No. 777,759. PATENTED DEC. 20, 1904.

J. J. THORESEN.

APPARATUS FOR AUTOMATICALLY STARTING ELECTROMOTORS AND FOR REGULATING PURPOSES.

APPLICATION FILED DEC. 2, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

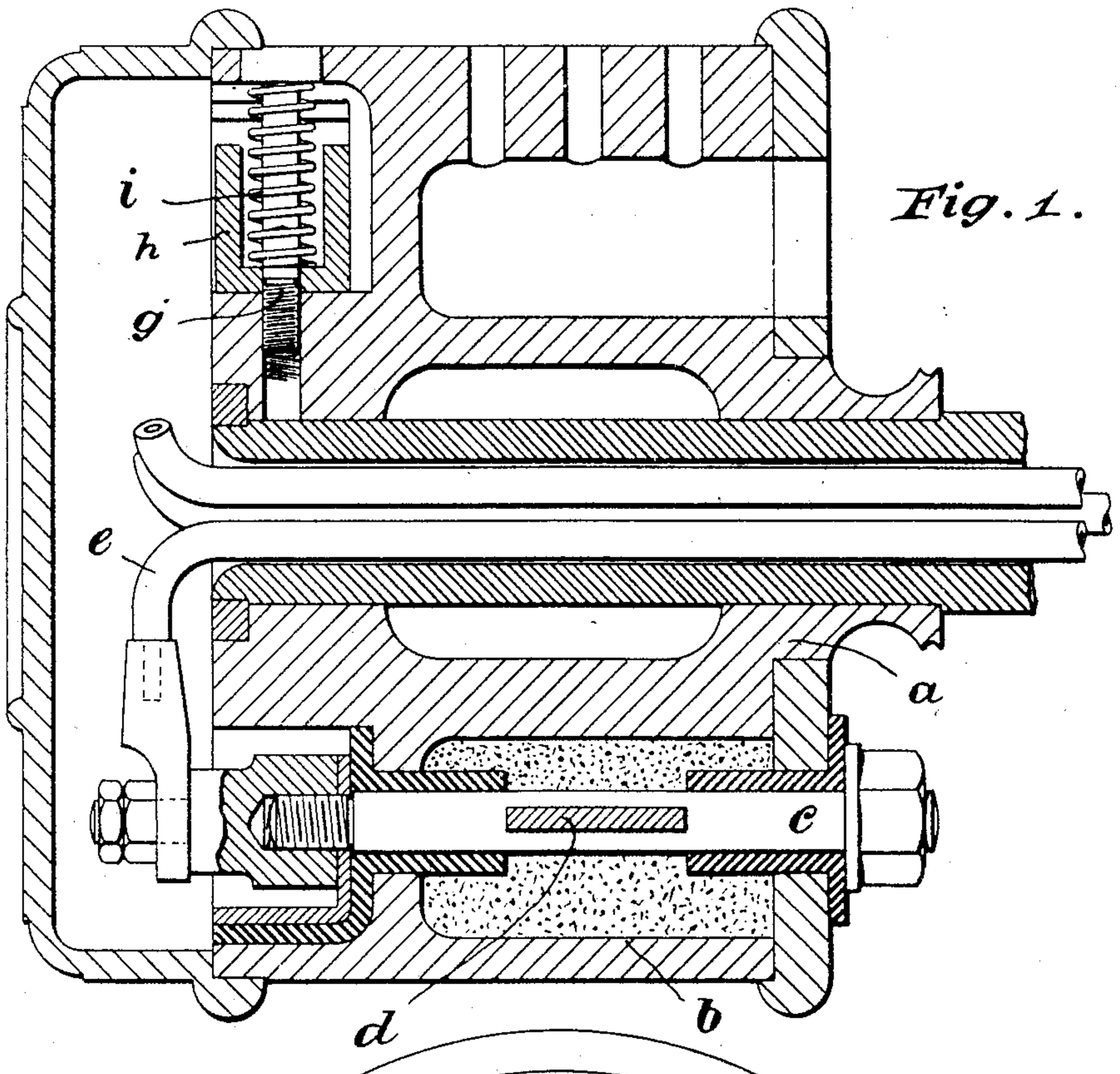

Fig. 1.

