AUTOMATIC TELEPHONE DIALS

CONTENTS

INTRODUCTION

The primary function of the automatic telephone dial is to interrupt a circuit so that current pulses having a specified duration and frequency are generated. The pulses control the operation of the automatic switching equipment which establishes a connexion between the calling and called subscribers. All the different types of dial in use by the B.P.O. are similar in appearance when viewed from the front. Fig. 1 shows a typical dial used on a modern telephone instrument, the finger plate and number ring are of rigid P.V.C. sheet and the figures and letters are printed on a number ring (label No. 355) attached to the telephone.

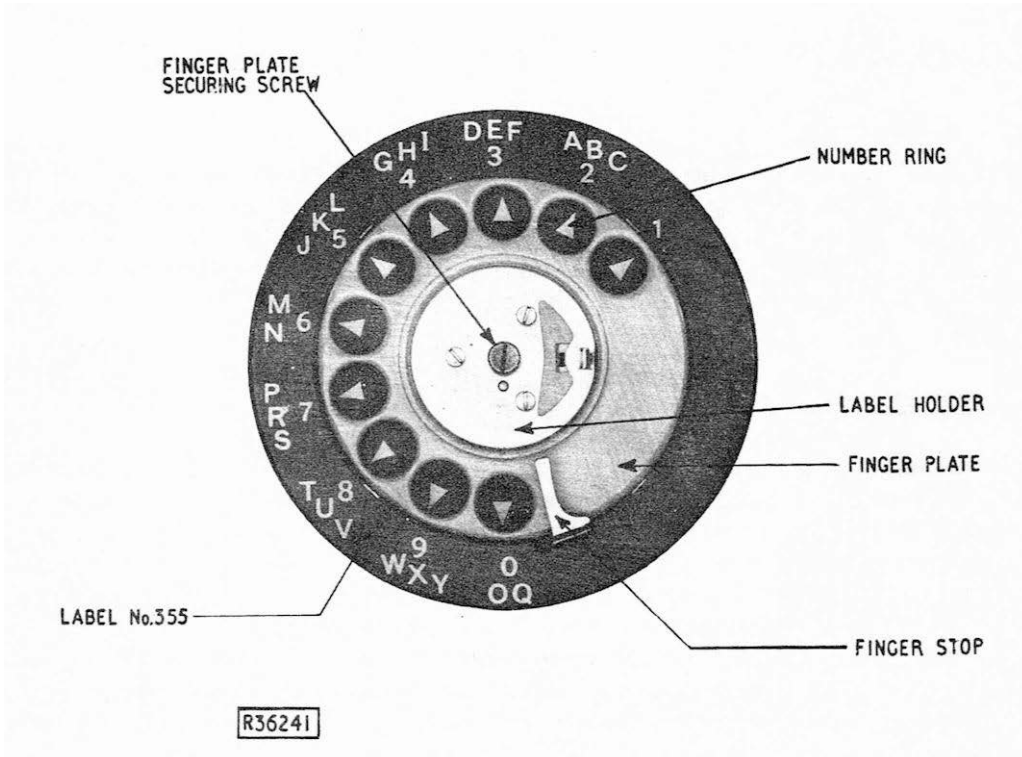

Fig. 1

Each type of dial embodies a finger plate, having ten holes, which is rotated by the finger from the selected digit or letter to the finger stop and then allowed to return unimpeded to the normal position. During the return motion a pulse wheel attached to the spindle on which the finger plate is fixed, operates a pulse contact unit to interrupt the associated circuit a number of times corresponding to the selected digit or letter. There are ten interruptions when "0" is dialled. The return speed of the finger plate, and consequently the rate at which the pulses occur is controlled by a centrifugal type of governor which is incorporated in the dial mechanism.

The series of interruptions produced by the dial is known as a 'pulse train', and it has a standard speed of 10 pulses per second (p.p.s.). The types of dial used by subscribers are designed so that each pulse consists of a $66\frac{2}{3}$ ms break period and a $33\frac{1}{3}$ ms make period; such a pulse is said to have a $66\frac{2}{3}\%$ break ratio.

The dial is also fitted with an 'off-normal' spring-set which operates when the finger plate is moved from the normal position. In practice the off-normal contacts are arranged to reduce the resistance of the pulsing circuit and also to prevent the caller from hearing each pulse as a click in the telephone receiver. The dials on pre-payment coin-box installations are fitted with 'auxiliary springs', which permit the caller to obtain connexion with the exchange operator for emergency or special services, without inserting money in the coin-box.

Whereas all the different types of dial are similar in appearance when viewed from the front, there are two quite distinct methods of ensuring that pulses are generated only when the finger plate is returning to normal. The older method utilizes a 'slipping cam' device and the standard method employs a 'trigger' mechanism.

THE SLIPPING - CAM DIAL

General

A rear view of the slipping cam type of dial with the finger plate in the normal position is shown in Fig. 2. When the finger plate is moved from the selected digit to the finger stop the pulse wheel, slipping cam and switching lever move in an anticlockwise direction. Before proceeding with a description of the action of the slipping cam, the relation between the pulse springs and the pulse wheel will be considered.

Pulse Springs and Pulse Wheel

The dial pulse springs in the open position, i.e. break period, during the last pulse in a train are shown in fig. 3. When rotation of the finger plate in the forward direction has been arrested by the finger stop, the appropriate number of recesses in the pulse wheel are exposed beyond the slipping cam as explained later; during return motion of the finger plate the pulse lever drops into each of the recesses in turn under the tension of the inner pulse spring. The pulse lever is insulated from the inner pulse spring by a buffer, and a buffer spring limits the travel (follow on) of the outer spring, which is tensioned to maintain the required contact pressure when the spring contacts are making. The teeth of the standard pulse wheel are designed to give a pulse of $66\frac{2}{3}\%$ 'break' and $33\frac{1}{3}\%$ 'make'.

