

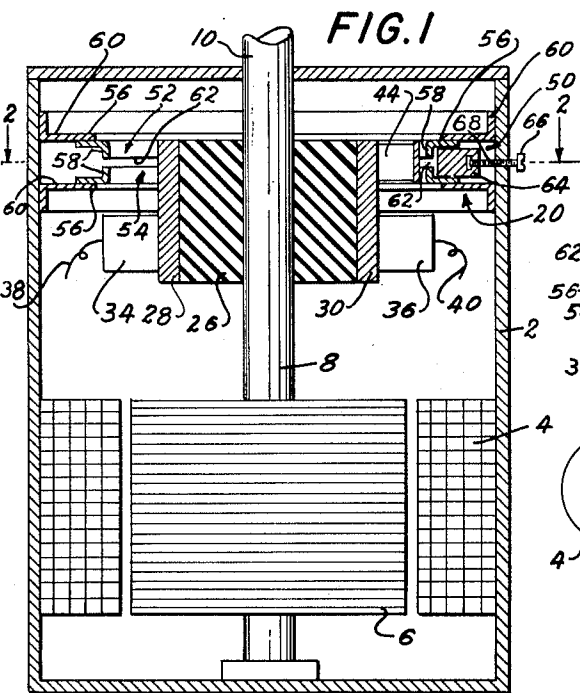
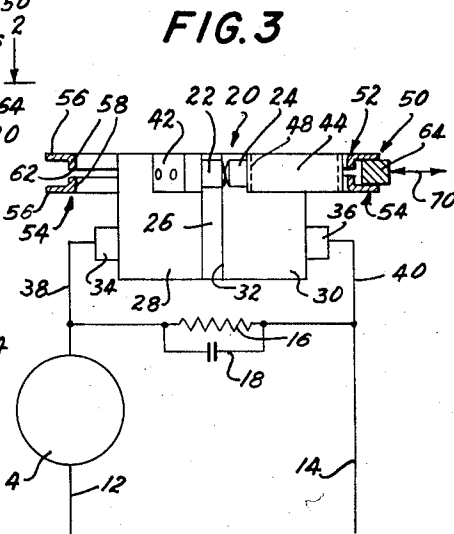
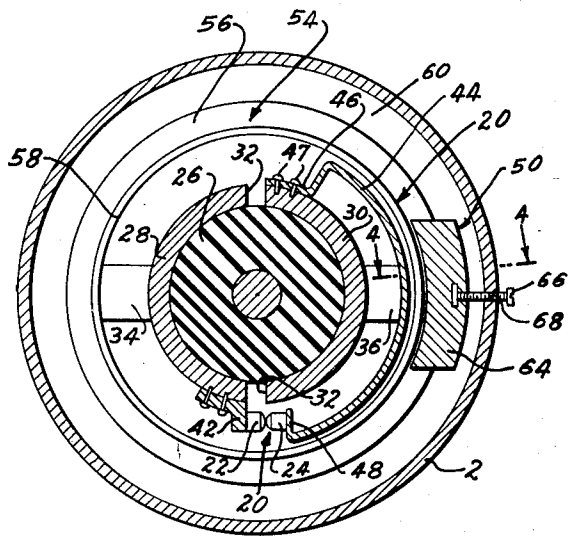
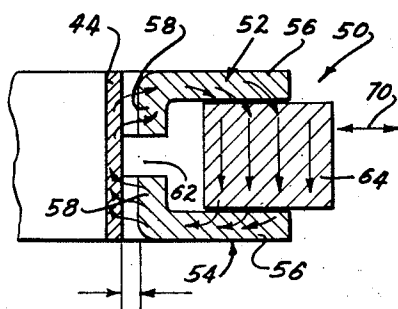
May 6, 1958

J. M. NAUL

2,833,879

SPEED REGULATOR

Filed Jan. 4, 1956



INVENTOR
JAMES M. NAUL

BY *James and Franklin*

ATTORNEY

1

2,833,879

SPEED REGULATOR

James M. Naul, Plainfield, N. J., assignor to Eastern Air Devices, Inc., Dover, N. H., a corporation of New York

Application January 4, 1956, Serial No. 557,289

11 Claims. (Cl. 200—80)

The present invention relates to a device for regulating the speed of operation of an electric motor or the like, and in particular to one in which the regulated speed may be varied even while the motor is in operation.

