in *para. 171–173*. Normally it will not be found necessary to vary the values of the appropriate compensating resistors, but

this should be done if the operating current is found to be something other than 150 mA.

(14) Set up the keying device for the call sign, etc., required in accordance with *para. 177–180* or *181–183* or *184–189*, as is appropriate.

(15) Have the keying device switched ON from the remote control, Type T, and check the correct functioning of the modulation and reflector relay control circuits, in the manner described in *para. 198, sub-para.* (*9*) and (*10*).

Monthly inspection

200.

(1) Perform the tests detailed in *para. 197* and *198* (*1*).

(2) Rotate S4 and S5 to their *set* positions, operate S1(Z) to the OFF position, and withdraw the fuse carrier with the fuses F1 and F2.

(a) Disconnect the flexible speed-regulator drive cable from both bosses, and withdraw K4 from MTR1.

(b) Drop MTR1 away from its fixings by either of the methods detailed in *para. 36*.

(c) Remove the motor top plate and the vertical drive spindle, from the motor casting.

(d) Clean and re-pack with grease the two end bearings of the armature shaft.

(e) Re-tighten the front end-plate and then replace the rear end bearing, adjusting and locking its position so that all armature shaft end-play is taken up.

(f) Clean the face of the governor disc.

(g) Spin the armature shaft by hand to test for free rotary movement and for clearance between armature and pole faces.

(h) Clean and re-grease the worm and the worm wheel and the lower bearing of the vertical spindle, and replace the spindle.

(j) Clean the contacts and felt pad of K4 in the usual manner, re-lubricate the felt pad and bolt K4 in position.

(k) Spin the vertical spindle and note the satisfactory operation of the governor gear.

(l) Locate the motor top plate on the casting, after cleaning and re-lubricating the upper bearing of the spindle, and bolt the top plate down.

(m) Refit the motor to the keying device, and

(n) Re-connect the flexible speed-regulator drive cable (the construction of the motor is described in *para. 36–39*).

(3) Withdraw K5 from MTR2 and drop MTR2 away from its fixings. Perform the same operations of K5 and MTR2 as have just previously been performed on K4 and MTR1. Before replacing the motor top plate

(a) Remove the cover of K6 and see that the Tufnol lever of K6 operates quite freely, then

(b) locate and bolt down the motor top plate.

(c) Support the base of the motor on a suitable block so that the motor is horizontal.

(d) Connect an ohmmeter to S4 between its middle free contact and its commoned contacts.

(e) With the switches S4 and S5 at their *set* positions, and with the meter thus connected, the opening and closing of the contacts K6 will be shown on the meter. The contacts are to remain permanently closed when the motor drive pinion is rotated slowly by hand but are to be permanently opened when the pinion is rotated at speeds, over ½ rev. per sec. (approximately), being closed again as the armature rotation ceases. If necessary, re-adjust the position of K6 on the motor top plate to obtain these conditions. Note that it will be impossible to obtain stable operating conditions for K6 if the armature shaft of MTR2 has any end-play.

(f) Having satisfactorily adjusted K6, replace its cover, disconnect the meter, and refit the motor to the keying device.

(4) Perform the operations detailed in *para. 199, sub-para.* (*3*)–(*7*).

(5) Ensure that the mechanical operation of the switch S4 is satisfactory, then clean and adjust K3 as follows:—

(a) Screw the *space* and *mark* contacts away from the *tongue*, after slackening the split-pillar screws just sufficiently to unlock the contact screws.

(b) Clean all contact surfaces, using a non-greasy solvent.

(c) Screw the *space* contact towards the *tongue* until contact between them is just established, then

(d) screw in the *space* contact a further 1½ turns.

(e) Lock the *space* contact in this position by re-tightening the split-pillar screw.

(f) Insert the 0·004 in. feeler gauge (which is packed with the kit of *minor spares*) between the *tongue* and *mark* contacts.

(g) Screw up the *mark* contact until the feeler gauge is lightly gripped, and

(h) lock the *mark* contact in this position.

(j) Check the contact gap after locking.

(6) Replace and locate the morse wheel on its spindle and tighten down the centre milled nut.

