PATENT SPECIFICATION

209,735

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COMPLETE SPECIFICATION.

Improvements in and relating to a Device for the Synchronisation of and the Prevention of Hunting in Single Phase and Polyphase Alternating Current Synchronous Machines, more particularly as Applied to Clocks.

I, ROBERT MICHL, of Ederova Ulica 6, Elektrana, Kosice, Slovakia, of Czecho-Slovakian nationality, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

As is well known, small electric alternating current synchronous motors can be synchronised by simply causing them by hand to run, when excited by the working current, at as nearly synchronous a speed of revolution as possible, until synchronism is obtained, that is, the motor has got into phase with the working current. This method, however, is inconvenient and uncertain, as usually the attempt must be repeated a number of times before it is successful. What is required therefore is an arrangement, by which synchronism may be obtained at once with certainty both by hand and automatically. Such an arrangement forms the subject of the present invention. It is characterised by the feature that for the synchronisation of and the prevention of hunting in single phase and polyphase alternating current synchronous machines, the rotor is given a moment of inertia, which increases and decreases with the speed of revolution of the same.

For this purpose centrifugal weights or pendulums may for instance be used, such as are commonly used in speed governors. These weights or pendulums, referred to below as "synchronising pendulums", may also be used for other purposes, for instance for automatic starting, for operating the switch of the starting motor and the like.

The accompanying drawings show a number of examples of how the invention may be applied and further modifications, the magnetic part of the synchronous machine being omitted, as applied to small synchronous motors, which may be used for the electric operation of clockwork mechanisms and the like, Figures 1 and 2, 3 and 4, 7 and 8 being three examples, in which the starting of the synchronous motor is effected by hand, while Figures 5 and 6 show an example, in which the synchronising pendulum for self-starting operate the starting switch and at the same time a clockwork mechanism. Figures 9 and 10 show a further modification of the starting electromagnet.

The synchronising pendulums a in Figures 1 and 5 swing under the influence of centrifugal force about the pins b in a plane passing through the axis of rotation. The same applies to the pendulums a^1 of Figures 3 and 4, but in this case the weights have not the form of balls as in Figures 1 and 5, but, for economising space, are made in the form of segments of a circular disc, which for the same reason move without a shaft on sliding surfaces at right angles to the axis and are not kept in a state of equilibrium with the centrifugal force as in Figures 1 and 5 by their own weight, but by spring action.

In the example shown in Figures 7 and 8 the synchronising pendulums a^2 are shown in Figure 8 from below and are mounted on the under surface of the disc-shaped rotor c of the synchronous motor, so as to rotate about the pins or bolts d. Owing to this arrangement the pendulums move under the action of the forces in a plane at right angles to the axis of rota-

[Price 1/-]

tion. By this arrangement, not only the centrifugal forces due to the rotation, but the forces resulting from the movement and inertia of the synchronising pendulums a^2 act in the same direction as the centrifugal forces, which latter forces are thereby magnified.

If the rotor of a single or polyphase synchronous motor or generator be provided with the synchronising pendulums a, a^1 and a^2 shown in Figures 1, 3, 4, 5, 7 and 8, according to one of the arrangements referred to, it is sufficient to bring it, when excited, either by hand or by motive power, to a speed of revolution, which is not less than the synchronous speed. The getting into phase is effected automatically by the action of the synchronising pendulums, while at the same time the pendulums prevent hunting and a getting out of phase. In the case of small synchronous motors, such as are for instance used for driving clockwork mechanisms, the motor may be started readily by hand by means of the devices shown in Figures 1, 2 and 7 and in the case of Figures 1 and 2 by the pawl e, together with the corresponding inertia and centrifugal pendulum f, which are mounted with the cam swell h on the sleeve g, being pressed by the second cam swell h^1 by means of the milled head, i, until the two cam swells cease to engage owing to their rotary motion, and the sleeve g together with the pawl e and the pendulum f is caused to spring back through the action of the spring k, which has been tensioned at the same time, the pawl e being forced by the inertia and the centrifugal force of the pendulum f to engage with the ratchet wheel l, which is fixed to the rotor c, and the latter, together with the synchronising pendulums a being caused to rotate. The pawl e is caused to disengage from the ratchet wheel l by the inertia of the pendulum f at the moment, in which the cam swell h strikes against the stop m, on the spring k contracting again. In the hand-starting device shown in Figure 7 the rotation of the milled head i^1 by hand is transmitted through the two toothed wheels n and n^1 directly by way of the pawl e and the pendulum f, which is not shown, to the rotor c.

