S. R. BERGMAN.

PROTECTIVE DEVICE FOR ELECTRIC CIRCUITS.

APPLICATION FILED OCT. 13, 1905.

940,578.

Patented Nov. 16, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

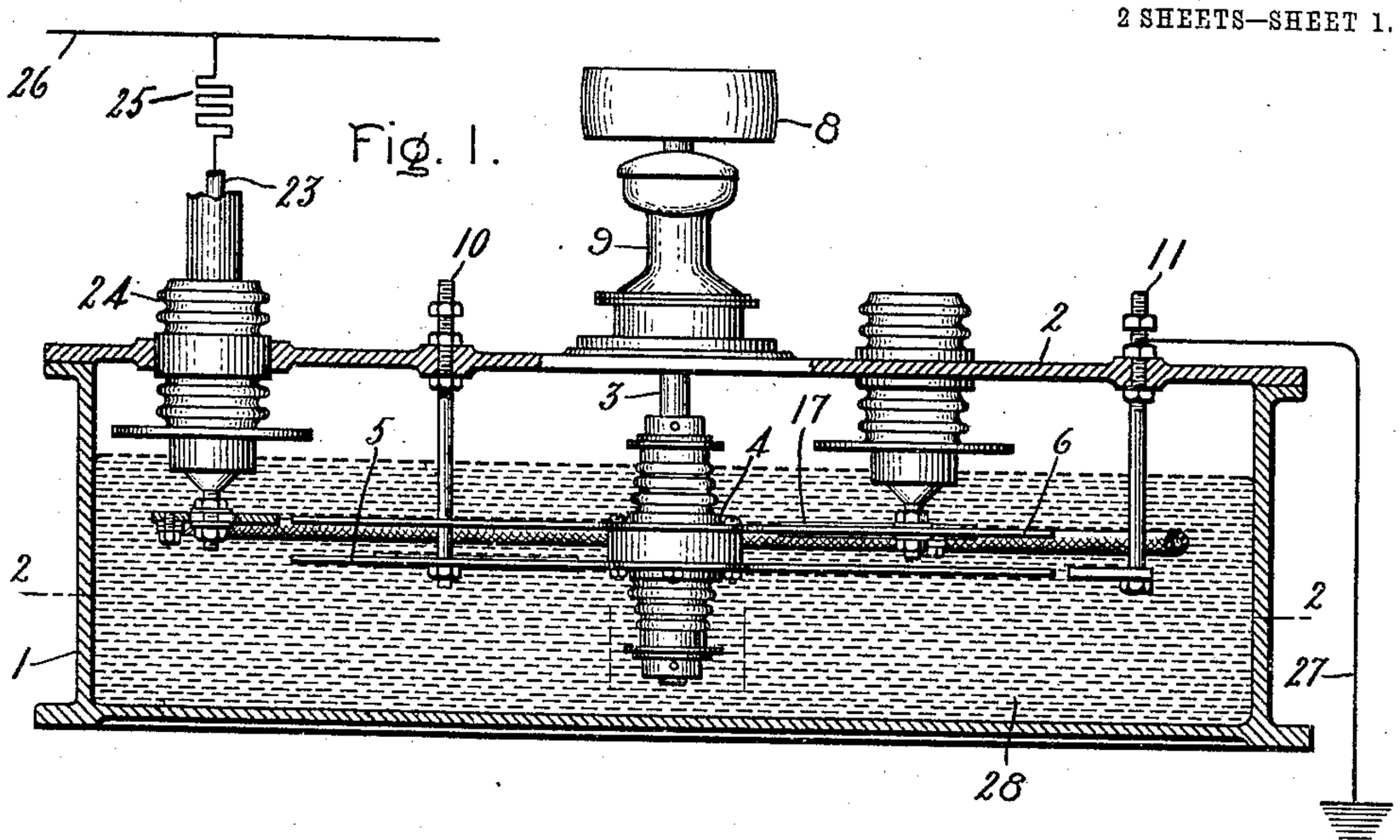
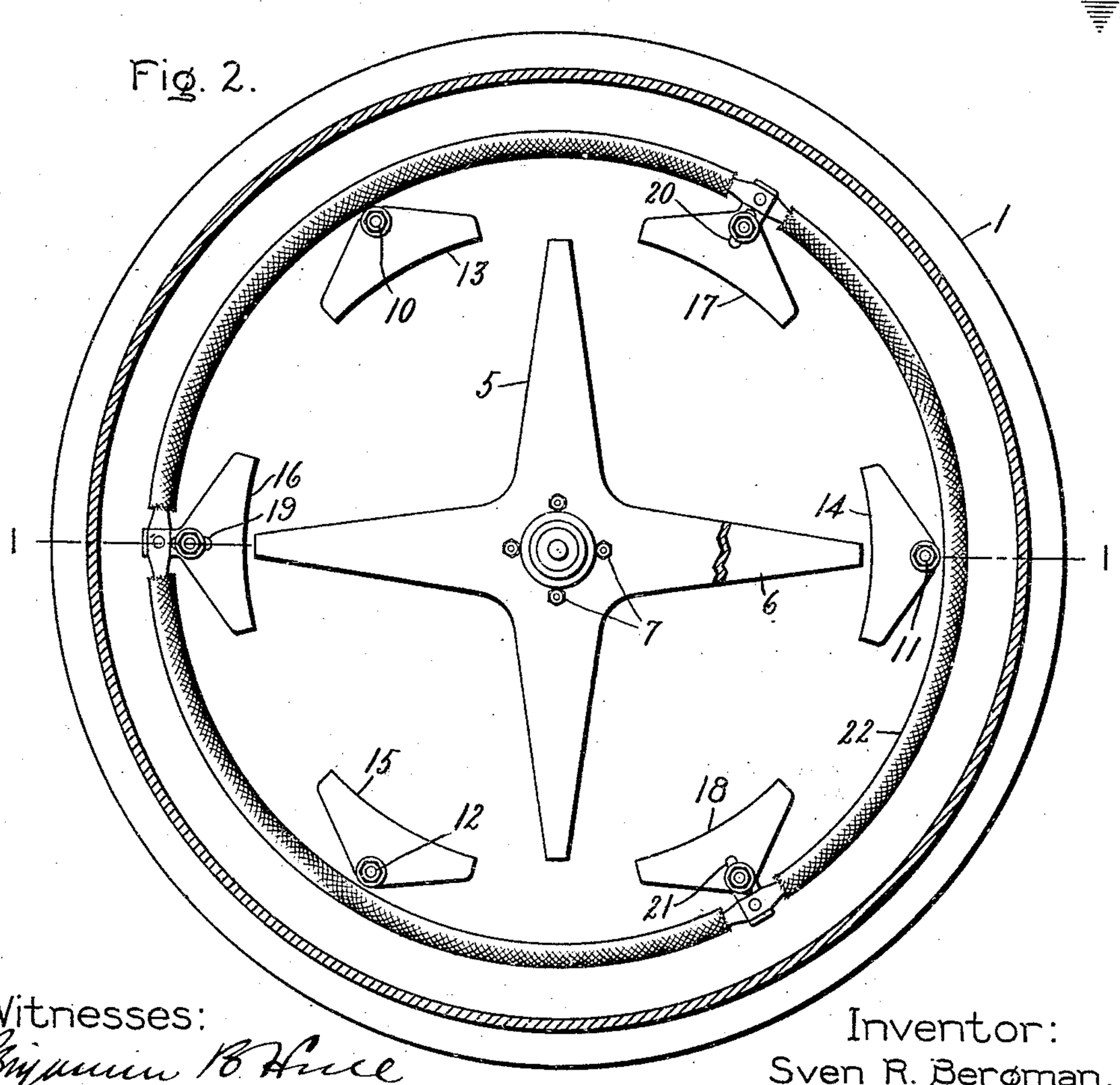


Fig. 2.