(a) On the morse wheel set up *continuous dots* by placing all upper bauds OUT and all lower bauds IN.

(b) Move MTR1 into POSITION 1.

(c) Rotate the morse speed control knob fully anti-clockwise.

(d) Replace the fuses F1 and F2, and

(e) raise the cycle timing carriage right back.

(f) Unsolder the *orange-red* lead from the *mark* contact pillar and move the lead out of position.

(g) Connect an ohmmeter across the *tongue* and *mark* contacts of K3.

(h) Switch on the keying device locally, and cause the morse wheel to rotate continuously at its maximum speed (over 15 w.p.m.) by steady but light hand-operation of the right-hand bell crank of S3. A pulsating reading will be observed on the test meter. Note the maximum and and minimum readings obtained over several revolutions.

(j) Now connect the ohmmeter across the *tongue* and *space* contacts, and again note the maximum and minimum readings obtained as the cam rotates at its fastest speed. These readings will be the same as those previously observed if the wiper arm assembly is correctly positioned, that is, if equal time-values are being given to the equally set-up *marking* and *spacing* impulses. If the two sets of readings are dissimilar,

(i) *slightly* slacken the bolts which secure the bracket of K3 to the top panel.

(ii) Move the bracket by slowly rotating the provided eccentric anti-clockwise with a large screwdriver, while at the same time

(iii) note the comparative readings obtained across each side of the morse key, K3, as the morse wheel rotates. If the two sets of readings are not approaching each other in value,

(iv) rotate the eccentric clockwise,

(v) draw back the bracket by hand and

(vi) recommence the adjustment.

When the correct position of K3 has been obtained,

(vii) tighten down the bolts which secure the bracket to the top panel.

(viii) Make a final comparative test to check that the position has not been varied by tightening the bolts, then

(ix) disconnect the meter,

(x) resolder the *orange-red* lead to the *mark* contact pillar, and

(xi) restore all the upper bauds to the IN position.

(7) Place MTR1 in neutral gear, and then check the operation of K1 and of K2 in accordance with *para. 199* (*8*), after carefully cleaning their platinum contacts with a suitable non-greasy solvent.

(8) Perform the operations detailed in *para. 199, sub-para.* (*9*)–(*15*).

Renewal of components

201. No difficulty should be experienced, mechanically or electrically, in renewing any unserviceable component, after reference to the appropriate section of the general description and of the inspection schedules. In some instances it will be obvious that the renewal of a component or of a portion thereof will necessitate the re-adjustment of the complete unit or assembly of which the renewed item forms a part. As an example, changing the *tongue* of K3 ("spring, contact—Stores Ref. 10G/13046") necessitates the readjustment of the contact pressure and gap [*para. 200* (*5*)] and the repositioning of the wiper arm assembly [*para. 200* (*6*)] before the keying device is once more ready for service. Again, when renewing either K4 or K5 tests are to be made to ensure that the spring set functions as described in *para. 40–42,* and that re-timing of the motor concerned is effected.

Minor spares

202. For convenience, a schedule of renewable components is given in APPENDIX A. Certain of these components are supplied, as a kit of *minor spares*, with the keying device. The kit comprises:—

Item	Ref. No.	Nomenclature	Qty.
1	10G/13050	Contact, screw	2
2	5L/1141	Lamp, filament, 12 V., P.O. No. 2	3
3	10G/6913	Fuse, Type 5	2
4	10F/1621	Spring set, Type 18	1
5	10F/-	Felt pad for item 10F/1621	5
6	10G/13046	Spring, contact	1
7	10F/2669	Switch, Type ~~223~~ 1549	1
8	10F/13101	Switch, Type 807	1
9	10G/4100	Band, friction	2
10	10G/13047	Wiper	1
11	N.I.V.	Gauge, feeler, 0·004 in.	1
12	N.I.V.	Pin, adjusting	1