It is quite common to use the centrifugal force developed in the rotation of an electric motor or the like to control the speed of operation of that motor. A well known type of device useable for that purpose is one in which a pair of contacts are resiliently biased toward one another and are adapted to be moved away from one another by centrifugal force, the opening and closing of the contacts controlling appropriate circuitry so as to cause the motor to slow down or speed up. When the motor is operating at a speed such that the centrifugal force tending to separate the contacts balances the biasing force tending to cause the contacts to become engaged, the motor will continue to operate at that speed. Any increase in speed will immediately cause the contacts to open and the motor will slow down. Any decrease in speed will cause the contacts to close and the motor to speed up. The contacts, when the motor is operating at its desired speed, rapidly alternate between engaged and separated positions, the time intervals of separation and engagement being such that the speed of the motor is, to all intents and purposes, constant.

With a device of this kind the speed at which the motor will run is determined by the force with which the contacts are biased toward one another. If that force is weak, the counterbalancing centrifugal force will be attained when the motor operates at a relatively slow speed, whereas if the biasing force is strong the motor will have to rotate more rapidly in order to produce a counterbalancing centrifugal force. Thus if the biasing force is raised the speed of operation of the motor is correspondingly varied. However, since the contacts themselves will usually rotate when the motor is in operation, adjustment of the biasing force usually cannot be carried out until the motor has come to a stop. This represents a substantial disadvantage insofar as use of devices of the type under discussion is concerned, such devices being otherwise extremely desirable because of their small size and inexpensiveness.

The present invention has for its object the provision of means by which the biasing force may be varied at any time, whether the motor is operating or not, thus enabling a centrifugally sensitive device of the type under discussion to be used in applications where frequent changes in speed are required while the motor continues to run.

In accordance with the present invention this is accomplished by applying two opposing biasing forces to the movable contact, one such force being substantially constant and derived from a spring or the like and the opposing force being variable and being magnetic in nature. The spring, since it must be physically active upon the contacts, rotates with the contacts. The magnetic force, however, is derived from stationary structure which is nevertheless operatively active upon the movable struc-

2

ture. The stronger that magnetic force, the less is the resultant biasing force active on the contacts, and consequently the slower need the motor operate in order for the centrifugal force produced thereby to counterbalance said resultant biasing force.

In the form here specifically disclosed the opposing magnetic force is derived from a permanent magnet which may be adjustably positioned in any desired manner in order to vary the strength of the operative magnetic field. However, this is but illustrative, and any desired form of variable magnetic means could be employed. For example, the magnetic means could comprise an electromagnet or a permanent magnet means could be provided with adjustable bypass elements. Other variations will suggest themselves to those skilled in the art.

The fixed resilient biasing means may comprise a leaf spring which is physically connected to one of the contacts and urges that contact toward the other. This spring, or an element operatively connected thereto, when the motor rotates, itself rotates within the magnetic field produced by the magnetic means, that magnetic field being operative thereon in such a direction as to tend to move the contact to which it is connected away from the other contact. The magnetic field is disposed circularly along the path of travel of the leaf spring or element operatively connected thereto so that the opposing magnetic bias is active on the leaf spring in a substantially continuous manner. This is accomplished by providing a pair of pole pieces in the form of rings concentric with the axis of rotation of the motor and within which and in close proximity to which the leaf spring rotates when the motor is in operation. Since the magnetic means is stationary its operative strength may be adjusted at any time and the operation of the motor will not interfere with that adjustment.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to an adjustable speed regulator as defined in the appended claims and as described in this specification, taken together with the accompanying drawings, in which:

Fig. 1 is a cross sectional view, in semi-schematic form, of an electric motor in which the present invention is embodied;

Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a schematic view of the regulator itself together with the electrical connections made thereto; and

Fig. 4 is a schematic cross sectional view taken along the line 4—4 of Fig. 2.

