(No Model.)

A. C. WHITE.

LIGHTNING ARRESTER.

No. 438,788. Patented Oct. 21, 1890.

Fig. 1.

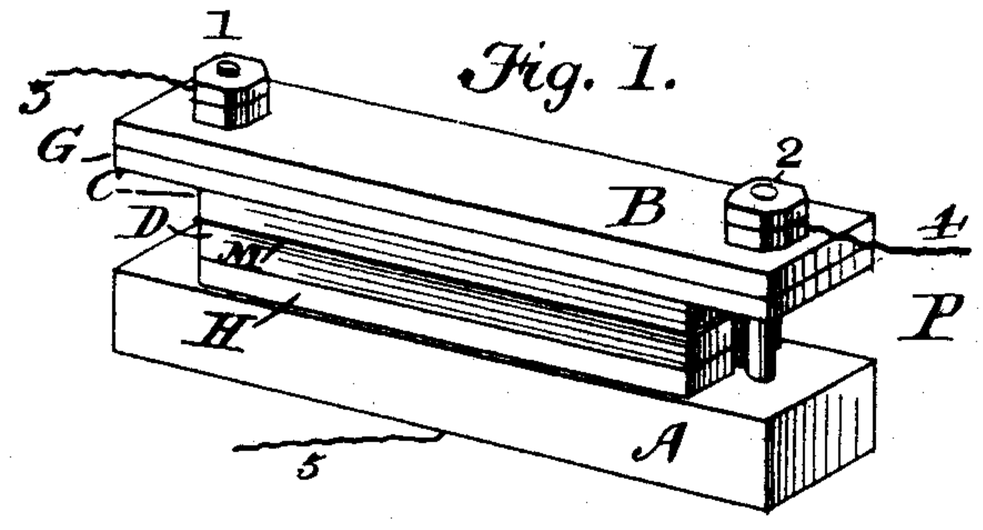


Fig. 2.

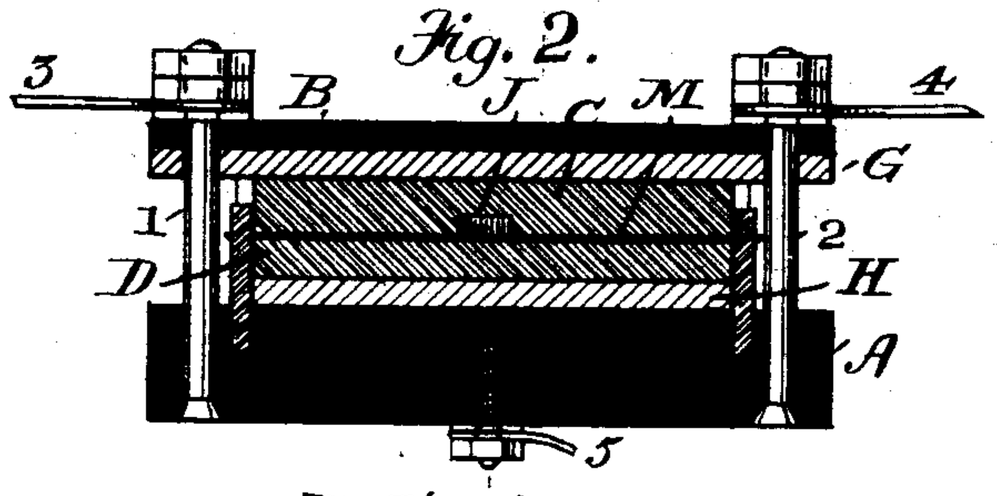


Fig. 3.

Fig. 4.

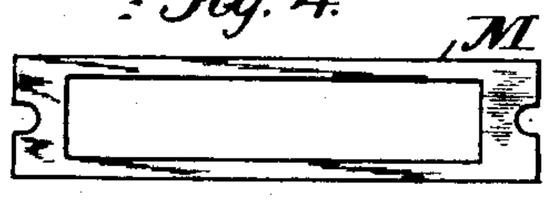


Fig. 5.

Fig. 7.