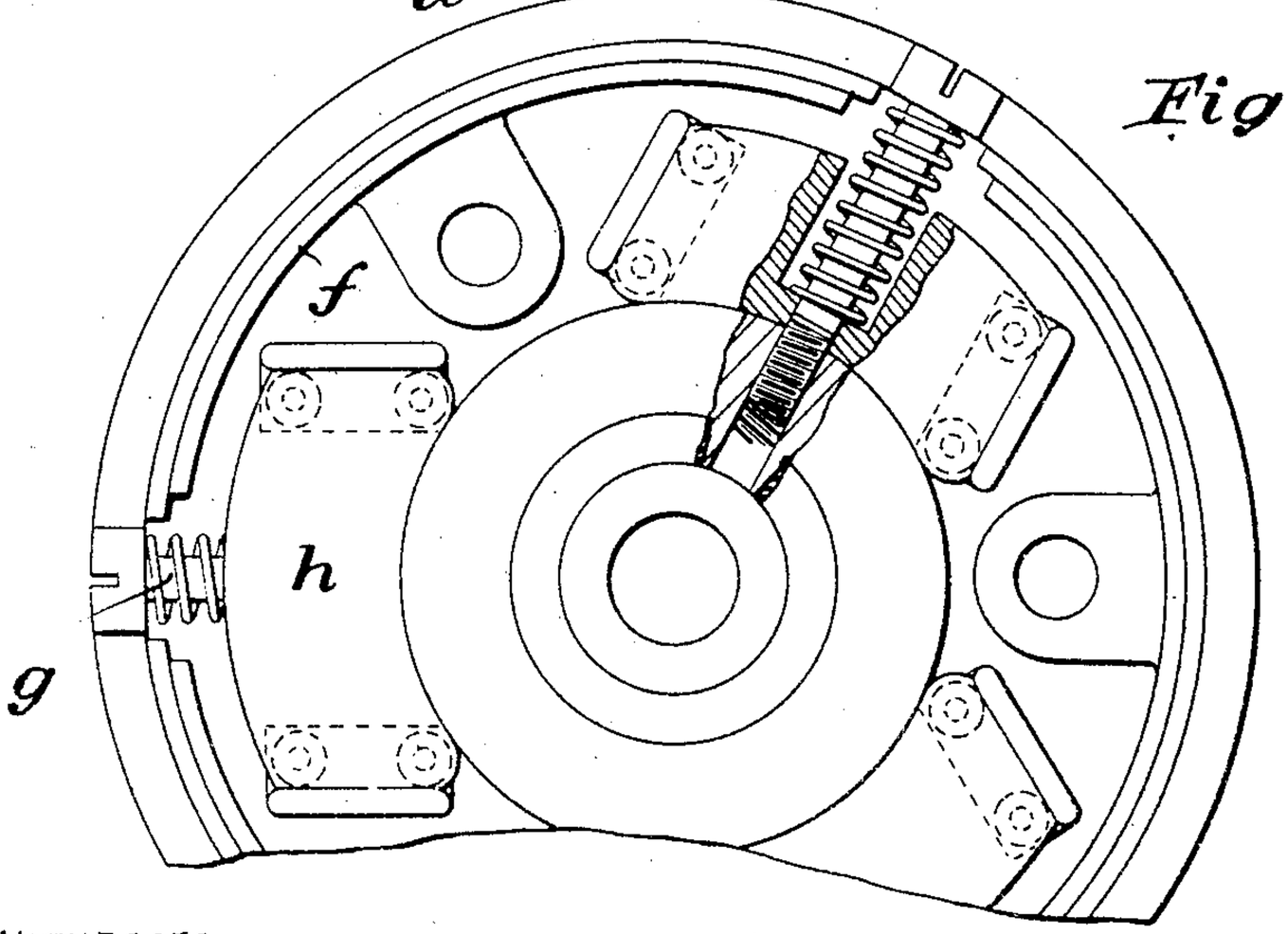

Fig. 2.