April 26, 1932. R. T. CLOUD 1,855,703

ELECTRIC GOVERNOR

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Fig. 1.

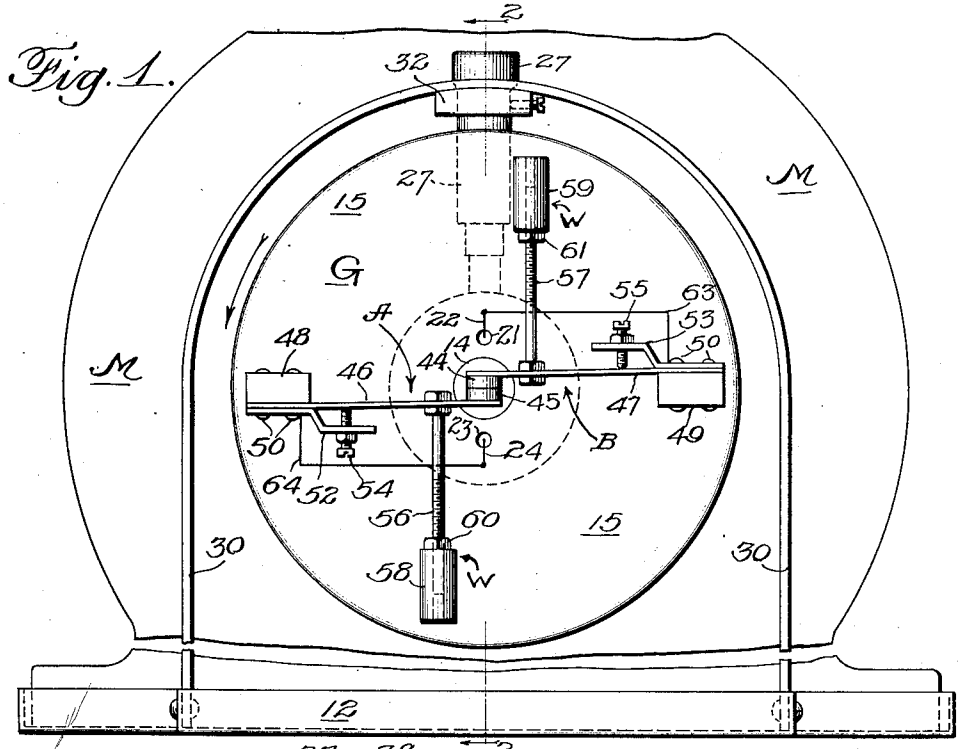
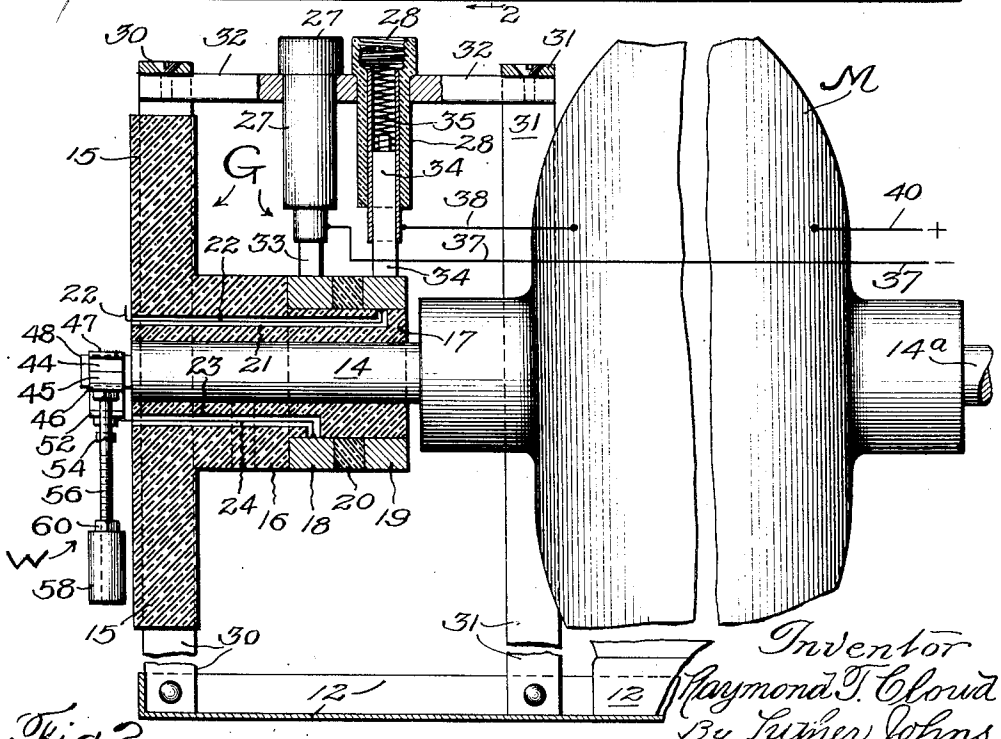


Fig. 2.



