CHAPTER XX.

LIGHTNING PROTECTORS.

235. LIGHTNING is a fruitful source of faults upon telegraph circuits of all descriptions, whether employed for speaking purposes or for block-signalling. Underground lines, where unconnected with open—that is aërial wires, are more free from its injurious effects. Some form of lightning protector is therefore necessary in order to prevent what would otherwise be the case, the fusion of the wire composing the coils, or other derangement of the instrument.

Several forms of lightning protectors have of late years been introduced, tried, and abandoned. Those known as the "reel," and the "carbon and boxwood" are no longer issued by the Postal system, although still very generally used on railways.

236. The former of these, the **"reel"** protector, consists of two insulated wires, usually covered with silk of a different colour, to distinguish the one from the other; twisted together, and wound upon a small reel of boxwood or metal, the latter, when employed, being connected with the earth. The wires are still further protected by being passed through melted paraffin, in order to prevent any leakage between them from dampness.

To one end of one of these two wires is connected the up line wire, and to the other the wire leading *to* the coils of the instrument. To one end of the other, the wire leading *from* the coils of the instrument, and to the other end the earth, or down line wire, is attached. Thus the line wire and the earth, or the up and the down line wires, are brought within close proximity to each other, being separated only by the silk covering of the wire and the thin coating of paraffin through which the wires have been passed. The object is that any high charge of atmospheric electricity, of sufficient intensity to damage the instrument, shall pass through the insulation of the twisted wires in order to get to the earth and so escape the coils. But where this takes place the protector is almost invariably sacrificed, the twisted wires being usually left in contact, thereby cutting the instrument out of circuit.

237. The **"carbon and boxwood"** protector consists of two insulated brass or copper rods, fitted within a boxwood case, the opposed ends of the rods within it being pointed, and so fixed that their points shall be $\frac{1}{20}$th of an inch asunder. The interior of the case is filled with a mixture of carbon and non-conducting matter in the form of a fine powder. To the metal rods are attached the in and the out wires of the coils. The protector thus acts as a shunt or short circuit, having a very high resistance compared with the coils, such that whilst preventing any appreciable diminution in the strength of the battery current, it shall, in the case of a discharge of atmospheric electricity of a high tension, afford a passage for it between the points of the metal rods and the intervening mixture of carbon between and around them. It has not unfrequently happened that the particles of carbon have become polarized, and

have thus practically placed the instrument on short circuit. This is remedied by shaking or tapping the protector so as to disturb the arrangement of the particles within it.

238. Each of these forms is now being fast superseded, in the Postal telegraph service, by what is termed the "**cylinder**" protector. Two wires, insulated with silk, are wound around a brass cylinder, which cylinder is connected with the *earth*, the wires being connected with the instrument wires as explained in § 236. This is a form of protector which also frequently obtains its object at the cost of its own destruction, as the wires become fused, or their insulation destroyed, much the same as with the "reel" protector.

239. The "**plate**" protector, which is coming very generally into use on Postal circuits, is probably the most useful and reliable. It is formed of two metal plates some two inches square, placed close together one above the other, but prevented from absolutely touching each other by the insertion of either thin ebonite washers, or a piece of paraffin paper. The opposing surfaces of the plates are serrated at right angles to each other, and thus present a number of small points which promote the discharge. One of the plates is connected to the line wire, and the other to the earth.

The inner surfaces of the plates should be kept clean and free from dust. The paraffin paper when employed should be examined after every thunder-storm, and even at other times occasionally; and if there is any indication (usually in the shape of a hole burnt through the paper, which may be readily recognised by holding the paper between the observer and the light) of a discharge having taken place, it should be replaced by a fresh piece.

240. Usually protectors are fitted to the instruments themselves. The examination of the protector thus involves the removal of the case, and not unfrequently of the entire instrument; which may not always be convenient, especially with block signals. *If fixed apart from the instruments, they would be equally serviceable*, might be examined at any moment, and if necessary replaced or refitted without in any way interfering with the working of the apparatus. The apparatus at every telegraph office or signal-box should be thus protected.

Switches.

241. Switches serve the same purpose for electrical circuits as do points for railway roads. By means of the one the electric current is shunted on to another wire in the same way, as, by means of the "points" of a line of railway, the traffic is diverted from the one line to another.

Under block-signalling, § 112, mention has already been made of the term switch. The instrument spoken of is equally as much a switch as is that which has now to be described, in that, by it, the line wire is switched from the earth wire to the battery, or *vice versâ*. The term switch in its general application, however, applies to an instrument by which the arrangement of the circuit may be altered at will: thus, a branch circuit which is usually terminated at the junction station, may be put through to a main line or other more important office, or a block circuit may be put through from A to C during the night, when the sectional box, B, is not required to be open, and by which the normal day arrangement may be readily restored when B opens for work in the morning.

242. Switches for this purpose are of different make.

The "**pin switch**" is that shown in Fig. 132. Such a switch is available for putting a wire through from, say A to C, or for terminating it at B. It is formed of four plates of brass fixed upon a piece of ebonite with a small space between each. Midway between these plates holes are drilled capable of receiving the connecting pin, the lower portion of which is formed of a round piece of brass

