C. F. FRANK.
COHERER.
APPLICATION FILED JUNE 10, 1914.

1,167,163.

Patented Jan. 4, 1916.
2 SHEETS—SHEET 1.

Fig. 1.

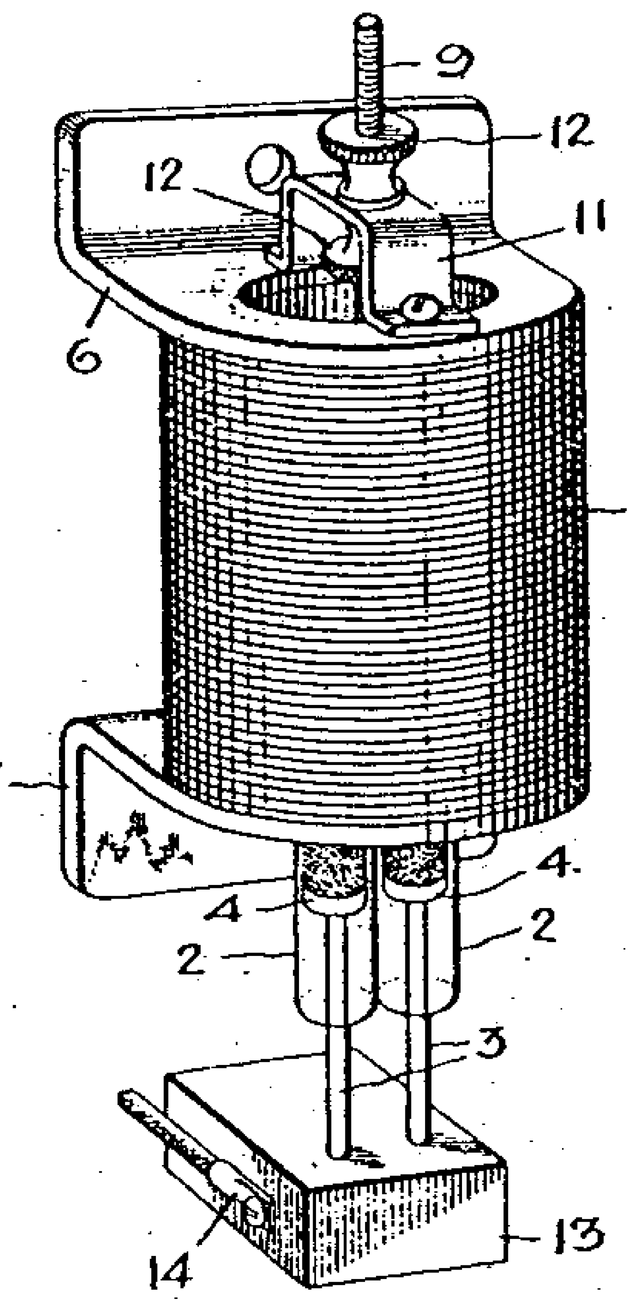


Fig. 2.