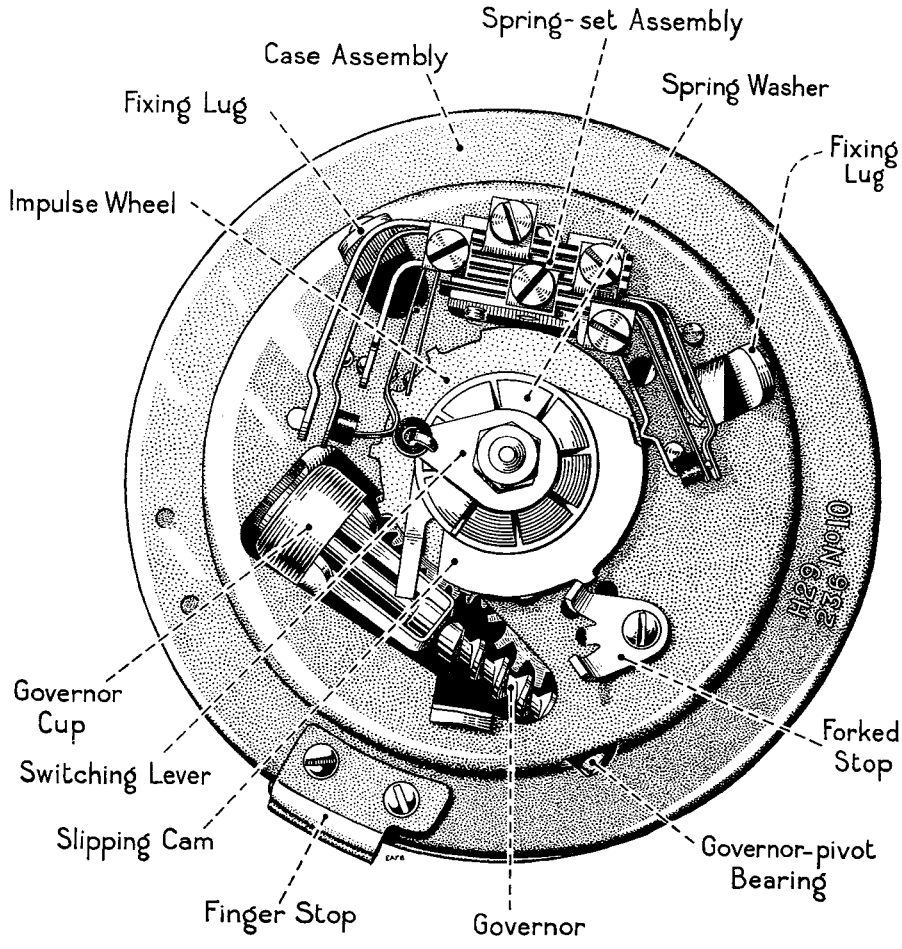
Spring-set Assembly
Case Assembly
Spring Washer
Fixing Lug
Fixing Lug
Impulse Wheel
Governor Cup
Switching Lever
Slipping Cam
Finger Stop
Governor
Forked Stop
Governor-pivot Bearing
R34598

Fig. 2

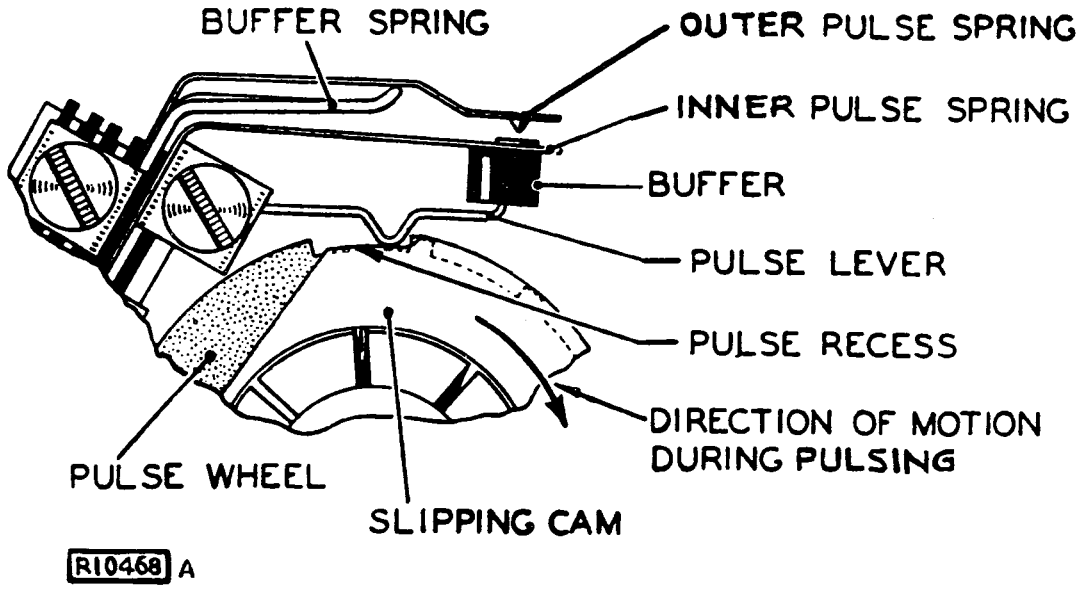
BUFFER SPRING
OUTER PULSE SPRING
INNER PULSE SPRING
BUFFER
PULSE LEVER
PULSE RECESS
DIRECTION OF MOTION DURING PULSING
PULSE WHEEL
SLIPPING CAM
R10468 A

