

LOOP-DISCONNECT PULSING - ELEMENTARY TREATMENTCONTENTS

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GENERAL

This pamphlet gives an elementary treatment of loop-disconnect pulsing, and describes how the pulses generated by the subscriber's or operator's dial control the selectors at the exchange. It also describes briefly the effects of the primary coefficients of the line on these pulses.

LOOP-DISCONNECT PULSES

Loop-disconnect pulses are, as the name implies, generated by 'making' and 'breaking' a loop between the two wires of a circuit such as that shown in Fig. 1. The pulses generated by the pulsing springs of a dial are used to control the operation of the selector mechanisms which establish the connexion from a calling subscriber to a called subscriber.

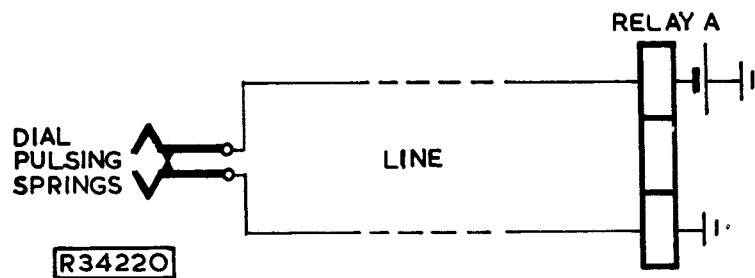


Fig. 1

The relay A in Fig. 1 will be operated for the duration of the time the pulsing spring contacts are closed. When the dial is operated, say, for digit 3, the pulsing springs will break and make three times as the dial returns to normal, and relay A will release and re-operate 3 times accordingly. In practice the dial is arranged to generate pulses at a speed of 10 pulses per second, and for each pulse the circuit of relay A is broken for $66\frac{2}{3}$ milliseconds and closed again, before the next break for $33\frac{1}{3}$ milliseconds. The operation and release of a contact unit of relay A controls the stepping of a selector mechanism.

ELEMENTARY MAGNET CONTROL CIRCUIT

Fig. 2 shows a schematic diagram of a circuit in which the pulses generated by the subscriber's telephone dial are used to cause the operation of a selector magnet, M.