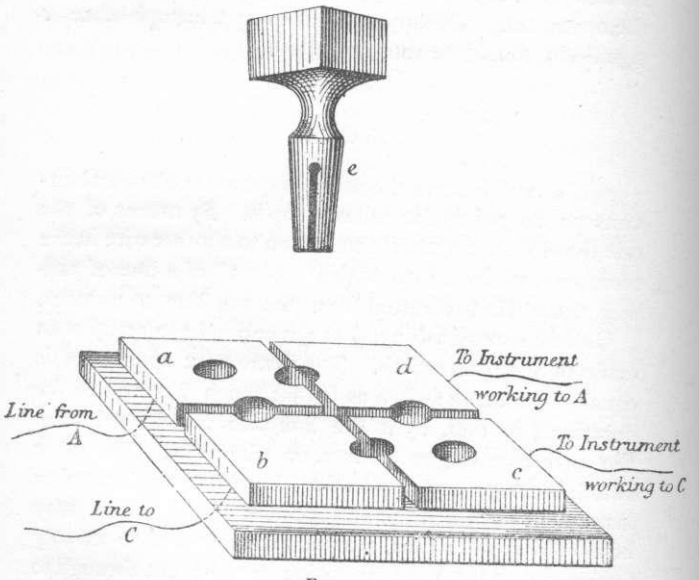

FIG. 132.

with a slit in it to give greater elasticity and biting power. The connections are as shown in the figure. By placing the pin *e* in the holes between the respective segments *a*, *b*, *c*, *d*, the wires in connection with them are brought into circuit and the line wires either connected to their respective apparatus, or joined through direct.

The divisions between the plates should be kept free from dust, and the socket holes should be truly cut, so as to secure a good contact between each plate and the pins.

243. The "**Tumbler switch**" is still, and very justly so, largely employed, especially where more than one wire has to be manipulated at the same time, as would be the case in altering the course of a double-needle circuit, or of a three-wire block system. Fig. 133 illustrates its action, *a* is a strong spring lever, centred at *c*, whose action is limited by the adjustable contact screws *d*, *e*.

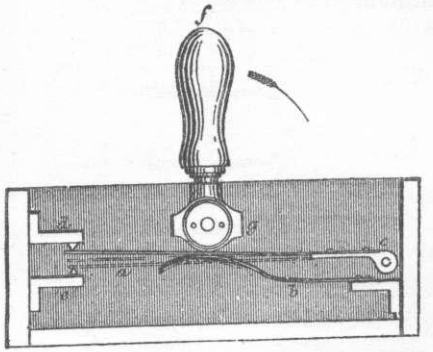

FIG. 133.

The lever, *a*, is acted upon, first by the spring *b*, which tends to raise or press it against the upper screw *d*; and by an eccentrically arranged barrel *g*, which carries upon its shaft a handle capable of assuming one of two positions—vertical and horizontal. When in the vertical position *a* is in circuit with *d*, and when the handle is turned down to the horizontal position, it is in contact with *e*.

Fig. 134 gives the electrical connections for dividing and putting in circuit two terminal sets of two-wire

apparatus, or for putting the two line wires through, leaving the terminal instruments disconnected. When the levers are in the position shown the line-wires are terminated through the instruments at B. When they are depressed the line wire *a* is placed in connection with *a′*, by means of the connecting wire *a a′*: *b*, in a similar way, becomes joined to *b′* by the connecting wire *b b′*.

It will be evident that any number of combinations may be provided for in this way. Main line circuits may be divided, and branch circuits switched on to the upper or lower portion; or one branch circuit may be switched through to another at will.

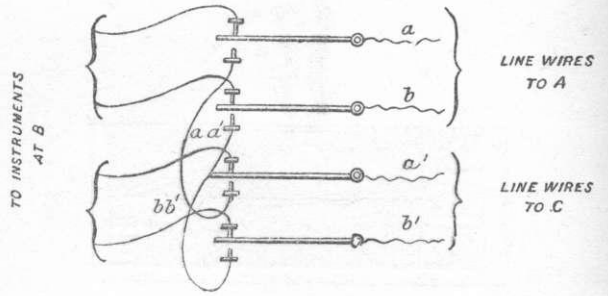

FIG 134.

The contact points of these switches require to be looked to occasionally. They should be carefully scraped and kept clean, as they sometimes become oxidised.

244. A very simple, and a very good switch, where it is in the hands of a reliable man, is **the movable bar switch** shown in Fig. 135. *a*, *b*, are two flat pieces of brass cut to the shape of G. A, B, B′, C, are ordinary instrument terminals fixed to small blocks of brass arranged at equal distances from each other upon a

base board. Each terminal is named according to the station or line with which it communicates, and the plates *a*, *b*, are inscribed "THROUGH TO." The plate *a* is capable of gripping the terminal B, or the terminal C; and plate *b* of gripping C or B. A and B are the centres upon which these plates work. It is clear then that if it is desired to put A through to B, and C to B′, the plates must be arranged as in the figure; but if it is required that A should be put through to C, then *a* must be removed from under the terminal B, and

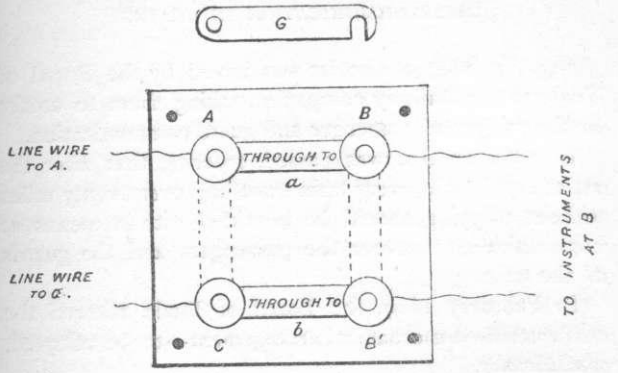

FIG. 135.

b replaced by it at C. In this case as B, B′, communicate with the two sets of instruments at B, it is not necessary that the plate *b* should be connected to B; but when such is the case it affords a means of testing the efficiency of the connection, as the two sets of instruments, being in circuit, can then be worked from the same box.

The plates require to be firmly screwed down whenever their position is changed.