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

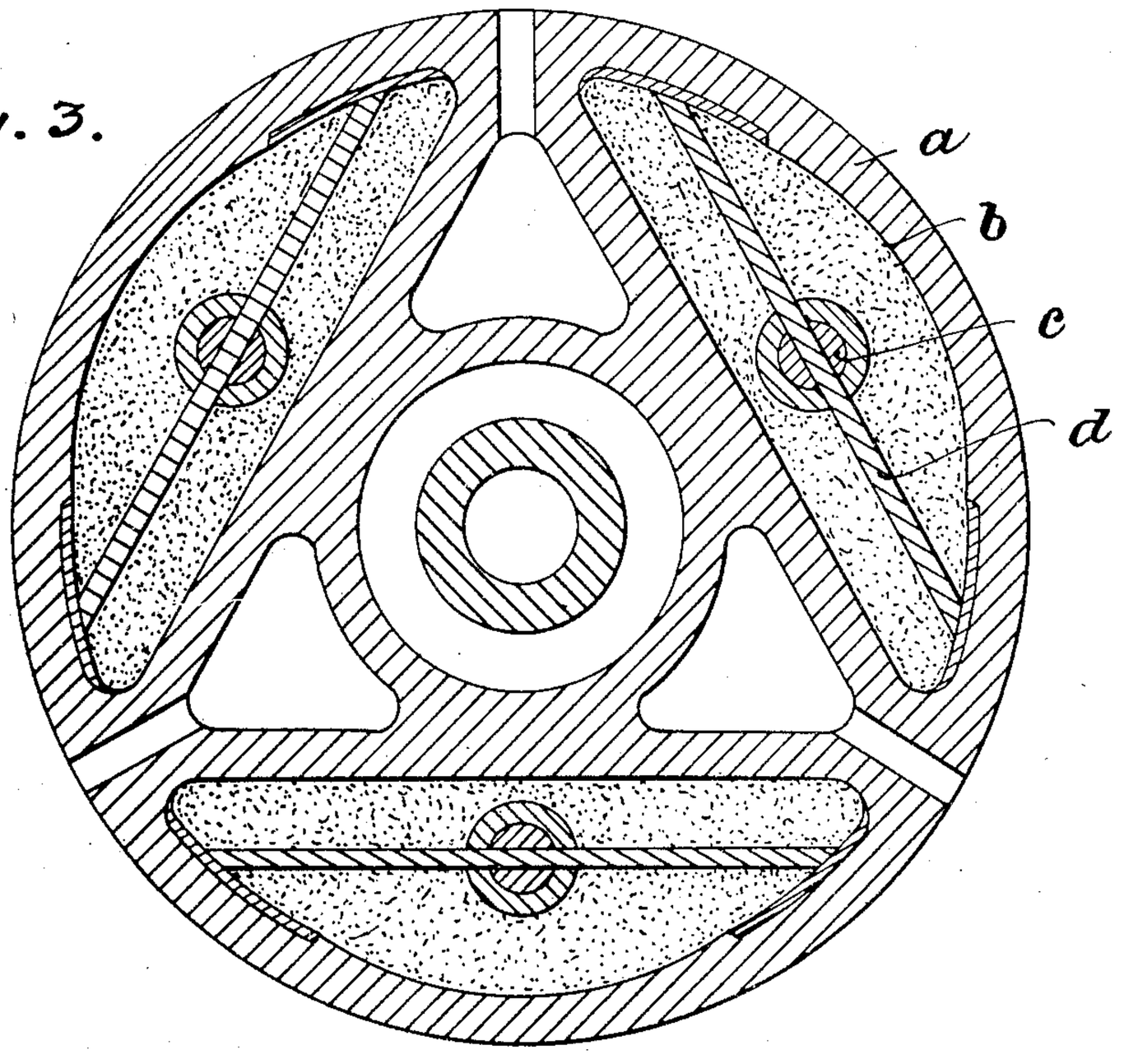