The motor, which is here shown only in semi-schematic manner, comprises a casing 2 having a conventional stator assembly 4 within which a rotor 6 rotates, that rotor 6 being fast on a shaft 8 which extends out beyond the casing 2 at 10. The stator 4 is adapted to be energized in any appropriate manner, as from the A. C. lines 12 and 14. Connected across the lines 12, 14 after the stator 4 is a resistor 16, bypassed by a condenser 18, as is conventional, in order to reduce sparking. The speed regulator is generally designated 20 and comprises a fixed contact 22 and a movable contact 24. The contacts 22 and 24 are connected in shunt with the resistor 16. When the contacts 22 and 24 are engaged the resistor 16 is short circuited, the amount of current which flows through the stator 4 is at a maximum, and the motor will tend to operate at an increased rate of speed. When the contacts 22 and 24 are separated the resistor 16 is placed in series with the stator 4, the current through the stator will decrease, and the motor will tend to operate at a reduced rate of speed.

Electrical connection to the contacts 22 and 24 is accomplished as follows: A hub 26 of insulating material is fast on the shaft 8. Conductive commutator segments

3

28 and 30 are secured to the hub 26, those segments being separated by gaps 32, here shown for purposes of clarity as exaggerated in circumferential length. A pair of brushes 34 and 36 are mounted on the casing 2 in any appropriate manner (not specifically illustrated) and are urged into engagement with the commutator segments 28 and 30, leads 38 and 40 connecting brushes 34 and 36 to the A. C. lines 12 and 14 respectively as shown in Fig. 3. The fixed contact 22 is physically and electrically connected to the segment 28 by means of bracket 42. The movable contact 24 is physically and electrically connected to the segment 30 by means of leaf spring 44, one end 46 of that leaf spring 44 being secured to the segment 30 by means of rivets or the like 47, the body of the leaf spring 44 being radially spaced from and extending around the segment 30 in a manner generally concentric therewith, and the other end 48 of the leaf spring 44 having the movable contact 24 secured thereto. The leaf spring 44 is here disclosed as formed of a resilient material which is magnetically attractable, but it may be formed of non-magnetic material with a magnetically attractable element fixed thereon or otherwise operatively connected thereto. The leaf spring 44 is so constructed as to resiliently bias the movable contact 24 into engagement with the fixed contact 22. When that engagement takes place a circuit is completed from A. C. line 12 through stator 4 to lead 38 and brush 34 and then from the segment 28 or 30 in engagement with the brush 34 through the contacts 22 and 24 and the leaf spring 44 to the other segment 30 or 28, and thence through brush 36, in engagement with that other segment, and lead 40 to the other A. C. line 14.

As the motor rotates the hub 26, segments 28 and 30, contacts 22, 24 and leaf spring 44 all rotate therewith. Centrifugal force will be active upon the leaf spring 44 and the contact 24 in a direction such as to urge the contact 24 away from the contact 22. When the motor is operating at a sufficient rate of speed for that centrifugal force to exceed the biasing force exerted by the spring 44, the contact 24 will move away from contact 22.