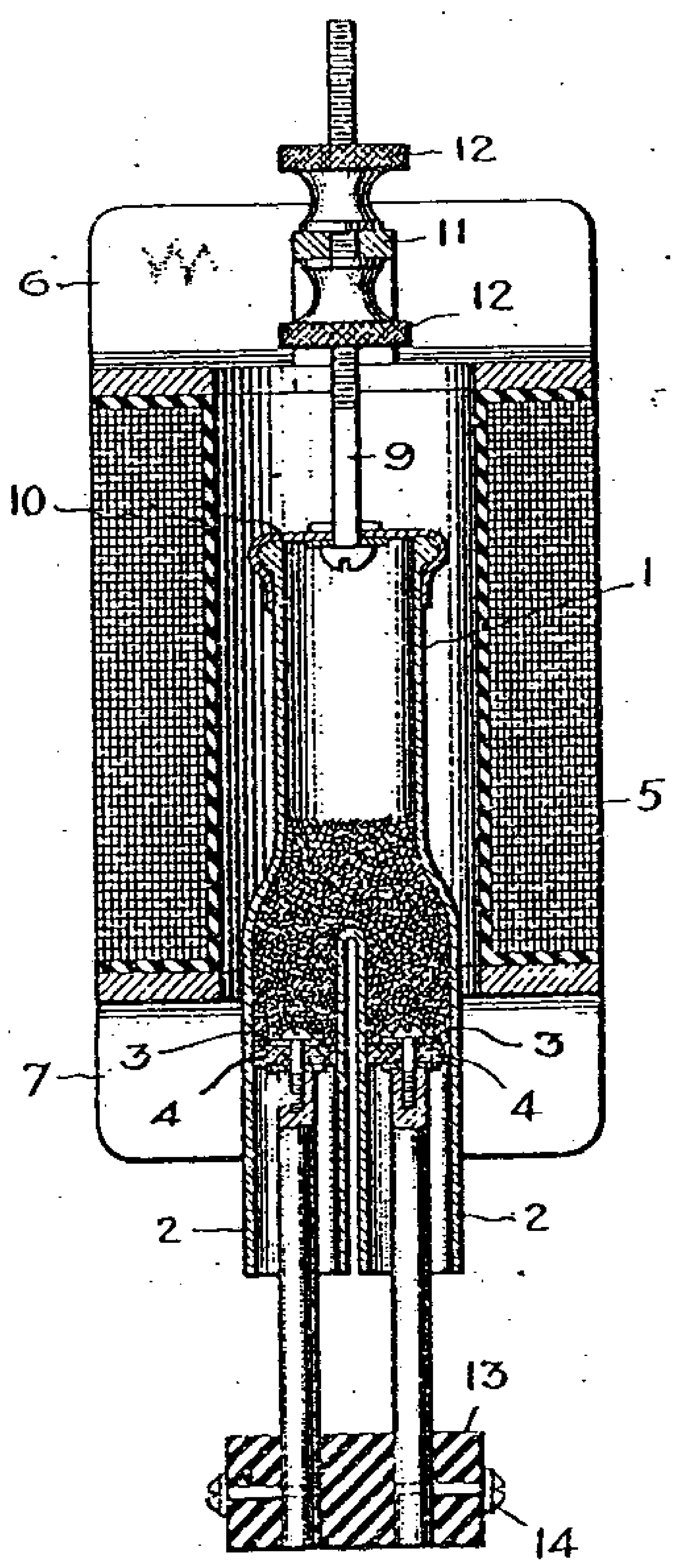
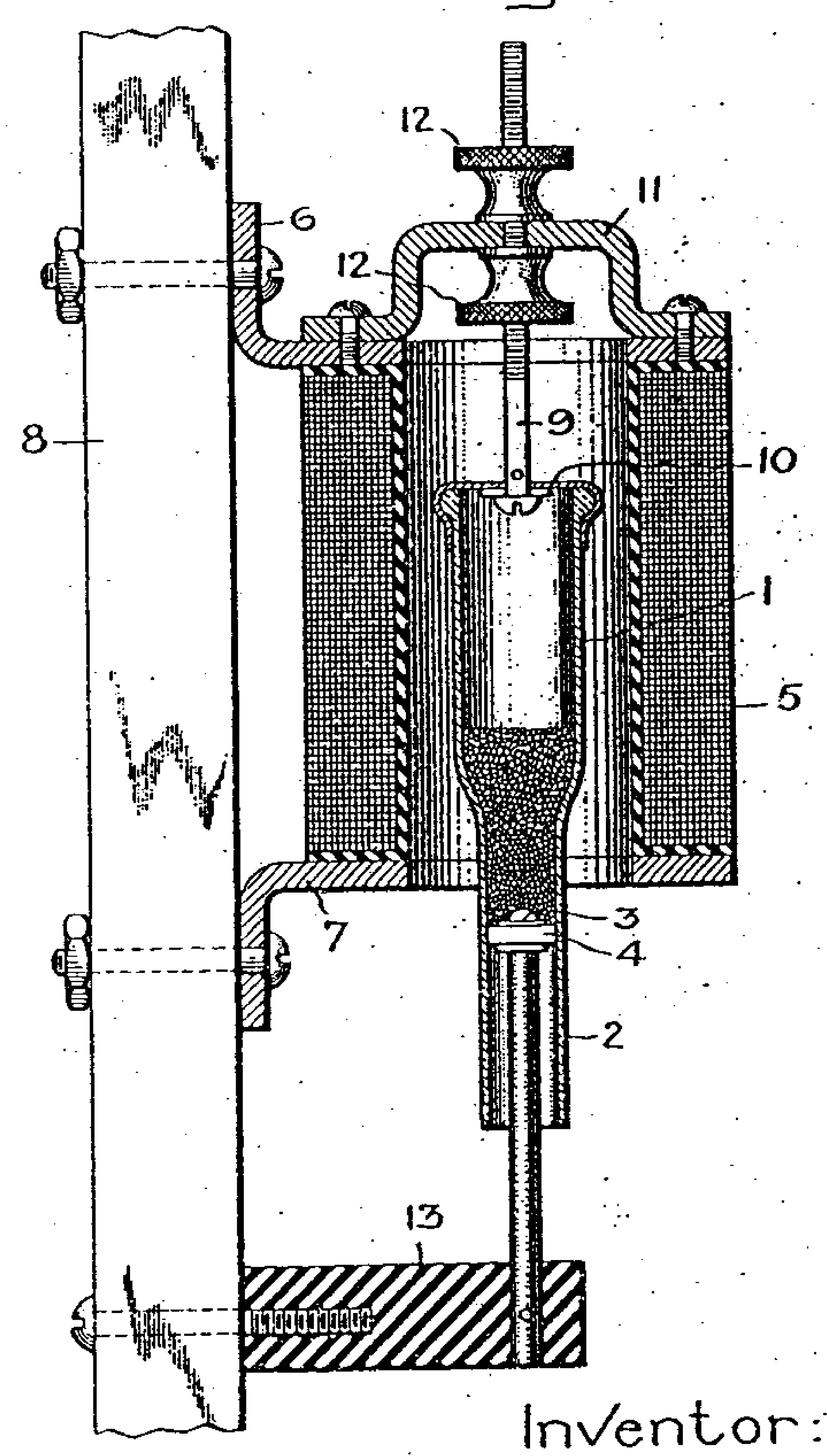