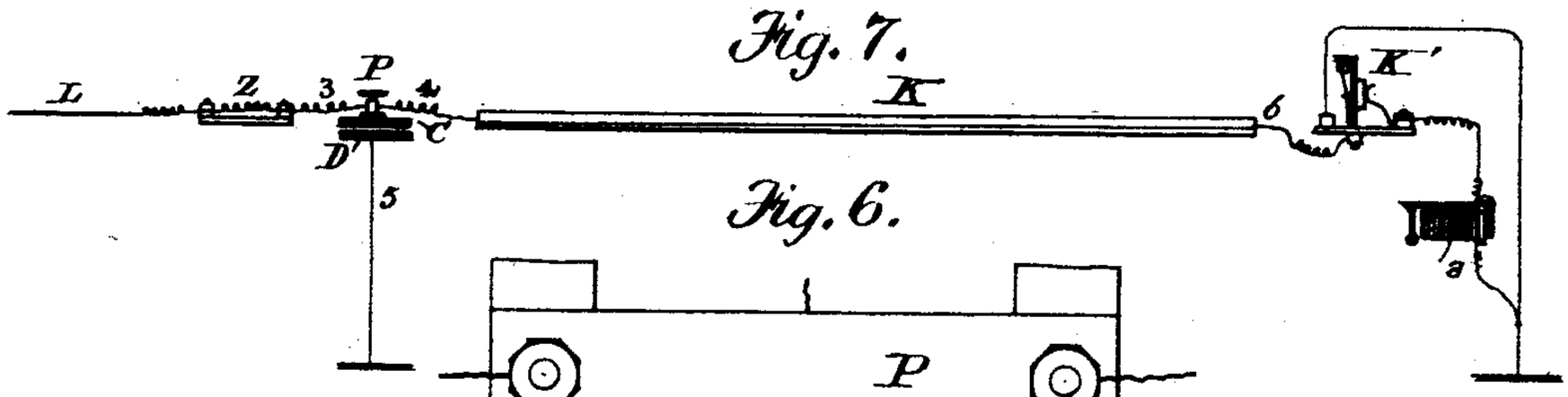
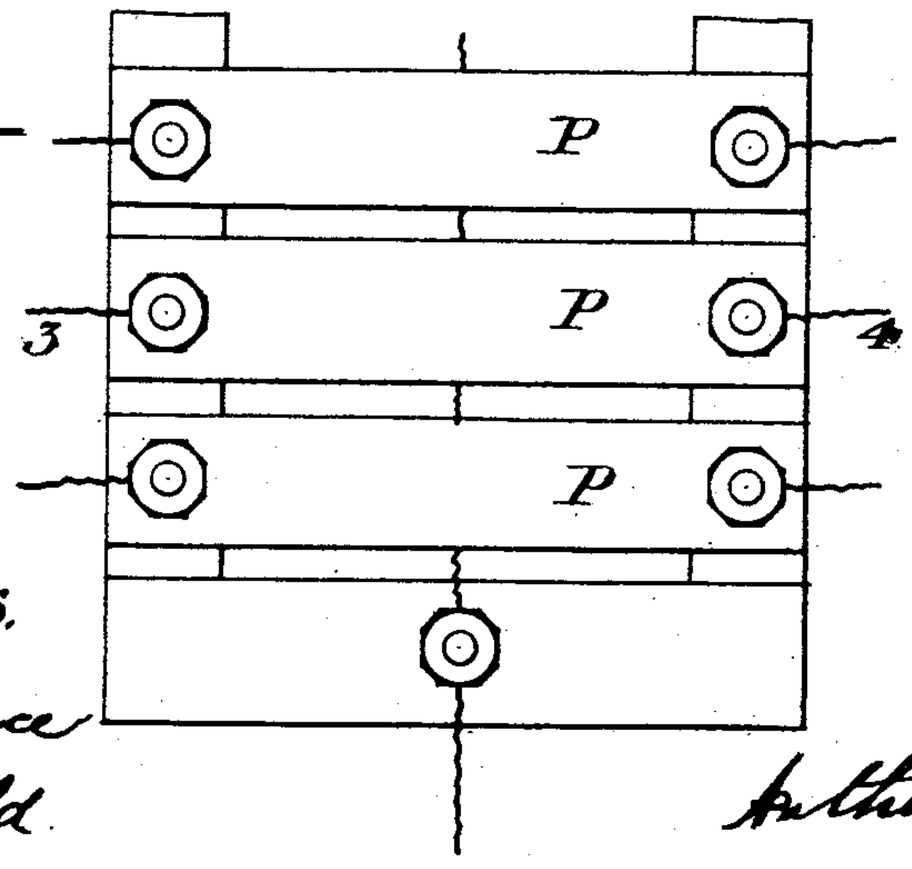


Fig. 6.