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ELECTRIC GOVERNOR

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These improvements relate to electric governors.

The prime object of the invention is to provide a highly sensitive electric governor, namely one which is effective to control the circuit upon the occurrence of slight variations in the speed of the device to which the governor is connected, to the end that the speed of the shaft or other rotatable device controlled may have but slight variations from the constant desired. It is an important object to provide such results in a governor of few parts, of simple and durable construction and of low manufacturing cost; one not likely to get out of order; and one wherein adjustments may be made to adapt the instrument to a particular use. Other objects and advantages will appear hereinafter.

In the drawings Figure 1 is an end view of a motor and governor unit, partly broken away, showing the governor device in end face view; and

Fig. 2 is a medial vertical section through the governor device, as on the line 2—2 of Fig. 1, the motor and some associated parts being in full side view but broken away.

The motor M and the governor marked as a whole G are shown as being mounted on a common base 12 as a unitary mechanism. The motor shaft extending at 14 drives the governor device while the part thereof extending at 14*a* is to be understood as being in driving relation to the machine or mechanism the speed of which is to be rendered substantially constant.

On shaft 14 is mounted a carrier shown as being of insulating material, for example hard rubber or bakelite. It may be of several pieces but is shown integral and as consisting of the circular disc-like face plate 15, a cylindrical hub 16 and a part 17 of reduced diameter. On this part 17 are tightly forced two metal collector rings 18 and 19 of good conductivity, such as copper, with an insulating spacing ring 20 between them. The parts 15, 16 and 17 are bored with a hole 21 and a copper wire conductor 22 (shown diagrammatically) in that bore leads to the collector ring 19 and is electrically secured thereto. The same carrier parts are similarly bored at 23 and the conductor 24 therein is similarly connected with ring 18.

There is a frame for holding brush devices 27 and 28 in association with the rings 18 and 19, this frame comprising a pair of U-shaped strap iron members 30 and 31 secured to the base 12 and having secured to their tops a bar 32 extending above the disc or wheel 15. The bar 32 is apertured to receive the cylindrical brush devices 27 and 28, as shown in Fig. 2, which brush devices are well known and contain nothing novel in themselves. Each thereof has a carbon brush, marked 33 in device 27 and 34 in device 28, with a spring 35 forcing the brushes into contact with the rings 18 and 19 respectively.

Conductor wires 37 and 38 (shown diagrammatically) are secured to these brush devices 27 and 28 so as to be in good electrical communication with the brushes 33 and 34 respectively. The wire 37 is shown as being one of the input wires for operating the motor 10. The wire 38 is to be understood as being connected with the motor windings while input conductor 40 is to be understood as being also connected with the motor windings.

The circuit thus far described provides that input current may flow through conductor 40, through appropriate motor windings, thence through conductor 38 to brush 34, and thence through ring 19 to conductor 22. The return may be assumed to be first, conductor 24, then ring 18, then brush 33 and then conductor 37, back to the power line.

From the foregoing it will be clear that if the electrical circuit thus described be suitably controlled the speed of the motor will be maintained substantially constant.

From Fig. 1 note that the opposed contact makers 44 and 45 are on the axis of revolution of the shaft 14 and carrier wheel 15. They are spring-pressed into contact with each other by means shown as leaf springs 46 and 47 respectively, and these springs are rigidly secured, as by rivets 50 to lugs 48 and 49 respectively and which lugs may be deemed integral with the disc 15. The same

rivets 50 hold brackets 52 and 53 each overlying an associated leaf spring, with adjusting screws 54 and 55 arranged to bear upon the leaf springs respectively so as to produce any desired degree of pressure between the contact makers 44 and 45.

Weight members marked W comprise the threaded rods 56 and 57 and weight elements 58 and 59. The rods are rigidly secured to the leaf springs 46 and 47 respectively and are directed away therefrom at a materially great angle, ninety degrees as shown, and are substantially parallel with plate 15 and are therefore directed across the path of their revolution. The weight elements 58 and 59 are threaded on the respective rods and are held by locking nuts 60 and 61. They may be adjusted outwardly and inwardly. Considering both contact devices A and B to be mechanically the same, the adjustments at 54 and 55 and at 58 and 59 should be the same respectively so as to preserve equality in the cooperative action of the two make-and-break devices.