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

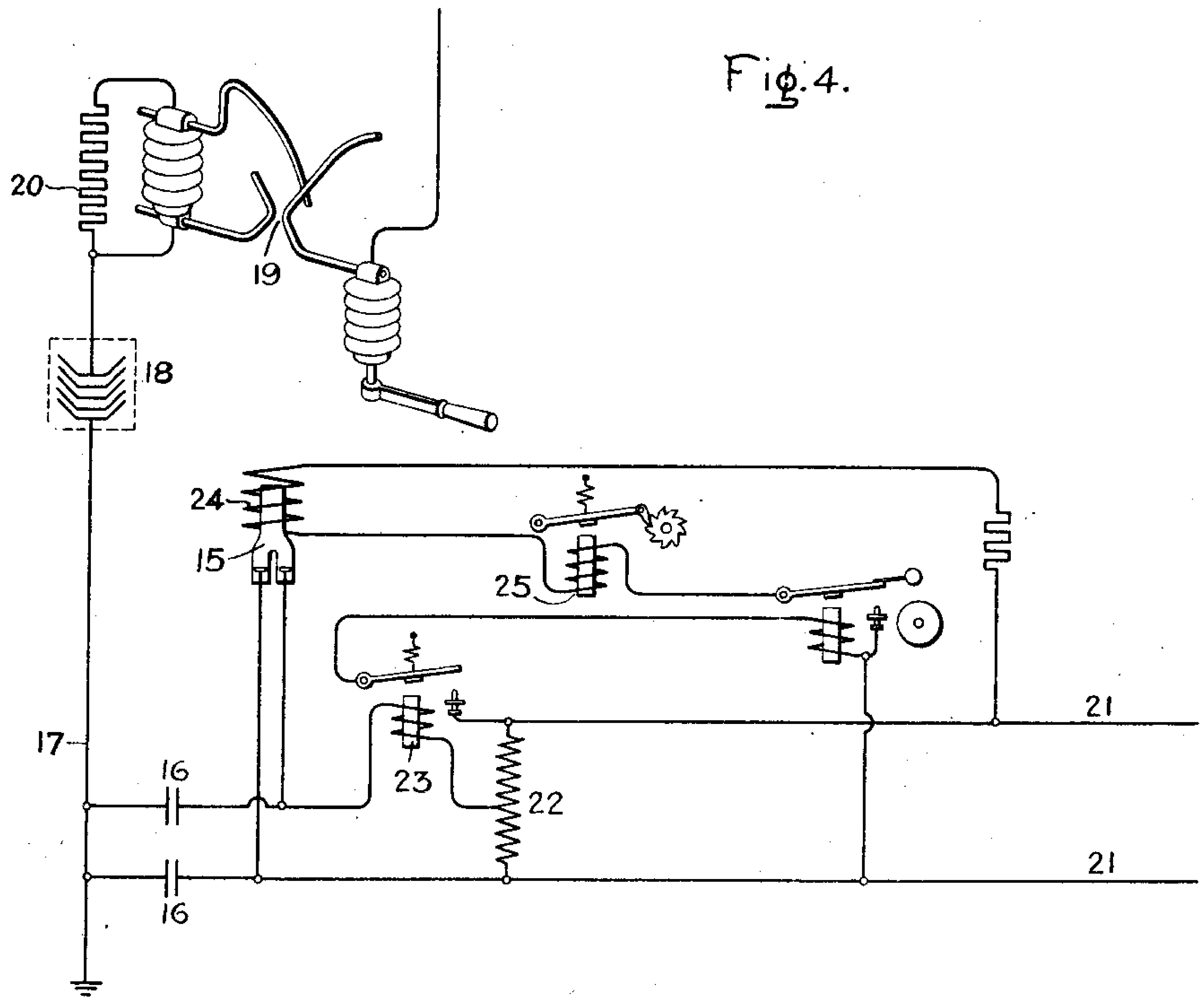
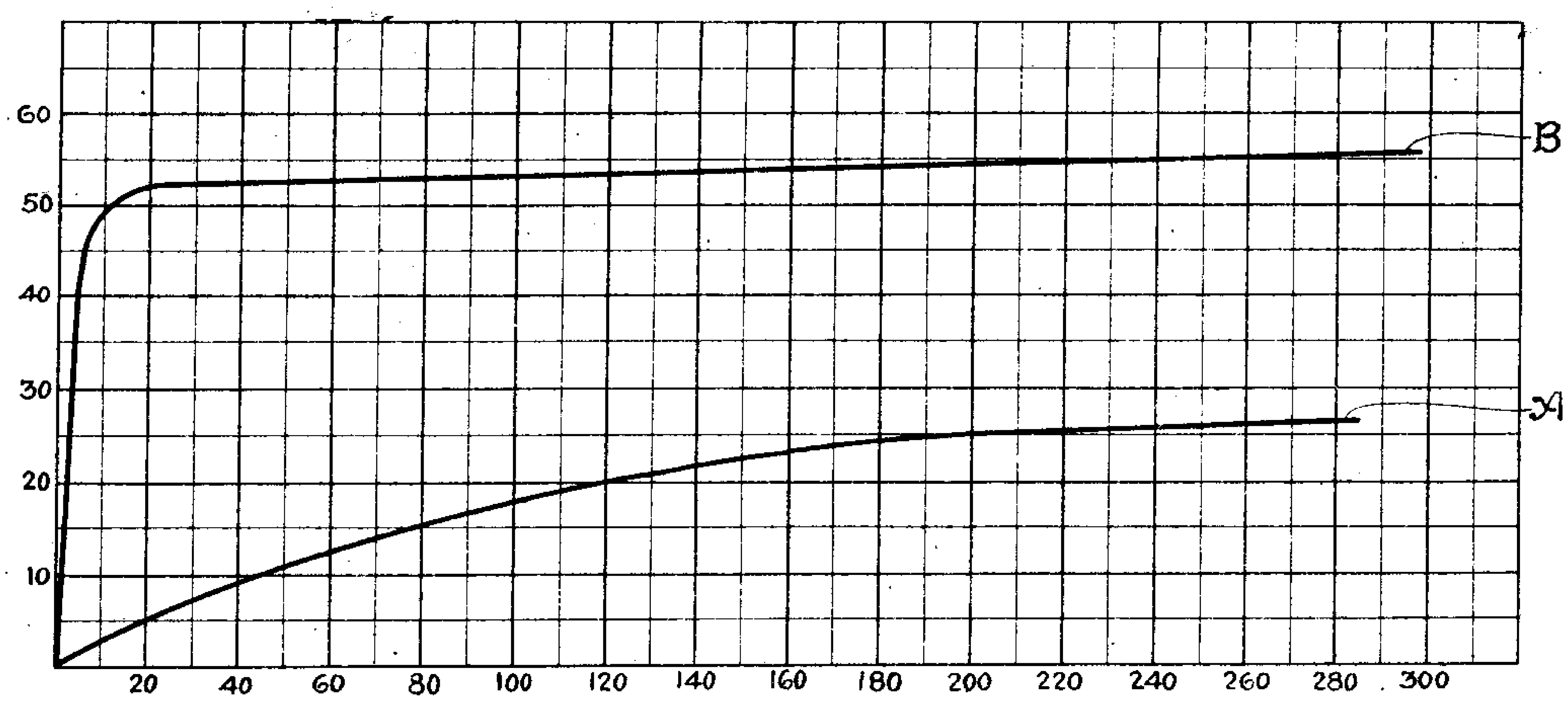