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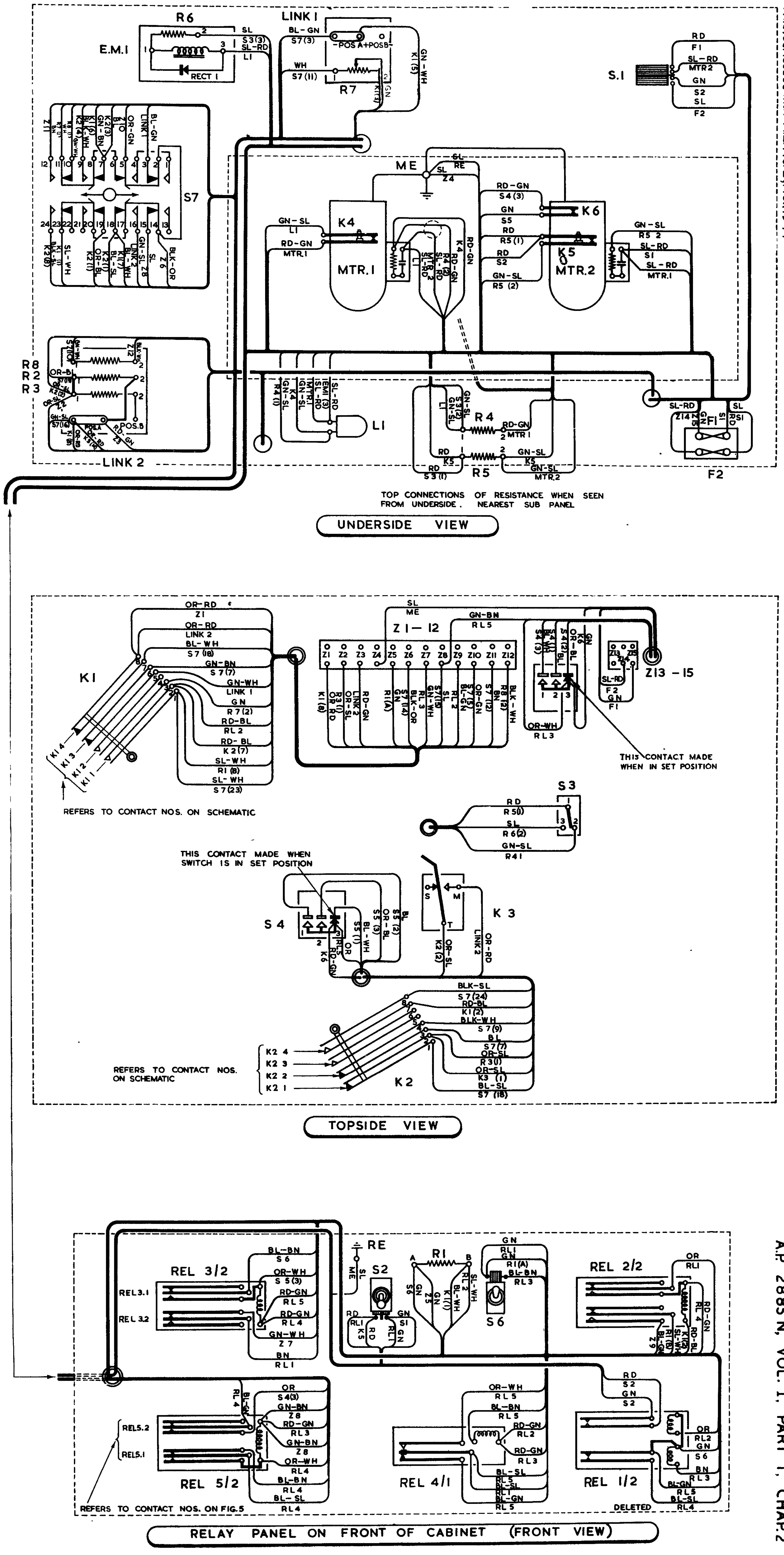

FIG. 20. WIRING DIAGRAM FOR AUTOMATIC KEYING DEVICE, TYPE 1A

APPENDIX A

Schedule of renewable components for automatic keying device, Type 1A (10G/1881)

