THE AUTOMATIC TELEPHONE DIAL

INTRODUCTION

The primary function of the automatic telephone dial is to generate impulses for controlling the operation of the automatic-switching equipment, which establishes a connexion between the calling and called subscribers.

The dial is fitted with contact springs which generate the impulses, and with 'off-normal' springs which (*a*) short-circuit the transmitter of the calling subscriber's telephone, thereby reducing the resistance of the dialling circuit, and (*b*) prevent the caller from hearing each impulse as a 'click' in the receiver.

The 'off-normal' springs of the dials on switchboards may also be used to control subsidiary circuits, and the dials on 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.

DESCRIPTION OF MECHANISM

General

A finger plate (**Fig. 1**) having ten holes, is mounted on the front of the dial. The mechanism is housed in the dial case, and is actuated by the rotation of the spindle on which the finger plate is fixed. By placing a finger in any one of the holes in the finger plate and rotating the plate in a clockwise direction until the finger is arrested by the finger stop, the dial-restoring spring is wound; if the finger is now withdrawn from the hole, the plate will return to normal under the influence of the spring. During this return to normal, a contact, controlled by an impulse wheel, interrupts the circuit a number of times corresponding to the digit that has been dialled (it should be noted that the circuit is interrupted ten times if '0' is dialled). Such a series of interruptions (or impulses) is known as an "impulse train". Impulsing, therefore, takes place on the return rotation of the dial, and the fact that the speed of return is controlled by a governor ensures that impulse trains will not be disturbed by any peculiarity in dialling or hesitancy on the part of a subscriber. The return rotation must, of course, be unimpeded.

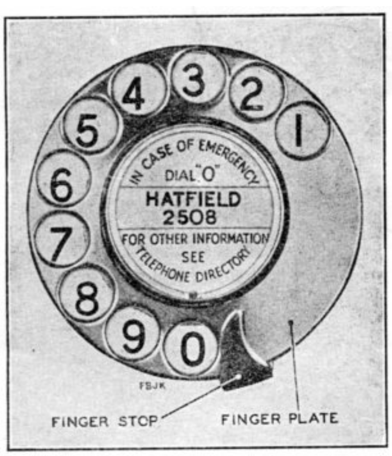

FIG. 1

Impulse Springs and Impulse Wheel

The dial impulsing springs which interrupt the subscriber's loop during the return motion of the finger plate are shown in **Fig. 2**. When rotation of the finger plate in the forward direction has been arrested by the finger stop, the appropriate number of recesses in the impulse wheel are exposed beyond the slipping cam (as explained later); during the return motion of the finger plate the impulse lever drops into each of the recesses in turn, under the tension of the inner impulse spring. The impulse lever is insulated from the inner impulse 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 impulse wheel are designed to give an impulse of $66\frac{2}{3}\%$ 'break' and $33\frac{1}{3}\%$ 'make'.

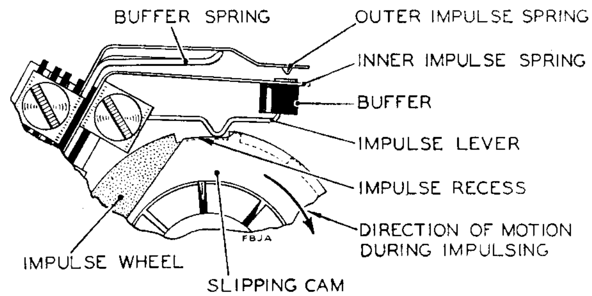

FIG. 2

The Slipping Cam

The slipping cam (**Fig. 3**) is held against the impulse 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 impulsing 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 impulse springs commence to operate, irrespective of the digit dialled. This is termed the "minimum pause", and is an interval 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 impulse trains.

