

# 10-Line Private Automatic Telephone Exchange

Cat. No. PX1211

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*The G.E.C. 10-line private automatic exchange provides a secret and reliable means of communication between up to ten extensions. It is equally useful in small organisations, where it can provide the sole means of internal communication, and in large organisations, where it can provide a valuable auxiliary to the main telephone system between extensions sharing a wide common interest. The exchange will operate for very long periods without attention, and consists essentially of two uniselectors and six relays together with their associated apparatus. The whole exchange, including a built-in mains power unit, is contained in a single wall-mounting cabinet 12½ins × 24ins × 7½ins, (30.8 × 61 × 19.3 cms).*

For more than two decades the G.E.C. 10-line "All Relay" private automatic exchange has been extremely popular with customers all over the world. It has, however, suffered from several disadvantages arising from the fact that it operates from a low-voltage supply of 8-12 volts d.c. These include :—

- Limited length of extension line (20-ohm loop maximum).
- The use of non-standard telephone instruments each fitted with a special d.c. ringer.
- 3-wire connexion to each extension instrument.

All these disadvantages have been overcome in the new exchange, which has been developed employing the well-proven operational principles of automatic telephony. It incorporates two uniselectors, one as a linefinder and the other as a final selector, and six relays. This article describes in detail the main features and construction of the equipment, followed by a description of the basic circuit elements.

## Features

The main features of the new exchange are :—

- Completely automatic and self-contained.
- Secret communication between ten extensions by dialling a single digit.
- Two-wire line connexion between the exchange and each extension.
- Extended line range of up to 300 ohms loop resistance, with wire-to-wire insulation resistance greater than 130 000 ohms.
- Standard G.E.C. automatic telephone instruments can be used with the exchange.
- One connecting link.
- Executive right-of-way for one extension.

At first sight only one connecting link may appear to be a disadvantage. However, during an extensive field trial of the exchange, the connecting link was found to be engaged only once in 72 calls. This, combined with the executive right-of-way facility at one extension,



Fig. 1.—10-line private automatic exchange.

which allows the executive to break in on an established connexion for urgent business, ensures that the exchange gives a satisfactory service for most requirements. When the executive right-of-way facility has been used, if one of the conversing extensions is the one required by the executive, the connexion is immediately established. Otherwise, the executive requests the two users to replace their handsets to free the link, and dials the number he requires. For this facility, the executive's telephone is fitted with a pushbutton, and an additional pair of wires must be connected from the telephone to the exchange.

The ringing current sent out by the P.A.X. is at mains frequency (50c/s or 60c/s). Since the telephone bells are normally adjusted for a 25c/s signal, a minor adjustment to the ringer may be necessary to obtain the best results. The different frequency has the advantage that where the 10-line P.A.X. is being used to supplement a larger system, the sounds from the bells of the two telephones positioned side-by-side and connected to different exchanges are easily distinguishable.

The built-in power unit operates from a 100/110 or 200/250 volt 50/60c/s single-phase a.c. supply, and is compensated against  $\pm 6\%$  mains fluctuation. The smoothed 50-volt d.c. output provides a noise-free current for the speech circuit and operates the switching apparatus. A separate winding on the mains transformer provides the ringing current. The power unit is adequately protected by fuses in the mains leads and in the low-voltage feed to the switching apparatus. A "protective" resistor is inserted in the ringing feed.

### Equipment

In designing the new exchange, consideration was given to the fact that a large number of them would be installed and maintained by people whose knowledge and experience of telephone equipment are very limited. All the apparatus has been well-proven for long life and reliability, and installation consists of simply fastening the exchange to a wall and running a single-pair lead from the exchange to each telephone. All the connexions necessary are made by screw-type terminals. A 3-core flexible lead is provided to connect the exchange to a suitable mains power point.

The exchange is shown in Fig. 1. All the apparatus is mounted on a steel base plate. A cover, which is finished steel furniture green, slides into position and is fixed by two captive screws. When the cover is removed all the components are readily accessible. The relays and uniselectors are fixed on swing-down mountings to display the wiring at the rear, when necessary. A sheet steel partition divides the switching apparatus from the power-unit components. The complete unit measures 12½ins × 24ins × 7½ins (30.8 × 61 × 19.3) and weighs approximately 38lb (17.24kg).

