Oct. 16, 1962 E. P. LARSH 3,058,355

CONTROL APPARATUS

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FIG-1

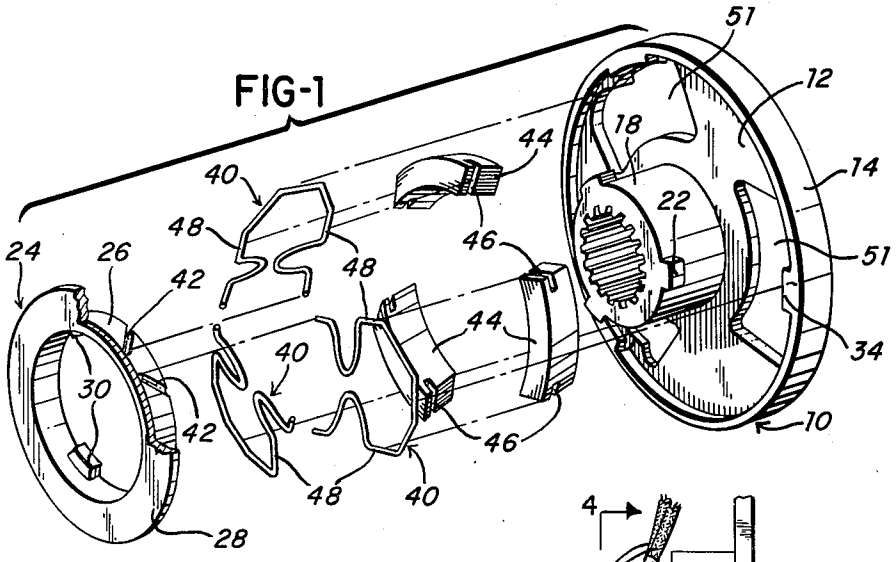


FIG-2

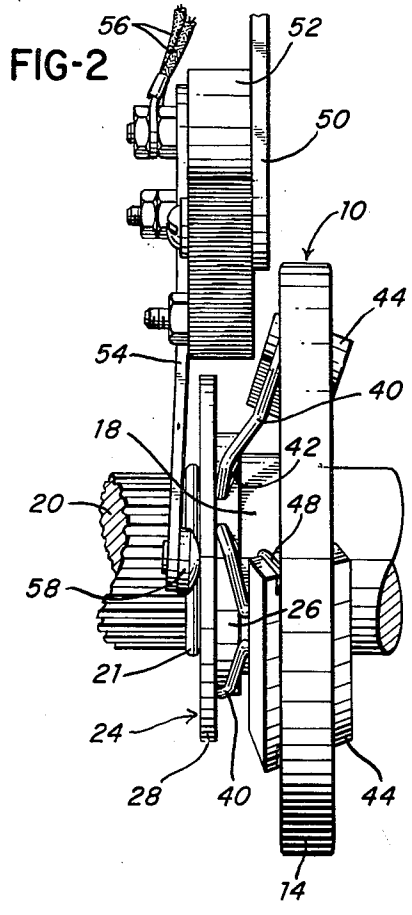
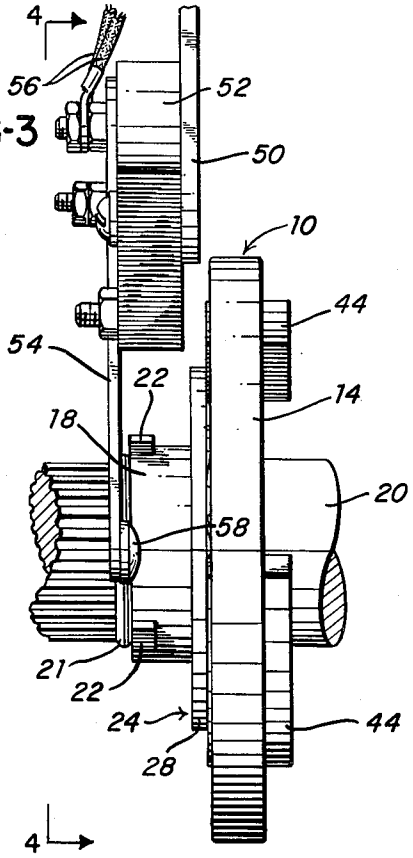