The magnetic means for providing a biasing force in opposition to that produced by the leaf spring 44 is generally designated 50. In the form here specifically disclosed it comprises a pair of rings 52 and 54 of magnetizable material, each of the rings being substantially L-shaped in cross section and comprising a radially extending portion 56 and a portion 58 extending at right angles thereto. The pole pieces 52, 54 are fixedly mounted within the casing 2, as by means of brackets 60, so that their portions 58 extend toward one another and are separated by an air gap 62, the portions 58 being axially in alignment with and radially slightly beyond the path of travel of the leaf spring 44 as the shaft 8 rotates. A permanent magnet 64 is adapted to be received between the radially extending portions 56 of the pole pieces 52 and 54, that magnet having magnetic poles of opposite polarity on its surfaces adjacent the inner surfaces of the pole piece portions 56, as may best be seen from Fig. 4. Means are provided for controlling the degree to which the permanent magnet 64 telescopes between the pole piece portions 56, that means being here semi-schematically shown in the form of a screw 66 threadedly received within an aperture 68 in the casing 2, the inner end of the screw 62 being appropriately secured to the magnet 64. As the screw 66 is screwed into and out from the casing 2 the magnet 64 will telescope into and out from the space between the pole piece portions 56, in the direction of the arrows 70 of Figs. 3 and 4. As will be most apparent from Fig. 4, the greater the degree to which the magnet 64 is telescoped between the pole piece portions 56, the greater will be the magnetic field produced by the magnetic means 50.

As may best be seen from Fig. 4, the presence of the

4

air gap 62 in line with and closely adjacent to the leaf spring 44 will cause the magnetic lines of force, or at least an appreciable proportion thereof, to pass through the leaf spring 44 in moving from one pole piece 54 to the other pole piece 52. Hence the magnetic means 50 will tend to attract the leaf spring 44 theretoward. The strength of this attraction will be determined at least in part by the strength of the magnetic field, and hence by the position of the permanent magnet 64 relative to the pole piece portions 56. This attraction will be in a direction opposite the resilient bias of the leaf spring 44, that is to say, the magnetic force will tend to move the leaf spring 44 radially outwardly so as to carry the movable contact 24 away from the fixed contact 22, whereas the resiliency of the leaf spring 44 tends to cause that leaf spring to move radially inwardly so as to bring the contact 24 into engagement with the contact 22. Thus the resultant bias tending to urge the contact 24 into engagement with the contact 22 will be determined by the difference between the spring bias in one direction and the magnetic bias in the other direction. From this it follows that the resultant bias tending to urge the contacts into engagement will be varied as the position of the permanent magnet 64 is varied relative to the pole piece portions 56.

It will be appreciated that since the adjustable magnetic means 50 is stationary the strength of its magnetic field may be adjusted at any time without requiring that the motor be stopped. For example, if the motor is operating at a given speed determined by an initial position of the permanent magnet 64, manipulation of the screw 66 so as to move the permanent magnet 64 further into the space between the pole piece portions 56 will have the following effect: The strength of the magnetic field produced by the magnetic means 50 will be increased, the leaf spring 44 will be urged radially outwardly thereby to an increased degree, the resultant bias tending to urge the contact 24 into engagement with the contact 22 will be lessened, and hence the centrifugal force exerted on the contact 24, formerly just balancing the resultant bias thereon in the opposite direction, will now exceed that resultant bias. The contact 24 will move away from the contact 22 and stay in that position until the motor has slowed down sufficiently so that the centrifugal force active on the contact 24 will once again be in balance with the reduced resultant bias on the contact 24. Manipulation of the screw 66 in the opposite direction will have just the opposite effect. The magnetic field of the adjustable magnetic means 50 will be decreased, the resultant bias on the movable contact 24 will be increased, and the motor will therefore operate at an increased rate of speed.

For purposes of simplicity of illustration, this invention has been here disclosed as controlling a squirrel cage type A. C. induction motor. However, it could be used to control the operation of a D. C. motor in conventional manner, the opening and closing of the contacts 22, 24 controlling the amount of current passing through the rotor of such a motor. Indeed, applicability of this device to the control of series A. C. motors, universal motors, or D. C. motors may well be greater than its applicability to its control of A. C. induction motors, the latter being here specifically shown solely for simplicity of illustration.