For the self-starting of a synchronous motor, the synchronising pendulums a may be combined in the manner usually employed in the case of centrifugal governors, and, as is shown by way of example in Figure 5, with a sliding sleeve o, by means of which, through the contact lever p, the switch for an electromagnetic starting device and other apparatus may be operated, by the balance wheel z of a clock mechanism, as shown by way of example in Figure 5, being locked and released, which mechanism in the case of the operation of an electric clock takes over the driving of the mechanism operating the hands, when the drive of the clock is temporarily interrupted. In the diagram of connections according to Figure 5, w and w^1 are the terminals of the driving alternating current and x is the winding of the synchronous motor, while y and y^1 are the fuses. The electromagnetic starting device may in this case consist, as is shown for instance in Figs. 5 and 6, of an electromagnet q, the armature r of which transmits its attractive force through the lever s, the pawl e and the pendulum f, already described in connection with the hand starting device, and the ratchet wheel l to the rotor c. For putting the synchronous motor into operation, a single movement of the armature r will usually be found to be sufficient, but this movement can be converted into a periodically oscillating one, by the provision of a contact-making device operated by the said armature, which breaks the circuit, when the armature is attracted and closes the circuit again when it swings back, which oscillating movement lasts as long as the circuit is closed by the contact lever p.

In the example shown in Figure 9 and 10 of the electromagnetic starting device, the pawl e and the pendulum f^1, which controls the pawl directly, for instance by its inertia, are mounted on a two-armed armature r^1, which is mounted symmetrically on the shaft t, by which means, not only the mechanical transmission resistances between the electromagnet armature and the pawl e are overcome, but, owing to the short path of the magnetic lines of force between the two poles n and n^1 of the electromagnet v through the armature r^1, the magnetic stray field becomes very small and consequently the action of the magnet becomes very strong.

In the case of larger synchronous motors, which can no longer be started by the electromagnetic starting device described, it is preferable to use one of the well-known alternating current motors starting under load, for instance a commutator motor having a main current field winding connected in series.

The synchronising pendulums described above can also be used for preventing hunting and a getting out of phase in the case of larger synchronous generators and motors as well, in which the synchronisation is to be effected with the means ordinarily employed for this pur-

pose, such as phase volt meters, phase lamps and the like.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A device for the synchronisation of and the prevention of hunting in single phase and polyphase alternating current synchronous machines, characterised by the feature, that the rotor of such machines is given an inertia moment, which increases and decreases with its speed of revolution.

2. A device as claimed in Claim 1, characterised by the feature, that the shaft of the synchronous motor is combined with centrifugal pendulums, or with centrifugal and inertia pendulums.

3. A device as claimed in Claims 1 and 2, characterised by the feature, that the adjustable ring of the centrifugal pendulum acts as the means for controlling the switch of the starting motor and other devices (for instance for stopping and starting a clockwork mechanism).

4. A device as claimed in Claims 1 to 3, characterised by the feature that, by coupling the pawl with the flyweight, the locking pawls are caused to engage automatically by their persistance of motion, on the auxiliary force coming into operation, and are automatically released again by the centrifugal force, after the said auxiliary force has ceased to act.

