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CONSTANT SPEED MECHANISM

Original Filed May 4, 1927

2 Sheets-Sheet 1

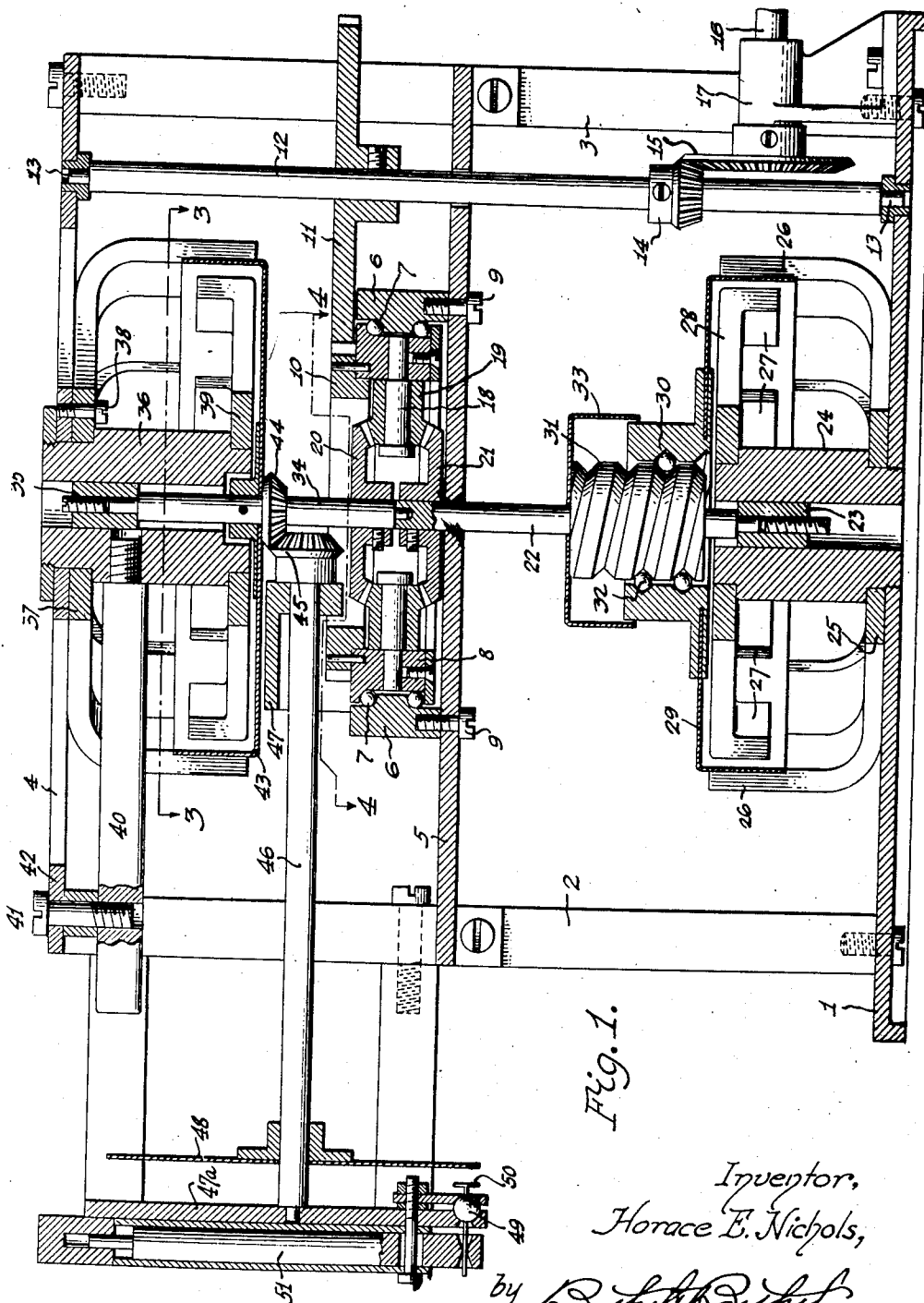


Fig. 1.

