# FIRE-ALARM SYSTEMS

## Classification, Method of Working and General Description of Various Systems

**1. Scope of Instruction.**—The instruction contains general information relating to fire-alarm systems, arranged as follows :—



**2. Other relevant instructions** are as follows :—
(*a*) Terms and definitions, B 0003
(*b*) General provision procedure, simple Fire-alarm systems, B 3001
(*c*) Description of apparatus commonly used for Call-bell and simple Fire-alarm systems, B 1010

**3. Classification of systems.**—Fire-alarm systems generally fall within one or other of the following classes :

Class I—*Call-bell and simple Fire-alarm systems.* —Open-circuit working to the P.O. F.A. plan numbers (see MISCELLANEOUS, Fire Alarms, B 3001).

Class II—*P.O. standard Police Telephone and Signal system* (see TELEPHONES, Stations, P Section).

Class III—*Proprietary systems,*
(i) open-circuit, code signalling or telephone
(ii) closed-circuit, code signalling.

**4.** *Applicability of systems.*—Systems in Class I are simple and comparatively cheap, and are planned to meet the needs of small communities in towns where economy is the main consideration. They may be provided and maintained by the P.O. on payment of an annual rental.

**5.** In districts in which the services of the firemen are only part time, it is sometimes necessary to provide an alternative method for summoning the firemen in the event of a fire call. This often consists of a power-driven siren, which is set in operation by means of a power relay fitted at the siren point and connected to the call point or the call-bell system. The P.O. does not provide, or maintain, either the siren or the relay, see MISCELLANEOUS, Fire Alarms, A 3003.

**6.** *The P.O. standard system is Class II, and is recommended whenever a more elaborate system than those in Class I is required, and is suitable for any community.*

**7.** Systems in Class III are the proprietary alternatives and the choice is with the council or authority concerned. The P.O. does not recommend any proprietary system, neither does it undertake their provision, installation or maintenance for the council, unless expressly represented and authorised by the Telecommunications Dept. The system must in all cases be approved by the E.-in-C. for connexion to the P.O. lines.

**8. Line plant required.**—It is usual for the P.O. to provide the lines for all these systems because—

(*a*) The circuits on a system with public call-points are A to B and are therefore within the P.M.G.'s monopoly (see T.S.I.B[4]).

(*b*) With private call- or ring-out points, although the circuits are A to A and outside the P.M.G.'s monopoly, it is invariably more convenient for the authority to rent the Department's line plant in preference to providing and maintaining its own.

**9.** *Circuit provision procedure* for fire-alarm systems is described in LINES, General, A 6391. When preparing to establish a system, one of the first points to be ascertained from the manufacturers, or the Chief Officer of the brigade, is the value of the resistance of the indicating apparatus at the fire station, so that the line resistance may be determined.

## METHOD OF RECEIVING A CALL

**10.** The reception of a call (except, of course, on a simple call-bell system) may be arranged by one or other of the following methods :—

(*a*) *Annunciating (or Indicator) systems,* in which a separate indicator is provided for each call-point. The " Brown " and the standard P.O. Telephone and Signal system are examples of this method.

(*b*) *Code-signalling systems,* in which registering apparatus is provided to respond to the coded impulses received from a call-point. Amongst these systems are the " Knight " open-circuit and the " Gamewell " closed-circuit systems.

**11. Annunciating systems.**—The essential apparatus in any annunciating system comprises a press button or pull handle at the call-point, connected by a pair of wires to an indicator and battery in the fire station. (Certain systems employ one wire and an earth return, but it is preferable to use two separate wires and a metallic return.) When the press button or pull handle is operated at any call-point, the circuit is completed, the indicator coil is energized,

and an alarm is given at the fire station, both by the dropping of the indicator and by the ringing of the fire-alarm bell. The fire-alarm circuit should be so arranged that the accidental dropping of the indicator does not operate the station alarm bells, and this arrangement should apply to all annunciating systems.

**12.** As current only flows when a call-point is operated, it is evident that a line fault, a short-circuit or earth fault records a false call and it is preferable to provide for facilities whereby a genuine call can be distinguished from a false one. The following methods of indicating false calls are in use :—

(*a*) The fitting of a buzzer or bell at the call-point and receiving the beats at the fire station, or

(*b*) by providing for the transmission of a code signal from a call-point to actuate recording apparatus at the fire station.

