J. D. HILLIARD, JR. & C. E. PARSONS.

LIGHTNING ARRESTER.

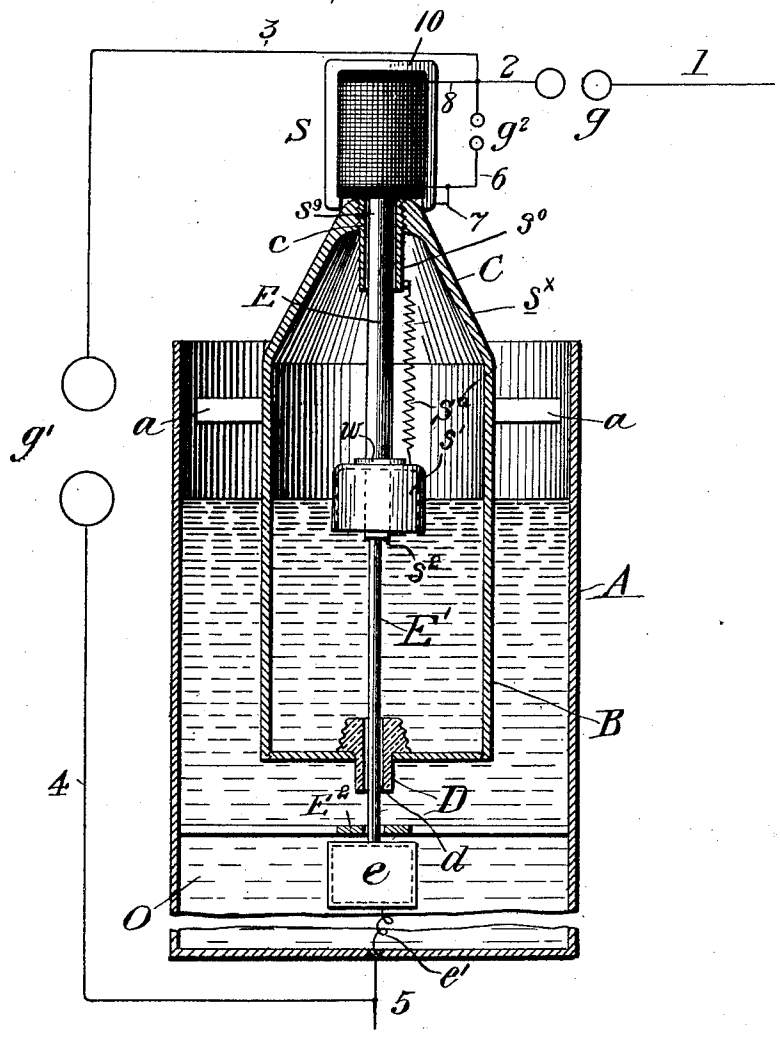
APPLICATION FILED AUG. 22, 1906.

1,005,033.

Patented Oct. 3, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

D. W. Edelin.

E. E. Edmonston Jr.

INVENTORS

John D. Hilliard Jr.

and Charles E. Parsons,

BY

Edward E. Clement

ATTORNEY

J. D. HILLIARD, Jr. & C. E. PARSONS.

LIGHTNING ARRESTER.

APPLICATION FILED AUG. 22, 1906.

1,005,033.

Patented Oct. 3, 1911.