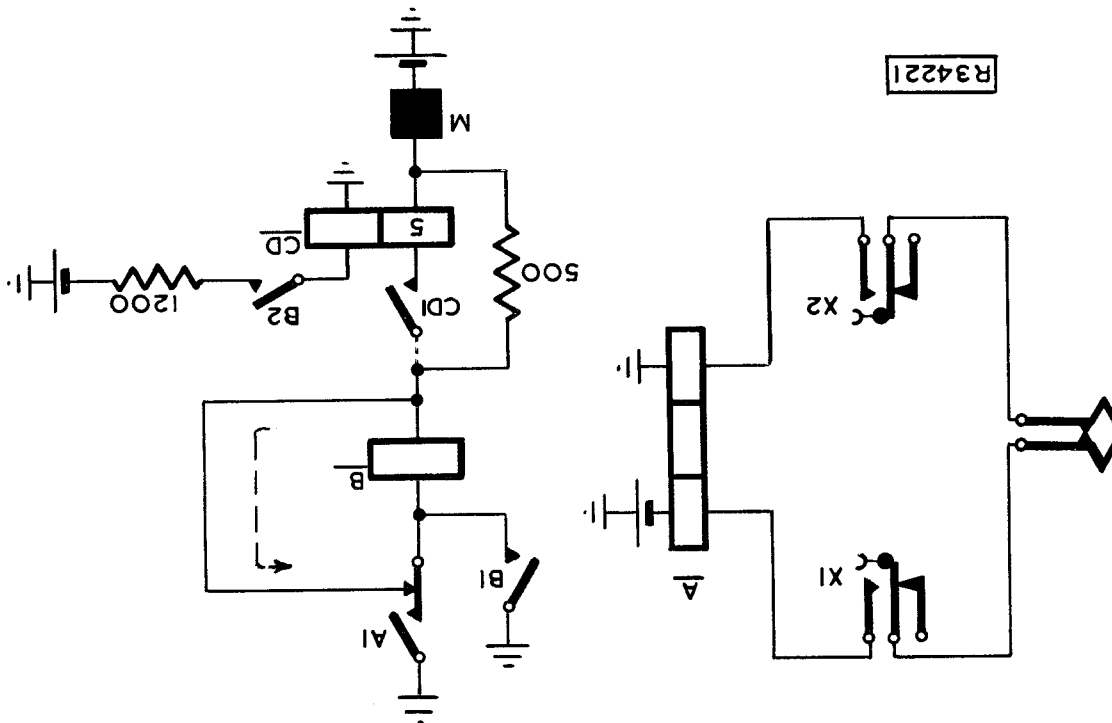


Fig. 2

When the subscriber removes the handset from his telephone contacts X1 and X2 operate and complete the operate circuit for relay A. Relay A operates and contact A1 operates relay B to the battery via the magnet coil M which, at this stage, does not operate. Contact B2 operates relay CD and contact CD1 prepares the operate circuit for the magnet M.

The dial pulsing springs open at the commencement of the first pulse and release relay A. Contact A1 short circuits relay B thereby making that relay slow-to-release, and also completes the operate circuit for the magnet M; earth, contact B1, contact A1, the short circuit of relay B, contact CD1, the 5 ohm coil of relay CD, and the coil of magnet M to battery.

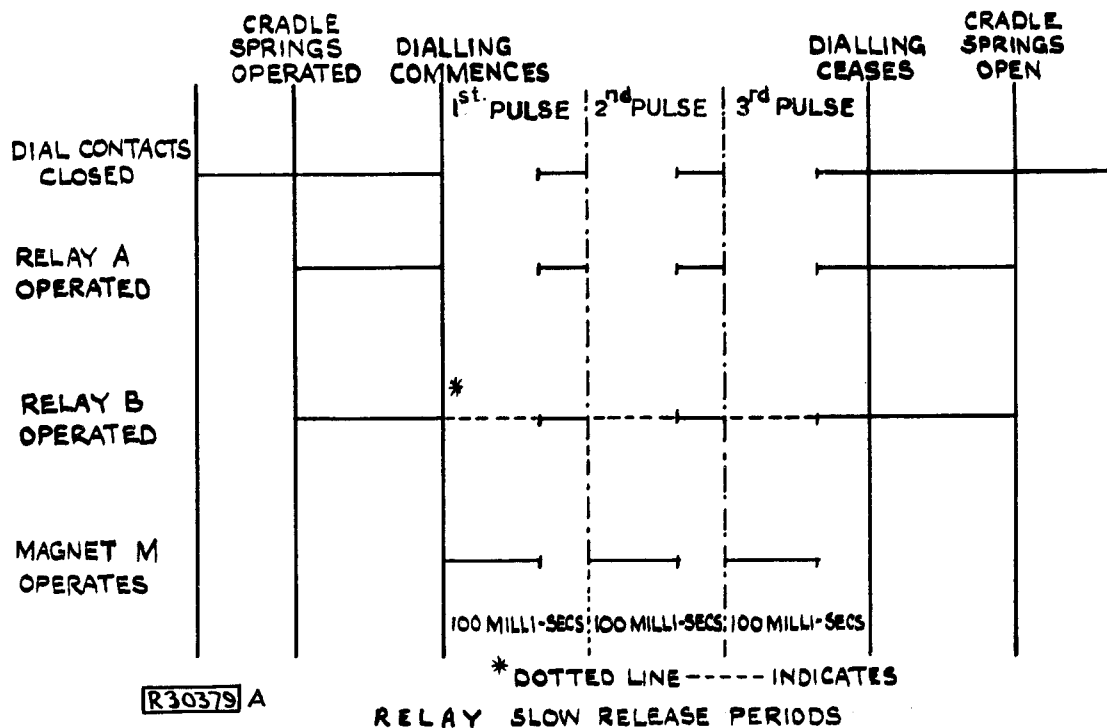
The short circuit on relay B provides a circuit for the induced currents, shown dotted in Fig. 2, which are in such a direction to prolong the existence of the original flux for a sufficient time to ensure that the relay holds during the release periods of relay A.