While but a single type of adjustable magnetic means 50 has been here disclosed, it will be apparent that wide variations may be made therein. Any appropriate structure could be employed for moving the permanent magnet 64, a plurality of such magnets could be employed spaced around the periphery of the pole pieces 52 and 54, pole pieces of specifically different construction could be employed, and electrical means rather than permanent magnet means could be used to vary the strength of the magnetic field produced by the magnetic means 50. Also, any desired type of linkage could be employed to vary

5

the position of the permanent magnet 64 or other operative component, and that variation could be accomplished manually or automatically as desired. Other variations will suggest themselves to those skilled in the art, all within the spirit of the invention as defined in the following claims.

I claim:

1. A centrifugal governor for an electric motor comprising a rotatable support, a pair of contacts thereon, means biasing one of said contact in one direction with respect to the other of said contacts, said one contact being movable in the other direction with respect to the other contact in response to centrifugal force, means for making electrical connection to said contacts, a stationary magnetic means operatively magnetically effective on said one contact continuously as said contact rotates with said support so as always to urge said one contact in the same direction with respect to said other contact, and means for varying the operative intensity of said magnetic means.

2. The centrifugal governor of claim 1, in which said magnetic means comprises a pair of separated ring-like pole pieces of opposite magnetic polarity with a gap therebetween, said pole pieces extending along the axis of rotation of said support.

3. A centrifugal governor for an electric motor comprising a support rotatable about an axis, a fixed contact on said support, a movable contact on said support and operatively connected to a resilient element effective to bias said movable contact against said fixed contact, said resilient element having a part extending around the axis of rotation of said support and formed of a material which is magnetically attractable, means for making electrical connection to said contacts, said movable contact being movable away from said fixed contact in response to centrifugal force, stationary magnetic means radially outside the path of travel of said part of said resilient element, positioned adjacent the entire path of travel of said part and operatively magnetically effective on said part so as always to urge said movable contact away from said fixed contact, and means for varying the operative intensity of said magnetic means.

4. The centrifugal governor of claim 3, in which said magnetizing means comprises a pair of separated ring-like pole pieces of opposite magnetic polarity with a gap therebetween, said pole pieces extending around and radi-

6

ally outside the path of travel of said element part and said element part rotating in close proximity to said gap.

5. The centrifugal governor of claim 4, in which said means for varying the intensity of said magnetic field comprises a permanent magnet adjustably movable relative to said pole pieces.

6. The centrifugal governor of claim 3, in which said resilient element comprises a leaf spring one end of which is secured to said support and the other end of which is secured to said movable contact, thereby defining means for mounting said movable contact on said support, and the body of which leaf spring, extending around the axis of rotation of said support, is radially spaced outwardly from said support and from said movable contact.

7. The centrifugal governor of claim 6, in which said magnetic means comprises a pair of separated ring-like pole pieces of opposite magnetic polarity with a gap therebetween, said pole pieces extending around the axis of rotation of said support.

8. In the centrifugal governor of claim 1, an element operatively connected to said one contact, rotatable with said support and formed at least in part of a material which is magnetically attractable, said stationary magnetic means being adjacent the path of travel of said element and operatively magnetically effective thereon as said element rotates, thereby being operatively magnetically effective on said one contact.

9. The centrifugal governor of claim 8, in which said means for varying the intensity of said magnetic field comprises a permanent magnet adjustably movable relative to said pole pieces.

10. The centrifugal governor of claim 8, in which said biasing means and said element are unitary.

11. The centrifugal governor of claim 1, in which said stationary magnetic means comprises an adjustably movable permanent magnet which constitutes the means for varying the operative intensity of said magnetic means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,446,923	Hardy	Aug. 10, 1948
2,508,619	Nilson	May 23, 1950
2,518,138	Goss et al.	Aug. 8, 1950
2,557,208	Thunberg et al.	June 19, 1951