Witnesses:

Benjamin B. Hicks

Margaret E. Hoolley

Inventor:

Sven R. Bergman,

by Albert G. Davis

Att'y.

S. R. BERGMAN.

PROTECTIVE DEVICE FOR ELECTRIC CIRCUITS.

APPLICATION FILED OCT. 13, 1905.

940,578.

Patented Nov. 16, 1909.

2 SHEETS—SHEET 2.

Fig. 4

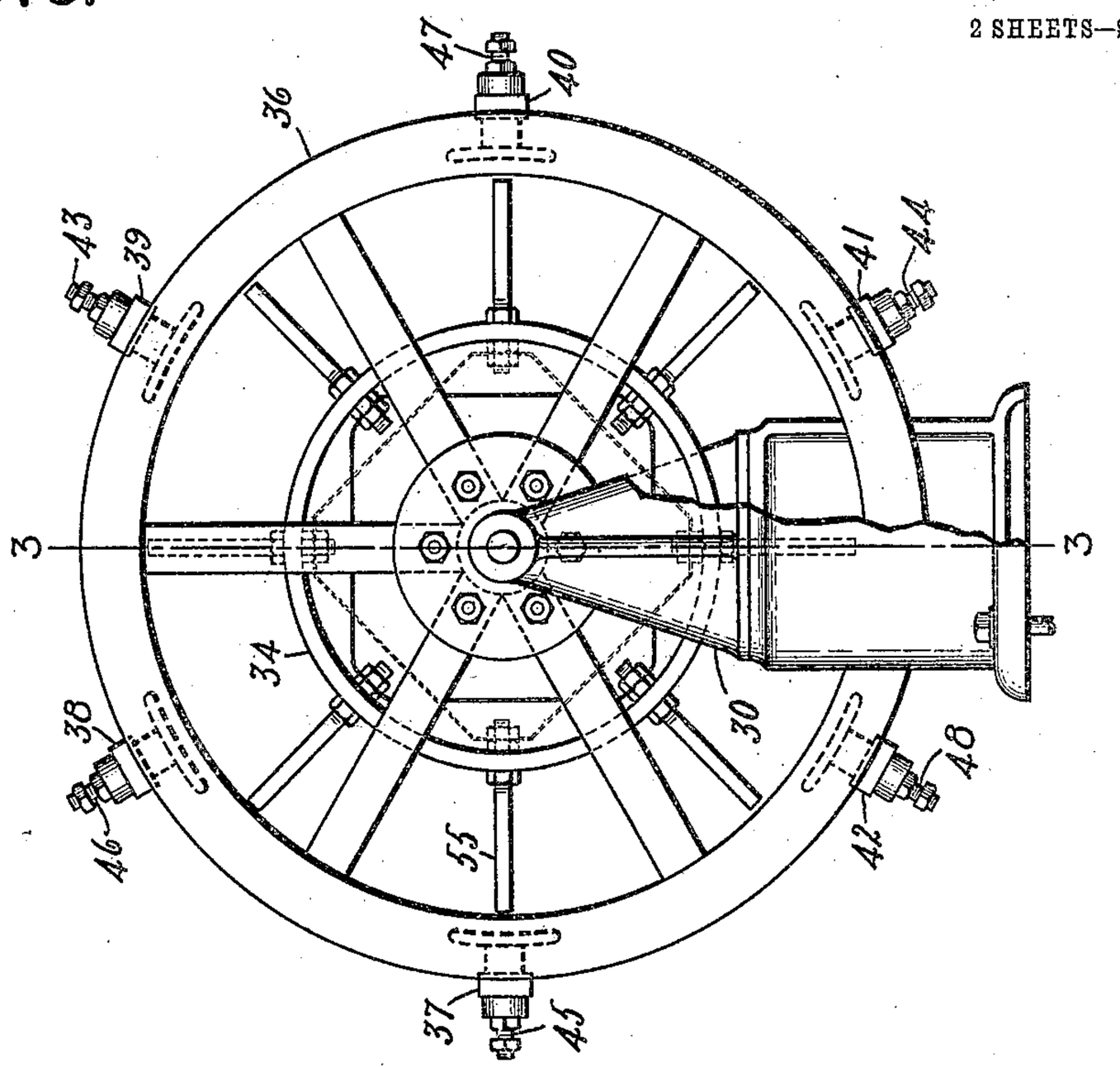
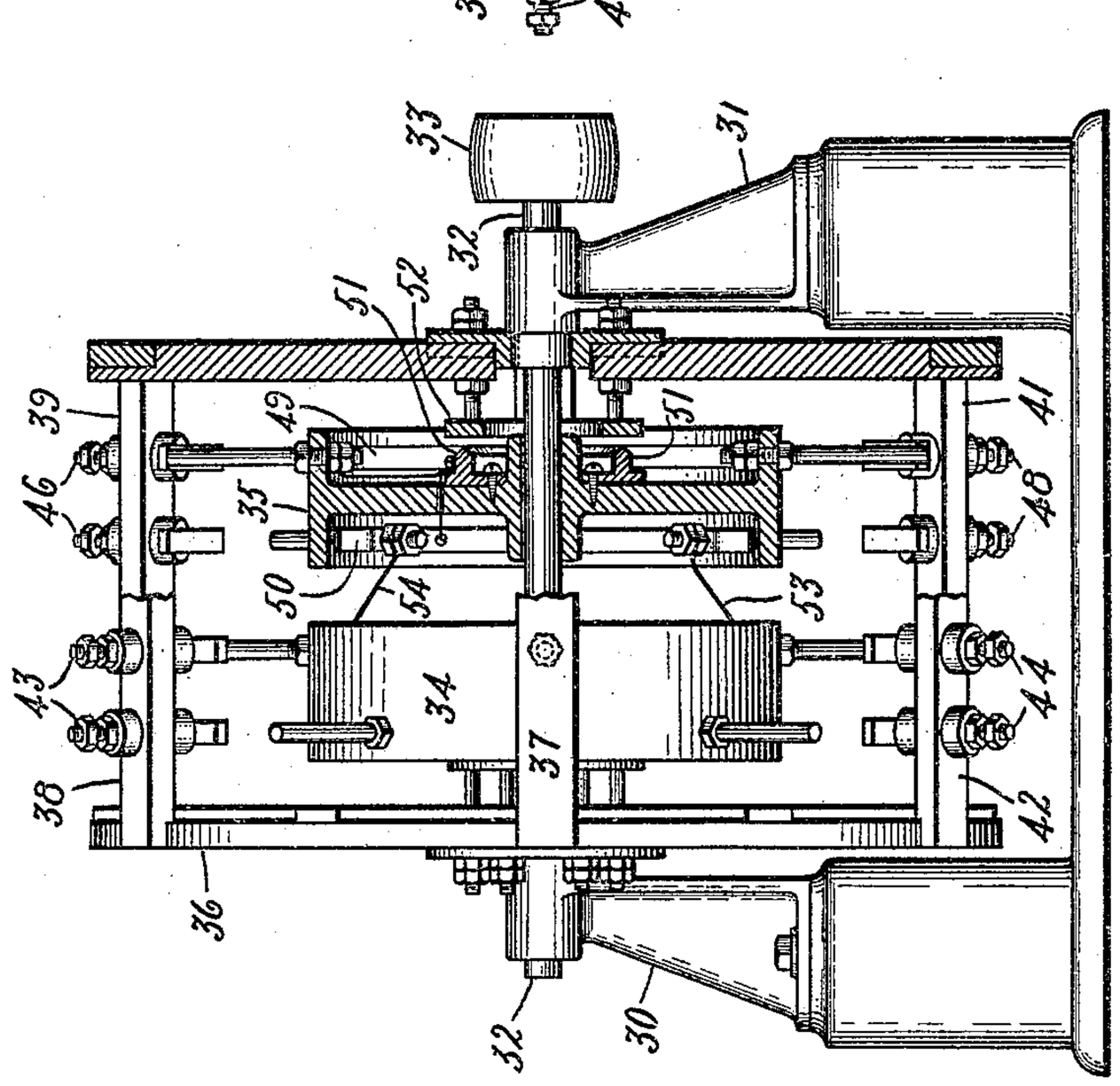


Fig. 3.