FIG-3



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FIG-4

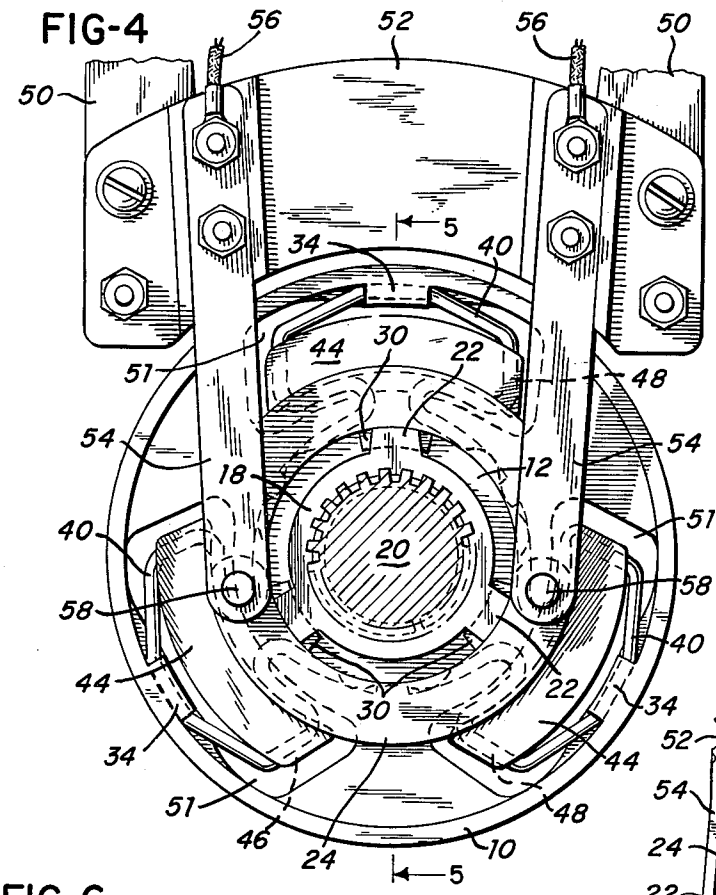


FIG-5

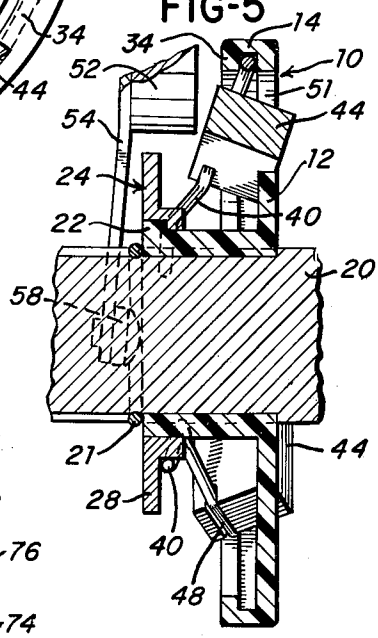


FIG-6

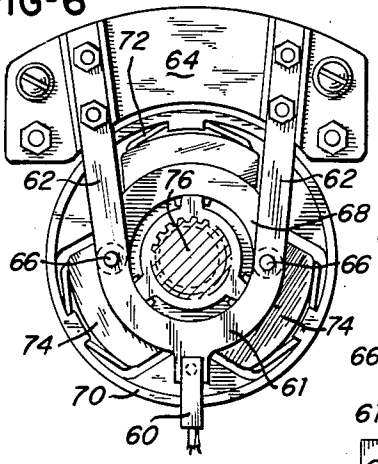
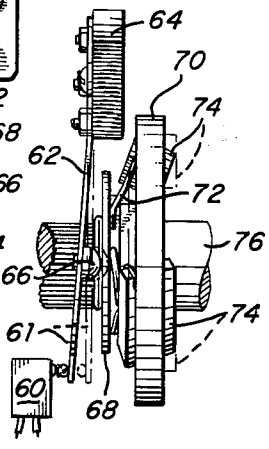


FIG-7



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CONTROL APPARATUS

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10 Claims. (Cl. 73—535)

This invention relates to control apparatus. The invention relates more particularly to control apparatus associated with rotary mechanism.

In various types of rotary apparatus there is a necessity for mechanism which functions in accordance with the rate of rotation thereof. For example, an electric motor having a winding which is used only for starting purposes must be provided with means for disconnection of the starting winding after a given rate of rotation has been obtained. Other types of apparatus are also provided with mechanism which operates when a given rate of rotation is obtained.

An object of this invention is to provide positive, snap action control apparatus which operates when a given rotational rate is obtained.

Another object of this invention is to provide such control apparatus which has a minimum number of elements.