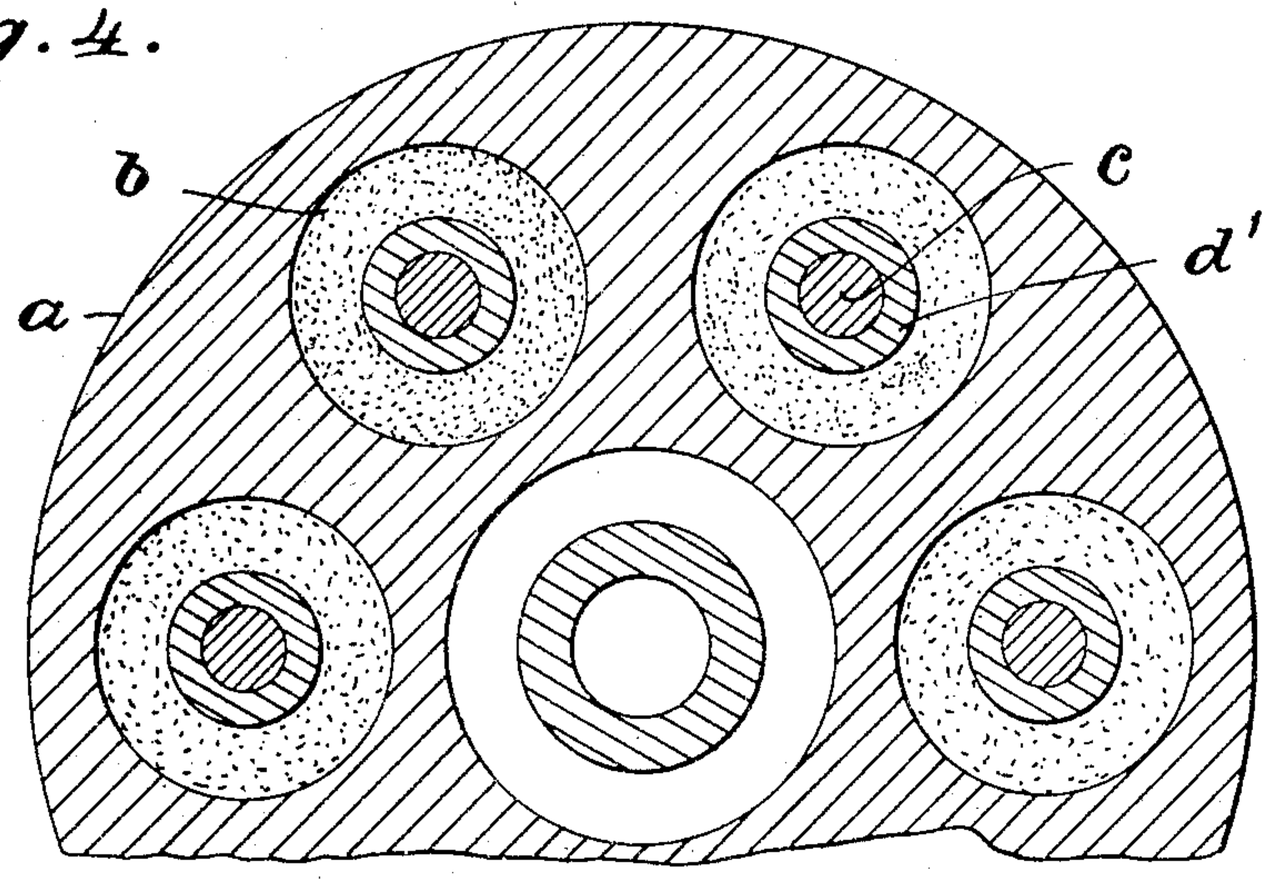