Fig. 3

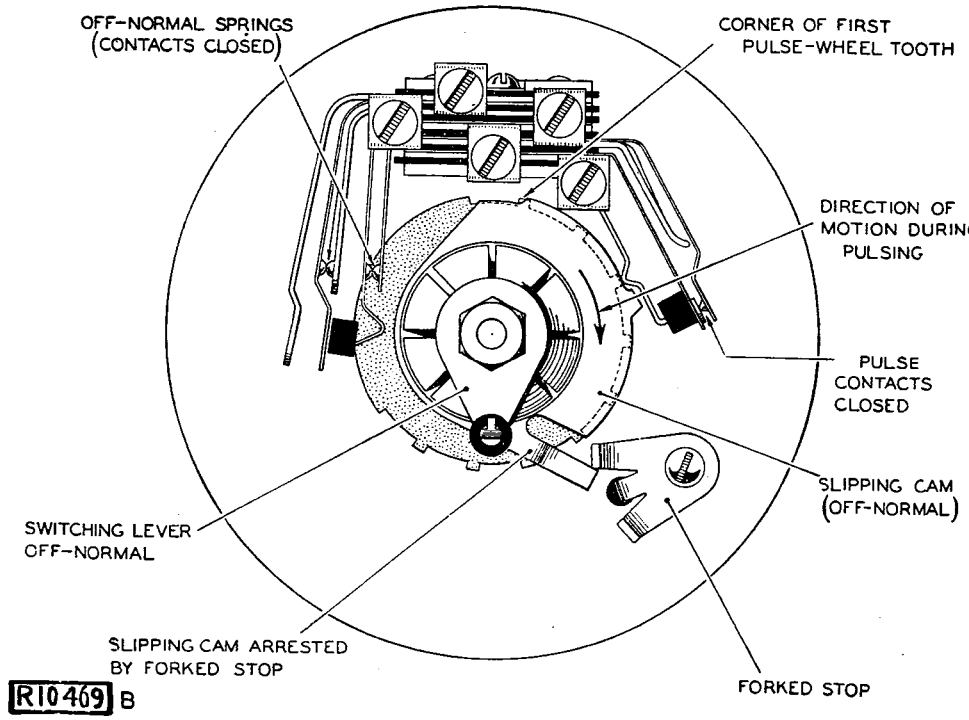
OFF-NORMAL SPRINGS (CONTACTS CLOSED)
CORNER OF FIRST PULSE-WHEEL TOOTH
DIRECTION OF MOTION DURING PULSING
PULSE CONTACTS CLOSED
SLIPPING CAM (OFF-NORMAL)
SWITCHING LEVER OFF-NORMAL
SLIPPING CAM ARRESTED BY FORKED STOP
FORKED STOP
R10469 B

Fig. 4

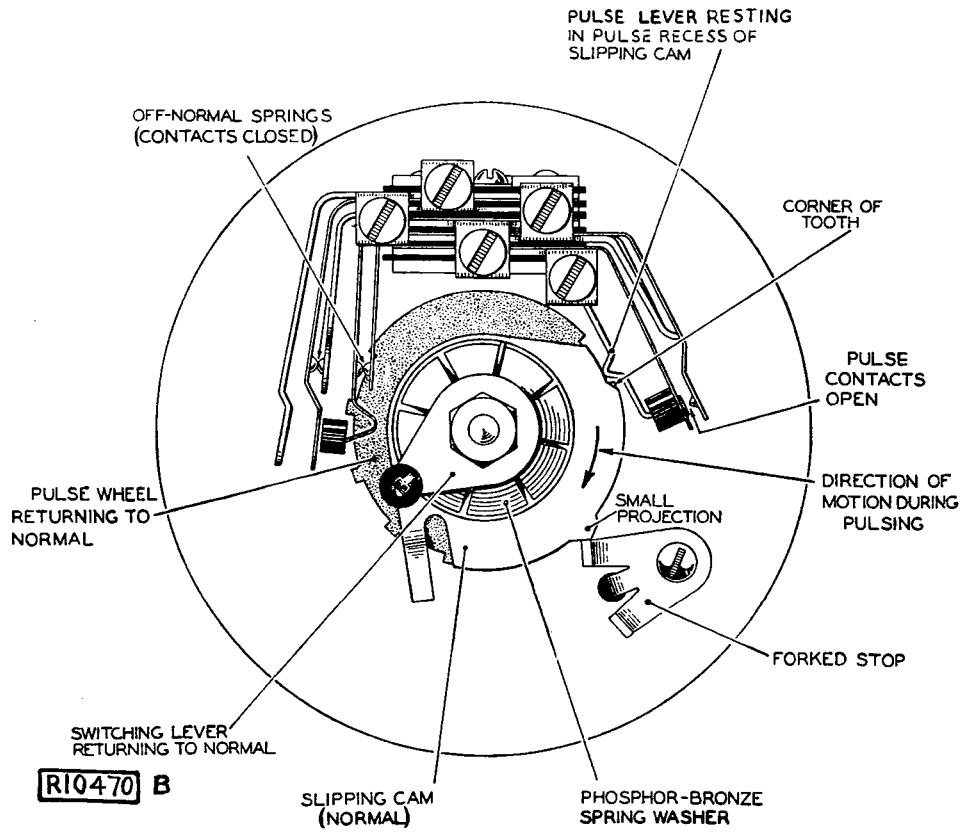
PULSE LEVER RESTING IN PULSE RECESS OF SLIPPING CAM
OFF-NORMAL SPRINGS (CONTACTS CLOSED)
CORNER OF TOOTH
PULSE CONTACTS OPEN
DIRECTION OF MOTION DURING PULSING
PULSE WHEEL RETURNING TO NORMAL
SMALL PROJECTION
FORKED STOP
SWITCHING LEVER RETURNING TO NORMAL
SLIPPING CAM (NORMAL)
PHOSPHOR-BRONZE SPRING WASHER
R10470 B

Fig. 5

The Slipping Cam

The slipping cam, Fig. 2, is frictionally coupled to the pulse wheel by a phosphor-bronze spring washer, so that when the finger plate is rotated in either direction the slipping cam will move with it, between limits set by a forked stop and projections on the cam. The functions of the slipping cam are;-

(a) to prevent operation of the pulse springs during the forward movement of the finger plate.