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

Immediately the finger plate commences to rotate in the forward direction, the slipping cam—travelling with the impulse wheel—engages the impulse lever and prevents it from dropping into the recess of the impulse wheel. After the movement of the slipping cam has been arrested by the forked stop, further rotation of the impulse wheel continues independently of the cam, until the motion of the finger plate is arrested by the finger stop. This later movement of the impulse wheel causes a number of the recesses (corresponding to the digit dialled) to be carried past the impulse recess of the slipping cam (see Fig. 2). In Fig. 3 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 impulse 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. 4.** During the greater part of this period, the impulse lever rests on the outside edge of the slipping cam, which has a radius slightly larger than that of the impulse wheel teeth, thus preventing the operation of the impulsing contacts ; the period thus provided is the minimum pause. When, however, the whole of this outside edge of the cam has passed the impulsing lever, the latter becomes dependent on the impulse wheel, and during the further motion of the dial, the impulsing contacts are opened when a recess passes the lever, and closed when a tooth passes the lever.

The minimum pause period, for which the slipping cam provides, is not needed for certain non-standard systems. The forked stop is used in such cases to restrict the movement of the slipping cam to the dis-

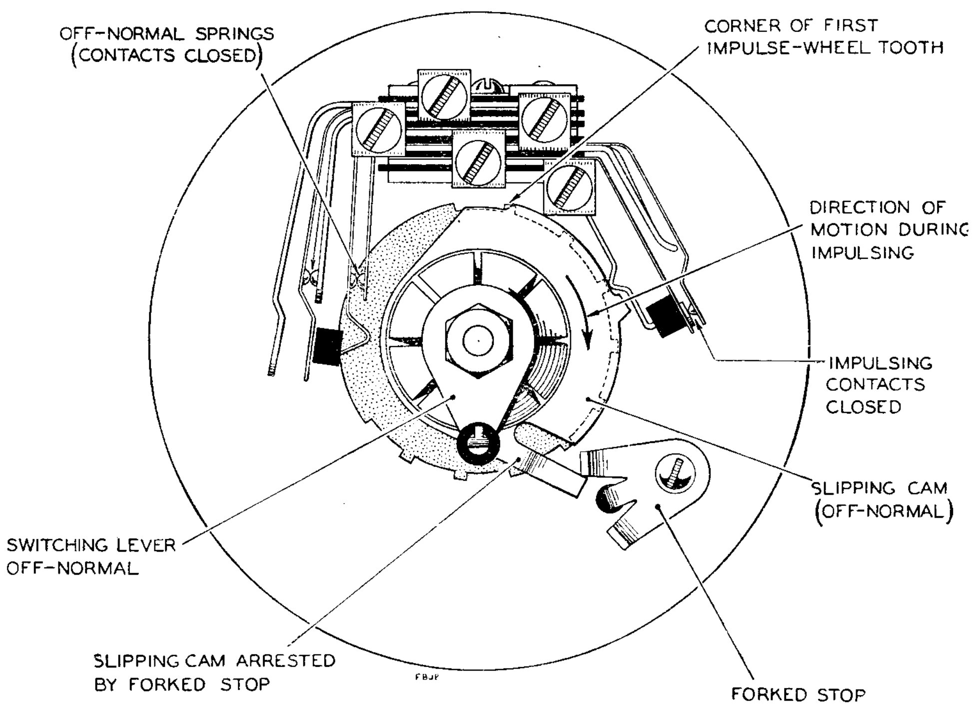

FIG. 3

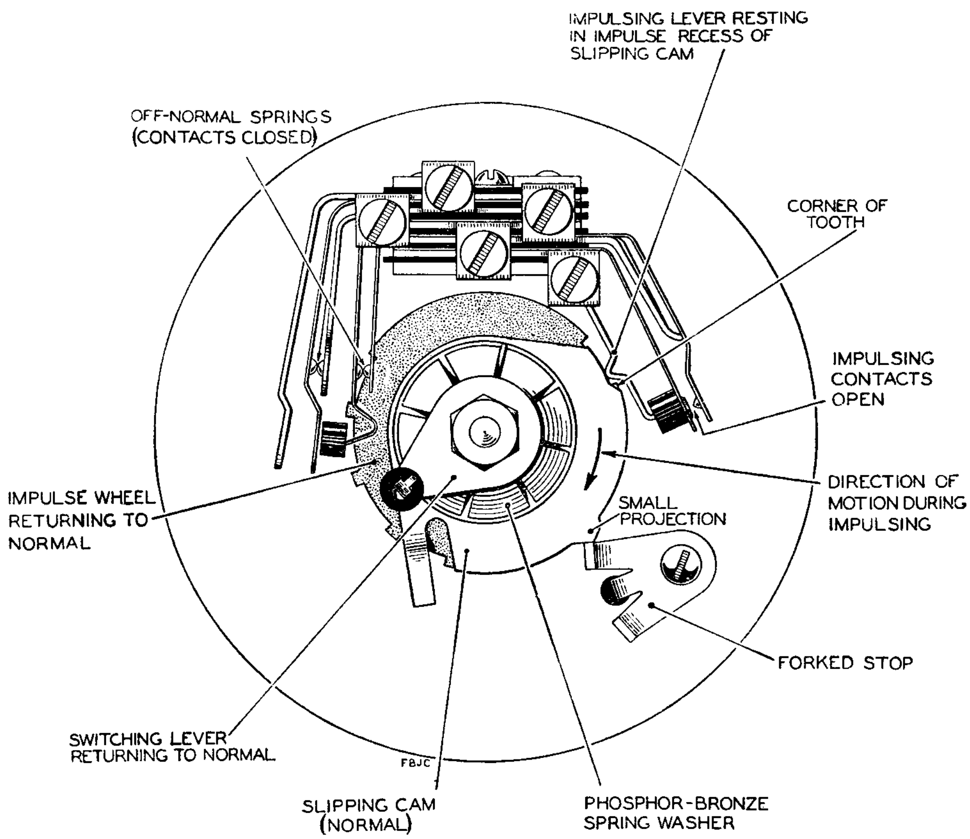

FIG. 4

