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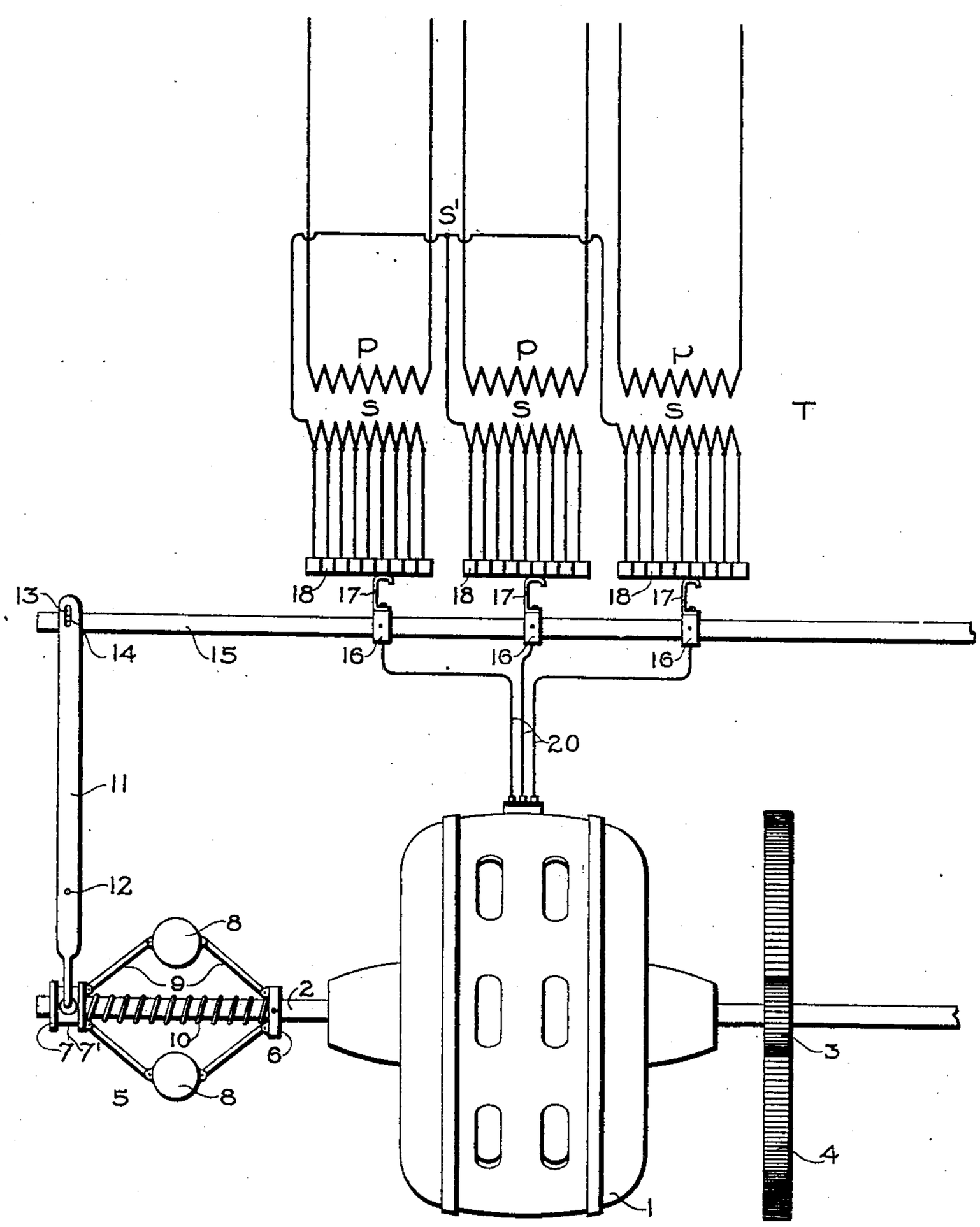
H. S. MEYER.

AUTOMATIC REGULATOR FOR MOTORS.

APPLICATION FILED SEPT. 4, 1902.

NO MODEL.



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No. 762,738. Patented June 14, 1904.

UNITED STATES PATENT OFFICE.

HANS S. MEYER, OF RUGBY, ENGLAND, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

AUTOMATIC REGULATOR FOR MOTORS.

SPECIFICATION forming part of Letters Patent No. 762,738, dated June 14, 1904.

Application filed September 4, 1902. Serial No. 122,051. (No model.)