(b) to ensure that, when the finger plate is released, there shall be a standard period of time before the pulse springs commence to operate, irrespective of the digit dialled. This is termed the "minimum pause" or "lost-motion period" and is an interval of some 220 milliseconds introduced into the operation of the dial to ensure that, with very rapid manipulation of the dial, selectors have time to complete rotary hunting in the interval between successive pulse trains.

These functions are explained, in detail, in the following paragraphs.

Immediately the finger plate commences to rotate in the forward direction, anticlockwise in Fig. 2, the slipping cam - travelling with the pulse wheel - engages the pulse lever and prevents it from dropping into the recess of the pulse wheel. After the movement of the slipping cam has been arrested by the long lug engaging the forked stop, further rotation of the pulse wheel continues independently of the cam, until the motion of the finger plate is arrested by the finger stop. This later movement of the pulse wheel causes a number of the recesses corresponding to the digit dialled to be carried past the pulse recess of the slipping cam, see Fig. 3. In Fig. 4 the mechanism is shown when the finger plate has been positioned ready to send digit '1'.

When the finger plate is released, the unwinding of the restoring spring causes the main spindle to rotate to its normal position, carrying with it the pulse wheel and the slipping cam which now retain their relative positions until the motion of the cam is arrested by the small projection meeting the forked stop, as shown in Fig. 5. During the greater part of this period, the pulse lever rests on the outside edge of the slipping cam, which has a radius slightly larger than that of the pulse wheel teeth, thus preventing the operation of the pulse contacts; the period thus provided is the minimum pause. When, however, the whole of this outside edge of the cam has passed the pulse lever, the latter becomes dependent on the pulse wheel, and during the further motion of the dial, the pulse contacts are opened when a recess passes the lever, and closed when a tooth passes the lever.

To ensure that the first pulse of any train of pulses shall be of standard duration, the mechanism is so adjusted that when digit '1' is dialled, the corner of the first pulse wheel tooth appears in the pulse recess of the slipping cam as shown in Figs. 4 and 5; it follows of course that, when digit '2' is dialled, the corner of the second tooth will appear in a similar position in the pulse recess, and so on for any other digits and their respective teeth on the pulse wheel.

Off-normal springs

When the finger plate is normal, the off-normal spring contacts are held open by an insulated bush on the switching lever attached to the main spindle as shown in Fig. 6. When the finger plate is moved from its normal position the switching lever moves away from the set in the contact spring and the two pairs of contacts 'make'. On the return of the finger plate to the normal position the switching lever again engages with the contact spring and the contacts 'break'. Thus the contact springs only make when the finger plate is off-normal. In practice these springs are provided to ensure that the circuit which is interrupted shall not include the resistance of the telephone transmitter and that the pulses shall not be heard in the receiver.

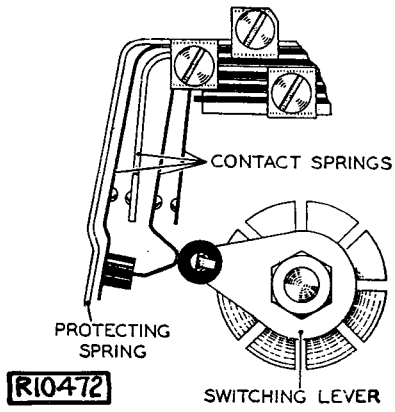

Fig. 6

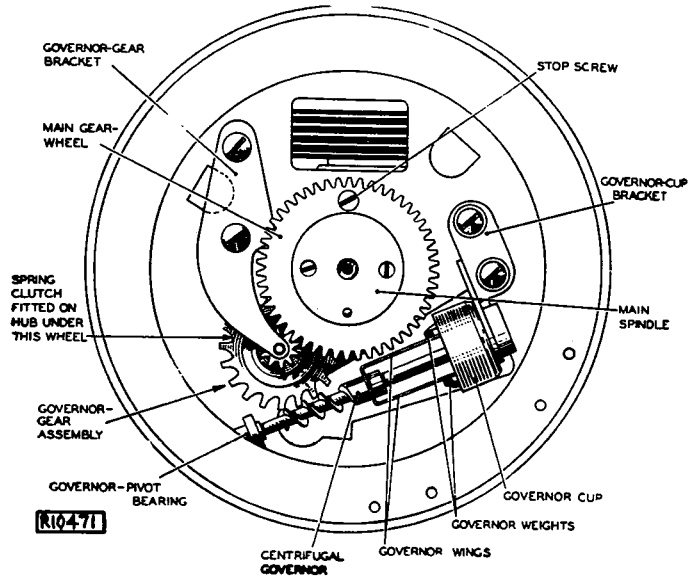

Fig. 7

The Governor

The speed at which the finger plate returns to normal is controlled by a centrifugal governor. The governor is driven via a gear wheel on the main spindle and a governor-gear assembly, which includes a spring clutch having a free-wheel action. Fig. 7 shows a front view of the dial with the finger plate and number disk removed. The governor accounts for the resistance experienced if the return rotation of the dial is speeded-up by hand. As the governor rotates, the weights on the ends of the wings fly outwards and press against the inside of the governor cup, thereby limiting the speed. The normal setting of the governor wings is such that the speed of pulsing is maintained at 10 p.p.s. although for maintenance purposes the speed may be between the limits of 9 and 11 p.p.s. The speed at which the finger plate is rotated to the finger stop is not restricted by the governor, as the motion in this direction brings the free-wheel action of the clutch into play.