**Operation**

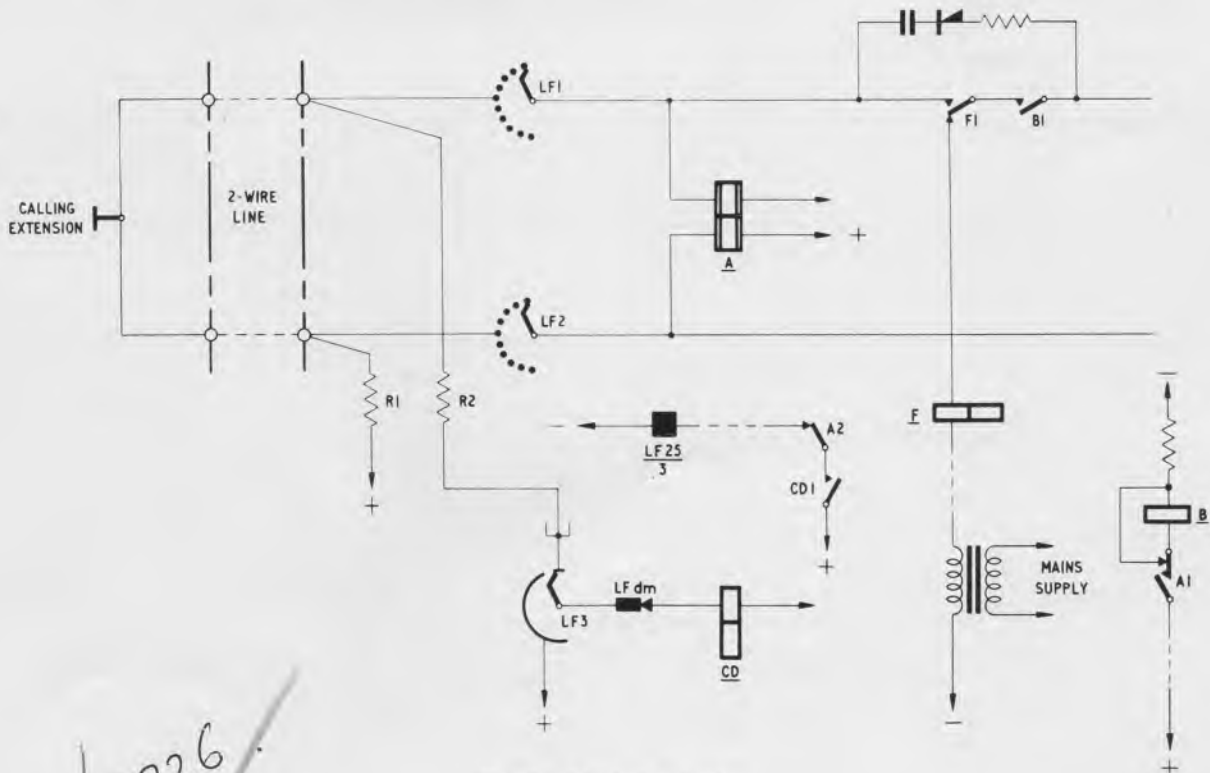
The exchange operates on a simple linefinder principle and employs a uniselector final selector. The circuitry is described in some detail to illustrate the extreme simplicity that ensures the minimum need for maintenance.

**Linefinder hunting**

Fig. 2 shows the linefinder circuit element. When an extension user lifts his handset to originate a call, relay

CD operates via the linefinder interrupter springs, the home contact of LF3 and the line loop through the extension telephone. Contact CD1 closes the circuit to energise the linefinder magnet LF. Operation of the LF armature opens the interrupter springs and relay CD releases. CD1 de-energises the LF magnet and, on release, the linefinder wipers step to the next contact. Relay CD then operates via the homing arc of LF3 and the cycle is repeated. The linefinder continues to step in this way until the LF1 and LF2 wipers reach the contact to which the calling extension is connected. Relay A then operates and disconnects the linefinder drive circuit at A2. Contact A1 closes and operates relay B.

The extension is now connected to the link circuit. If the link is free, the operation of relay B connects dial tone of a low-voltage alternating current at mains frequency to the caller via a coil of relay F. The metal rectifier in the dial tone path makes the 50/60 cycle frequency easier to hear. If this tone is not heard by the extension user on lifting the handset, the link is already in use.



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Fig. 2.—Linefinder circuit.