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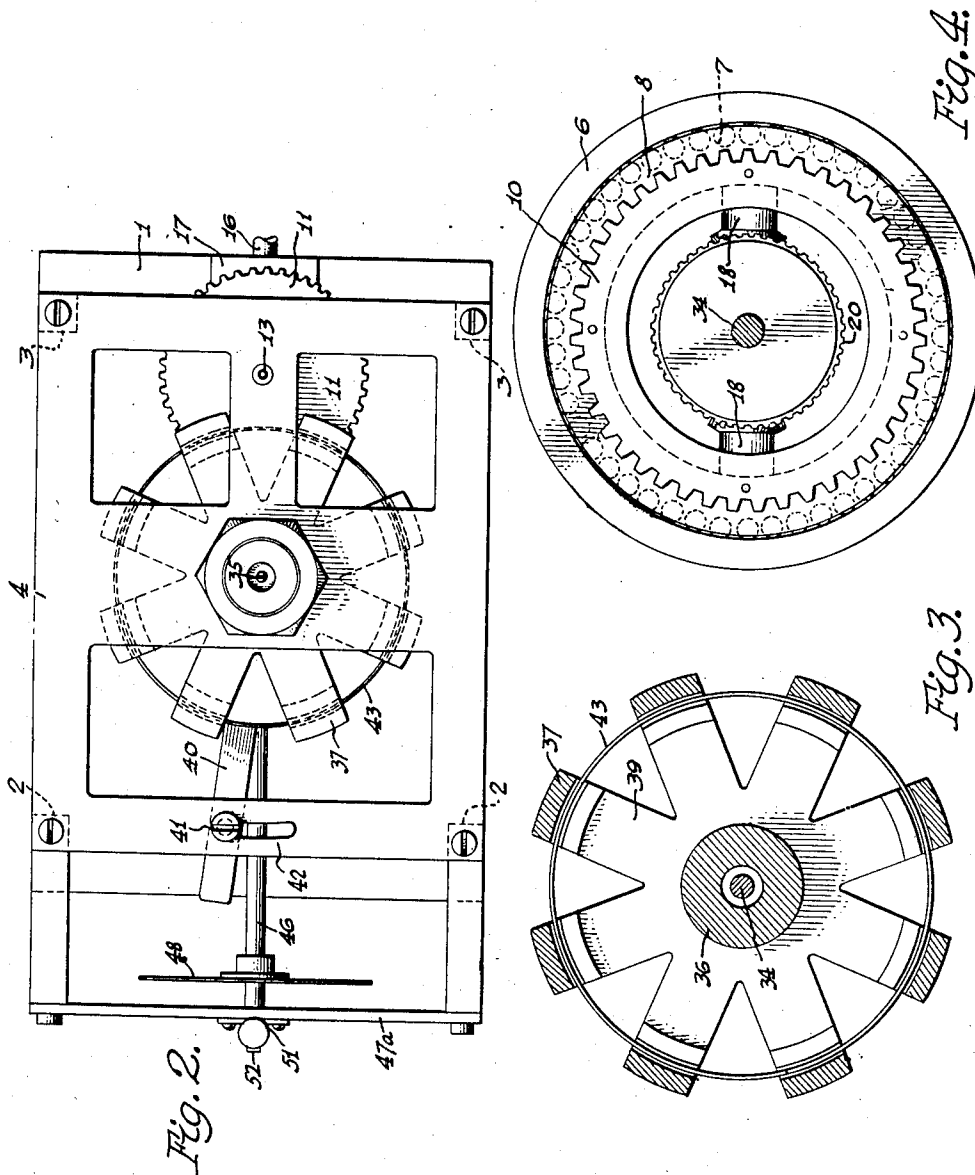
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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CONSTANT SPEED MECHANISM

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Original application May 4, 1927, Serial No. 188,839, now Patent No. 1,903,832, dated April 18, 1933. Divided and this application April 17, 1933, Serial No. 666,497

11 Claims. (Cl. 172-284)

This is a divisional application of my co-pending application filed May 4, 1927, Serial No. 188,839, patented April 18, 1933, No. 1,903,832.