At the end of the $66\frac{2}{3}$ mS break period of the first pulse, the dial pulsing springs make and relay A re-operates and remains operated for $33\frac{1}{3}$ mS, that is until the commencement of the next pulse. Contact A1 operated disconnects the operate path for magnet M which releases, removes the short circuit from relay B and completes the original operate circuit for relay B.

Relay A releases and operates to subsequent pulses and the magnet M is operated and released accordingly. Fig. 3 shows the sequence of operation of the dial pulsing springs, relay A, relay B and the magnet M.

In practice the circuit of the 700 ohm coil of relay CD is such that after the first operation of the magnet M, the relay is held during subsequent pulsing by the current pulses in the 5 ohm coil.

If selectors are to function accurately, it is essential that their magnets should be energized and released for certain minimum periods. If, in the pulsing circuit described, the break period of the dial became too long, relay B would release and the circuit to the magnet M would be broken at contact B1. In the event of the break period becoming too short, sufficient time would not elapse for the flux in the magnet M to build up and operate the armature before the next operation of relay A.



SEQUENCE OF OPERATION OF SIMPLE PULSING CIRCUIT

Fig. 3

EFFECT OF LINE PRIMARY COEFFICIENTS

The primary coefficients of the line, that is, resistance, leakance, inductance and capacitance affect the operation of the pulsing relay, relay A in Fig. 2, as follows:-

RESISTANCE

When the resistance of the line is increased the value of the current which flows in the coils of relay A is reduced. Assuming that the current is not reduced below that value necessary to operate the relay, it can be shown that the time taken for the relay to operate lengthens as the resistance of the line increases. On the release of the relay the increased resistance shortens the release time. The effect is, therefore, to shorten the make period and lengthen the break period thus resulting in a higher break to make ratio. Referring to Fig. 2, this will mean reduced lengths of pulses of current to the B relay causing consequent reduction of flux in this relay and longer periods of fluxing of the magnet M and relay CD.

LEAKANCE

If there is appreciable leakance between the wires of a telephone pair, the effect is to provide a number of very high resistance paths from one wire to the other. These paths combined, tend to place a high resistance in series with the coils of the relay and cause a partial growth of the operating flux in the core. When the subscriber's loop is closed, a premature operation of the relay will result due to the existing flux. On the opening of the dial pulsing springs a circuit through the leakance paths is maintained which causes the relay to be slow to release. The combined effect is, therefore, to lengthen the period of operation of the relay and the break-to-make ratio is therefore reduced. It will be seen that as the break period is decreased, the magnet and CD relay receive shorter periods of fluxing during each pulse with the possibility, in the extreme case, of a failure of operation of the magnet or the release of relay CD (resulting in each case in lost pulses and consequent wrong numbers).

INDUCTANCE

Excessive inductance in a subscriber's loop will affect the pulsing relay. The inductance will, when the circuit is closed, oppose the increase of current in the relay and delay the operation. On release, and if a suitable circuit exists, an induced current will flow opposing the decay of the original current. In practice the path for this self induced current is provided by the spark quench across the dial contacts. In the case of overhead or faulty lines, a leakance path between wires or to earth provides an additional path and it is in these cases that the effect of inductance is more noticeable. Inductance does not alter the character of the pulse, it merely delays the operation and release of the pulsing relay.

CAPACITANCE

The capacitance between the A and B wires of a subscriber's line and the resistance of the line can be represented as shown in Fig. 4.