**13.** *Disadvantages of annunciating systems.*—It is impossible to make a call over a circuit in which a disconnexion has occurred, because an indication that the circuit is out of order cannot be given either to the fire station or to the public. For this reason, it is usual for the fire brigade to make a routine test from each point once a day. If a disconnexion occurred immediately after this routine test, however, it would not be brought to notice until the next test was made. The absence of a really reliable indication of the true nature of a call —together with a doubt as to whether all the points are always in working order—are disadvantages common to practically all annunciating systems, and it is for these reasons that fire brigade authorities are inclined to favour code-signalling systems.

**14. Code-signalling systems.**—In code-signalling fire-alarm systems, a number of call-points may be connected to a single wire (or pair of wires) and the circuit is completed at the fire station by the recording apparatus and batteries. An audible indication of a call is made by means of a bell or loud-sounding gong. If a considerable number of call-points are required, they may be divided between two or more circuits, but each call-point is still identified by means of the particular code-signal transmitted by it.

**15.** The call-points are of the " break glass and pull handle " type, and the operation of a handle causes a clockwork mechanism to drive a code wheel, on which teeth are cut to correspond with the numerical code number of the call-point. The rotation of this wheel transmits a series of " make " and " break " impulses to the line. The signals thus transmitted are registered audibly at the fire station by means of the alarm bell. A different code wheel is used at each call-point, so that a different series of signals is transmitted from each. If required, a visible indication may also be given by the recording apparatus.

**16.** In some systems, arrangements are made to prevent one *call-point* interfering with another connected to the same circuit when two or more points are operated simultaneously. In all systems, however, arrangements are made at the fire station to prevent one *circuit* interfering with another in the event of two points on separate circuits being pulled at the same time. The code-signal transmitted from any point is generally repeated automatically three times, to ensure definite identification of the particular point in operation. A two- or three-digit code is generally used and, to minimize the time taken in signalling, it is customary to use combinations of the digits 1 to 6 only.

## METHODS OF WORKING

**17.** There are two distinct methods of working fire-alarm systems :—

(*a*) OPEN CIRCUIT, in which current does not flow to line until a call-point is actually operated ;

(*b*) CLOSED CIRCUIT, in which the current circulates continually in the line, except when interrupted by a call.

**18. An Open-circuit system** may consist either of a pair of wires (or a single wire and earth return), to which the call-points or call-bells may be connected singly or in omnibus. The effects of line faults will be as follows :—

(*a*) *A disconnexion* will prevent the operation of the apparatus ;

(*b*) *A short-circuit* will cause a false call, unless special signalling apparatus is provided, as already described, to differentiate between genuine and false calls ;

(*c*) *An earth* will have the following results :—

(i) in a single-wire system an earth fault will be indicated as a genuine call, unless code-signalling is used. The circuit will probably be rendered inoperative, depending upon the position of the earth on the circuit (location of fault) ;

(ii) in two-wire systems where the battery is not earthed, an indication of the fault will not be given unless a routine test is made, and the working of the apparatus will not be affected. If the battery is earthed, the effect will be the same as that of a short-circuit.

**19. A Closed-circuit system** consists essentially of a continuous wire connecting the call-points in series. By the provision of suitable apparatus at the fire station, any line fault can be definitely identified and, generally, the operation of the calling apparatus will not be affected. The results of faults on these systems are as follows :—

(*a*) *A disconnexion* will be immediately indicated by the interruption of the normal circulating current, the release of an indicator normally held in the OFF position, and a single ring on the bell. Arrangements can then be made at the fire station

temporarily to receive any signals via earth, and the operation of a circuit is not impeded.

(*b*) *A short-circuit* will be indicated by an increase in the normal line current, which will be registered on a milliammeter usually connected in series with the line. A short-circuit near the fire station will render all the call-points on the loop inoperative unless, as in the latest design, special apparatus is provided to record calls under this condition. The two ends of the loop should be led into the fire station separately, to reduce the risk of short-circuiting the complete loop.

