Telephone Protectors

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A telephone must not only be a reliable instrument capable of supplying the best possible communication service; it must also be a completely safe instrument. One possible source of hazard is accidental high voltages such as those that might result from lightning discharges. To guard against this, a protective device is installed between the telephone and the outside lines. Continuing improvements in design and materials have made it possible to provide new protectors that are extremely reliable, yet more economical and more easily maintained than their predecessors.

Since the early days of the telephone it has been general practice to provide protective apparatus on customers' premises to safeguard people – both the public and Bell System employees – and to minimize the possibility of fire or other damage to the customer's property. Such protection is required because of the possibilities of dangerous lightning potentials, and of accidental contact between the telephone lines and electric power distribution circuits. The protective apparatus also, of course, guards against damage to telephone equipment and against service interference.

In providing protection it is important to minimize the voltage which might develop between conducting objects that a person might touch simultaneously, or that might give rise to a discharge that could cause fire or other damage. In other words, the relative potentials between adjacent objects are far more important than absolute potentials measured to a distant reference point. Since the nature of the circuit generally makes it impossible to ground telephone wires directly, connections to ground are made through protectors, which keep the circuit isolated under normal conditions, but make direct connections to ground in the presence of abnormal voltages.

The protectors used for many years at customers' telephone installations consist of low voltage arresters and fuses. One such arrester, which will break down at about 350 volts rms, is connected from each telephone wire to ground. A seven-ampere fuse is also provided in each line wire ahead

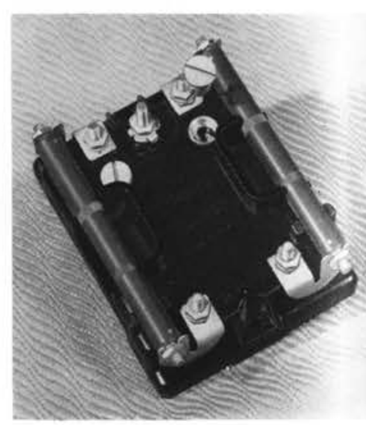

Fig. 1 — The 106A protector with carbon blocks mounted in moisture-proof cylindrical wells. The cap has been removed from the well in the upper right part of the protector.

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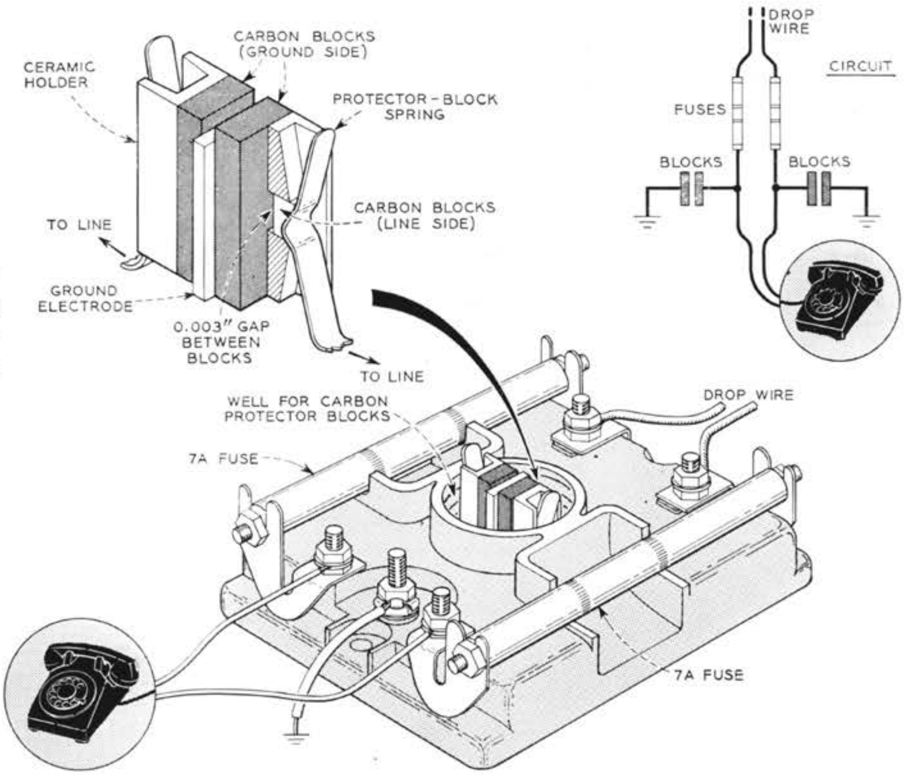
of the arrester. This fuse interrupts power contact current if that current is large enough, and persists long enough, to overheat the protector and possibly start a fire.