The invention relates to a constant speed mechanism that may be advantageously used in connection with electrocardiographs, heliographs, heliotropes, and other types of light flashing apparatus. For instance, in an electrocardiograph a light beam is projected on to a mirror and reflected through a driven slitted shutter or flasher on to a sensitized film, and a motor or other source of power is employed for revolving the apertured shutter or flasher. Such an instrument is employed for making a visible and permanent record of heart actions and consequently the speed at which the apertured shutter or flasher is revolved must be constant in order to determine time intervals throughout a diagnosis of a heart action. Other instances of timing may be in connection with the interruption or reflection of light beams; the operation of clock dials and time switches, and the controlling of relays and maximum demand meters.

My invention in its broadest aspect, involves driving and driven elements, with an element of force interposed; first, as a power transmission device to permit the driving element imparting movement to the driven element, and second, as an instantaneous constantly active compensating device affording a load for the driving element, said load being unchanged when the movement of the driving element is decreased, or increased; the result being an imperceptible intermediary compensation of any variations of movement of the driving element, thus insuring constant uniform movement for the driven element.

My invention further aims to provide a constant speed mechanism wherein electromagnetic governors are associated with a differential mechanism for automatically maintaining a constant speed of a driven element by a driving element. Should the driving speed be increased or decreased the governors immediately rectify the same and establish constant driven speed, and this is accomplished by a durable and compact mechanism, which for an electrocardiograph or similar apparatus must be exceedingly compact, especially when the electrocardiograph is portable.

The constant speed mechanism will be hereinafter described and then claimed, and reference will now be had to the drawings, wherein

Figure 1 is a longitudinal sectional view of the mechanism;

Fig. 2 is a plan of the same on a reduced scale;

Fig. 3 is a horizontal sectional view of an adjustable electromagnetic governor, taken on the line III-III of Fig. 1; and

Fig. 4 is a similar view taken on the line IV-IV of Fig. 1, showing the differential mechanism.

In the drawings, the reference numeral 1 denotes a base provided with sets of uprights 2 and 3 having the upper ends thereof connected by a frame 4 and intermediate the ends of said uprights is a platform 5.

Centrally of the platform 5 is the outer race member 6 of a horizontally disposed anti-frictional thrust bearing which includes two series of anti-frictional balls 7 and an inner race member 8 which is rotatably supported in the outer race member 6 by balls 7. The outer race member 6 may be secured to the platform 5 by screws 9 or any suitable fastening means.

Suitably fixed to the upper end of the inner race member 8 is a ring gear 10 constantly meshing with a horizontally disposed gear wheel 11 mounted on a vertically disposed shaft 12 having pintle ends 13 journaled in the base 1 and the frame 4. Adjacent the lower end of the shaft 12 is a small beveled gear wheel 14 meshing with a large beveled gear wheel 15 mounted on a drive shaft 16, journaled in a bearing 17 supported from the base 1. The shaft 16 may be driven by an electric motor or any suitable source of power (not shown).

The inner race member 8 which rotates with the ring gear 10 is provided with two or more inwardly projecting studs 18 for rotatable differential pinions 19 constantly meshing with horizontally disposed differential gears 20 and 21.