Fig. 4.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 7

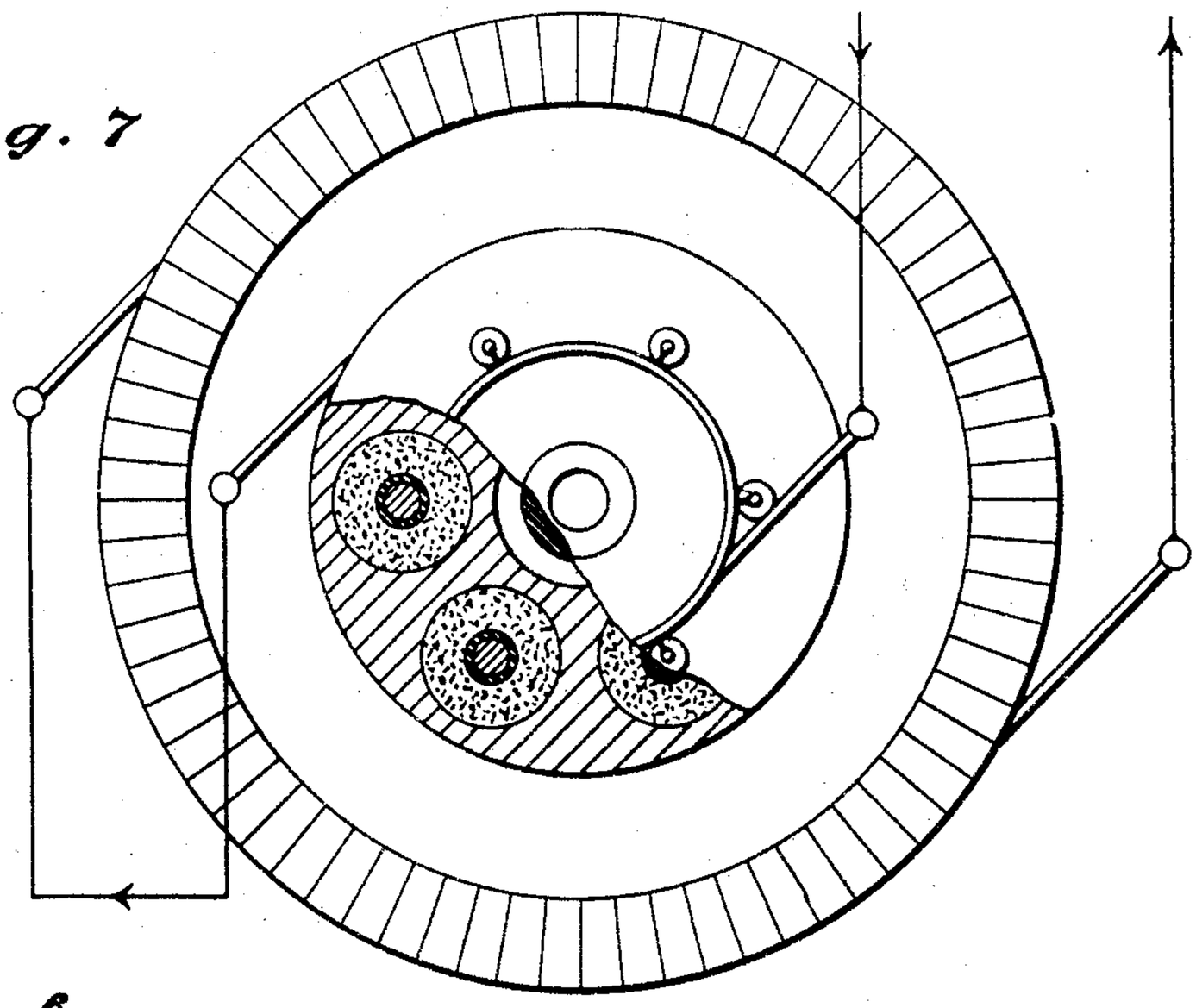


Fig. 6.