5. A device as claimed in Claims 1 to 4, characterised by the feature that, for the purpose of obtaining automatic starting in the case of small synchronous motors, that is, for causing them to get up speed, the lift of the armature of an electromagnet or of the iron core of a solenoid is used.

6. A device as claimed in Claims 1 and 5, characterised by the feature that, for starting the synchronous motor, a pawl is mounted directly on the armature, which is rotatable about its axis.

Dated this 4th day of January, 1924.

MARKS & CLERK.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1924.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

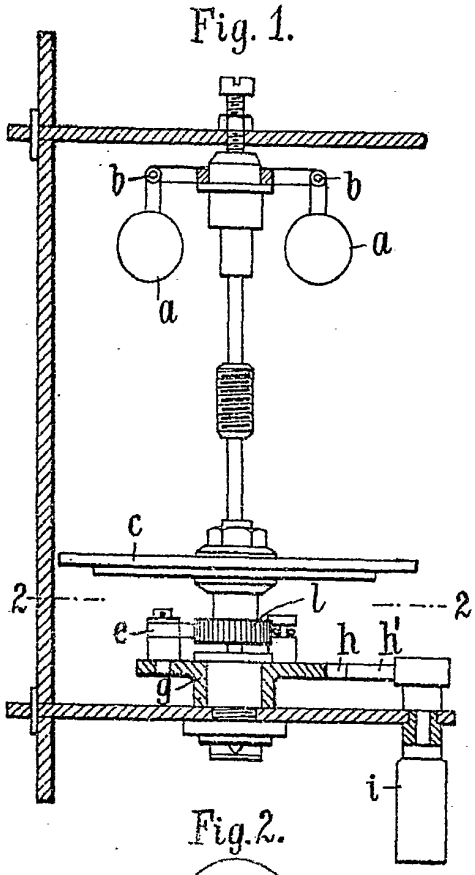


Fig. 3.

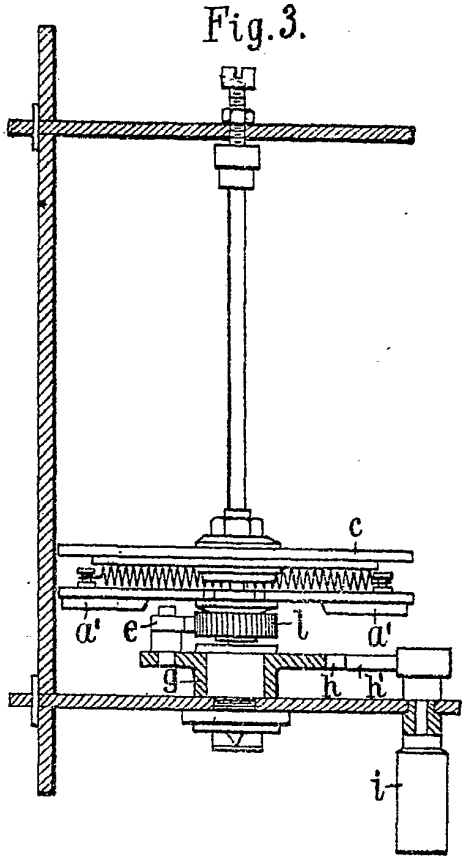


Fig. 2.

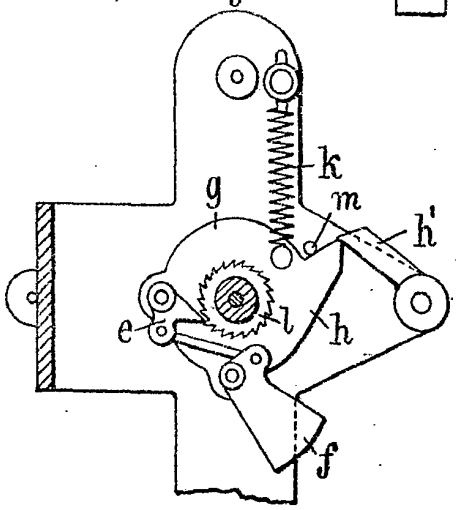


Fig. 4.