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UNITED STATES PATENT OFFICE.

ANTHONY C. WHITE, OF BOSTON, MASSACHUSETTS.

LIGHTNING-ARRESTER.

SPECIFICATION forming part of Letters Patent No. 438,788, dated October 21, 1890.

Application filed July 19, 1890. Serial No. 359,270. (No model.)

To all whom it may concern:

Be it known that I, ANTHONY C. WHITE, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Circuit and Apparatus Protectors, of which the following is a specification.

This invention relates to appliances designed for the protection of apparatus connected with electric circuits from the destructive or injurious effects of excessive charges or abnormally-strong currents of electricity, and especially to that class of such appliances operating by means of a disruptive discharge through a thin dielectric.

It is well known to those skilled in the art that telephonic and telegraphic circuits are liable to be crossed with electric circuits conducting heavy illuminating and power currents, and that these are usually developed under comparatively high potential. Thus in addition to the certain injury to which telephonic and telegraphic apparatus is exposed, resulting from the undesigned circulation of dangerously-strong currents through the circuits with which it is connected, it has been found that the said apparatus, as well as the insulation of cable-conductors, is also frequently damaged simply by being electrically charged to a dangerously-high potential. Metallic circuits, though normally having no connection with the earth, are in common with earth-completed circuits subject to such dangerous charges and to be damaged thereby. Furthermore, electric circuits may be charged to an unsafe potential not only by the causes I have already indicated, but also by the inductive attraction, as well as by the earthward discharge of atmospheric electricity, as in the charged passing thunder-cloud or the lightning-stroke. These considerations show that a proper system of protecting telegraphic, telephonic, and similar electrical apparatus and conductors from the injurious action of excessive currents or charges should include for each circuit an ordinary fuse-protector, placed in the main-line circuit outside of cables and apparatus and adapted to become operative and to melt and open the circuit on the passage of a trespassing current of great volume; a potential-discharger operating by disruptive discharge, constructed and adjusted to become active when a potential sufficiently high to be dangerous comes upon the line and acting by its operation to discharge the same to earth, and, finally, a protector organized to operate when comparatively feeble yet dangerous currents or low electro-motive forces come upon the circuit, and to protect the apparatus by shunting the instruments or in some other substantially equivalent way. If, as is usual in telephone systems, the circuit passes outwardly through a cable-conductor, the "potential-discharger" or "lightning-arrester," as it may be termed, if preferred, should be located at the outward end thereof.

The object of my present invention is to provide an improved form of the second element of this system of protection—namely, the "lightning-arrester" or "potential-discharger"—which can be applied with equal facility to either metallic or earth-completed circuits; which shall not involve the normal conductive connection of an earth-wire to the circuit; which can readily be adjusted to discharge with any given or desired potential; which shall be equally efficient, whether the charge coming on the circuit be a transient and instantaneous impulse, as in the case of lightning, or a sustained and protracted impulse, as in the case of a cross with a dynamo-circuit operated under any electro-motive force exceeding the minimum to which the appliance is set, and which in the latter event will rapidly and certainly establish a short-circuit to earth, thereby effecting a discharge which is permanently maintained as long as the charge continues, and preventing the said charge, irrespective of the period of its continuance, from causing injury to cable or apparatus.

My invention, in pursuance of these objects, comprises a conducting earth-plate mounted parallel and closely adjacent to a similar conducting-plate connected electrically with the line, but separated therefrom by a thin dielectric partition interposed between the plates to maintain the requisite distance of separation, and slotted or perforated to facilitate disruptive discharge, one of the plates, preferably the upper one, having a plug of fusi-

ble conducting material fixed in a hole in its surface, which, fusing when an arc has been maintained from one plate to the other sufficiently long to heat them, runs down between the said plates and supplies a conducting medium there, which, rapidly cooling, solidifies and unites them electrically and conductively, furnishing a path for continuous and safe discharge. These plates are preferably both made of carbon, because if formed of metal portions of them would be carried from one to the other by each spark-discharge with the effect of producing papillæ thereon and an ultimate but undesired and unnecessary metallic contact between the two plates. I also prefer to roughen the opposed surfaces of both carbon plates, such roughened surfaces being virtually composed of a large number of interspersed points and depressions, it having been experimentally ascertained that such a formation facilitates discharge and prevents short-circuiting of the plates; and the interposed solid dielectric is preferably mica, because carbonizable dielectrics—such as paraffined paper—which are often used, when perforated by spark or flash discharges, frequently leave a carbonized edge round the perforation, which develops into a perfect and permanent earth-connection.