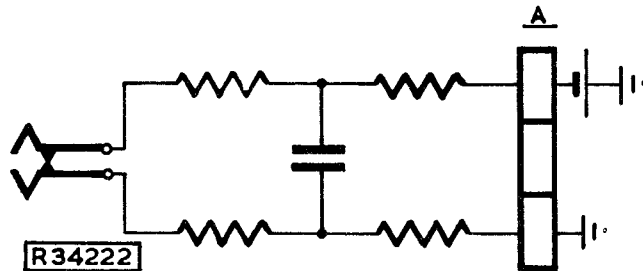


Fig. 4

When the pulsing springs break, the current flow in the relay coils does not immediately fall to zero, but decreases exponentially, that is gradually, as the line capacitance is charged. The release of the relay is, therefore, slightly delayed. When the pulsing springs close the operation of the relay is delayed because the potential across the capacitor, which ideally is equal to the potential of the battery, is effectively short circuiting the relay. The capacitor discharges in the circuit provided by the pulsing springs and as the potential across its plates decreases current commences to flow in the relay coils.

The duration of the relay release and operate lags is dependent on the value of the line capacitance. Ideally, the effect of capacity is to delay the pulse, as shown in Fig. 5, without introducing any distortion.

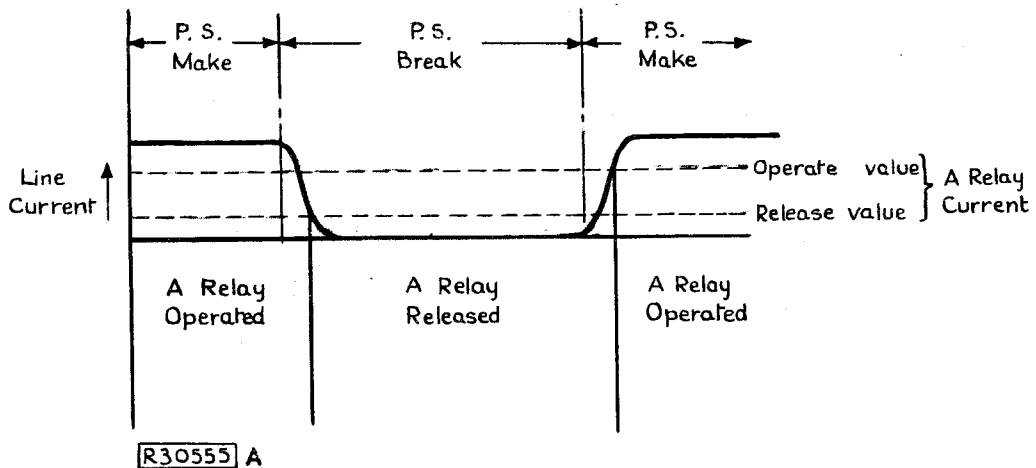


Fig. 5

CONCLUSIONS

The effect of resistance, leakance, inductance and capacitance when considered separately, on the operation of relay A in the simple pulsing circuit of Fig. 1, is shown in Fig. 6. Since the primary coefficients of the line do not occur singly and due also to other causes e.g. variations in battery voltage, the operation of the relay does not faithfully follow the diagram, this being approximate only. The conclusions to be drawn from Fig. 6 can be summarized as follows:-

| <u>Condition of subscriber's line</u> | <u>Pulse</u> | |
|---------------------------------------|--------------|-------------|
| | <u>Break</u> | <u>Make</u> |
| Large Resistance | Lengthened | Shortened |
| Large Leakance | Shortened | Lengthened |
| Large Inductance | | displaced |
| Large Capacitance | | displaced |

All subscribers' lines have resistance capacitance, inductance and leakance in varying degrees.

In some cases these factors tend to cancel each other in respect of the effect on pulsing. It will be realized that some distortion of the pulses will take place, therefore it is essential that the pulses generated by the dial should conform as closely as possible to the standard ratio and standard speed to ensure the correct operation of the equipment. For maintenance purposes tolerance of ± 10 per cent on 10 pulses per second are allowed and ± 3 per cent tolerance is allowed in the ratio of the make to break period.