Fig. 5.



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UNITED STATES PATENT OFFICE.

CROSBY FIELD FRANK, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

COHERER.

1,167,163. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed June 10, 1914. Serial No. 844,194.

To all whom it may concern:

Be it known that I, Crosby Field Frank, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Coherers, of which the following is a specification.

My present invention relates to improvements in coherers of the type which have largely been employed in wireless telegraphy. The present device while adapted for use in that connection is especially suitable for use with signaling or indicating apparatus for electrical distribution systems, such for example as that described in Patent No. 1,062,083, issued to Elmer E. F. Creighton on May 20, 1913. Coherers of this type as ordinarily constructed have consisted of a straight tube containing two electrodes with a mass of small metallic particles between them. This mass normally has a comparatively high resistance but when an electrical potential is impressed upon it its resistance decreases and a greatly increased current flows between the electrodes which are connected to a constant voltage source of direct current. When the exciting potential is withdrawn the resistance of the mass does not decrease to its original value but some means for shaking the particles to effect a rearrangement thereof is necessary in order to restore the mass to its original high resistance. With the materials heretofore used the decrease of the resistance of the mass has been more or less gradual with increase of the applied potential. For the successful application of a coherer to signaling or indicating apparatus for use in connection with electrical distribution systems, however, it is desirable that the material used should have a sharp critical voltage at which the resistance suddenly decreases and permits a largely increased current to flow to operate the desired apparatus. It is also essential that the critical voltage shall not vary to any great extent after long continued operation of the coherer. I have discovered that by the use of granules of magnetic material, preferably nickel, properly prepared I am able to construct a coherer which has a remarkably sharp critical voltage and in which the critical voltage remains practically constant as long as the apparatus is used. One convenient method of preparing the granules consists in reducing the oxid of the metal by means of hydrogen at a temperature at which the particles are partially sintered together. The resulting product is crushed in order to secure particles of the desired size and the granules resulting have a dull, gray appearance, are porous and have a large number of sharp projections scattered over their surface. These granules are substantially free from oxid and if placed in a coherer in this condition will gradually acquire an oxid coating and the critical voltage will consequently rise. After a certain time, however, their condition becomes stable and the critical voltage will then remain constant. If it is desired to produce a coherer having a higher critical voltage than may be conveniently obtained in this way the granules may be given a thicker coating of oxid by heating them to a high temperature in the presence of oxygen. For the successful operation the mass should be thoroughly decohered after each operation. By improvements in the shape of the tube and the decohering apparatus I have been able to produce a coherer in which a thorough decoherence is absolutely certain.