In the drawings which form a part of this specification, Figure 1 is a perspective view of my discharging appliance. Fig. 2 is a longitudinal sectional elevation thereof. Figs. 3, 4, and 5 are details representing plan views, respectively, of the upper and lower conducting-plates and the interposed dielectric partition. Fig. 6 represents a portion of a frame, showing the arrangement of a number of my appliances mounted together. The drawings show the appliance as being of a size which has been found convenient in actual practice. Fig. 7 is a diagram of an electric circuit provided with the said appliance.

Each individual appliance P is mounted on a base A of non-conducting material—such as vulcanite—through which at the ends pass the clamping bolts or screws 1 and 2. The holes through the said base are preferably countersunk to fit the screw-heads, which when in place are thereby made flush with the lower surface of said base. A similar but lighter non-conducting piece of vulcanite B also surmounts the operative parts of my appliance, through which also, by means of coinciding holes near the ends, pass the bolts 1 and 2, so that by screwing up the nuts of said bolts the conducting-plates constituting the protector are securely clamped and held in place.

Between the upper and lower non-conducting plates or bars are clamped, as described, two conducting-plates C and D, made preferably of hard carbon. The upper plate C is in contact with and forms a part of the line-circuit, the connection being by wires 3 and 4, and, if desired, through one or both of the bolts 1 and 2. The lower is in connection with the earth by means of the wire 5. These plates, if of carbon, are provided with backing-plates G and H of metal—such as brass—whereby their contact with the line and earth connections can be securely and conveniently made, there being a comparatively large superficial extent of each carbon plate with its metal re-enforcing plate. The carbon plates C and D, which face each other, are not in contact, but are separated by a partition M of some suitable dielectric, mica, as being of high resistance, easily handled, conveniently worked, and as having a natural disposition to split into flat laminæ, being preferred.

The plates C and D may be kept in line by suitable guides. I have shown them as being grooved vertically at the ends, and provide insulating-pins *a* and *b*, fixed at one end to the base-plate A and projecting upwardly, the end grooves of the carbon plates and interposed mica partition being slid over these pins.

As indicated in Fig. 4, the mica dielectric has a central rectangular slot *s* cut from its substance, so that, in fact, there is but a border of mica and a central expanse of air-space, of thickness equal to that of said mica, between the plates C and D.

In actual practice I have found that if it be desired to provide against minimum potentials of about two hundred and fifty volts an air-space not exceeding thirty-five ten-thousandths (.0035) of an inch operates satisfactorily. I therefore may employ a mica sheet of that thickness, centrally slotted, as described.

An electric disruptive discharge is effected through a dielectric of air with much greater facility than through a solid dielectric of like thickness. Hence by slotting the mica sheet, and thereby leaving an air dielectric at its center, I am enabled to use a thicker mica partition than could otherwise be employed, and this is advantageous, in view of the fact that a dielectric space materially thinner than that which is specified herein would tend, as has been proved experimentally, to short-circuit the legitimate electrical generators of the circuit if these be adapted, as are some telephone-transmitters and magneto-generators, to throw potentials of considerable value upon the circuit.

As shown in Figs. 2 and 3, the upper carbon plate C is centrally perforated to a suitable depth, and the hole so made is filled with a plug or mass J of any suitable easily-fusible metal or alloy. The size of said perforation is not of great consequence; but I have found a diameter of one-fourth of an inch to be convenient. The said metal is dropped in a fused condition in the hole, and, expanding laterally as it solidifies, is tightly held therein. Its surface when cold may be flush or slightly below the surface of the plate. Provided that the protective appliance be at all times vertically mounted, the fusible plug J might be placed in either of the plates C or D; but it

may be convenient to mount the appliance under some circumstances horizontally, in which case it would be necessary to have the said plug J in the top plate C, as if it were let in the bottom plate D it would even, though fused, be held as in a cup. The simplest way to provide for this is to always place it in the top plate C.

Fig. 6 shows a number of my discharging-protectors mounted in series upon a common frame to supply an equal number of lines. Under such circumstances a common ground-connection may of course be provided for the series.