Gears 20 and 21 are axially aligned and are carried respectively by the aligned shafts 22 and 34, these shafts being mounted to permit relative rotatable movement therebetween; in Figure 1, the lower end of shaft 34 is shown as having a step bearing relation to the upper end of shaft 22, this being illustrative of a simple and compact arrangement by which the two shafts can be properly and efficiently arranged. The lower end of shaft 22 is shown as supported adjustably and rotatably by a jewel or pivot bearing 23 mounted in a post 24 carried by the base 1, the post being indicated as preferably screwed into the base. The upper end of shaft 34 is shown as journaled in a jewel or pivot bearing 35 mounted in a rotatably adjustable post 36 supported from the frame 4.

Shaft 34 carries a pinion 44 adapted to mesh with a complementary pinion 45 carried by a shaft 46, the inner end of the latter being journaled in

a bearing 47 carried by platform 5, while the outer end of shaft 46 extends into a bracket 47a supported from the uprights 2. Said shaft 46 is designed to carry the part which is to be given the uniform and constant movement, such part, in the illustration, being shown as an apertured or slitted shutter 48 of an electrocardiograph, for instance. To complete the showing of the specific apparatus that co-operates with the shutter 48, it may be noted that the bracket 47 carries a universal support 49 for a mirror 50, said mirror being adjustable by a member 51 carried by the bracket 47a. Provision is also made, as at 52, for clamping the mirror in an adjusted position so that it cannot become accidentally displaced. The mirror 50 is in proximity to shutter 48, and a light beam projected on said mirror is adapted to be intermittently reflected through the apertures of the shutter 48.

In the structure thus far disclosed, it will be understood that shaft 12 constitutes a drive shaft the rotation of which will, through the connections shown, rotate ring gear 10 and the inner race member 8, the studs 18 of the latter being carried in an orbital path the center of which is the axis of gears 20 and 21, the movement of the studs being in synchronism with that of the drive shaft. The studs 18 carry the pinions 19 which mesh with gears 20 and 21, and it will be readily understood that if the load on shafts 22 and 34 is equal, so as to provide an equal load on the two gears 20 and 21, pinions 19 will not rotate on the studs, and the entire gear train—ring-gear 10, inner race member 8, studs 18, pinions 19, and gears 20 and 21—will rotate as a unit; if, however, the load on one of the gears varies from that of the other, the orbital travel of the studs will cause the pinions 19 to rotate on their axes to set up a differential movement between the two gears 20 and 21. The arrangement thus has the characteristics of the usual differential mechanism, in which the difference in resistances serves to affect the differential action of the gear train. The adaptation of the differential mechanism to the particular uses contemplated by the present invention, however, is designed to give a somewhat different result from that which the usual differential mechanism is designed to produce. For instance, the purpose of the invention is to deliver the power and speed of shaft 12 to shaft 46, so that the latter will operate at the desired constant speed regardless of irregularities in speed of the shaft 12. If shaft 12 were certain to always operate with exact uniformity and speed—the requirement placed on shaft 46—the gear train connections between the two shafts could be of simple nature with the usual arrangements for permitting variations in the relative speeds of the two shafts; such an arrangement would not require the use of a differential mechanism. The difficulty comes from the fact that although shaft 46 must have this uniform speed with exactness, the usual power structures are unable to provide a similar result upon shaft 12; hence, with the usual simple connection of gears, shaft 46 would partake of the variations which would be present in the speed of shaft 12.

The present invention is designed to remedy this condition, so that the variation in speed condition of shaft 12 will not be communicated to shaft 46 and the latter will have its rotations at uniform speed exactness. The result is obtained by a compensating mechanism, of which the differential gear structure forms a part. And

since it is impossible to foresee the variations of the power structure as to time and magnitude, it will be readily understood that the compensating mechanism is also required to act additionally as a detecting mechanism for detecting such variations, so that the compensating mechanism must operate automatically and be responsive with rapidity so that the variations of the shaft 12 will not be communicated to shaft 46 to materially affect the speed of the latter.