One of the most commonly used protectors is illustrated in Figure 2. The drop wire termination, fuses, protector blocks, grounding connection and the wire to the telephone instrument are shown diagrammatically in this figure. The cutaway view of the protector block shows a three-mil gap between a carbon insert in the porcelain block, and a rectangular carbon block with which it mates when it is assembled between a protector spring and ground plate. In the event of a voltage surge from a lightning discharge to the outside telephone plant, the resulting high voltage causes the current to jump across the gap between the protector blocks. The surge is thus discharged to ground. The magnitude and duration of such a surge is usually insufficient to blow the fuses. Hence at the end of the surge, service is still available. With sustained power contacts, blowing a fuse prevents overheating the protector and eliminates a possible fire hazard on the customer's premises.

Fig. 2 — The 98A protector, with details showing circuit schematic and assembly of carbon blocks.



As a result of development work in recent years, several changes have been made in the design of station protectors to reduce the number of service interruptions and maintenance visits that result from causes other than normal operation. The principal source of these interruptions has been the action of moisture on the fuse shell and on the carbon blocks. The fuse shell that encloses the lead fuse wire expands and contracts with changing humidity and thus causes the fine wire to recrystallize. This may break the element or make it more susceptible to melting on lightning surges which it might otherwise carry. Moisture bridging the air gap of the protector block promotes electrolysis of the carbon, thus increasing the possibility of permanent grounding by normal telephone operating voltages.

The 106A protector shown in Figure 1 was developed to reduce moisture troubles in protector blocks. The rectangular blocks were replaced by smaller cylindrical blocks mounted in two moisture-proof cylindrical wells, each having a screw type cap. In the photograph, the cap from the upper right hand well has been removed. Also the fuses were redesigned and lead fuse wire was replaced by a lead-antimony-zinc alloy wire that is less susceptible to recrystallization when the fuse is subjected to varying moisture conditions. Field trials indicated that this protector substantially eliminated moisture troubles, and service experience in humid areas has fully confirmed the improved performance of the protector.

An extensive analysis of the factors involved in a contact between power-supply conductors and telephone lines led to the conclusion that it was safe to omit fuses in station protectors where the station was served by drop wire from grounded metallic sheath cable, provided the protector had adequate current-carrying capacity. According to this concept, the small-gauge conductors in the stub cable of the terminal, from which the customer is served, are fusible links which will melt and open the circuit if sufficient current flows because of a power cross. Under these circumstances, the protector must be able, without overheating, to withstand sustained current either until the small-gauge outside wires fuse or until the power contact is cleared.

Existing types of protectors lacked this current-carrying ability. Since about 90 per cent of protected Bell System telephones are served by grounded metal-sheath cable, however, there was strong incentive for development of a fuseless protector having the required current-carrying properties. The requirements have been met in the design of the new 111-A protector, shown in Figure 3. This protector has been approved for the intended use by the Underwriters' Laboratories, as required by the National Electrical Code, and is now in production.

Fig. 3 — The 111A protector incorporating carbon blocks and improved current-carrying elements.

The make-up of this new protector is illustrated in Figure 5. Like the 106A, it has a sealed, moisture-proof carbon-block assembly, and includes a low melting-point alloy spacer mounted in the cap above the blocks. With sustained current, the heat generated in the blocks melts this spacer. A spring on the underside then forces the blocks up into the cap until a metal-to-metal contact is obtained between the spring assembly and the lower part of the screw-in cap. A low-resistance path to ground is thus provided to carry possible sustained power currents. A heavy low-resistance spring is used in this protector, and the contacting members are plated to reduce the over-all resistance. These features provide a fuseless protector capable of safely carrying any currents that may be impressed upon it. In earlier protectors, any voltage high enough to cause an arc across the carbon blocks, if sustained for an appreciable time, would melt the cement holding the smaller carbon block in its ceramic frame. Under pressure from the mounting spring, the small carbon block would then move into contact with the large one and permanently ground the line. In the new design, a similar action takes place but it is relatively unimportant since the fusing of the low-melting alloy spacers leads to grounding over a metallic path as described.