To all whom it may concern:

Be it known that I, HANS S. MEYER, a subject of the Emperor of Germany, residing at Rugby, England, have invented certain new and useful Improvements in Automatic Regulators for Motors, of which the following is a specification.

My invention relates to improvements in alternating-current motors, and particularly induction-motors.

In induction-motors of the ordinary type, as is well known, the torque exerted at starting is generally less than that at a speed which approaches synchronism. For motors which start under load or partial load, and especially for motors in which the starting load is greater than the normal running load, it is necessary to provide means whereby the starting torque may be increased. One way in which this has been accomplished is by inserting resistance in the rotor-circuit. This has the effect of increasing the starting torque, and if the resistance be rightly proportioned the torque of the motor may be at its maximum when the rotor of the motor is at a standstill. The effect of this resistance, however, is to impair the efficiency of the motor when running at the normal speed, and when used the torque at full speed is less than that at zero speed or at some intermediate speed, depending upon the amount of resistance inserted, as is well known in the art. It therefore becomes necessary to cut out the resistance as the speed of the motor increases where this resistance is employed in a sufficient quantity to give a large starting torque, and this of course complicates the operating mechanism of the motor; but in any event the maximum torque which may be obtained with any given voltage of impressed electromotive force is limited, and if a torque is desired above such a limit it is necessary to increase the electromotive force impressed upon the terminals of the motor, it being well known that the torque of an induction-motor varies approximately with the square of the impressed voltage. Under certain conditions—as, for instance, in railway-service—the load on the motor while bringing the car up to speed is considerably greater than the load carried by the motor in keeping the car up to speed when speed has once been obtained. In this case if the voltage at full speed is decreased, the load then being light, as above stated, the energy losses in the motor are less than if the voltage is maintained at the same value.

In a prior application I have disclosed an induction-motor-regulating device for automatically regulating the potential at the motor-terminals, so as to cause it to increase with an increase of the load and to decrease with a decrease of the load, which is controlled in its operation by the current flowing through the primary member of the motor.

The object of the invention disclosed in the present application is to provide an induction-motor-regulating device which shall vary the potential so as to cause it to decrease with an increase of the speed of the motor and to increase with a decrease of the speed and which shall be controlled in operation by the speed of the motor.

In the accompanying drawing I have illustrated one form of my invention.

A three-phase induction-motor is designated by the numeral 1, the shaft 2 of which carries at one end the gear 3, which meshes with the gear 4 of the mechanism to be operated by the motor. A centrifugal governor 5 of the ordinary type is placed on the shaft 2 and comprises a sleeve 6, secured to the shaft 2, a sleeve 7, loosely mounted on the shaft 2, weights 8, links 9, connecting the weights with the sleeves, and a spiral spring 10 for normally separating the sleeves 6 and 7. The sleeve 7 is provided intermediate its ends with a peripheral groove 7′. A forked lever 11 is pivoted at 12 to some fixed part of the supporting structure. The forked portion (not shown) of the lever 11 straddles the grooved sleeve 7, engaging the walls of groove 7′, so that as the sleeve moves back and forth on the shaft 2 the lever 11 is oscillated about its pivot 12. The other end of the lever 12 is provided with a slot 13, the walls of which are engaged by a pin 14, carried by a reciprocating rod 15. The reciprocating rod 15 carries three holders 16. The holders 16 are each provided with a contact-piece or switch 17, which engages contact-blocks 18. The contact-blocks 18 are

divided into three groups corresponding to the three switches 17 and are so placed that the outer block of each group will just be reached by the appropriate switch 17 when it is at the limits of its travel due to the reciprocation of the sleeve 7. Each switch 17 is connected to a line 20, which in turn is connected to the stationary winding of the motor in the usual manner. The contacts or switches 17 are each insulated from the other and from the framework of the machine.

A three-phase transformer is shown at T. The three primary coils or windings P of the transformer are adapted to take current from some three-phase source of current. (Not shown in the drawing.) The three secondary windings S have one side each connected to a common neutral point S'. The same side of each secondary winding is also connected to the left-hand contact-block of the appropriate group of contact-blocks 18. It will be observed that these groups of contact-blocks 18 and the switches 17 correspond one each to one of the secondary windings S. The other end of each secondary winding is connected to the right-hand contact-block of its appropriate group. The intermediate coils or groups of coils of each secondary winding are connected in regular order to the intermediate contact-block of the appropriate group.