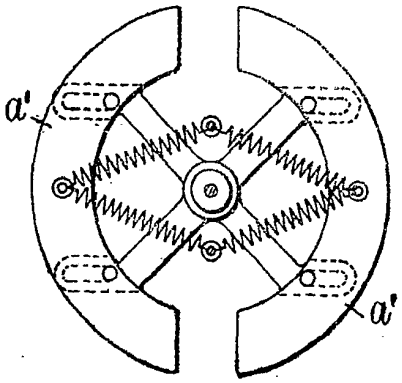


Fig. 5.

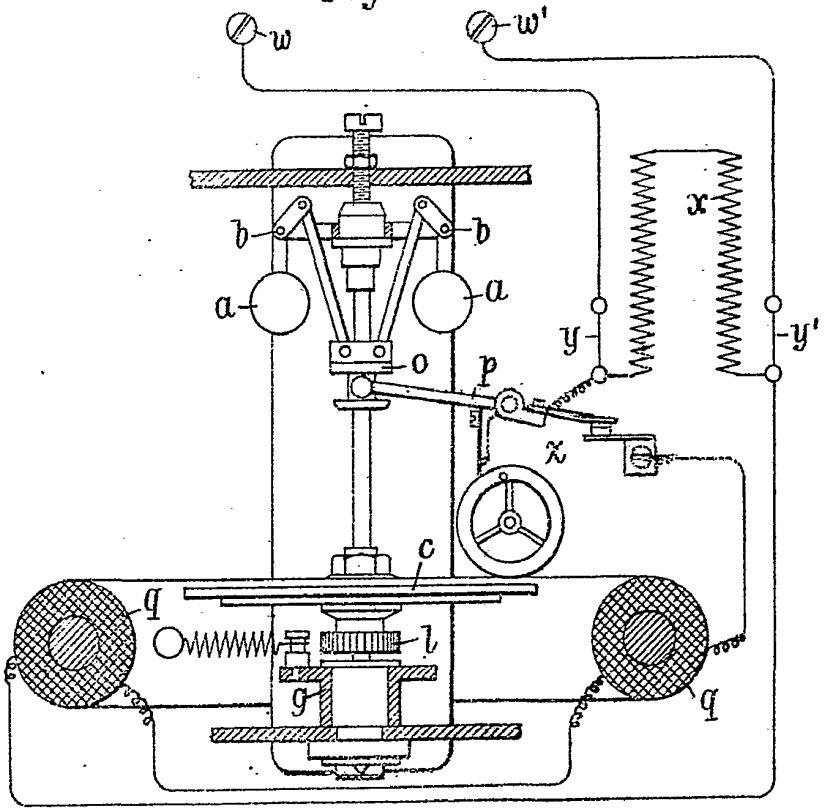
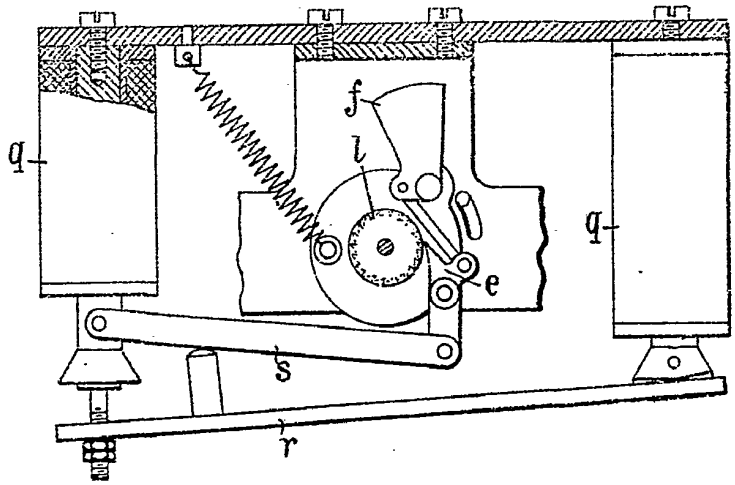


Fig. 6.