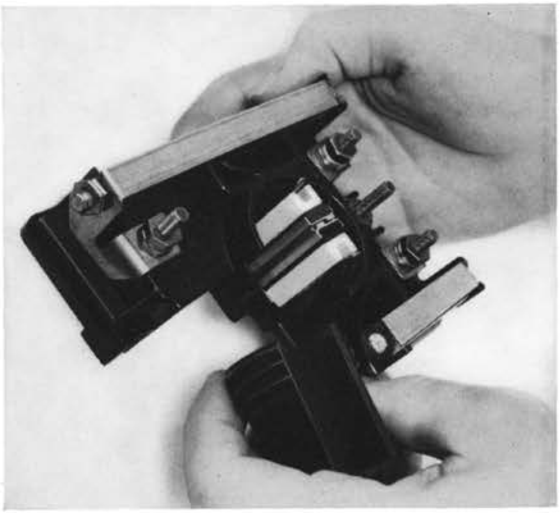


Fig. 4 — Cutaway model of the converted 98A protector showing adapter tabs around carbon blocks.

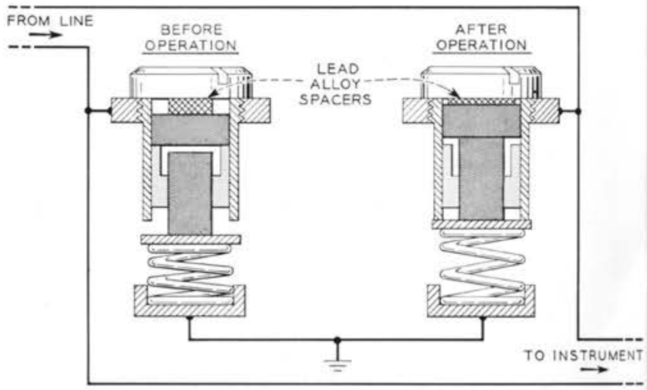


Fig. 5 — Operation of the 111A protector — the alloy spacer melts and causes metal-to-metal contact between spring assembly and cap.

Since it would not be economical to replace present protectors with the new type in existing installations, two other devices have been designed for converting presently installed 98A protectors. This conversion may be made as stations are visited by repairmen for any reason. A cutaway view of a converted 98A protector is shown in Figure 4. Brass strips bypass the fuses and metal adapters are placed in back of the larger rectangular protector block of each pair. The make-up of this protector-block arrangement is illustrated in Figure 6. The protector-block springs normally hold the blocks in their proper positions and also provide contact to the line side of the circuit. The large blocks formerly made direct contact with the ground plate but, as shown in the figure, they now make contact with the ground plate through the adapter. When current is sustained, the heat generated by the blocks anneals the springs, and the softened metal contacts the tab on the lower part of the adapter. In addition, the adhesive holding the smaller blocks in their ceramic holders softens sufficiently to permit the block to move into contact with the larger block and provide another path to ground. Thus, as in the 111A fuseless protector, a low-resistance path to ground is provided to carry possible sustained power discharges.

These protectors are a good example of the continuing effort at the Laboratories directed toward effectively safeguarding the telephone customer and his property.

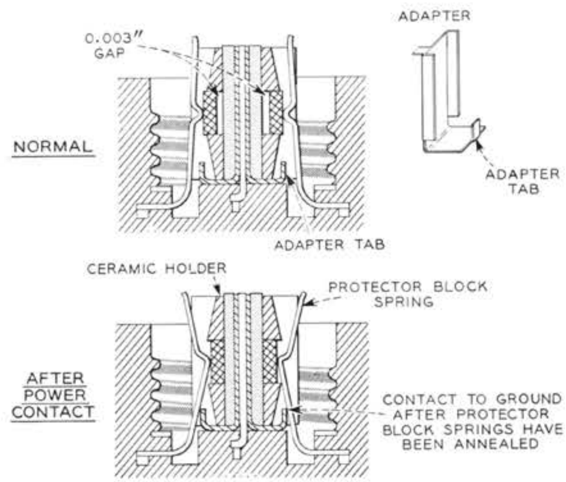


Fig. 6 — Operation of adapters — springs sag when heated and make contact to adapter tabs.

THE AUTHOR

A. C. KANE joined the Laborato:ies in 1927 and received the B.S. degree in E.E. from New York University in 1936. As a member of the Transmission Instruments group, he was early concerned with the development of telephone handsets, including work on the combined set and on the use of plastic materials for the housing and handle. During World War II he transferred to a group working on the development of high-powered loudspeakers for public address systems used in military aircraft and landing operations. After the war, Mr. Kane engaged in work on lateral feedback recorders, reproducers, and magnetic tape recorders, and in 1949 he transferred to the Outside Plant Development Department, where he was concerned with cable terminals and protectors. In February of 1956, Mr. Kane was transferred to the Laboratories location at Point Breeze, Maryland, where he is a supervisor of a group concerned with development work on cable terminal apparatus.

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