2 SHEETS—SHEET 2.

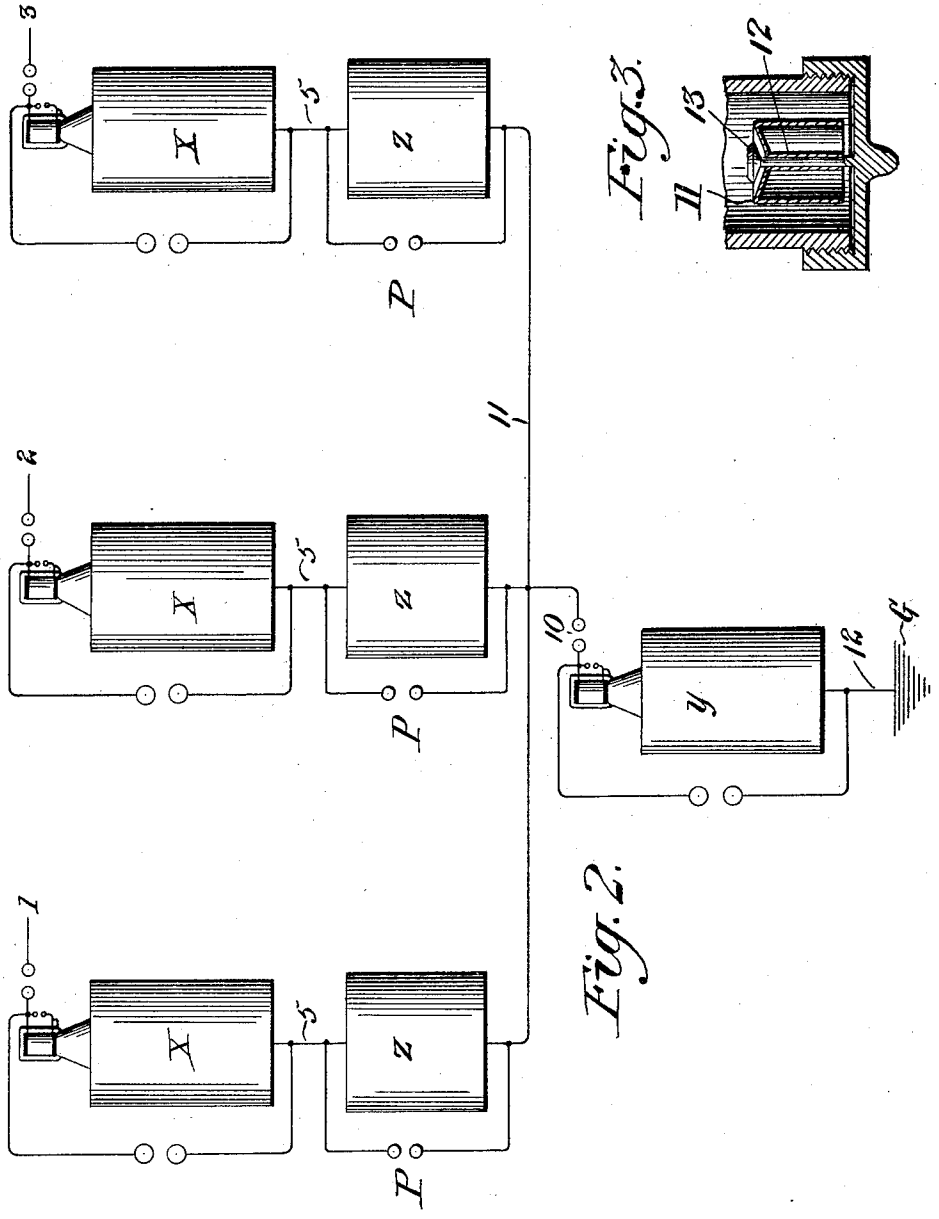


Fig. 2.

Fig. 3.

WITNESSES:

W. F. Boyle

C. Edmonston

INVENTORS

John D. Hilliard Jr.
and Charles E. Parsons,

BY Edward E. Clemens

Attorney

UNITED STATES PATENT OFFICE.

JOHN D. HILLIARD, JR., AND CHARLES E. PARSONS, OF GLENS FALLS, NEW YORK.

LIGHTNING-ARRESTER.

1,005,033. Specification of Letters Patent. Patented Oct. 3, 1911.

Application filed August 22, 1906. Serial No. 331,553.

To all whom it may concern:

Be it known that we, JOHN D. HILLIARD, Jr., and CHARLES E. PARSONS, citizens of the United States, residing at Glens Falls, in the county of Warren and State of New York, have invented certain new and useful Improvements in Lightning-Arresters, of which the following is a specification, reference being had therein to the accompanying drawing.

Our invention relates to protective devices for electrical circuits and has for its object the provision of an improved lightning arrester, especially adapted for interior use where a goat horn arrester can not be used because of the room required by the arc.