The operation of the apparatus described is as follows: At starting, the weights 8 of the governor under the influence of the spring 10 will lie against the shaft 2. The sleeve 7 will be at the extreme left at the limit of its motion in that direction, and the contacts or switches 17 will be at the extreme right in contact with the last block 18 of each group, so that the voltage impressed upon the terminals of the motor will be that due to the full number of coils arranged in series of the secondary windings S. As the speed increases, the lower end of the lever 11 will move toward the right under the influence of the governor and the switches 17 will move toward the left, cutting out coils of the secondary winding S, so that the voltage impressed upon the terminals will decrease as the speed of the motor increases.

While I have shown in the drawing the governor and the switches so placed that the voltage impressed upon the terminals of the motor will vary from the maximum starting voltage to zero voltage as the speed of the motor varies from zero to a maximum, yet it is readily apparent that the contact-blocks 18 may be so positioned that the voltage impressed upon the motor-terminals will not vary uniformly with the speed, but may be so arranged that the voltage at any speed may be of any desired value, and in practice the voltage impressed upon the motor-terminals when the maximum speed is reached is a considerable proportion of the starting voltage.

In practice the switches 17 and contact-blocks 18 may be arranged to operate in oil, and the governor 5 instead of being placed on the shaft of the motor may be placed on any rotating shaft of the mechanism.

Instead of continually decreasing the impressed voltage from a maximum at starting to a minimum at the maximum speed it may be desirable in some cases to have the coils so arranged that the maximum voltage will be obtained at some other predetermined speed.

While my invention is of general application to alternate-current motors, it possesses especial advantages for use in railway-service. To take a concrete example, suppose an electric car equipped with an induction-motor which is designed to give a starting torque of two or three times its normal full-speed torque when supplied with a normal voltage of five hundred volts. Such a motor would take a magnetizing-current of about twenty to thirty per cent. of the current corresponding to the full-load rate. Suppose also this car is provided with a transformer, the primaries receiving current at a voltage of five thousand, the secondaries to have divided coils, and the number in series to be controlled by a governor applied to the axle of the motor or of the car or to some other moving part. Now if the voltage given by the secondaries at starting is seven hundred the starting torque would be about doubled, or, in the case in hand, raised to from four to six times the torque at normal speed. Such a torque is often required in starting railway-cars. If this voltage were maintained, however, the internal losses in the motor due to the magnetizing-current would be much increased, as this current varies approximately with the impressed voltage, and hence would be about forty per cent. greater at seven hundred volts than at five hundred volts. As the car runs up to average speed the voltage is decreased to the average voltage of five hundred through the action of the governor, and the motor losses are decreased accordingly, and as in railway service the load on the motor at high speed is usually less than that at average speed the governor-actuating-switch mechanism could be set to reduce the voltage to less than five hundred, with a corresponding saving in the motor losses. In this arrangement, the variation in the voltage being obtained automatically, no additional work or skill is required of the motorman.

Instead of continually decreasing the impressed voltage from a maximum at starting to a minimum at the maximum speed it may be desirable in some cases to have the coils so arranged that the maximun voltage will be obtained at some other predetermined speed.

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

1. The combination of a source of current, an induction-motor connected thereto, and automatic means controlled by the speed of

the motor for decreasing the voltage of the current source as the speed of the motor increases.

2. The combination of an induction-motor, a transformer for supplying the motor with current, and automatic means controlled by the speed of the motor for increasing the ratio of transformation of said transformer as the speed increases.

3. The combination of an induction-motor, and automatic means controlled by the speed of the motor for impressing upon the motor a voltage decreasing in response to increases of speed of the motor.

4. In combination, a transformer having primary coils and secondary coils, an induction-motor operated by the current from the secondary coils, and automatic means controlled by the speed of the motor for varying the ratio of transformation between the primary and secondary coils so as to increase said ratio as the speed of the motor increases and to decrease said ratio as the speed of the motor decreases.

5. In combination, a transformer having primary and secondary windings, the secondary winding having a plurality of coils in series, an induction-motor receiving current from the secondary coils, and automatic means controlled by the speed of the motor for decreasing the number of active coils in the secondary windings according to a fixed law as the motor speed increases.

6. In combination, a transformer having primary and secondary windings, the secondary winding comprising a plurality of coils in series, an induction-motor receiving current from the secondary winding of the transformer, a centrifugal governor device operated by the motor, and means operated by the said governor device to reduce the number of active coils in the secondary winding according to a predetermined law as the speed of the motor increases.

In witness whereof I have hereunto set my hand this 20th day of August, 1902.

HANS S. MEYER.

Witnesses:

LEONORE RASCH,

A. M. SIMON.