Witnesses:

Benjamin B. Hull

Margaret E. Hoolley

Inventor

Sven R. Bergman,

by Albert G. Davis

Atty

UNITED STATES PATENT OFFICE.

SVEN R. BERGMAN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PROTECTIVE DEVICE FOR ELECTRIC CIRCUITS.

940,578. Specification of Letters Patent. Patented Nov. 16, 1909.

Application filed October 13, 1905. Serial No. 282,583.

To all whom it may concern:

Be it known that I, SVEN R. BERGMAN, a subject of the King of Sweden, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Protective Devices for Electric Circuits, of which the following is a specification.

Electrical distribution circuits are often subjected to abnormal potentials caused by lightning or other atmospheric disturbances or by resonance or other abnormal conditions on the line. A lightning arrester or other protective device for such circuits must provide a ready path for the removal of this abnormal potential without subjecting the distribution line to an abnormal rush of current or to other disturbing influences.

Various lightning arresters have heretofore been designed in which a spark gap is included in the path over which the discharge or current passes, the spark gap being so adjusted that it does not break down under the normal potential of the line, but nevertheless permits a current of abnormal voltage to pass. Unless special precautions are taken there is danger that the line current will follow across the gap on the arc established by the high voltage discharge, and will thus short-circuit the line or at least produce a violent disturbance.

According to my present invention a spark gap is used in the path of the high voltage current, but the apparatus is provided with novel means for preventing any appreciable quantity of line current from following through on the high potential discharge.

The details of my invention will be better understood by reference to the following description taken in connection with the accompanying drawings, in which—

Figure 1 is a sectional elevation on the line 1—1, Fig. 2, showing the details of one modification of my improved protective device; Fig. 2 is a transverse section on the line 2—2 of Fig. 1, showing the parts as seen from beneath; Fig. 3 is an elevation of a second modification with parts shown in section on the line 3—3 of Fig. 4; and Fig. 4 is an end elevation of the apparatus shown in Fig. 3.

Referring to Fig. 1, an oil-tight compartment 1 of metal or other suitable material is provided with a cover 2 through which is inserted a shaft 3 carrying an insulating hub 4, and a plurality of metal plates 5 and 6, clamped together by bolts 7 passing through the outer rim of the insulating hub 4. Each of these plates is provided with four radial arms and the plates are so arranged that the arms of plate 5 are directly below the arms of plate 6, as shown in Fig. 2, in which one of the arms of plate 5 is broken away to show the corresponding arm of plate 6. These plates may be made of steel, and while electrically connected by the bolts 7, are nevertheless insulated from the shaft 3 by the insulating hub 4. Shaft 3 carries a pulley 8, and is provided with a suitable thrust bearing 9 supported by cover 2, so that the shaft and metal plates carried thereby may be conveniently rotated at a high speed.

Projecting through the metal cover 2 are three brass studs 10, 11 and 12 each of which carries at its lower end what I choose to designate as a contact plate or shoe. These contact shoes 13, 14 and 15 have their inner edges cut in the shape of an arc, and are so placed as to be on the same horizontal level as the rotating plate 5, and so arranged that the arms of this plate are separated from the curved surface of the shoes by a gap of a predetermined length. This gap constitutes one of the spark gaps in the path of the high potential discharge. Cover 2 also carries three heavy insulating bushings which support at their lower ends three contact shoes 16, 17 and 18. These shoes are on the same horizontal level as the rotating plate 6, and are separated from the arms of plate 6 by a suitable air gap. This air gap may be adjusted throughout a definite range by unclamping the nuts which hold the shoes on their corresponding rods, and slipping the shoes so that the supporting studs move forward or backward in the slots 19, 20 and 21. The shoes 16, 17 and 18 are electrically connected by an insulated cable 22, so that the stud 23 which passes upward through bushing 24 is permanently connected to all three of the shoes. When the apparatus is in operation stud 23 may be connected through a resistance 25 to a line 26 to be protected. Contact shoes 13, 14 and 15 are electrically connected to the cover 2 by their supporting studs, and this cover is grounded in any suitable manner, as for instance by a

conductor 27. When the apparatus is installed the pulley 8 is belted to any suitable source of power so that the metal plates 5 and 6 may be rotated at a relatively high speed.