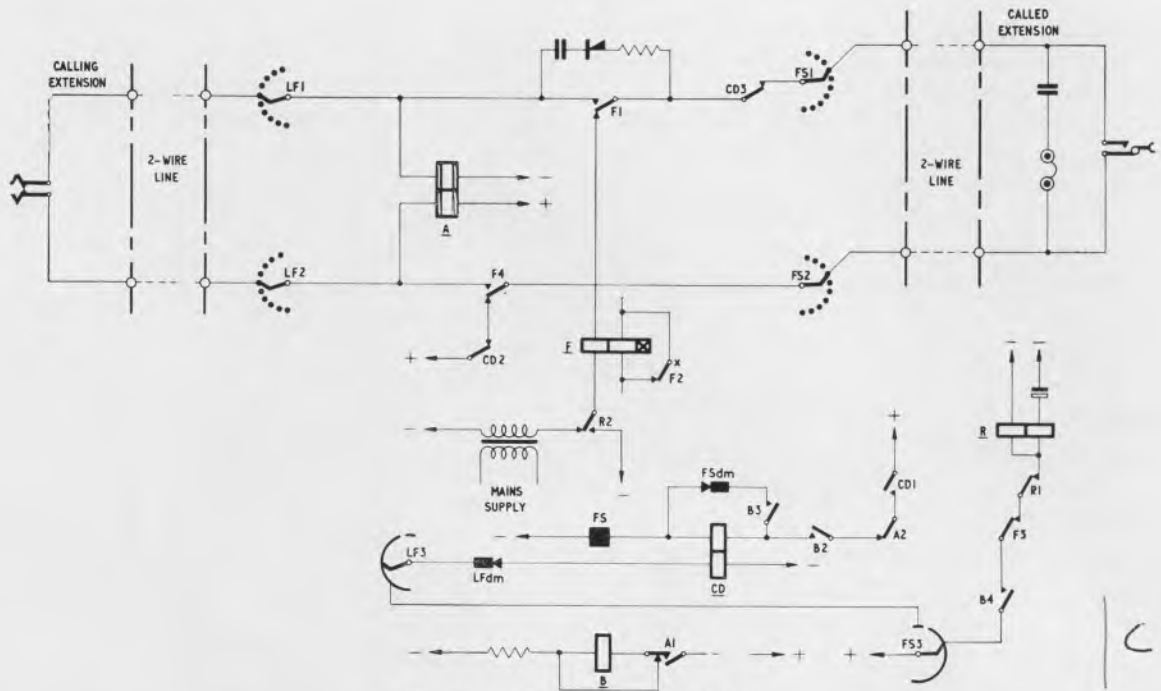


Fig. 3.—Dialling and ringing circuit.

**Dialling and Ringing**

When the caller dials the single digit necessary to gain connexion to the wanted line, relay A pulses in a similar way to the dialling of a digit in a main exchange (see Fig. 3). Contact A2 pulses and operates the final selector magnet a number of times corresponding to the number dialled, thus stepping the wipers to the required line. Relay CD is operated during pulsing, but is then released due to the short circuit on its winding by the final selector interrupter springs. When contact CD3 restores to normal, interrupted ringing current is connected to the wanted extension via relay F. A proportion of this interrupted ringing current is fed back to the calling extension through the network across the contact F1, thus giving a ringing tone. Relay F, being slow to operate, does not operate to the a.c. current.

The interruptions to the ringing current are produced by relay R. When the final selector wipers FS3 step on the homing arc, current flows through both windings of relay R. These windings are wound in opposition to

one another and relay R does not operate. However, as the electrolytic capacitor charges, the current in the associated winding of relay R reduces until relay R operates. Contact R2 disconnects the ringing current and R1 disconnects the circuit of relay R, which does not release immediately due to the capacitor discharging through the two coils in series. When the capacitor has discharged, relay R releases. Contact R2 re-

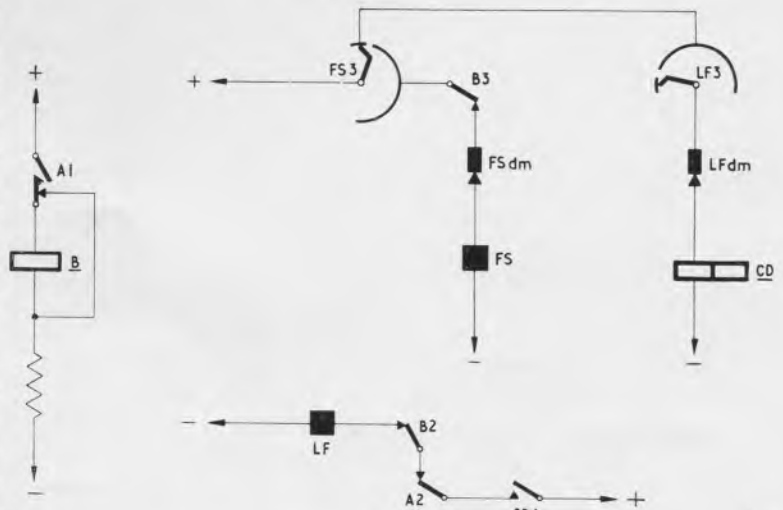


Fig. 4.—Release circuit.