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SHEET 1

Fig. 1.

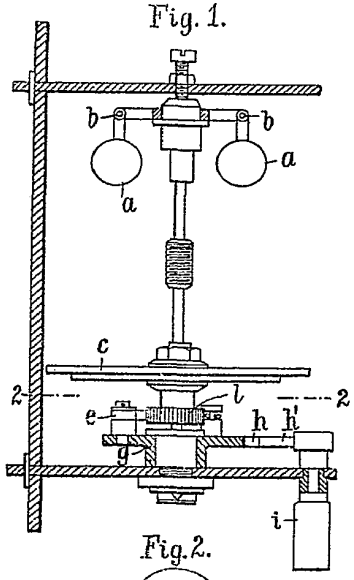


Fig. 3.

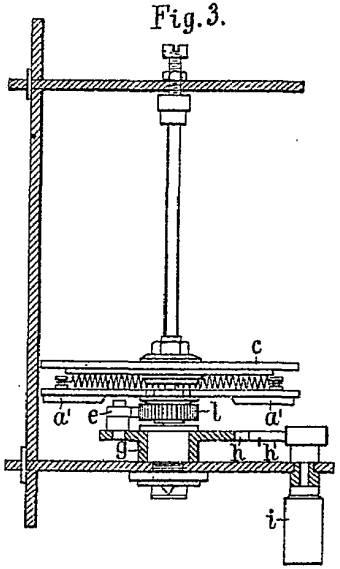


Fig. 2.

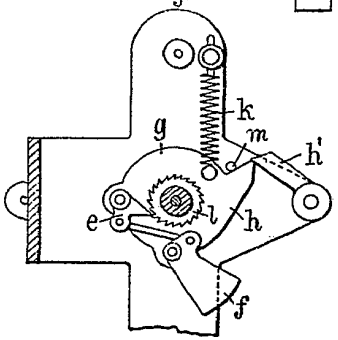
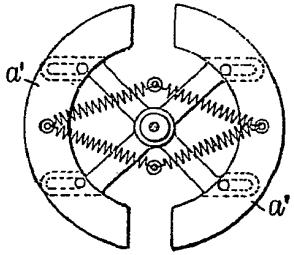


Fig. 4.



SHEET 2

Fig. 5.

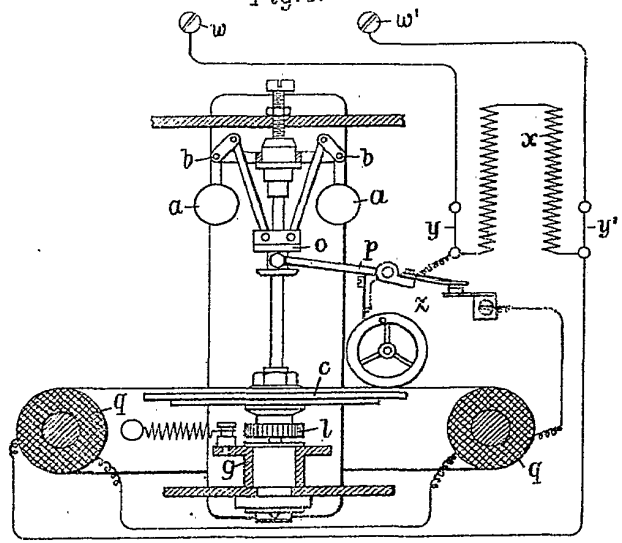


Fig. 6.