This result is obtained through utilizing the load conditions of the differential mechanism as a means for not only detecting the variations of shaft 12 but also to provide the compensating action. For instance, the load for shaft 34 can be made constant, while the load of shaft 22 is made variable. If, then, the speed of shaft 12 be varied, the effect of such variation will be carried into the differential mechanism and made active upon the shaft having the variable load, to effect a differential action which will compensate for the change, whether the speed change be in the direction of an increase or a decrease in speed of the shaft 12. In this respect, broadly, the present invention distinguishes from the usual differential mechanism functions. Specifically, the invention distinguishes to a much greater extent, as will be understood from the following:

Referring first, to what may be considered as the constant load in the above statement, the post 36 supports pole pieces 37 and 39, the pole piece 37 being located adjacent the upper end of post 36 and non-rotatably held against the frame 4 by a screw 38, while pole piece 39 is secured to the lower end of post 36. The pole pieces are of magnetic material with the poles of a piece arranged in spaced relation, pole piece 37 preferably having its poles extending in a direction to simulate an inverted cup, the arrangement being such that the poles of the two pieces are spaced apart in a more or less confronting position with respect to an annular channel between them, the latter being adapted to receive a cup-shaped drag-member 43 of non-magnetic material and which is mounted on shaft 34, the drag member thus being rotatable between the poles of the two pole pieces. Since the poles of a piece are spaced apart, it will be readily understood that zones of eddy current characteristic are set up within the magnetic field and provide a magnetic reaction which will tend to retard the rotation of the drag member, thus setting up the characteristics of a load upon the shaft 34.

In order to vary the load conditions of shaft 34, provision is made for manually shifting the poles of pole piece 39 relative to those of pole piece 37, so that the magnitude of the magnetic field can be controlled by the area of the zone of one pole which confronts the pole of the other pole piece. This shifting is provided by moving post 36 rotatively by a crank or handle 40 connected to the post and which is shown as having its outer end supported from frame 4 by a screw 41 which extends through a slot 42 in the frame 4, the slot permitting adjustment of the position of screw 41 which can be tightened to retain the crank in its adjusted position. It will be understood, of course, that in any adjusted position of the post, the load conditions set up by the magnetic field will remain substantially constant.

The variable load operates in connection with shaft 22, and also utilizes the action of a magnetic field produced by pole pieces 25 and 27, having poles 26 and 28, respectively, pole piece 25

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corresponding to pole piece 37, while pole piece 27 corresponds to pole piece 39, pole pieces 25 and 27 being carried by post 24, the arrangement showing the pole pieces as inverted from the position of pole pieces 37 and 39. The drag member for this magnetic field structure is indicated as 29. Unlike the pole pieces 37 and 39, pole pieces 25 and 27 are not designed for adjustment to vary the magnetic field between them, post 24 being held stationary, as heretofore pointed out.

However, provision is made for obtaining the effect of a variation in the load characteristics of the magnetic field of pole pieces 25 and 27, this being done by varying the position of the drag member 29 vertically within the field produced by the poles. As will be understood, the retarding effect of the field on the drag member depends upon the area of the drag member which is directly within the field; if the skirt of the drag member extends throughout the field, as in Fig. 1, for instance, the drag member will be subject to the retarding effect of the complete field; if the skirt be raised so that it extends but partially into the field, only that portion of the skirt that is within the field will be affected, with the result that the retardation is decreased, and the load lessened accordingly.

Advantage is taken of this condition, by mounting the drag member on to what may be termed a large nut member 30 which has an internal coarse thread which is adapted to co-operate with the complementary thread of a screw 31 carried by a shaft 22, the thread relation being completed by the use of anti-frictional balls 32. A hood 33 overlies nut 30, as shown. By this arrangement, the drag member 29 is supported by the shaft 22, but is secured thereto only through the screw and nut connection referred to, the weight of the nut constantly tending to move the drag member 29 downwardly and hence in the direction to increase the retarding effect of the field, whenever the member has been raised so as to reduce such effect. As will be understood, rotation of screw 31 will raise nut 30 unless the latter is travelling at the same speed with the screw, so that the arrangement of the two elements is such that the rotation of shaft 22 is constantly trying to raise the nut, while the weight of the latter is constantly attempting to cause the nut to travel down the screw; as a result the two forces set up a somewhat unstable condition which provides for a sensitive action.