With the apparatus arranged as above described an abnormal potential on line 26 will break down the spark gap between one of the contact shoes 16, 17 or 18, and one of the contact arms of plate 6 and the discharge current will pass through the bolts 7 to the lower plate and out to one of the grounded shoes 13, 14 or 15, and thus to ground. As will be seen from the drawing the angular width of the contact shoes is such that there is always one arm of plate 6 at the proper sparking distance from one of the three shoes connected to line, so that no matter how rapidly the high potential strains may follow each other there is always a suitable path to ground. This feature of my device I consider of importance.

If the line current tends to follow across the spark gap on the high potential discharge the movement of the rotating arm away from the shoe immediately ruptures the circuit and prevents any substantial rush of current through the ground connection. By arranging the grounded shoes in a different plane from that of the shoes connected to lines there is no danger that an arc drawn out from a line shoe will be carried over by the rotating arms to the succeeding grounded shoe. I prefer to immerse the revolving plates and the contact shoes in a body of oil 28 as I find that the arcs are more easily ruptured under oil and that the rupture occurs at the zero point of the electromotive force wave, so that oscillations or surges are not produced in the line.

Figs. 3 and 4 show a modification of my invention adapted more particularly for use on circuits of relatively low voltage. The apparatus comprises suitable standards 30 and 31 supporting a shaft 32 on which is mounted a pulley 33 by which the shaft may be rotated. Two wheels 34 and 35 of wood, fiber or other suitable insulating material are rigidly secured to shaft 32, and carry in their periphery a plurality of radial arms. Each wheel is provided with eight arms arranged equidistant about the periphery but so staggered that four of the arms are in one plane near one edge of the wheel, and the remaining four are in another plane near the opposite edge of the wheel. This staggered relation of the arms, while not absolutely necessary, is nevertheless of value in preventing the possibility of an arc generated by one arm from jumping over to the arm which immediately follows, as it will be seen that by the staggered relation the distance between arms is doubled so far as this jumping action of the arc is concerned. A wooden frame-work 36 rigidly mounted on the metal standards 30 and 31 is provided with six cross-bars 37, 38, 39, 40, 41 and 42. Each of these cross-bars supports two contact shoes bolted thereto and insulated therefrom in any suitable manner. These shoes are arranged in pairs on the cross-bars and are staggered with respect to the rotating wheels so that three alternate pairs 43, 44 and 45 coöperate with wheel 34, while the other pairs 46, 47 and 48 cooperate with wheel 35. All the arms of wheel 35 are electrically connected by metal bands 49 and 50, and these bands are both electrically connected to the annular flange 51 mounted on wheel 35, and separated by a spark gap from a metal plate 52 electrically connected with the metal standard 31, or otherwise suitably grounded. The arms of wheel 34 are connected together in a similar manner and are provided with a spark gap similar in all respects to that formed by the annular flanges 51 and 52 of the other wheel. Conductors 53 and 54 connect the studs on one wheel to those of the other.