The dial mechanism is held at its normal position against the tension of the pre-wound restoring spring by the stop screw, which projects through the main gear-wheel, and engages with a projection on the dial frame.

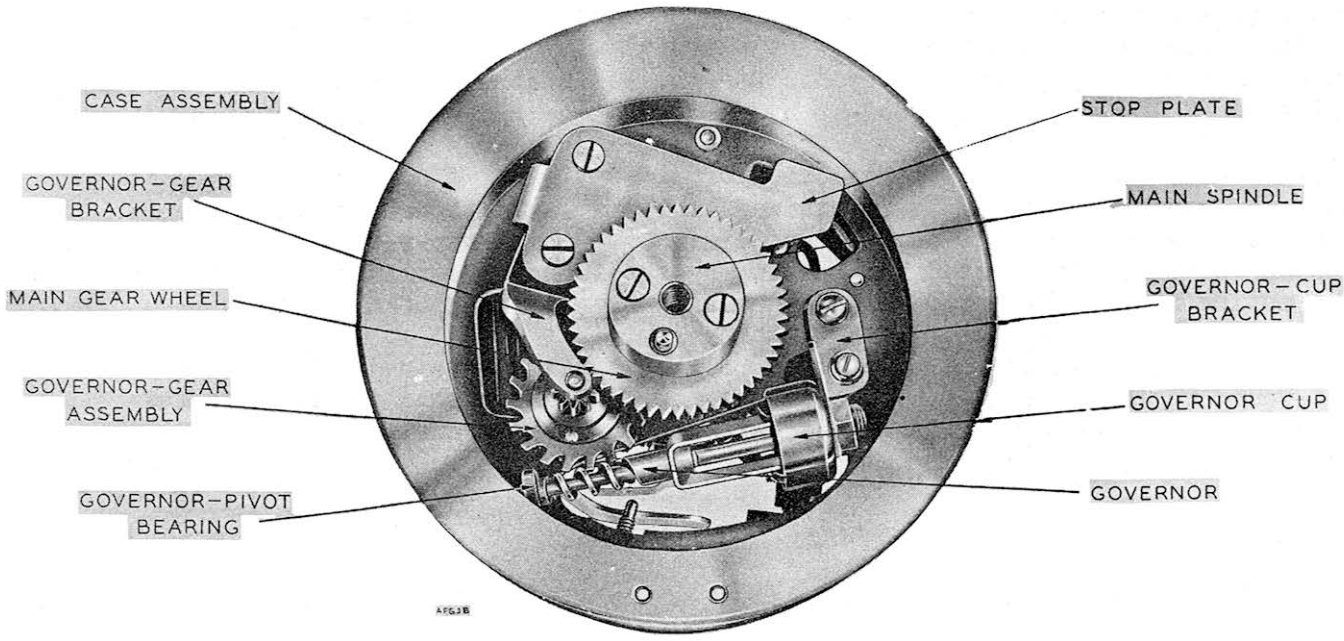

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Fig. 8

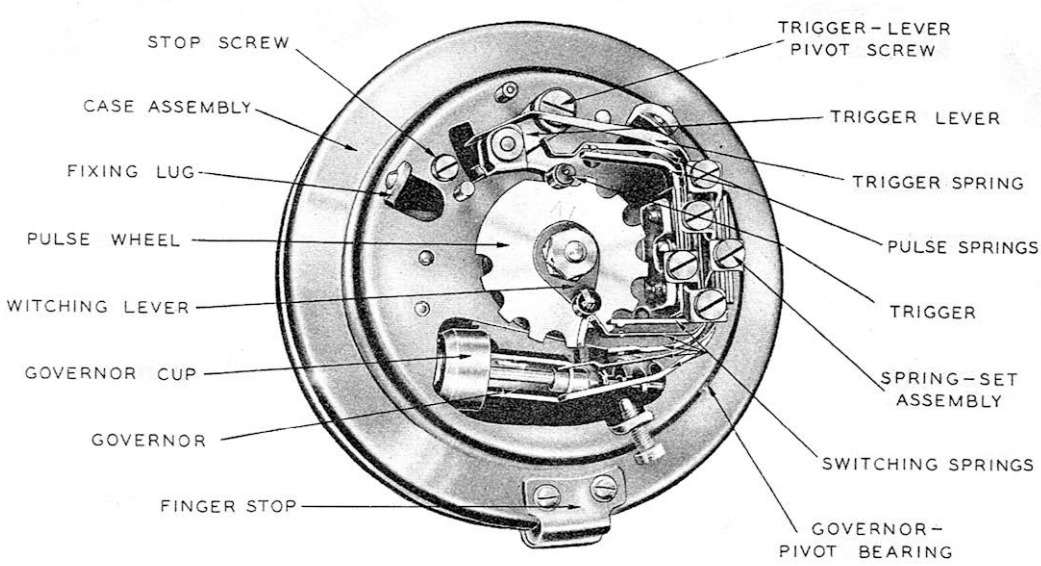

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Fig. 9

THE TRIGGER DIAL

General

The dial described in the foregoing paragraphs has been found sometimes to fail in service owing to faulty operation of the slipping cam. In the new type of dial now in use the slipping cam has been eliminated, and a trigger mechanism introduced. This mechanism performs the same functions as the slipping cam, i.e. it prevents transmission of pulses during the forward motion of the dial and provides the minimum pause or lost-motion period before each pulse train. The minimum pause period has been increased to about 240 milliseconds by reducing the width of the finger stop and so allowing the finger plate a greater angular movement.