If we now connect conductor 22 to one contact maker and connect conductor 24 to the other contact maker, as by wires 63 and 64 respectively the contact makers 44 and 45 become switch elements in the motor circuit. By suitably making and breaking the circuit at these contacts the speed of the motor will be controlled.

With this understanding of the construction illustrated, which not only serves to explain the principles but is a peculiarly advantageous embodiment of the invention, note first that the governor device is free of gravitational effects militating against a uniform action. As the device is illustrated in Fig. 1 the springs with their contact elements and weights are subject to the maximum gravitational effects. That is to say, gravitation tends to draw downward the contact device marked as a whole A, but the arrangement is such that its tendency is equally to draw downward the device marked as a whole B, and thus to any extent (and it is a very appreciable factor) that gravitation acts on one member the same action on the other member maintains the contact makers 44 and 45 in the same relative position with respect to each other.

A governor device operated on a vertical axis does not always contain this gravitation problem, but the provision of means designed merely to change the direction of rotation of a horizontal shaft to be controlled would be highly objectionable for many reasons. Note that I avoid all gearing and the possibility of lost or irregular motion at any place between the motor and the governor.

Next observe that the contact makers and their spring connections (omitting the weight elements) are substantially free from the action of so-called centrifugal force, owing to the substantially radial arrangement of the springs. Note also that they are substantially free of counteracting inertias. Assuming disc 15 in Fig. 1 to be rotating in the direction of the arrow the inertia of the contact makers themselves tending to move them relative to the axis of rotation is substantially nil, assuming them to be like and the axis to pass medially between them. In any event (still assuming the weight elements removed), whatever inertia may affect the contact makers and their associated spring supports 46 and 47 affects each in a direction tending to move the contact makers toward each other. I deem this very slight tendency to be neutralized by a slight tendency of the contact makers to move apart by centrifugal action due to such factors as that the center of gravity of the contact makers is slightly off of the axis of rotation and the springs 46 and 47 are not exactly radial.

It is not strictly essential that the contact makers and their springs supports be substantially free of the total effects of inertia, momentum and centrifugal force, or of either of them, for the device employs both inertia and momentum acting tangentially and centrifugal force acting radially as factors in the desired control, and some thereof could be permitted to inhere in these structural parts. If, however, these parts be free or substantially free of influences like gravitation, inertia, momentum and centrifugal force it would appear that their operation in practice could be expected to be more uniform under the influence of definite control elements such as the weight members W than if there were various cooperating or antagonizing influences entering into the equation. The gravitational effect would be especially objectionable, and the devices A and B should therefore be as nearly exact counterparts of each other as possible.

Considering now the effects of the weight members W, their arrangement is such as to introduce very distinctly the factors of inertia, momentum and centrifugal force. On accelleration of the shaft 14 the inertia of members W causes them to lag or seemingly move back relative to the carrier. On decelleration of the shaft 14 momentum carries the members W forward relative to the carrier. The lag movement flexes the springs 46 and 47 and separates the contact makers 44 and 45 while the forward momentum movement closes them or permits the springs to close them. Since the respective lags or advances of the members W are simultaneous and equal the balance of the parts is not disturbed, and, further, since these weight movements always affect the contact makers in opposite directions, a slight lag or advance movement effects a rapid separation or meeting of the contact members.

The outward centrifugal action of the

weight members, being in opposite directions for devices A and B, tends to effect a separation of the contacts. On decelleration of shaft 14 the loss of outward centrifugal force permits the springs to close the contacts.

The radial or centrifugal action is not alone sufficient for a notably sensitive control since that action is concomitant with speed variations at a given time already under way. The lag or other tangential relative movement is different in this respect, being initiated immediately there is a change in speed. Tangential momentum and inertia are likewise not sufficient alone for accurate control. For one thing they do not provide a maximum or a minimum speed limit, but concern themselves only with a change of speed. The radial or centrifugal action can limit the speed, and that property is used in the device shown.

For illustration of the action, let us suppose the adjustments at the weight members W and at screws 54 and 55 to be such as to provide a maximum speed of one thousand revolutions per minute of the shaft 14. When the current is applied to the circuit shown the motor will rapidly pick up from zero to the speed mentioned, for the tension of the springs 46 and 47 will not be overcome by the actions of weights W during the preliminary starting increments. At approximately one thousand revolutions per minute a substantially balanced condition would exist between the forces tending to separate the contacts and the forces tending to hold them together. If dependence were now had upon the centrifugal movements alone we would find that the speed would vary considerably. If we assume that the centrifugal action would break the circuit at 1000 R. P. M., then the ensuing decrement in speed would have to be under way before the loss of centrifugal force would operate to permit the springs to close the gap at the contact makers, and then the speed would have to continue its increment for awhile before the centrifugal action would again operate to break the circuit.