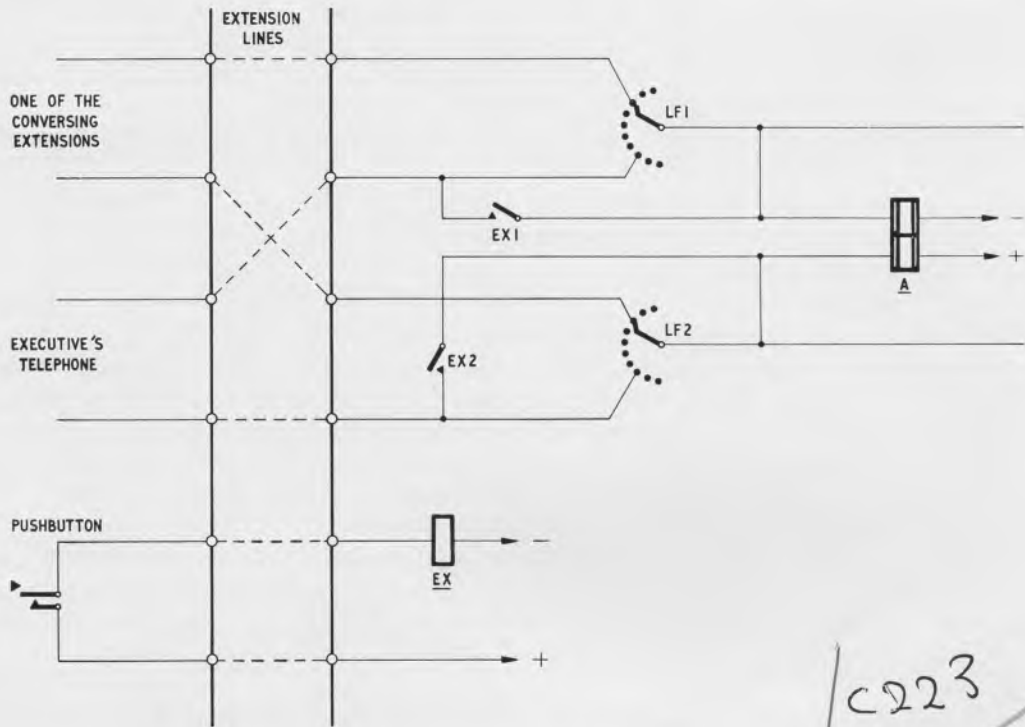


Fig. 5.—Executive right-of-way facility.

connects the ringing current to the line, and R1 re-connects relay R, and the cycle is repeated. Interrupted ringing current is fed to the line in this way until either the called extension answers or the caller clears.

**Called Extension Answers**

When the called extension answers, relay F operates and disconnects the circuit of R at F3. Contacts F1 and F4 complete the connexion between the two extensions and, at the same time, extends the battery and earth from relay A to the called extension. Conversation can now take place.

**Release**

As relay A is held by both extensions, release of the link is not effected until both parties have replaced their handsets. When relay A releases, relay B is released, which in turn releases relay F. Contacts B2 and B3

complete the circuits for the homing of the linefinder and final selector, respectively (Fig. 4). When the linefinder steps to its home contact, relay CD releases, thus restoring the circuit to normal in readiness for the next call.

**Executive Right-of-Way**

When the executive lifts the handset and does not hear dial tone, indicating that the link is engaged, he can press the pushbutton on his telephone. This operates relay EX. Contacts EX1 and EX2 connect the executive direct to the conversing parties (Fig. 5). While the pushbutton is held operated, the executive can ask for the existing connexion to be cleared down, whereupon the executive can release the pushbutton and dial the wanted extension. If, however, it is recognised that one of the conversing parties is the one required by the executive, he can talk, if required, without clearing down the original connexion.