A front view of the trigger type dial with the finger plate and number ring removed, is shown in Fig. 8, and a rear view in Fig. 9.

The trigger mechanism

The trigger assembly together with the pulse springs, pulse wheel and off-normal springs is shown in the normal position in Fig. 10. The trigger A, Fig. 11, which is made of stainless steel, is pivoted at one end to a movable lever B, and at the other end is 'V' shaped to rise on the pulse wheel. This end also has a projection carrying an insulated bush which engages with the pulse springs. The end of the lever B remote from the trigger is free to rotate about the shank of a screw which is screwed into the dial case. The trigger is pressed on to the pulse wheel under the tension of a trigger spring which is part of the pulse spring assembly.

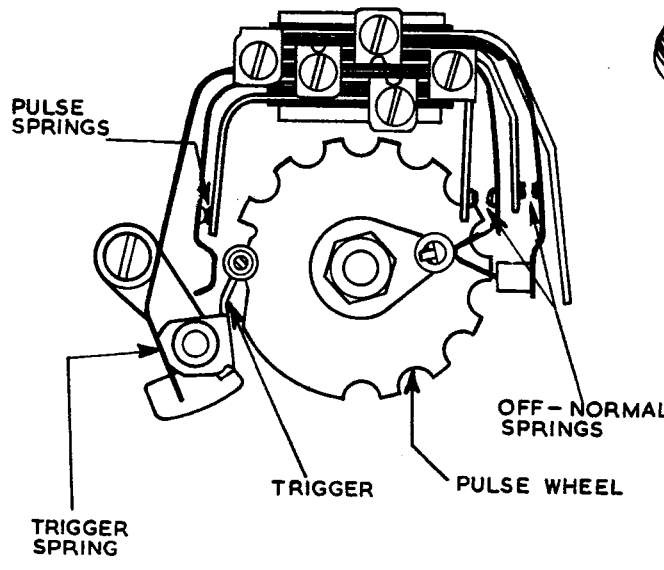

Fig. 10

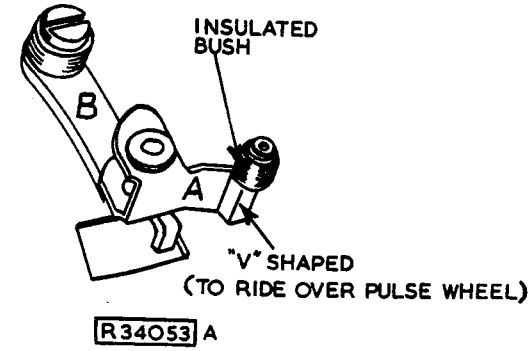

Fig. 11

Pulsing

During forward movement of the finger plate, the restoring spring (not shown) is wound and the pulse wheel is moved in unison. The front of the first tooth in the wheel engages with the tip of the trigger and causes the trigger to rotate to a position well clear of the pulse springs as shown in Fig. 12, thus preventing pulsing during the forward movement of the finger plate. On the return of the finger plate to normal under control of the main spring, a tooth in the pulse wheel again engages with the trigger as shown in Fig. 13. The wheel is now moving in an clockwise direction and the trigger is turned back to the pulsing position; the time taken for this movement provides the minimum pause. As the return movement continues the trigger rides over the pulse wheel as shown in Fig. 14 and at each tooth the insulated bush opens the pulse contacts; the number of teeth passed equals the digit dialled. The size and shape of the pulse wheel and the tension of the buffer spring determine the pulse ratio. To guard against distortion of the trigger and to prevent trigger backlash, stops are provided which limit the movement of the lever carrying the trigger.

The major advantages of the trigger mechanism over the slipping cam with respect to the production of pulses are as follows:-

(i) The trigger operation does not rely on frictional contact between surfaces. Frictional contact can vary considerably over the years of service expected from a dial, and such variations can cause false pulsing.

(ii) The position to which the finger plate must be rotated to select the digit required is less critical; the correct number of pulses will be obtained if the finger plate is moved short of, or past, the finger stop by half the diameter of a finger hole.

(iii) Wear of the pulse contacts and wear of the trigger or pulse wheel affect the pulse make to break ratio in opposite ways, thus any changes tend to neutralize one another. In the slipping cam design, any wear on the pulse wheel teeth tends to increase the break to make ratio of the pulses.

Off-normal springs

The design and operation of the off-normal springs are essentially the same as in the slipping cam dial.

The governor

The governor mechanism is shown in Fig. 9, and is similar to that used in the slipping cam dial. There are, however, changes of detail designed to both quieten and improve the running of the dial mechanism. The main changes are the use of a resin bonded fabric material for the governor gear wheel and the insertion of a rubber washer behind the number ring.

The dial mechanism is held in its normal position against the tension of the pre-wound restoring spring by a stop plate, Fig. 8. The stop plate is positioned by the stop screw, Fig. 9, so that it engages with a pin on the underside of the main gear-wheel when the dial reaches the normal position on its return movement.