My invention will best be understood by reference to the following description taken in connection with the accompanying drawing, in which—

Figure 1 is a view in perspective of the complete coherer; Fig. 2 is a vertical cross section thereof; Fig. 3 is a vertical cross-section taken through a plane at right angles to that of Fig. 2; Fig. 4 is a diagram showing one of the numerous methods of connecting my coherer to a lightning arrester discharge alarm; and Fig. 5 shows volt-ampere characteristics of ordinary nickel filings and nickel granules such as used in my coherer.

In the form here shown my coherer comprises a forked tube 1 having two vertical prongs 2, 2, in each of which an electrode 3 is placed. The granules of magnetic material fill each of the branches of the tube above the electrodes and extend well up into the central tube so that there is a continuous mass of granules between the two electrodes. Flexible washers 4 attached to the electrodes as shown prevent the granules from dropping out of the tube.

As decohering means I employ a solenoid 5 surrounding the upper part of the coherer. When current flows in this solenoid the granules are raised clear of the electrodes and drawn up into the main tube. The apparatus is preferably so arranged that when the path of current between the electrodes is interrupted, current in the solenoid is also interrupted and the granules drop back to the normal position. The shape of the coherer tube insures that the mass of granules in rising and falling shall be thoroughly shaken so that there is no possibility for them to rise and fall as a single mass and thus fail to be thoroughly decohered. I am aware that electro-magnetic means have heretofore been used to raise magnetic coherer material and thus decohere but in all such devices the arrangement has been such that the cohering material may rise and fall as a single mass without any change in the relative positions of the separate particles. As a result decoherence is more or less imperfect and the critical voltage at which such a coherer breaks down is not constant.

Various ways may be devised for conveniently mounting the different parts of my device. As here indicated the solenoid is supported by brackets 6 and 7 attached to a suitable support 8. The coherer tube is held in operative relation to the solenoid by means of the threaded rod 9 which passes through the metal cap 10 on the upper end of the tube and is fastened to the strap 11 on the bracket 6 by means of thumb screws 12. By means of these thumb screws the coherer tube may be raised and lowered to vary the length of the current path through the granular material between the electrodes. The electrodes are rigidly secured to the block 13 of insulating material which is fastened to the support 8. Suitable terminals 14 for the coherer may be provided upon the block 13. Inasmuch as the critical voltage of the coherer is dependent upon the distance between electrodes the adjustability of the tube allows of its use with various critical voltages as desired.

In Fig. 4 I have illustrated one of the numerous applications of my improved coherer. In this case the coherer 15 is connected through the condensers 16 to two points in the ground connection 17 of the aluminum arrester 18. This arrester is separated from the distribution system by a horn gap 19 which may be short circuited through the resistance 20 in order to charge the aluminum cell whenever necessary. The operating voltage for the coherer is supplied by the direct current mains 21, a potentiometer arrangement 22 being provided to obtain any operative voltage desired. When there is a high voltage impressed upon the ground leg of the arrester, due either to an arcing over of the spark gap or the charging of the arrester the coherer is cohered allowing current to flow to actuate the relay 23. This closes the circuit of the bell thus causing it to ring at the same time close the circuit containing the solenoid 24 and the magnet 25 of a suitable counter. This lifts the particles away from the coherer electrodes and thus opens the circuit of relay 23. This opens the bell magnet circuit and the solenoid circuit in turn and allows the particles to drop again to their original position.

In Fig. 5 curve A represents the volt-ampere characteristic of a coherer using ordinary nickel filings, the ordinates representing voltage and the abscissæ current. Curve B is the volt ampere characteristic of a cohere using nickel granules reduced from the oxid by hydrogen. The conditions under which these curves were obtained as regards the size of particles, size of tube and distance between electrodes were the same in both cases.

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

1. The combination in a coherer of a vertical tube comprising a main portion and two branches at its lower end, an electrode in each branch and a mass of metallic granules filling said branches above said electrodes and a part of the main portion of the tube.

2. The combination in a coherer of a tube comprising a main portion and two branches, an electrode in each of said branches, a mass of finely divided magnetic material in said tube between said electrodes and means for withdrawing said magnetic material from contact with said electrodes.

3. The combination in a coherer of a tube comprising a main portion and two branches, an electrode in each of said branches, a mass of finely divided magnetic material in said tube between said electrodes and a solenoid surrounding said tube.