This will be understood from the fact that under the conditions of opposing forces such as this, there is some position where the two become equal, and where this condition is present and maintained, the position of the nut vertically will remain constant. In the present arrangement, the weight of the nut being constant, the selection of the point of equilibrium of nut and screw is determined by the speed of rotation of the screw—an increase in speed raises the nut and the latter thus takes up a higher position on the screw as the point of equilibrium, taking a lower position when the speed of the screw is decreased, stability in position of the nut being obtained only where the speed of the screw is constant. Since the raising movement of the nut is in the direction to decrease the retardation of the drag member, it will be understood that an increase of speed of shaft 22 will have the effect of decreasing the load provided by the retardation, while a decrease in speed of the shaft will increase the load effect. And, as will be readily understood, the change in speed is immediately

detected by the nut and screw arrangement and an immediate response made to the change in conditions.

The effect of the shift in position of nut 30 is made manifest within the differential mechanism, through the variation in the load applied to shaft 22 through the retardation effect on the drag member. One of the general characteristics of a differential mechanism is that where the resistance is unequal, the tendency is for the power to be centralized on the part of lesser resistance—when the resistance is located wholly on one side of the differential, the power is generally made manifest on the parts of the other side, thus speeding up that side of the mechanism relative to the other or greater resistance side. Hence, when a change in speed has been made manifest in the speed of the orbital travel of the studs 18, and initially made manifest, as by an increase in speed of shaft 22 with the consequent change in the value of the load on that shaft, the relative change in resistance on the opposite sides of the pinions 19 produces the reaction of causing the pinions to rotate on the studs, with the result that gear 21 is driven faster than gear 20—assuming the power speed to have increased—the faster movement of gear 21 tending to slow the speed of gear 20; the arrangement of the parts being such that the relative slowing of the movement of gear 20 leaves it travelling at the same speed as it travelled prior to the change in the power speed, the increase in power being absorbed in the increased speed of gear 21. If the power speed is a decrease instead of an increase, the action is opposite, in that the change in load characteristic between the two sides, has made the side of gear 20 of less resistance relative to that of gear 21, and the greater power is exerted on that side through the action of the pinions, so that the speed of gear 20 still remains as before, the compensation being provided by the reduced speed of shaft 22 and gear 21.

It will be understood, of course, that the power device generally does not vary in speed to a wide extent, but that more or less fluctuation is present within narrow limits. At the proper speed of rotation of shaft 34, the nut 30 is in equilibrium at an intermediate point, and hence is able to shift in either direction with a resultant change in the position of the drag member 29 in its magnetic field, with the change made manifest through a variation in the retardation load on shaft 22. Ordinarily, the parts are so set that the nut is travelling at say twice the drive speed when in proper position, and where the power device is brought under service conditions which provides a material variation from the general standard which would produce the desired result, the load on shaft 34 can be varied by a change in position of lever 40, such change having the effect of restoring the desired conditions with regard to drag ring 29, so that the mechanism then takes care of the fluctuations in the power in the manner indicated.

As a result the arrangement, which can be termed an electro-magnetic governor, provides a practically instantaneous, constantly active, compensating device which is capable of controlling the activities of the shaft 22 by varying the magnetic flux conditions made active on the drag member 29. The parts are so set that a predetermined speed of shaft 22 will produce the proper speed of shaft 34, and when the speed of shaft 22 becomes varied through variation in

speed of the power, the lines of force cut by the travelling drag member are changed in number by the shift in position of the drag member—through the shift in position of nut 30—and thus the load provided by the retarding effect is changed; if the speed of shaft 22 is increased, the number of lines of force that are active is decreased, and vice versa when the speed of shaft 22 is decreased below the predetermined speed.