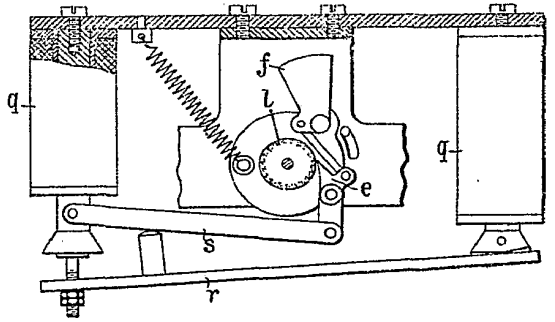


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Fig. 7.

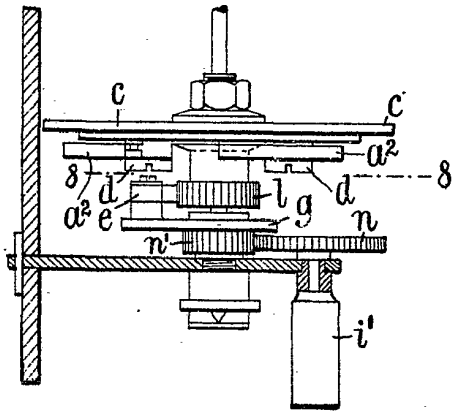


Fig. 8.

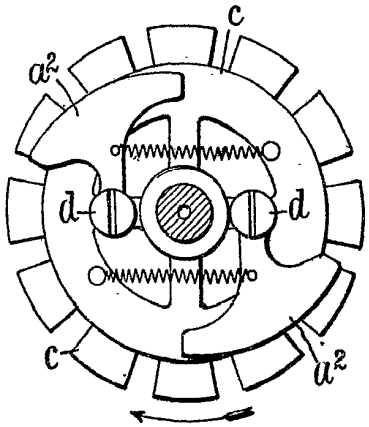


Fig. 9.

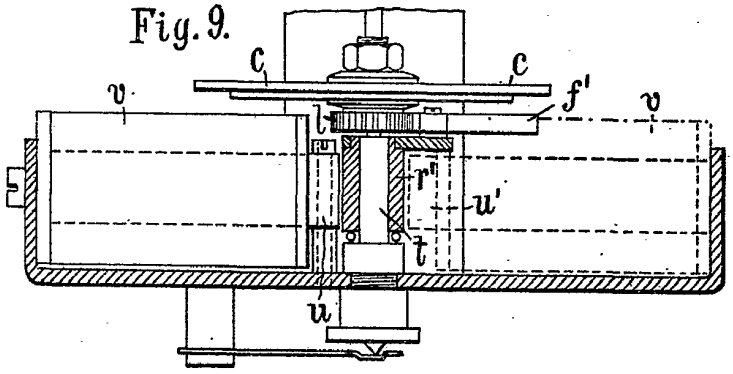
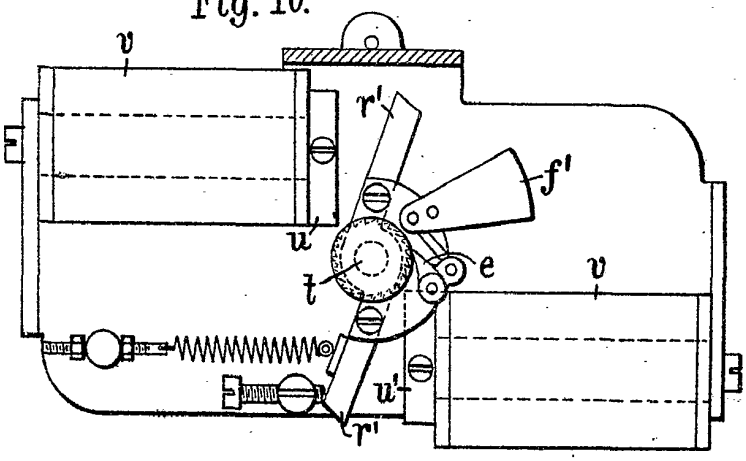


Fig. 10.



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