(*c*) *An earth.*—Normally the circuit is unaffected by earth faults, because the battery at the fire station is not directly earthed. Earth faults can, however, be detected by connecting one pole of the battery to earth through a high-resistance relay.

## BRIEF DESCRIPTION OF VARIOUS SYSTEMS

**20. Call-bell systems.**—In a small town or village, the fire-alarm system generally consists merely of call-bells connected to a ring-out point, which may be a magneto generator or a switch, and does not include any street fire-alarm. A ring-out point may be

(*a*) A fire station where there is at least one resident fireman,

(*b*) A police station,

(*c*) A private residence of one of the members of the brigade,

(*d*) A hotel, or

(*e*) The residence or the business premises of some public-spirited person convenient to the fire station.

In every case it is very desirable that an exchange line be provided at the ring-out point, and the ring-out generator or switch should be fitted alongside the exchange line instrument.

**21.** *Battery versus magneto for ringing.*—The call-bell system should preferably be of the battery-ringing type—as opposed to magneto—for the reason that trembler bells can be set in action in a fraction of a second by a suitable switch, without interruption to the receipt of vital information over the exchange line and without prejudice to the efficiency of the immediately subsequent duties of the operator, whether police or fireman, in relation to the fire fighting. The trembler-bell system also lends itself readily to the addition of one or more public call-points to the system in such a manner that the signals from the fire alarm are automatically transmitted to the bell system in a distinctive manner.

**22.** *A mechanical time switch,* which is quickly set in action and stops automatically at the end of a minute, is very suitable for battery-operated systems. Particularly is this the case when a ring-out point is a police station. The police generally have their own responsibility in a fire emergency, and valuable time may be spent—after taking down particulars of the fire call—in turning the generator or returning to switch-off an ordinary battery-switch before leaving the police station.

**23.** *Ring-out points remote from fire station.*—When a ring-out point is at a police station or hotel, etc., situated some distance from the fire station, the difficulty of communicating particulars of the fire to members of the brigade upon their arrival at the fire station may be overcome by providing a direct telephone line, between the ring-out point and the fire station, upon which the ring-out facility may be superimposed, see Plan FA 6 [Diag. FA(L) 189].

**24.** *Bell point at fire station.*—An important point to be noted in connexion with a normally unattended fire station is that an alarm may be sent out at a time, say in the evening, when some or all of the firemen are engaged at the station on routine maintenance or drill. It is therefore advisable that the fire station should be a bell point on a call-bell system.

**25. Numerical code closed-circuit fire-alarm systems.**—The systems developed in this country are frequently described as "Gamewell" after the original inventor of many of the principles involved. The street call-boxes are arranged in one or more groups. The boxes in each group are linked together by a single wire (or bunched pair), which commences at the fire station, passes progressively from call-point to call-point, and terminates at the fire station again. Each loop has its own battery, which maintains a current continually around the loop. The street call-boxes may be either of the "plain-sector" or "succession" type, both types being operated on the "break glass and pull" principle.

**26.** A register and loud-sounding gong are included in each loop circuit and, in addition, apparatus for measuring and adjusting the line current to a fixed value. There is also auxiliary apparatus for detecting and indicating such line faults as a disconnexion, an earth or a short-circuit.

**27. Plain-sector working.**—The sector box contains clockwork mechanism, which is wound by a toothed "sector" when the handle is depressed. In the latest proprietary models the spring is fully wound by an attending fireman, and the mechanism is tripped when the handle is pulled. Upon release, the mechanism drives a code wheel, which interrupts the line circuit and so actuates the recording apparatus in the fire station. The code is transmitted four times, the code wheel also earthing the line at each impulse.

**28.** At the end of a call, a delayed-action contact on the register completes the circuit of an automatic time and date stamp.

**29.** If the line should become disconnected, a single signal is recorded on the gong and on the register, and the connexions of the battery are modified—either manually or automatically—so that the two ends of the loop are connected to the negative terminal of the battery and the positive terminal is earthed.

**30.** It is under these conditions that the earth pulses of an operated box are effective, and the box automatically employs that section of a loop which does not contain the disconnexion. There is no doubt that this facility greatly increases the reliability of the system.