In order to prevent a continuous arc due to the line currents following a high potential discharge by way of metallic gases formed by the arc, it is our purpose to arrange the apparatus herein described in a manner similar to that described in our copending application filed January 29, 1906, S. No. 298,439, but in this case we use balls, cylinders, or blunt points instead of horns. Since the discarding of the goat horn arrester does away with the means for breaking the arc, we provide means for performing that function separately from the spark gap or gaps, which will be claimed herein, comprising an automatic oil switch actuated by a solenoid. The line arrangement, with bridges containing the arresters and their resistances, will also be claimed herein, as this system differs somewhat from the above mentioned application. We may state the features of the oil switch broadly, as follows: An outer containing vessel of wood is partly filled with oil in which is sunk, to a suitable level, an inner vessel in which the switch parts proper are housed. Mounted upon the upper part of this vessel is a solenoid whose stem extends down and constitutes one electrode, being fitted preferably with a float. Supported by another float in the outer vessel and projecting into the inner vessel, is a rod constituting the second electrode, connected also to a flexible pig tail, carried through the outer vessel in order to make a suitable outside connection. One spark gap is provided in the line connection, one around the entire vessel, and one around the solenoid for its protection. The discharge from the line passes through the solenoid and through the switch to ground or one of the other lines, whereupon the solenoid immediately opens the switch, breaking the arc. If a second discharge comes, or if the line potential piles up while the switch is open, the main gap around the apparatus which is set for a high break-down point, will take care of the discharge until the switch closes.

We shall describe herein a safety system for polyphase circuits employing the foregoing lightning arrester; but the said system will not be claimed herein, since it forms the subject matter of a copending divisional application, Serial No. 579,546, filed August 29, 1910, for "Protective system for polyphase circuits."

Our invention is illustrated in the accompanying drawings, wherein—

Figure 1 shows our lightning arrester unit, with the arc-breaking switch in section, and its connections indicated diagrammatically. Fig. 2 is a diagrammatic view of a safety system for polyphase circuits in which this lightning arrester unit may be employed. Fig. 3 is a detail of a shock absorber used in the resistances z.

Referring to the drawing, and especially to Fig. 1, 1 indicates the line which is to be protected, or a branch therefrom. This is separated from the wire 2 by an air gap between the terminals, g, which are set for break-down at any desired point, and constitutes the principal air gap element of the apparatus. From wire 2, separate paths to ground are provided, one through the solenoid S, flexible pigtail s^a, (this being connected to a sliding core, E, magnetically lifted into the coil of the solenoid, S, and retracted by gravity) float s', contact s^2, the rod E′, its float, e, and the flexible pigtail, e', to wire 5; the other through wires 3 and 4 to the wire 5, through spark terminals, g', interposed and adjusted with a relatively wide air gap so as to have a high break-down point for this branch. The circuit of the solenoid itself is from wire 2 as follows: 8, S, 7, s^9, s^a, s', s^2, E′, e to wire 5. The shunt wire 6 with air gap, g^2, is connected around the solenoid and is grounded upon the iron yoke, 10^a, around the coil, which is normally in connection with the top, s^x, of the inner vessel B.

The mechanical structure of the switch is as follows: An outer containing vessel, A, is provided, preferably of wood or other similar material, with supporting arms or studs, a, extending radially from its inner wall to support the inner vessel, B, which

is preferably constructed of heavy steel pipe to resist the excessive pressure generated when the switch is opened. This vessel contains the working parts of the switch. These comprise two rods, E and E′, arranged axially in the cylindrical inner vessel and projecting from opposite ends thereof, the upper one, E, forming the core of the solenoid, and therefore made of soft laminated iron. As we have already stated, the vessels are partly filled with oil of a suitable character to smother the arc. Each of the rods, E and E′, is provided with a float, which, being submerged or partly submerged in the oil carries the weight of the rod for a purpose which will be apparent from the statement of operation. The upper rod, E, as stated, forms the core of the solenoid, S, which is conveniently supported by the conical head, $s^{\times}$, integral with the inner vessel, B, its upper end carrying the spool and supporting the winding of the solenoid, while from its apex depends a tube, s°, to form a stop for the upward movement of the float, s', and the contact, s^2, carried thereby. The tube, s°, is preferably connected to the inner vessel, B, by being threaded into the head, $s^{\times}$, as shown, and may be extended to constitute the inner tube of the solenoid. The lower rod, E, passes through an opening, d, in an insulating bushing, D, fitted in the bottom of the vessel, B.