Ref. No.	Nomenclature	Detail	Position
10G/4100	Band, friction	1 in. diam. × $\frac{1}{8}$ in. × $\frac{1}{8}$ in.	Friction tyre (cycle timing drive)
10G/3557	Brake, electro-magnetic	——	EM1
	Cam plate		
10G/3558	15-baud	——	Morse wheel unit
10G/3559	17-baud	——	Morse wheel unit
10G/3691	31-baud	——	Morse wheel unit
10G/13050	Contact, screw	Fitted with gold-silver contact	*Mark* and *space* contacts of K3
10H/9613	Fuse, Type 5	1-amp. glass cartridge, 1$\frac{1}{4}$ in.	F1, F2
10G/13250	Gear train, 4 : 2	——	Friction plate drive and stroboscope drive
10G/13251	Gear train, 2 : 1	——	Morse wheel drive
◀ 5LX/964104	Lamp, neon	200/260V, 0.5W, B.C.	L1 (stroboscope)
10K/13102	Motor, Type 63, *including:—*	200/250-volt AC., with 20-tooth pinion	MTR1, MTR2
10CZ/115510	Condenser (1 off)	0·25 mfd, 500V., DC working, tubular	C1, C2 ▶
10W/1215	Resistor, Type 1215 (1 off)	2,500 ohm, 6W., vitreous	R9, R10
10F/1621	Spring Set, Type 18 (1 off)	1-break. Complete with felt pad	K4, K5
10D/1521	Rectifier, metal, Type 153	Half-wave, rod type	Rect 1
	Relay, magnetic		
10F/1592	Type 559	2-makes, 1,000 + 2,000-ohm coils	REL1
10F/1594	Type 561	2-c/o, 2,000-ohm coil	REL2, REL3, REL5
10F/1593	Relay, thermostatic, Type 20	1-c/o, 200-ohm heater coil	REL4
	Resistor		
10W/6368	Type 6368	300-ohm, 10W., wire-wound	R1
10W/758	Type 896	2,000 ohm, 6W., vitreous	R2, R3
10W/8865	Type 2294	5,000 ohm, 10W., with holder	R4, R5
10W/10795	Type 3580	5,000-ohm, 10W., wire-wound	R6
10W/10796	Type 3581	300-ohm, with adjustable clip	R7
10W/1668	Type 1668	50-ohm, 6W., vitreous	R8
10F/1622	Spring set, Type 19	1-make, lever operated, with cover	K6

RESTRICTED

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APPENDIX A—*cont.*

Ref. No.	Nomenclature	Detail	Position
10G/13046	Spring, contact	Arm, contacts and spring, complete	*Tongue* of K3
	Switch unit		
10F/1624	Type 150	2-makes, 2-breaks, on bracket	K1
10F/1625	Type 151	As for Type 150, but with spring sets reversed on bracket	K2
	Switch		
◀ 10F/2669	Type 1549	D–P, on/off, toggle, 250V	S1 ▶
10F/169	Type 241	S–P, on/off, toggle, 250V	S2
10F/13101	Type 807	S–P, c/o Micro-push action	S3
10F/1626	Type 1189	S–P, 3-way, continuous rotary action	S4, S5
10F/1623	Type 1188	S–P, normally closed, spring-loaded toggle	S6
10F/10255	Type 145	Lever key, 4-c/o, locking, each side. Without mounting plate	S7
	Wheel, gear		
10G/13044	Large	200-teeth	Morse wheel, drive, friction plate drive, cycle timing wheel
10G/13045	Small	20-teeth	Motor pinion, cycle timing pinion
10G/13047	Wiper	Tufnol, $\frac{3}{8}$ in. wide $\times$ $\frac{3}{16}$ in. thick	Bolted to *tongue* of K3

APPENDIX B

Schedule of components—remote control, Type T (10J/100)

Ref. No.	Nomenclature	Detail	Position
	Cap, lamp		
◀ 10A/19616	Type 59	Green	Cap for holder of P1
10A/19616	Type 59	Amber	Cap for holder of P2
10A/19617	Type 60	White	Cap for holder of P3
10H/18611	Jack, lamp, Type 21	——	Holder for P1, P2, P3
5LX/959111	Lamp, filament, 12V, 1·2W	P.O. No. 2	P1, P2, P3 ▶
10F/1620	Relay, magnetic, Type 582	2-c/o, 1,000-ohm coil	REL1, REL2
10F/994	Switch, Type 715	Lever key. 1st side; stop. 2nd side; Locking, 3-c/o. Without mounting plate	S1