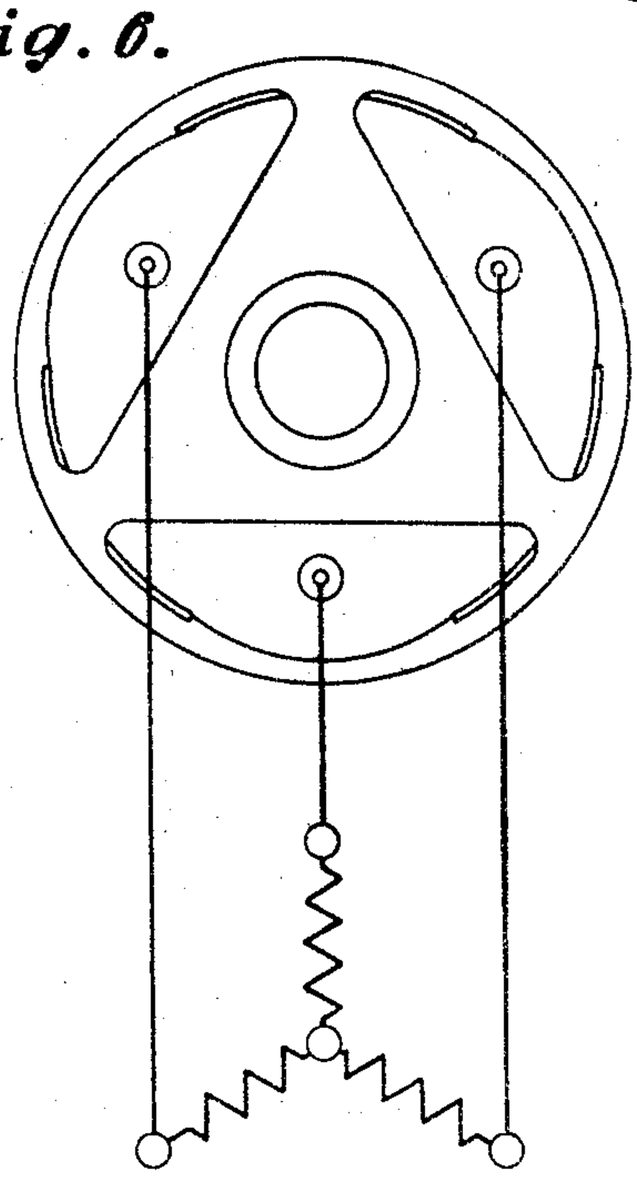
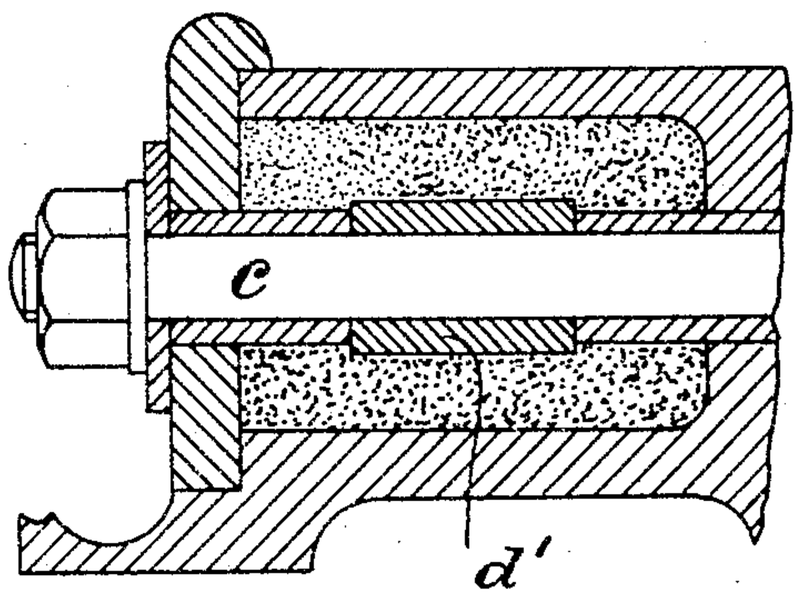


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHAN JETMUND THORESEN, OF BYGDÓ, NORWAY.