Fig. 7 indicates the manner of connection of the said appliance in the circuit to be protected, L being the incoming main line, Z the heavy-current fuse therefor, P the discharging-protector or lightning-arrester, its upper plate C being connected by wires 3 and 4 with the circuit, while its lower plate D is connected by wire 5 with the earth at E. A cable K contains the leading-in conductor 6, which, emerging at the central station, passes successively the protector K′, which is designed to arrest such trespassing currents as may be able to pass the fuse Z and discharger P but which are too heavy to be safe, and the station-instrument *d*, and terminates at the earth.

In the operation of the discharging-protector any transient charge coming on the line of sufficiently-high potential to menace any part of the circuit or apparatus, whether due to lightning or to a momentary dynamo cross, will discharge between the plates C and D, which, as stated, are sufficiently close with an air dielectric to discharge a potential as low as two hundred and fifty volts, but which still are sufficiently distant to prevent the short-circuiting of the legitimate operating currents of the circuits. Should a cross with a dynamo circuit occur, charging the protected line dangerously, and should such charge become continuous, the spark of discharge between the plates C and D tends of course to develope instantly into an arc through which an actual current passes to earth. If such an arc is maintained, there is of course danger from fire; but when such an arc has been maintained long enough to heat the carbon plates to the temperature at which the plug J fuses such fusion occurs, and the fused metal or alloy runs into the slot between the plates C and D and forms a conducting-link between them. The current taking this path, the arc is immediately extinguished, and the fused metal quickly cooling becomes a solid connection between the two plates, which safely conducts the trespassing current to earth.

This appliance can be applied with equal efficiency to metallic circuits, it being obvious that if a cross occur between such a circuit and a dynamo-circuit which is perfectly insulated there is no tendency for electrical transfer, while if the said dynamo circuit be leaky, as usually happens, the protected circuit will receive from it not a current but a charge, the protected circuit rising to a potential equal to that of the attacking circuit at the point of connection. An inductive circuit is thus established between the two crossed circuits and the earth through the discharger-plates, and when charged to a sufficiently-high potential disruptive discharge occurs, the subsequent operation being as above stated.

I do not claim the construction of the third element in the system of protection described herein—viz., the protector *k*, operating under comparatively weak yet dangerous currents—that having been invented by Hammond V. Hayes and claimed in application for patent made by him, filed July 17, 1890, and numbered 359,073; but

I do claim—

1. A potential-discharging protector or lightning-arrester comprising two conducting-plates placed with parallel surfaces closely adjacent to each other, adapted to be connected, respectively, with an electric circuit and the earth, and an interposed thin dielectric, one of the said plates having a plug or mass of easily-fusible conducting material embedded in its approximate surface, substantially as hereinbefore described, and for the purposes specified.

2. The combination, substantially as hereinbefore described, in a protecting appliance, of two carbon plates, one in electrical connection with the line and the other with the earth, having their approximate parallel surfaces closely adjacent to one another, an interposed thin dielectric of mica centrally slotted, as described, and a plug or mass of metal or alloy, fusible at a low temperature, embedded in the lower surface of the upper carbon plate, adapted to melt upon the establishment of an arc and electrically to unite said plates, for the purposes set forth.

3. In a protecting appliance substantially of the class referred to herein, a carbon line-plate, a carbon earth-plate facing the same and closely adjacent thereto, an interposed thin partition of mica centrally slotted, as described, whereby a dielectric consisting of an air-space surrounded by a border of mica is provided to separate said carbon plates, and a plug or mass of easily-fusible metal or alloy embedded in the upper carbon plate flush or below the surface thereof, adapted to melt upon the undue heating of said plates and thereupon to electrically unite the said plates, uniting an earth-connection to the main circuit.

4. A protecting appliance comprising two carbon plates interposed between the conductor of an electric circuit and an earth-connection and connected, respectively, therewith, the said plates having their opposing surfaces roughened, as described herein, and placed closely adjacent to each other, but electrically separated by an interposed thin dielec-

tric, as described, whereby the disruptive discharge of a dangerous potential from an electric circuit to earth may be effected, and means, such as a mass of fusible metal or alloy, for automatically establishing conductive union between the said plates upon the development of an electric arc between them, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 17th day of July, A. D. 1890.

ANTHONY C. WHITE.

Witnesses:

GEO. WILLIS PIERCE,

V. M. BERTHOLD.