With the tangential action included, however, the effects are quite different. We are assuming the speed to be approximately at the predetermined rate and with the forces operating on the contact makers substantially balanced. A change of speed now occurs and the tangential action at once becomes effective. Assuming the speed of the shaft 14 to be reduced, the weights W move forward relative to the carrier and the contacts are closed almost instantly with the change of speed. Assuming the speed of shaft 14 to be increased, the lag operates almost instantly to open the circuit.

Throughout the entire operation, however, the centrifugal action is in effect. The springs were adjusted to exert considerable pressure between the contact makers. The centrifugal action has reduced this pressure to a very small amount and maintains substantially a state of equilibrium between the springs and the centrifugal force. The extreme nicety of control occurs through the introduction of the tangential action to play upon this condition of substantial balance. Substantially the slightest increment or decrement in speed affects the weight members tangentially, and it thus happens in practice that the circuit is made and broken incessantly at the contacts—apparently with perfect regularity and I would estimate as often as at least fifty times a second in the tests I have made.

As indicating the effectiveness of this governor I may mention that a purely hand-made device, made substantially to scale with these drawings, but without the usual refinements in construction or any attempt to balance otherwise than as would result from the assembly of the substantially like parts, showed a variation in shaft speed, in a continuous test of thirty-six minutes, of about one revolution in fifteen hundred, or a variation from constant of about one-fifteenth of one percent. A more accurately made device would show an even better approximation of constant speed. The test was made with a squirrel-cage type of induction motor with shaded poles.

In practice the location of the weight elements W on the springs may vary from a place opposite the contacts respectively (making a radial arrangement) inward toward the supports 48 and 49, or they could be carried by extensions of the springs beyond the contacts. It will be clear also that the principles and combinations thus set forth may be embodied in various other kinds or types of mechanisms. I therefore contemplate as being included in the present invention all such changes, departures and variations from what is thus specifically illustrated and described as fall within the scope of the appended claims.

I claim:

1. An electric governor comprising a rotatable carrier having weight members and contact members, the weight members being mounted for radial and tangential movements relative to the carrier under the influence of speed variations in the carrier, the contact members being under the control of said relative movements of the weight members, and means for connecting the contact members in a circuit to be controlled.

2. An electric governor comprising a rotatable carrier, oppositely arranged weight members carried for revolution by the carrier and mounted for tangential and radial movements relative to the carrier under the influence of speed variations in the carrier, oppositely arranged contact members associated with and under the control of the

weight members respectively to make and break a circuit under the influence of such relative movements of the weight members, and means for connecting the contact members in the circuit to be controlled.

3. An electric governor comprising in combination a rotatable carrier, contact makers carried thereby, means for connecting the contact makers in a circuit, resilient means pressing the contact makers into contact-making position to complete the circuit, and weight means associated with each of the contact makers to open and close the circuit, said weight means being mounted for revolution by the carrier and for movements relative thereto having a tangential component and a radial component under the influence of speed variations in the carrier.

4. An electric governor comprising a rotatable carrier, a pair of oppositely disposed spring-pressed contact makers, a pair of weight members associated with the contact makers respectively and being severally mounted to move relative to the carrier with a tangential component and with a radial component under the influence of variations in the speed of the carrier to move the contact makers relative to each other to make and break a circuit, and means for connecting the contact makers in the circuit to be controlled.

5. An electric governor comprising a rotatable carrier, weight members carried for revolution by the carrier and being mounted for tangential and radial movements relative to the carrier under the influence of speed variations in the carrier, a circuit, and contact members substantially on the axis of carrier revolution and under the control of said weight members respectively and operative to make and break the circuit under the influence of such relative movements of the weight members.

6. In an electric governor the combination of a horizontal shaft, a carrier mounted thereon, a pair of opposed contact makers meeting each other face to face substantially on the axis of shaft rotation, spring means carried by the carrier and adapted to force the contact makers resiliently toward and into contact with each other, oppositely-disposed weight members mounted for rotation by the carrier and for movements relative thereto having a radial component and a tangential component, the weight members being operatively connected to the contact makers respectively to move them toward or away from each other when the weight members move relatively with respect to the carrier, means for adjusting the spring members respectively, and means for connecting the contact makers in a circuit to be controlled.