tance between the forks, and the finger stop is moved to curtail the travel of the finger plate. The alteration in the position of the finger stop compensates for the reduced period for which the impulse wheel is masked by the slipping cam, by introducing a corresponding reduction in the forward rotation of the finger plate.

To ensure that the first impulse of any train of impulses shall be of standard duration, the mechanism is so adjusted that when digit ' 1 ' is dialled, the corner of the first impulsing tooth appears in the impulse recess of the slipping cam (see Figs. 3 and 4); it follows of course that, when digit ' 2 ' is dialled, the corner of the second tooth will appear in a similar position in the impulse recess, and so on for any other digits and their respective teeth on the impulse wheel.

The Governor

The speed at which the finger plate returns to normal is controlled by a centrifugal governor; this 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. 5** shows a front view of the dial with the finger plate 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 impulsing is maintained at 10 impulses per second (10 i.p.s.), though, for maintenance purposes the speed may be between the limits of 9 and 11 i.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 stop screw shown in the figure projects through the main gear-wheel and engages with a projection on the dial frame to limit the rotation of the dial.

With a governor adjusted to give a standard speed of 10 i.p.s. and using a standard impulse wheel, the impulse will be of 100 milli-seconds (mS.) duration, of which $66\frac{2}{3}$ mS. will be a ' break ' period, and $33\frac{1}{3}$ mS. will be a ' make ' period.