As will be understood, the control is made manifest through the employment of a force which co-operates with but is made manifest in opposition to the force exerted by the power—the weight factor of nut 30 in co-operation with the screw 31; this factor is constantly present and active during the operation of the mechanism, and serves as a means for producing the immediate response of the governing mechanism to speed changes of the power device. Through its action in varying the extent of the active magnetic field as a direct response to the variations in speed of the power source, and at the same time prepared as a detector to note the next change, the nut and screw, within the relationship of a speed responsive shaft carrying the screw and the drag member carried by the nut, with the nut and screw having the direct connection through the screw-thread relation, provides a structure which is especially fitted to meet the conditions of a governor in this type of devices.

As will be understood, this arrangement made up of a speed-responsive shaft, a magnetic field, and a non-magnetic drag member operatively connected with the shaft by the nut and screw connection disclosed, sets up the conditions of a torque reaction variable as to value in response to variations in speed, and is brought into operative relation to the torque reaction of constant value produced by the magnetic field and drag member which, in this particular form of the invention is operatively connected to the driven shaft 34. In this particular embodiment of the invention, the magnetic-fields are produced by non-rotating members, but the invention is not limited in its application to such specific arrangement.

What I claim is:—

1. In a constant speed mechanism, a driving shaft, a driven shaft, a differential mechanism transmitting power from said drive shaft to said driven shaft and including differential pinions, and an electromagnetic governor operatively connected to one of said differential pinions, said governor being responsive directly to variations in drive shaft speed and operative on said differential pinions to maintain the speed of the driven shaft constant in presence of such variations.

2. A constant speed mechanism as called for in claim 1, wherein said electromagnetic governor includes a magnetic field into which extends a rotary drag member actuated from the differential pinion.

3. A constant speed mechanism as called for in claim 1, wherein said electromagnetic governor includes a rotary drag member, and means adapted for either raising or lowering said drag member when there is any variation in the speed differential mechanism.

4. A constant speed mechanism as called for in claim 1, wherein said electromagnetic governor includes opposed poles, a drag member between said poles, and a screw and nut connection between said drag member and the differential pinion.

5. In a constant speed mechanism, alining shafts, a differential for driving said shafts, a governor for each shaft, one of said governors being regulated for a predetermined speed, and the other governor being responsive to any variation in the speed of said differential mechanism to maintain a constant speed for the shaft of the regulated governor.

6. A constant speed mechanism as called for in claim 5, wherein the first mentioned governor is of the electro-magnetic type having a manually adjustable drag member.

7. A constant speed mechanism as called for in claim 5, wherein the last mentioned governor is of the electromagnetic type having a magnetic field into which extends a rotary drag member adapted to be raised and lowered in said magnetic field.

8. The combination of a rotary shutter, a differential mechanism including a driven gear for driving said shutter, an electromagnetic governor operatively connected with said driven gear and adapted to be manually adjusted to provide a load characteristic thereto active within the differential mechanism to produce a predetermined speed for said shutter by said differential mechanism, said load characteristic being of definite and constant value determined by the manual adjustment of the governor, and another governor operated by said differential mechanism and adapted to automatically rectify any variations in the source of speed of said differential mechanism to maintain said driven gear at constant speed.

9. The combination of a rotary shutter, a differential mechanism for driving said rotary shutter, and a governor operated by said differential mechanism and susceptible to speed variations by said differential mechanism to influence said differential mechanism and maintain a constant speed for said rotary shutter.

10. The combination called for in claim 9, wherein said governor is of the electromagnetic type having a drag member for influencing said differential mechanism.

11. The combination set forth in claim 9, wherein said governor is of the electromagnetic type having a drag member articulated with said differential mechanism by a screw and nut connection adapted for raising said drag member in the magnetic field of said governor.

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