7. In an electric governor, the combination of a substantially horizontal shaft, a carrier mounted for rotation on said shaft, a pair of leaf spring members mounted on the carrier in approximately radial direction therewith, the free ends of said springs being adjacent to each other close to the axis of shaft rotation, a contact maker carried by each spring member adjacent to said axis of rotation, means for adjusting the tension of said spring members respectively, weight elements carried by said spring members respectively, the weight elements being positioned effectively a materially great distance from the spring members respectively and in line substantially at right angles to the spring members respectively whereby the weight members will have movement relative to the carrier in both radial and tangential directions under the influence of speed variations in the carrier, and means for connecting said contact makers in a circuit to be controlled.

8. In an electric governor a horizontal rotatable shaft, a carrier on the shaft, a pair of leaf spring members secured to the carrier and extending substantially radially inward, contact-making means associated with said spring members, means for connecting said contact-making means in a circuit to be controlled, and weight members carried by the spring members respectively and being mounted for movements relative to the carrier in both tangential and radial directions under the influence of speed variations in the carrier.

9. In an electric governor the combination of a shaft, a carrier rotated thereby, an electric make-and-break device carried by the carrier and having contact members substantially on the axis of shaft rotation and adjacent to the carrier, and weight means carried by the carrier for rotation and operatively associated with said make-and-break devices respectively, said weight means being mounted for movements relative to the carrier with tangential components and with radial components, means for connecting the make-and-break devices in a circuit, said make-and-break devices being under the control of the tangential and radial relative movements of said weight members.

10. An electric governor comprising a rotatable carrier, a pair of elongated spring elements rigidly secured to the carrier and directed in lines substantially parallel with each other from substantially diametrically opposite places on the carrier, each of said spring elements having a contact maker, said contact makers facing each other substantially on the axis of rotation, means for adjusting the tension of said spring elements, a rod extending from each of said spring elements a substantial distance in a direction transverse to the direction of carrier rotation, a weight carried by each of said rods at a substantial distance from the spring elements respectively, and means for connecting the contact makers in a circuit to be controlled.

11. An electric governor comprising a ro-

tatable carrier, a pair of elongated spring elements rigidly secured to the carrier and directed in lines substantially parallel with each other from substantially diametrically opposite places on the carrier, each of said spring elements having a contact maker, said contact makers facing each other substantially on the axis of rotation, means for adjusting the tension of said spring elements, a rod extending from each of said spring elements transversely to the direction of carrier rotation, an adjustable weight carried by each of said rods at a substantial distance from the spring elements respectively, and means for connecting the contact makers in a circuit to be controlled.

12. An electric governor comprising a carrier mounted for rotation, and a pair of oppositely-disposed and coacting make-and-break devices carried by the carrier, each of said make-and-break devices including a weight element having tangential and radial components of movement relative to the carrier under the influence of speed variations of the carrier.

13. An electric governor comprising a carrier mounted for rotation, a pair of oppositely-disposed and coacting spring-tensioned contact makers carried by the carrier, means for adjusting the spring tension of the contact makers, each of said contact makers having a weight element mounted for tangential and radial movements relative to the carrier under the influence of speed variations of the carrier, and means for adjusting the weight elements.

14. A rotatable electric governor having contact means for controlling a circuit, control means for the contact means including weight means mounted as part of the governor for rotative movements and also for tangential and radial relative movements under the influence of speed variations of the governor, the contact means and the control means being operatively connected together by means including spring-tensioning means operating normally to maintain the contact means closed to complete the circuit at the contact means, the tension of said spring-tensioning means and said weight means being proportioned whereby when the governor speed reaches a predetermined amount the tension of the spring-tensioning means is substantially balanced by the centrifugal force acting radially on the weight means, the arrangement providing that when the centrifugal force of the weight means and the tension of the tensioning means are thus substantially balanced the tangential action of the weight means under the influence of a variation in governor speed will control the contact means to control the circuit.

15. An electric governor which includes a spring-tensioned contact maker, a rotatable carrier for a weight member, a weight member carried by said carrier for movement therewith and also for radial and tangential relative movements under the influence of speed variations in the carrier, the weight member being operatively connected to the contact member to move the same into circuit-breaking position when the centrifugal force acting on the weight member reaches a given amount, the spring tension of the contact maker being such as substantially to balance said given amount of centrifugal force, said weight member being operatively connected to the contact maker to control the contact maker by a tangential movement of the weight member due to a variation in the speed of the carrier when said spring tension and said centrifugal force are substantially in balanced relation to each other.

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