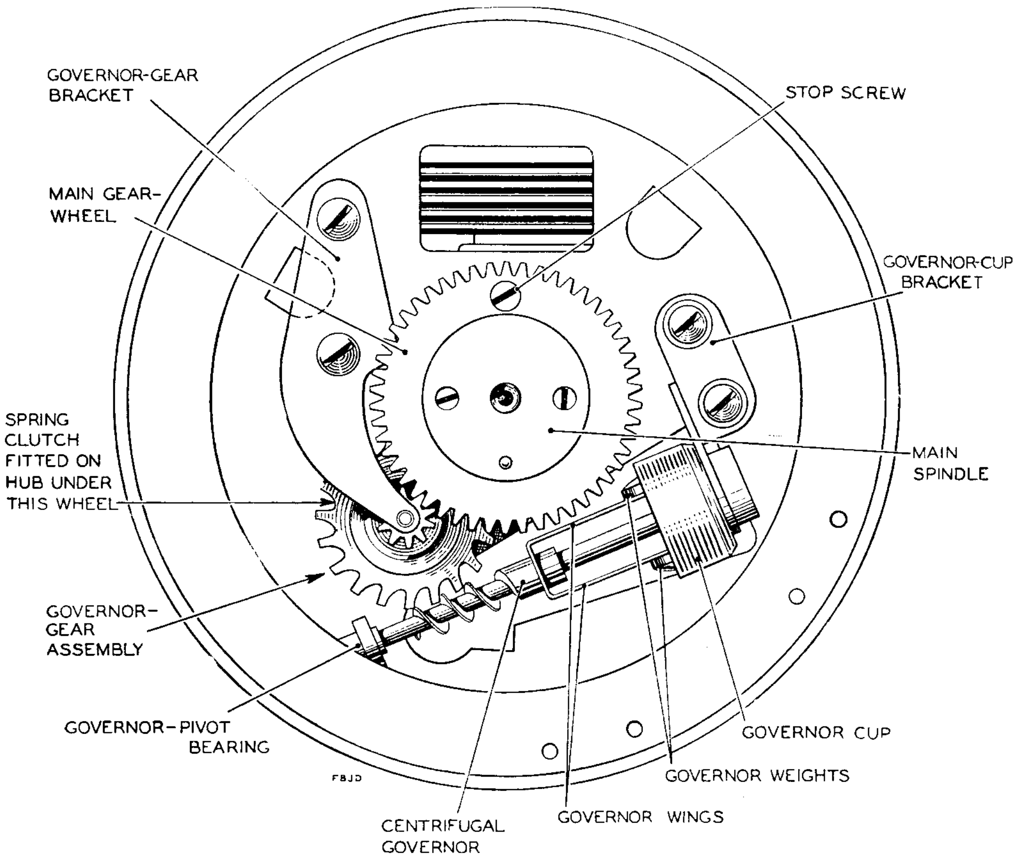

FIG. 5

Off-normal Springs

When the dial is normal, the off-normal springs are held open by an insulated bush on a switching lever attached to the main spindle (**Fig. 6**). When the finger plate is moved from its normal position, the two pairs of contacts 'make' (see Figs. 3 and 4). These springs are provided to ensure that the impulsing loop shall not include the resistance of the subscriber's transmitter and that the line disconnexions, during dialling, shall not be heard in the receiver.

STANDARD DIAL FOR COIN-BOX CIRCUITS

The telephone-instrument circuits used with the prepayment type of coin-collecting boxes are designed so that the caller cannot operate the exchange apparatus without prepayment, except when making calls to

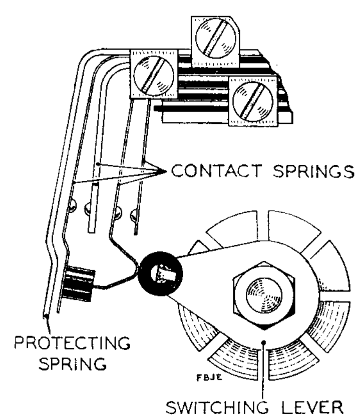

FIG. 6

an auto-manual switchboard or (in certain areas) for ' emergency call ' service, in either of which cases a pre-determined digit (usually ' 0 ' or ' 9 ') must be dialled. To prevent the effective dialling of digits other than the predetermined digit(s), the dial used is similar to that already described, but has additional mechanism and an auxiliary spring-set. The impulsing contacts of a coin-box dial are normally short-circuited by the auxiliary spring-set, connected in series with contacts in the coin-box mechanism. Dialling cannot therefore become effective unless either money is inserted to open the contacts of the coin-box mechanism, or the finger plate is rotated to the pre-determined digit, thus opening the auxiliary contacts.

The rear view of a coin-box dial (**Fig. 7**) shows the addition of the auxiliary spring-set, for the operation of which there is an auxiliary impulse-control cam which is free to move on the main spindle. When the dial is normal, the auxiliary cam causes the auxiliary springs to 'make', thereby short-circuiting the impulsing contacts. During the rotation of the finger plate to the finger stop, the control cam, which is free, remains stationary until the bush of the switching lever (already described in connexion with the operation of the off-normal springs) strikes a control screw projecting beneath the auxiliary cam. The dial has not reached the finger stop at this stage, so that further movement of the switching lever moves the auxiliary cam and allows the auxiliary springs to ' break ', thereby removing the short-circuit to permit impulsing to take place during the return rotation of the dial. The stage at which the release of the auxiliary springs occurs is determined by the position of the control screw on the auxiliary cam ; there are ten holes in the cam and to permit impulsing when the