4. The combination in a coherer of a tube of insulating material comprising a main portion and two branches, a stationary electrode in each of said branches, a mass of metallic granules in said tube between said electrodes, means for moving the tube with respect to the electrodes to vary the distance between said electrodes through said metallic mass, and a solenoid for withdrawing said metallic granules from contact with said electrodes.

5. The combination in a coherer of a vertical tube comprising a main portion and two branches at its lower end, an electrode extending into each of said branches, a mass of metallic granules in said tube between said electrodes, means for lifting said metallic mass from contact with said electrodes.

6. The combination in a coherer of a vertical tube comprising a main portion and two branches at its lower end, a stationary electrode in each of said branches, a mass of metallic granules in said tube between said electrodes, and means for raising said tube

to vary the distance between said electrodes through said metallic mass.

7. A coherer comprising a container of insulating material, electrodes therein, and a mass of granular material between said electrodes having a sharp critical voltage.

8. A coherer comprising a container of insulating material, electrodes within said container and a mass of metallic granules between said electrodes having a high resistance for all voltages impressed thereon below a certain predetermined critical voltage.

9. A coherer comprising a container of insulating material, electrodes therein and a mass of metallic granules between said electrodes, the material of which said granules are composed being such that the volt ampere characteristic of the device has a sharp bend therein.

10. A coherer containing metallic granules of magnetic material made by reducing the oxid of the metal at a temperature at which it is partially sintered.

11. A coherer containing nickel granules made by reducing nickel oxid by means of hydrogen at a temperature at which it is parially sintered.

12. Coherer material consisting of porous nickel granules.

13. Coherer material consisting of porous granules of magnetic material.

14. Coherer material consisting of porous granules of partially sintered magnetic material.

15. Coherer material consisting of porous nickel granules partially sintered.

16. Coherer material consisting of porous, partially sintered, oxid coated nickel granules.

17. Coherer material consisting of porous oxid coated granules of partially sintered magnetic material.

18. Coherer material consisting of porous, partially sintered oxid coated nickel granules having a plurality of sharp projections scattered over the surface.

19. Coherer material consisting of porous oxid coated granules of partially sintered magnetic material having a plurality of sharp projections scattered over the surface.

20. Coherer material consisting of porous oxid coated granules of magnetic material.

21. Coherer material consisting of porous oxid coated nickel granules.

22. Coherer material consisting of porous oxid coated granules of magnetic material having a plurality of projections scattered over the surface.

23. Coherer material consisting of porous oxid coated nickel granules having a plurality of sharp projections scattered over the surface.

24. Coherer material consisting of porous, partially sintered granules of magnetic material having a plurality of sharp projections scattered over the surface.

25. Coherer material consisting of porous, partially sintered nickel granules having a plurality of sharp projections scattered over the surface.

26. Coherer material consisting of oxid coated nickel granules partially sintered.

27. Coherer material consisting of oxid coated partially sintered granules of magnetic material.

28. Coherer material consisting of porous granules of magnetic material having a plurality of sharp projections scattered over the surface.

29. Coherer material consisting of porous nickel granules having a plurality of sharp projections scattered over the surface.

30. Coherer material consisting of oxid coated partially sintered nickel granules having a plurality of sharp projections scattered over the surface.

31. Coherer material consisting of oxid coated partially sintered granules of magnetic material having a plurality of sharp projections scattered over the surface.

32. Coherer material consisting of partially sintered granules of magnetic material having a plurality of sharp projections scattered over the surface.

33. Coherer material consisting of partially sintered nickel granules having a plurality of sharp projections scattered over the surface.

34. Coherer material consisting of oxid coated nickel granules having a plurality of sharp projections scattered over the surface.

35. Coherer material consisting of nickel granules having a plurality of sharp projections scattered over the surface.

36. Coherer material consisting of partially sintered granules of magnetic material.

37. Coherer material consisting of partially sintered nickel granules.

In witness whereof, I have hereunto set my hand this 9th day of June, 1914.

CROSBY FIELD FRANK.

Witnesses:
BENJAMIN B. HULL,
MARGARET E. WOOLLEY.