**31. " Succession " working.**—If two boxes on the same loop with " plain sector " working were to operate simultaneously or so as to overlap, the respective codes would mix and become unintelligible. With " succession " working, this difficulty has been overcome as follows :—

(*a*) When a box is pulled, a short-circuit is removed from across the mechanism, which is set in motion. A brief test period ensues, during which the line is tested for availability. If the loop current continues to flow throughout this period, the box is permitted to transmit its code.

(*b*) On the other hand, if the line current is interrupted momentarily due to another box sending its code, then the box which has just been pulled is barred from transmitting its code. The mechanism continues to run on and, after an interval, a second test is made for line availability. This sequence is repeated until the line is free, whereupon the box transmits its code and then stops. The " succession " feature therefore has the effect of " queuing " the calls and releasing them, in turn.

The detail of " succession " box mechanism varies slightly with different makers. The precise arrangement in any given case can be ascertained from the mechanical description issued by the manufacturers.

**32.** *" Knight " fire-alarm system.*—This system consists of one or more external circuits with one or several call-points connected to each, terminated at the fire station on an annunciator switchboard. The number of call-points connected to a circuit is limited in respect of signalling by the line resistance. This system is similar to the " Gamewell " in that code-signalling is employed but it is not a closed circuit in the accepted sense of the word.

**33.** A separate pair of wires is taken from the fire station to the first call-point on each circuit. Between the first and second call-points, a further pair of wires is employed, and so on, until the final point is reached and the circuit terminates in a resistance. The pair of wires is necessary in each case, because speaking from the call-points requires a loop circuit.

**34.** When a call-point is serving as a spur from the main route, it is necessary to provide two pairs in the spur, one to the box and the other from the box, to the next call-point. Every call-point is equipped with a telephone and a clockwork mechanism, which drives a code wheel.

**35.** In signalling, the two wires are used in parallel. The circuits, which are normally " open," are connected to an earthed battery. When a call-point is " pulled," both wires are earthed at the box and an annunciator indicator associated with the circuit at the fire station drops. Simultaneously, the clockwork-driven code wheel is set in motion and earth pulses are transmitted. The impulses are received at the fire station on a trembler bell and on a register, which provide an audible and visible indication of the call.

**36.** A " succession " feature is incorporated in this system in that the call-point mechanism can only revolve while there is a current on the line. A call-point, when actually transmitting, disconnects the circuit to succeeding boxes. If another is " pulled " on the same circuit, it remains quiescent until the preceding box has transmitted its code, whereupon continuity is re-established and the second box transmits its code. If a box nearer to the fire station than the one transmitting is " pulled," it takes precedence over the point actually transmitting and interrupts the signals from the latter. After the preceding box has transmitted its code the line is re-connected to the more distant box, which

(*a*) is restored to normal, or
(*b*) transmits its code,

depending upon whether it had transmitted a complete code before the interruption occurred. The code is transmitted twice for each " pull."

**37.** It is arranged at the fire station that, during the period whilst a call is incoming, the battery is automatically disconnected from the other circuits and the register and bell are associated with the circuit transmitting.

**38.** The speaking circuit in this system is similar to that on the " Gamewell " system, although the telephone connexions in the station and the boxes are not in accordance with standard practice, the microphone and receiver being connected in parallel to each other.

**39.** A feature of this system is that after a street box has transmitted its code twice, the door is automatically swung open, revealing the telephone and an instruction plate directing the person to speak to the fire station. Facilities are provided at the station to indicate, or to test for, various line faults.

**40. " Carter Micro " system.**—The " Carter Micro " system is an annunciating system operating on the open-circuit principle. The box provided at the call-point is fitted with a loud-speaker, microphone and

ringing generator. Access to the loud-speaker and microphone is obtained by opening a door. This action automatically causes the generator to operate and gives an alarm at the fire station, by the fall of an indicator and by the ringing of the alarm bell. The call is acknowledged by the attendant at the fire station speaking to the caller, via a two-stage amplifier and the loud-speaker.

**41.** The same equipment can also be employed for ambulance and police-alarm purposes. For the latter, the call-points are equipped with signal lamps which can be controlled individually or collectively from the station switchboard. All the facilities that this system provides are catered for by the standard P.O. Police Telephone and Signal system.

References:—B 0003, B 1010, B 3001 (S)

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