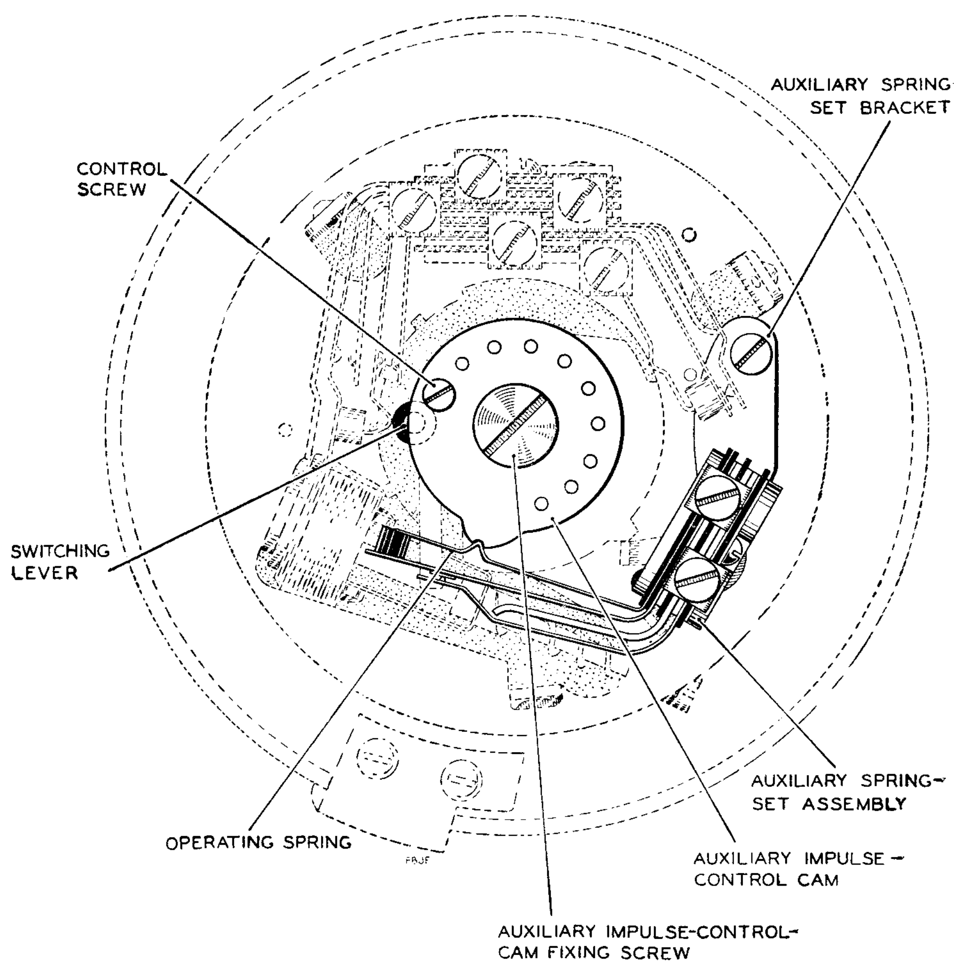

FIG. 7

pre-determined digit, or any digit which is numerically above the pre-determined digit (including ' 0 ') is dialled, the screw is placed in the appropriate hole. When the impulses have been sent, the dial, in returning to normal, causes the switching lever to engage the control screw, and the cam again causes the auxiliary springs to ' make '. The position in which the control screw is shown (Fig. 7), adjacent to the bush of the switching lever, is that occupied in order that ' 0 ' may be dialled without prepayment. The adjacent hole would be used if ' 9 ' were the pre-determined digit for emergency service. The other positions in the auxiliary cam are seldom used.

NON-STANDARD IMPULSE RATIOS

Certain non-standard systems require impulse ratios differing from standard; e.g. the S.T. & C. rotary system requires impulses having 18·5% ' breaks ' and a final ' break ' of not less than 92·5% of the total impulse period, and the early Siemens' type exchanges require impulses having a $66\frac{2}{3}$% ' make ' period and a $33\frac{1}{3}$% ' break ' period. These ratios are obtained by the use of special impulse wheels, having suitably arranged teeth.

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