In connecting up the apparatus for operation, I connect the three pairs of shoes 43, 44 and 45 to one line, and the remaining three pairs 46, 47 and 48 to the other line of the circuit to be protected. In case of an abnormal voltage between the two line conductors a discharge will take place from one shoe to the arm which happens to be near it, and then across through the wire connections to the other wheel and back to the other side of the line through a second air gap. Thus for instance, a discharge might take place from shoe 45 to the arm 55, and then across to the other wheel 35 and out to contact shoe 47. If the abnormal strain is between one line and ground the discharge will take place from one shoe to the rotating arm and then across the air gap between flange 51 and plate 52 and then to ground. By making the angular width of the contact shoes equal to or greater than 15° there will always be one arm of each wheel at proper sparking distance from one of the contact shoes, so that no matter when the high voltage is developed in the distribution circuit there will be a suitable path to ground. The rapid rotation of the wheels and the quick break at the contact shoes prevents any abnormal flow of line current across the gaps.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. In a lightning arrester, a rotary member having a plurality of conducting arms, a plurality of contact plates in proximity to said arms but each having an angular width less than the angular distance between adjacent conducting arms, a second rotary member having conducting arms, a second set of contact plates coöperating therewith, means for continuously moving said rotary

members, and means for permanently connecting one set of said contact plates to the line to be protected.

2. In a lightning arrester, a rotary member having arms, a plurality of contact plates arranged about said rotary member and coöperating therewith to form spark gaps, said rotary member having spaces between arms so proportioned with respect to the angular width of said contact plates that a constant sparking distance to said rotary member is insured while the sparking distance to any particular arm periodically increases and decreases as the rotary member is revolved.

3. The combination with a line conductor to be protected, of a rotary member having projecting arms, segmental contacts disposed about said rotary member, said contacts each having an angular width sufficient to permit high potential currents to discharge through said line to said projecting arms at any instant but insufficient to bridge across from one projecting arm to the next, and means for moving said rotary member.

4. The combination with a line conductor to be protected, of a conducting plate forming one side of a spark gap, a rotary member comprising a hub and radial arms, said member being movable with respect to said plate and separated therefrom by a gap which periodically increases in length, and other conducting plates coöperating with said rotary member to maintain a constant discharge path to said rotary member.

5. In a lightning arrester, a plurality of conductive plates connected together, a rotary member having radial arms coöperating with said plates to form spark gaps, the angular width of each of said arms being substantially less than the angular distance between adjacent plates, and means for moving said rotary member.

6. In a lightning arrester, a plurality of conductive plates spaced about a rotary member, and radial arms on said rotary member some one of which is at any instant within sparking distance of a plate, each of said plates having an angular width such that each of said radial arms passes out of sparking distance with one plate before coming into sparking distance with another plate.

7. In a lightning arrester, the combination of a plurality of conductive plates electrically connected and spaced about a rotary member, arms on said rotary member at least one of which is always within sparking distance of one of said conductive plates, and cut-away portions between said arms for periodically varying the sparking distance from said rotary member to any one of said plates.

8. In a lightning arrester, a plurality of conductive plates connected together and grouped about a rotary member, and arms on said rotary member differing in number from the conductive plates, said plates having such angular width that a spark gap path to said rotary member is present at all times.

9. In a lightning arrester, a rotary member carrying two sets of conducting arms, a plurality of conductive plates coöperating with each of said arms to form a discharge path including a plurality of spark gaps.

10. In a lightning arrester, a plurality of conductive plates connected to line, a rotary member having arms which periodically come within sparking distance of each of said plates, and means between said rotary arms and ground for forming a discharge path including a spark gap, the opposing conductors of which are in relative motion.

11. In a lightning arrester, a rotary member having a plurality of radial arms, conductive plates disposed about said member and forming a discharge path to one or another of said arms at any instant, a second set of rotary arms connected with said first set, and conductive plates coöperating with said second set of arms to form a discharge path therefrom at any instant.

12. In a lightning arrester, the combination of a plurality of conductive plates connected together, a rotary member coöperating therewith and having an irregular periphery to periodically vary the sparking distance between each conductive plate and said rotary member, and a plurality of paths for discharges from said rotary member, said paths being established progressively by movement of said member.

In witness whereof, I have hereunto set my hand this eleventh day of October, 1905.

SVEN R. BERGMAN.

Witnesses:
JOHN A. MCMANUS, Jr.,
HENRY O. WESTENDARP.