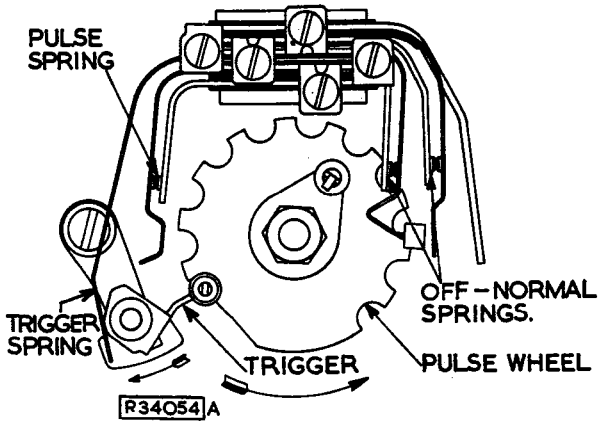

Fig. 12

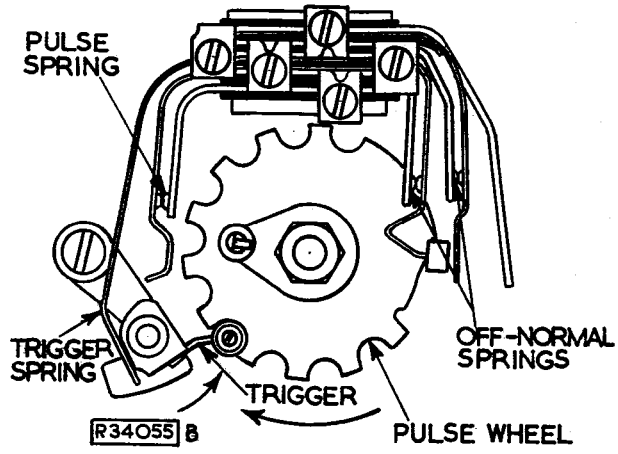

Fig. 13

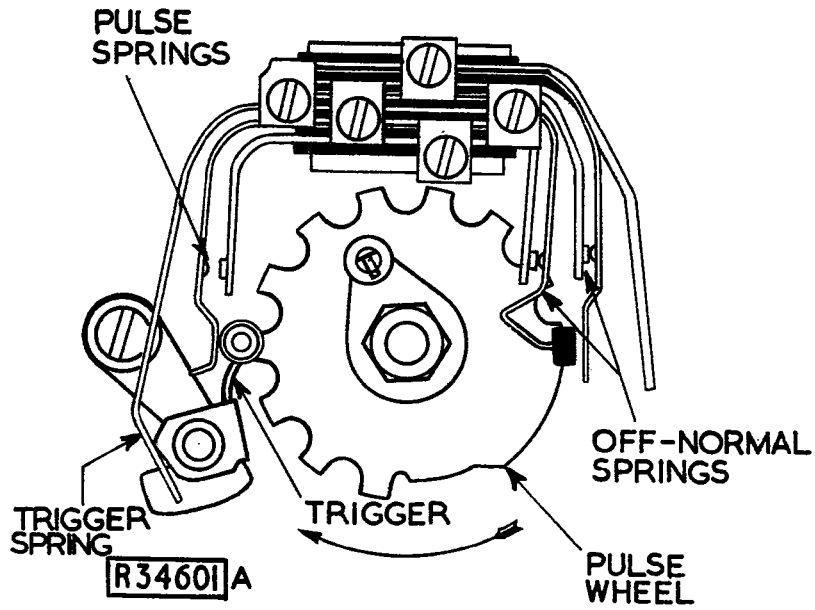

Fig. 14

THE PREPAYMENT COIN-BOX DIAL

General

The telephone-instrument circuit used with the prepayment type of coin-collecting box is designed so that the caller can obtain connexion with services such as assistance and emergency without payment. To enable certain digits to be effective without payment, the dial used for the coin-collecting box circuit has auxiliary contacts which open when certain digits are selected, and remain open until the necessary pulses are transmitted. In practice the pulsing contacts of the dial are normally short-circuited by the auxiliary spring contacts connected in series with mechanically operated contacts in the coin-box mechanism. Dialling cannot, therefore, become effective unless either money is inserted to open the coin-box contacts, or the dial finger plate is rotated to the predetermined digit, thus opening the auxiliary contacts.

The mechanical arrangement on a coin-box dial which allows the digits 8, 9 and 0 to be effectively dialled without payment is shown in Fig. 15.

Auxiliary spring-set

The contacts of the auxiliary spring-set are normally held in the made position by an auxiliary pulse cam mounted on an extension of the main spindle. The cam is free to turn on the main spindle and has a light helical spring attached to it from a bracket on the auxiliary spring-set. Two control pins corresponding to the digits 9 and 0 are rivetted into the cam and project on the underside. A tapped hole is provided to allow a control pin corresponding to the digit 8 to be fitted if required.

Normally, when any digit up to and including 8 is selected, the spindle moves but the cam is held in its normal position by the pressure of the auxiliary spring-set. The auxiliary spring-set therefore, remains operated during the movement of the finger plate. If, however, 9 or 0 is selected the insulating bush on the switching lever (shown dotted) strikes the operating pin during movement of the finger plate. The insulating bush rotates the cam during the remaining movement of the finger plate allowing the auxiliary spring contacts to open removing the short-circuit from the dial pulse springs. On the return motion of the dial 9 or 0 is 'pulsed out', the auxiliary spring-set remaining operated because the helical spring is not strong enough to turn the cam and lift the lever spring up the cam step. When pulsing is completed the switching lever bush strikes the resetting pin and resets the cam and auxiliary spring contacts as the finger plate completes its movement.

When the dialling of the digit 8 without payment is required a control pin is screwed into the tapped hole, this pin then becomes the operating pin.

Fig. 16 shows the arrangement adopted to allow the effective dialling of the digit 1 without payment. When the finger plate is in the normal position the insulated trigger is engaged by a cam on the masking plate and holds the auxiliary spring contacts open. When the finger plate is moved off-normal, the cam remains engaged with the trigger until the digit 1 finger hold is about half-way to the finger stop. The cam then leaves the trigger and the auxiliary spring contacts close; in practice the short circuit of the pulse springs is now completed.

During the return motion of the finger plate, the auxiliary spring contacts remain closed until the cam re-engages the trigger just before the break period of the last pulse commences. Thus assuming the auxiliary pulse cam has not been operated, only one pulse is effective irrespective of the digit selected.