APPARATUS FOR AUTOMATICALLY STARTING ELECTROMOTORS AND FOR REGULATING PURPOSES.

SPECIFICATION forming part of Letters Patent No. 777,759, dated December 20, 1904.

Application filed December 2, 1902. Serial No. 133,638.

To all whom it may concern:

Be it known that I, JOHAN JETMUND THORESEN, a subject of the King of Sweden and Norway, residing at Bygdó, near Christiania, Norway, have invented certain new and useful Improvements in Apparatus for Automatically Starting Electromotors and for Regulating Purposes; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

For the starting of induction-motors it is customary, as known, to insert non-inductive resistances in the secondary circuit of the motor, also called the "rotor." This is made with a view of preventing, on one hand, momentary fluctuations of the tension in the circuit and to secure, on the other, a greater turning moment (torque) at the start by reducing the difference of phase between current and tension in the rotor. The turning moment, as known, is proportional to the product of the intensity of field by that part of the rotor-current which corresponds in phase with the tension of watt-current of the rotor. Such resistances may be placed within the secondary core of the rotor, in which case particular means have been provided for placing the resistance in short circuit. If the resistance be located outside the motor, sliding rings are provided upon the rotor and the rotor-current is directed from the brushes through suitable wires to a starting resistance. As resistance material iron or some alloy has been employed in most cases in the form of coils which for not being perfectly non-inductive are liable to impair the turning moment of the motor.

The object of the present invention is an apparatus designed for the purpose above stated which unites with a considerably-simplified arrangement the advantage of operating automatically.

The invention is characterized by the employment of a powdered or granulated resistance material lodged in closed spaces provided in some rotating part and consisting, preferably, of carbon or any other material behaving in a similar way. Carbon powder, as will hereinafter be explained, possesses properties which make it particularly fit for the employment here in view. In operation these resistance-boxes act as the velocity of rotation increases to diminish the resistance owing to the pressure produced by the centrifugal force, so as to permit of automatically cutting out the resistance.

Referring to the annexed drawings, which illustrate some constructional forms of a starting apparatus embodying the present invention, Figures 1 to 3 show, respectively, an axial section, end elevation, and cross-section of an apparatus for three-phase current. Figs. 4 and 5 illustrate a modification. Fig. 6 is a line diagram, and Fig. 7 is a diagram illustrating the application of this invention for continuous current.

The apparatus consists of a cast-iron cylinder *a*, wedged upon one end of the rotor-shaft and which may, if desired, also be used as a pulley. Symmetrically located in this cast-iron cylinder are three or more chambers or boxes *b* for reception of the resistance material, the arrangement being preferably as follows: Extending centrally through each box is a bolt *c*, which is insulated from the iron cylinder and provided at its center with a plate *d*, offering a contact-surface for the resistance material, which is besides in contact with the walls of the boxes. These bolts are directly connected to outtake-cables *e* from the windings of the rotor. In connection with each of the contact-bolts is mounted outside the box a metal segment *f*, Fig. 2, which is insulated from the cylinder.

Mounted on a guide-screw *g* between each two contact-segments is a movable metal piece *h*, held fast as long as the rotor is at rest by spiral springs *i*, which press it toward the

center, but forced outwardly by the centrifugal force when the rotor obtains a certain velocity, so as to place the contact-segments, and consequently the resistance lodged in the boxes, in short circuit. The pressure of the spiral spring may be varied by means of the screw.

Screwed upon one end of the cylinder is a cast-iron lid closing the resistance-boxes against the atmosphere, and upon the other end is screwed a lid for the short-circuit-closing device.