In Fig. 2 a complete three-phase line equipment is shown, and inasmuch as we have already described the automatic switches, shown at $x\ x\ x$ and y, nothing further need be said regarding their construction.

Connected to the line 5 and in series with the automatic switches, $x\ x\ x$, are resistances, z, which are connected to a wire, 11, leading to the automatic switch, y, which is grounded at G by wire, 12. These resistances are similar to those described in our pending application filed Jan. 29, 1906, Serial No. 298,439 in that they use acidulated water or a saline solution as a conducting medium.

Experience with the type of water resistance shown at z proves that it has one serious objection, it breaks under severe discharge. This break is due to a water hammer, which is produced when the steam is formed in the tile and suddenly condensed when the arc is broken. To remedy this difficulty we place an air chamber, 11, in the bottom of the tile which comprises an open ended cylinder inverted so as to contain gas or air, and having a tube, 12, passing through it to receive the rod, 13. This cylinder, therefore, normally floats with its top against the enlargement on the end of the rod, 13, and whenever there is an increase in pressure, the air within the float is compressed and acts as a cushion to prevent the tile being broken.

The operation of our apparatus is as follows: A discharge from line 1, passing the gap, g, is conducted partly through the solenoid and partly through the shunt, g^{2-6}, thence through pigtail, s^a, rods E and E′, wires e^1 and 5 to one of the resistances, z, wire 11, gap 10, automatic switch, y, and ground through wire 12. Solenoid, S, of the automatic switch becoming energized, which may be either by a portion of the actual discharge or by a portion of the line energy which follows it, draws up its core, E. This requires the expenditure of a very small amount of energy, because under normal conditions the weight of the rod, E, is sustained by the buoyancy of the floats, s^1 and e. As the rod, E, lifts, the contact, s^2, leaves the top of the rod, E^1, and an arc is established and drawn out therebetween until the leather washer, w, on top of the float, s^1, strikes against the lower end of the tube s°, sealing the latter against the escape of the gases. The generation of such gases due to the arc immediately produces a very high pressure upon the surface of the oil, which after having forced out the rod, E, is itself in part forced downward and expelled violently from the inner vessel through the orifice, d, at the bottom. This smothers the arc, whereupon the line being cleared, the solenoid is deënergized, the core, E, drops, the rod, E^1, rises through its guide, F^2, to meet it, and normal conditions are reëstablished.

The rods are adjusted with their contacts normally beneath the oil, so as to obtain a great submersion of the rod, E, for the break. We do not limit ourselves to this, or other details of arrangement, which may be varied without departing from the scope and purview of our invention.

In case a second discharge follows the first, or in case the potential of the line piles up to a dangerous point while the switch is open, which might readily occur, the increased tension will break down the gap, g', taking the discharge through the wires 3, 4 and 5. In such case, as soon as the solenoid has dropped its core, and the circuit through the rods of the switch has become reëstablished, the arc at g' will disappear, and the solenoid S will then operate as before to break the connection at s^2 and smother the arc.

The current after leaving wire 5 passes through resistances, z, on to line 11, through the gap 10 and the automatic switch y in the manner above described and thence to ground, G, through wire 12.

Should the potential across the resistances, z, pile up to a dangerous point the gaps, P, shunting said resistances will break down and permit a free discharge to ground through the gap, 10, and the automatic ground switch, y. These gaps are normally

so adjusted that no discharge passes over them except under extreme conditions.

We do not herein claim the switch shown in Fig. 1, except as part of the system, the switch structure itself forming the subject of a separate application, filed September 3, 1908, Serial No. 451,617.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. A safety system comprising a primary or normal air gap, connected in series with an automatic break device, and a secondary air gap forming a shunt around the automatic break and itself set to break at a higher potential than that which operates said automatic break, substantially as described.

2. A safety system comprising a line branch and an air gap, an automatic switch adapted to break the arc formed upon a discharge, and a high potential shunt around said switch normally inoperative but becoming operative upon the occurrence of a high potential while the switch is in inoperative condition, substantially as described.