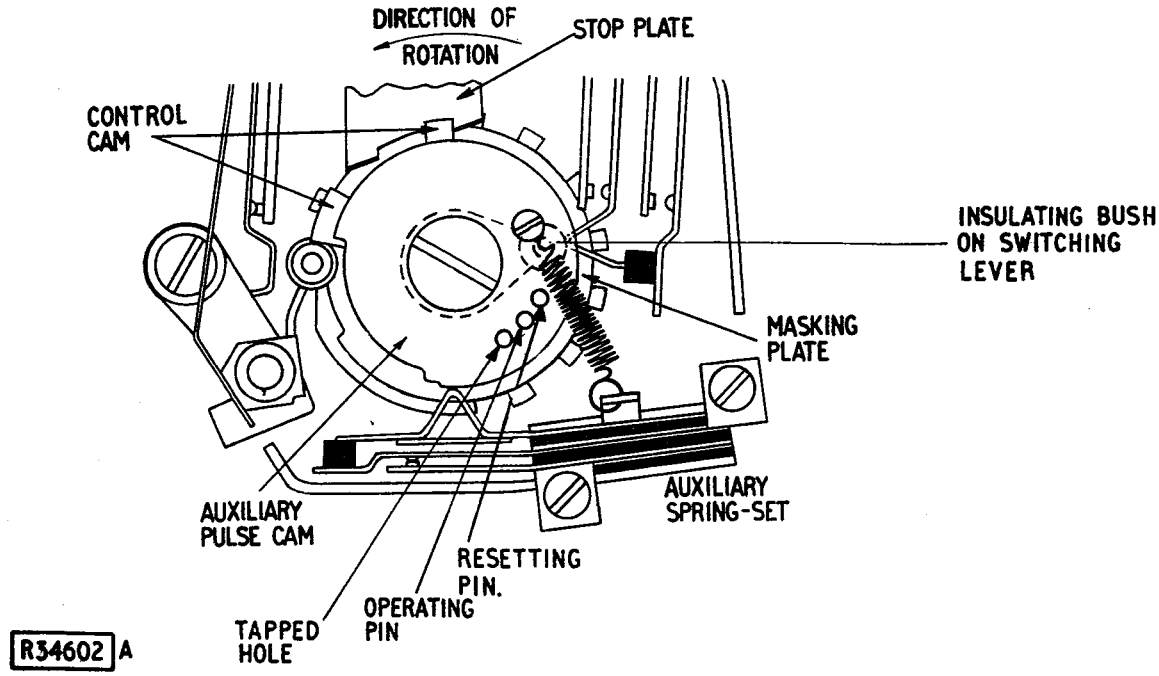
DIRECTION OF
ROTATION
STOP PLATE
CONTROL
CAM
INSULATING BUSH
ON SWITCHING
LEVER
MASKING
PLATE
AUXILIARY
PULSE CAM
AUXILIARY
SPRING-SET
RESETTING
PIN.
OPERATING
PIN
TAPPED
HOLE
R34602 A

Fig. 15

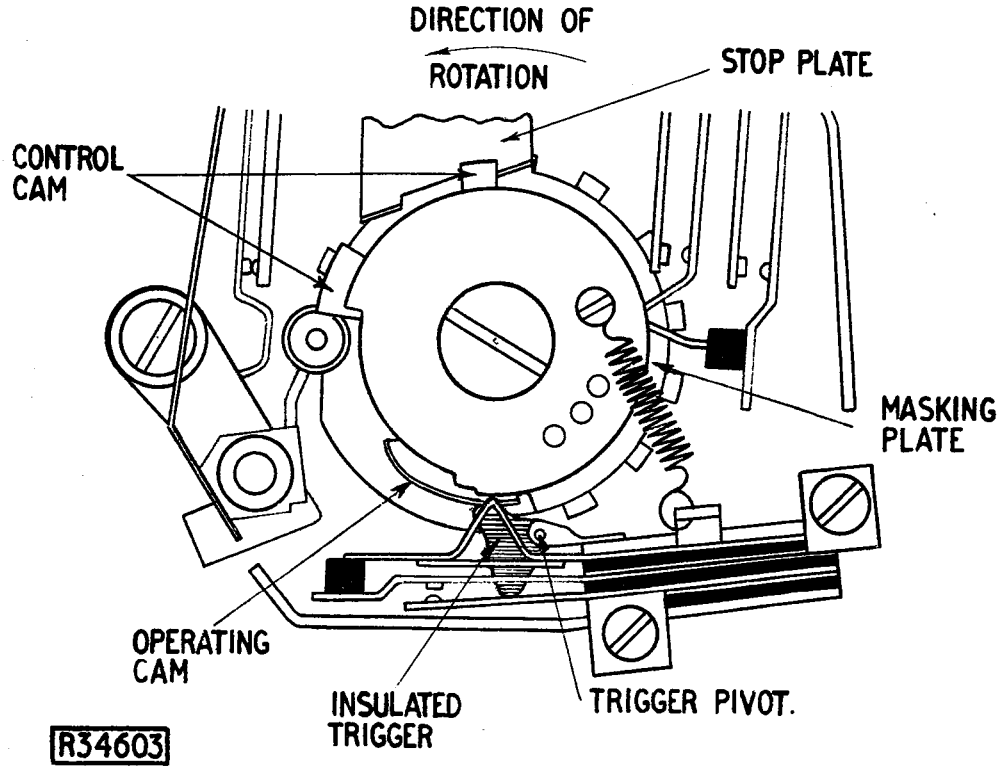
DIRECTION OF
ROTATION
STOP PLATE
CONTROL
CAM
MASKING
PLATE
OPERATING
CAM
INSULATED
TRIGGER
TRIGGER PIVOT.
R34603

Fig. 16