The resistance material consists of a finely-pulverized and carbonized coal or graphite, with which the boxes are filled up and packed to a certain degree of density. This material forms a perfectly non-inductive resistance offering a large radiating-surface for the generated heat. By experiments I have found in this material a quality which makes it particularly fit for application as a resistance when used in the way above stated. The resistance ought, in fact, to be cut out—*id est*, to decrease in proportion as the velocity increases—and in the present types of apparatus this is usually operated manually. In the apparatus forming the object of this invention the operation is as follows: In proportion as the velocity of rotation increases the centrifugal action will force the carbon particles outwardly, thereby generating between the contacts and the carbon a pressure which increases in proportion with the second power (the square) of the speed, and this increasing pressure acts by improving the contact to reduce the resistance of the material. By measuring the resistance in this apparatus I have found that it decreases approximately in direct proportion to the velocity. As the intensity of current used in these experiments was very low, the variation which the resistance underwent could only be due to the increased pressure generated by the centrifugal force. By currents of higher intensities I found that the heat when not exceeding a certain limit only produced a constant decrease of resistance from zero to the maximum velocity of the rotor. If the temperature exceeds a certain maximum degree—that is to say, if the starting be prolonged, owing to a heavier load, the resistance will decrease in a more rapid progress.

The variation of resistance due to the heating of the material is insignificant unless the temperature be raised above a certain maximum degree. In this case a very rapid decrease of resistance will ensue. This fact will facilitate the starting, since the greater be the desired turning moment the less resistance is required and the greater must be the amount of energy transformed into heat in the apparatus.

It is evident that the size of the apparatus must depend upon the load to be started, for the greater be the turning moment the greater is the consumption of energy and the larger must be the radiating-surface of the apparatus. Owing to the particular construction of the apparatus, the radiating-surface is very large relatively to the size of the apparatus.

When the segments are to be connected in short circuit, the resistance in the apparatus will be sufficiently reduced to allow of a sparkless connection. The decrease of resistance being directly proportional with the velocity of rotation, it is evident that the starting may be effected with a practically constant intensity of current and a constant turning moment.

In the constructional form hereinbefore described the apparatus is available in any case where it is not required to regulate, but only to start the motor—as, for instance, in elevators, lifts, workshop-machines, pumps, or the like. It suffices for the purpose to close the circuit by means of a switch, after which the apparatus acts automatically to cut out the resistance, and finally to connect the same in short circuit.

The modification shown in Figs. 4 and 5 differs from the arrangement of the resistances above explained by the employment of cells or boxes having a circular cross-section. This modification presents certain advantages, inasmuch as this form of the boxes conjointly with a corresponding form of the contact-pieces d' will facilitate an equal distribution in the boxes of the powdered material and its close and intimate contact with the contact-surfaces. This form of resistance-boxes is designed for use in connection with the diagram in Fig. 7, illustrating the application of this invention to a motor for continuous current.

From the drawings it will easily be seen that the invention may also be used for regulating purposes where the speed of rotating parts of machines and the like are to be regulated. In this case the apparatus is applied in such a way that it takes part in the rotation of the machine to be regulated, and the intensity of current sent through the apparatus will thereby be varied according to the speed of said rotating part, and this current may then be used for operating a regulating device for the machine.

I claim—

1. In an apparatus for automatically starting electromotors and for regulating purposes, the combination with a rotating part, of one or more chambers formed in the same and containing a powdered or granulated resistance material and conductors in contact with separate parts of the said material.

2. In an apparatus for automatically starting electromotors, and for regulating purposes, the combination with a rotating part of one or more chambers formed in the same and

containing a powdered or granulated resistance material and an automatic short-circuit device in connection with the said conductors, substantially as described.

3. In an apparatus for automatically starting electromotors and for regulating purposes a pulley, one or more chambers formed in the same and containing a powdered or granulated resistance material and conductors in contact with separate parts of the said material.

In witness whereof I have hereunto set my hand in presence of two witnesses.

JOHAN JETMUND THORESEN.

Witnesses:

HENRY BORDEWICH,

JAN VAAK.