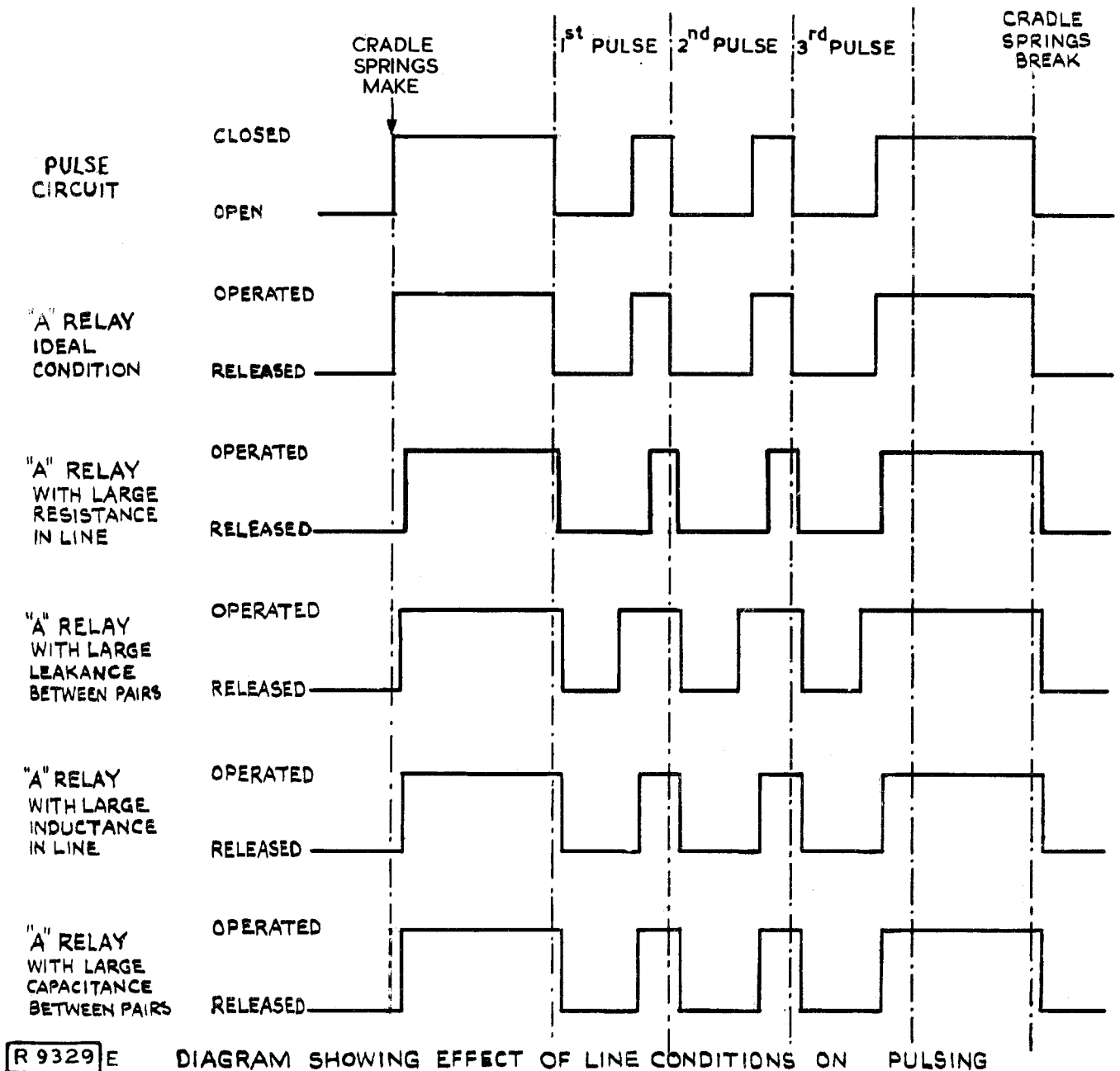


Fig. 6

It will be appreciated that the foregoing is an elementary treatment of the subject of loop-disconnect pulsing, and a more detailed consideration, taking into account all factors which affect pulses, is given in Educational Pamphlet - Draft Series - Telephones 5/3.

References

Educational Pamphlet - Draft Series - Telephones 5/3.

END