3. In a safety system of the character described, an automatic arc-breaking switch, and a high break-down gap in shunt of the switch contacts, whereby a constant discharge path is provided whether the switch be opened or closed, substantially as described.

4. In a safety system of the character described, an automatic arc-breaking switch, an air gap interposed between the same and the line to be protected, and a second air gap in shunt around the switch, substantially as described.

5. In a lightning arrester, the combination with an automatic circuit breaker adapted to open the circuit and again close the same and operated by the normal current, of a permanent discharge path associated with said circuit breaker.

6. In a lightning arrester, the combination with a discharge path, of an automatic circuit breaker adapted to open the circuit and again close the same and operated by the normal current and in shunt to a portion of said discharge path, whereby said discharge path remains unaffected during the operation of the circuit breaker.

7. In a lightning arrester, the combination with an automatic circuit breaker adapted to open the circuit and again close the same and having separable contacts to disrupt the normal arc, of a permanent discharge path associated with said circuit breaker.

8. The combination with a discharge path, of an automatic circuit breaker in shunt to a portion of said discharge path and having separable contacts to disrupt the normal arc, whereby said discharge path remains unaffected during the operation of the circuit breaker.

9. In a lightning arrester, the combination with discharge electrodes having air gaps therebetween, of a shunt path for drawing the arc of the normal current away from one or more of said air gaps, and means for automatically interrupting the flow of normal current in said shunt path.

10. In a lightning arrester, the combination with discharge electrodes having air gaps therebetween, of an automatic circuit breaker in shunt to one or more of said air gaps and adapted to be operated by the normal current, for interrupting the flow of normal current in said shunt.

11. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said air gaps and in series with the other of said air gaps, and means operated by normal current for disrupting the normal arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said disrupting means.

12. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said air gaps and in series with the other of said air gaps, and means operated by normal current and included in said path for disrupting the normal arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said disrupting means.

13. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said air gaps and in series with the other of said air gaps, and an automatic circuit breaker included in said path for disrupting the normal arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said circuit breaker.

14. In a lightning arrester, the combination with discharge electrodes having air gaps therebetween, of a magnet coil in shunt to one or more of said air gaps, said shunt path having a lower resistance than the air gap shunted thereby, so as to draw the arc of the normal current away from said shunted air gap or air gaps, and means actuated by said magnet coil for interrupting the flow of normal current in said shunt path.

15. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said gaps and in series with the other of said air gaps, a magnet coil in said path, and means actuated by said coil for disrupting the normal

arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said disrupting means.

16. In a lightning arrester, the combination with discharge electrodes having air gaps therebetween, of a shunt path for drawing the arc of the normal current away from one or more of said air gaps, and means for opening the circuit of the normal current in the shunt path.

17. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said air gaps and in series with the other of said air gaps, and means for mechanically disrupting the normal arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said disrupting means.

18. In a lightning arrester, the combination with a discharge path having air gaps therein, of a path for the normal current in shunt to one or more of said air gaps and in series with the other of said air gaps, and means included in said path for mechanically disrupting the normal arc across said last-mentioned air gaps, said discharge path remaining unaffected during the operation of said disrupting means.

19. In a lightning arrester, the combination with a discharge path including a resistance and a plurality of discharge electrodes having air gaps therebetween, of a path for the normal current in shunt to one or more of the air gaps, and an automatic circuit breaker in said shunt path for interrupting the flow of normal current therein, said circuit breaker being operated by the normal current.

20. In a lightning arrester, the combination with a discharge path including a resistance and a plurality of discharge electrodes having air gaps therebetween, of a path for the normal current in shunt to one or more of the air gaps and in series with said resistance and the other of the air gaps, and an automatic circuit breaker in said shunt path for interrupting the flow of normal current therein.

21. In a lightning arrester, the combination with a discharge path including a resistance and a plurality of discharge electrodes having air gaps therebetween, of a path for the normal current in shunt to one or more of the air gaps and in series with said resistance and the other of the air gaps, a magnet coil in said shunt, and means actuated by said coil for interrupting the flow of normal current in said shunt path.

In testimony whereof we affix our signatures in presence of two witnesses.

JOHN D. HILLIARD, JR.
CHARLES E. PARSONS.

Witnesses:
C. L. SNOW,
L. A. JONES.