Another object of this invention is to provide such control apparatus which can be produced at comparatively low costs.

Another object of this invention is to provide such control apparatus which is durable and long lived.

Another object of this invention is to provide such control apparatus which can be applied to numerous types of mechanisms for operation of an element thereof.

Another object of this invention is to provide control apparatus which can be used in association with a starting winding of an electric motor to energize and deenergize the starting winding.

Another object of this invention is to provide such control apparatus for an electric motor in which the control apparatus may include a portion of the circuitry or in which the apparatus can be used to operate a switch element.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture, and the mode of operation, as will become more apparent from the following description.

In the drawings:

FIGURE 1 is an exploded perspective view with parts broken away showing control apparatus of this invention.

FIGURE 2 is a side elevational view of control apparatus of this invention attached to a rotary shaft and showing the elements of the apparatus in positions thereof when rotation of the shaft is below a given rate.

FIGURE 3 is a side elevational view similar to FIGURE 2, but showing elements of the apparatus in positions thereof when rotation of the shaft is above a given rate.

FIGURE 4 is a sectional view taken substantially on line 4—4 of FIGURE 3.

FIGURE 5 is a sectional view taken substantially on line 5—5 of FIGURE 4.

FIGURE 6 is an end view showing a modification in the control apparatus of this invention.

FIGURE 7 is a side elevational view of the apparatus of FIGURE 6.

Referring to the drawings in detail, control apparatus of this invention comprises a rotor 10 which is preferably made of electrically non-conductive material such as plastic materials or the like. The rotor 10 includes a body portion 12 having a rim 14. Integral with the body portion 12 is a hub 18 which is splined to receive a splined portion of a shaft 20. A retainer member 21

engages the hub 18 and secures the rotor 10 in the desired axial position upon the shaft 20. The hub 18 is provided with lugs 22 extending radially therefrom, as best shown in FIGURES 1 and 3.

Encompassing the hub 18 is an annular engagement member 24 having an axial portion 26 and a flange portion 28. At least the flange portion 28 is of electrically conductive material. Within the axial portion 26 are a plurality of inwardly extending lugs 30 which are axially aligned with the lugs 22 and prevent direct axial movement of the engagement member 24 from the hub 18.

The rotor 10 is provided with spaced-apart tabs 34 extending inwardly from the rim 14 and spaced from the body portion 12.

Arm members 40, preferably in the form of bent wire members extend from the rim 14 of the rotor 10 to the axial portion 26 of the engagement member 24. The configuration of the arm members 40 is best shown in FIGURE 1. Each of the arm members 40 is shown as consisting of an elongate wire having the two ends thereof disposed within angular grooves 42 of the axial portion 26 of the engagement member 24. Each end of each wire member forming an arm 40 abuts the end of the groove 42 within which it is disposed. The end of each groove 42 is adjacent the flange 28. The midportion of each wire forming an arm 40 is pivotally disposed between one of the tabs 34 and the rim 14 of the rotor 10, as best shown in FIGURE 5. Thus, the arms 40 normally urge the engagement member 24 in a direction from the hub 18. As stated above, the lugs 30 of the engagement member 24 are engageable with the lugs 22 of the hub 18 to prevent movement of the engagement member 24 from the hub 18. The engagement member 24, as shown in FIGURE 4, is supported by the arms 40 concentric with the hub 18 and slightly spaced from the hub 18. Thus, the engagement member 24 is free to readily axially move with respect to the hub 18.

Each of the arms 40 carries a weight member 44 which has slots 46 into which portions 48 of the arm 40 are disposed so that each weight member 44 is firmly retained by its respective arm member 40. Each slot 46 is disposed closer to one edge of the weight member than to the opposite edge thereof, as shown in FIGURES 1 and 5, so that a lever action is possible, as discussed below. Each weight member 44 is freely disposed within an opening 51 of the rotor 10.

A support bracket 50 fixedly disposed adjacent the rotor 10 carries a terminal block 52 of suitable electrical insulating material. The block 52 has attached thereto a pair of resilient contact fingers 54. Conductor members 56 connect to the contact fingers 54 for transmisison of electrical energy to and from the contact fingers 54. Each contact finger 54 has a contact tip 58 which is normally in engagement with the flange portion 28 of the engagement member 24, as shown in FIGURES 2 and 5. The contact tips 58 engage the engagement member 24 at diametrically opposite portions, as shown in FIGURE 3. The lower portions of the resilient fingers 54 are normally bent as the engagement member 24 forces the contact tips 58 in a direction away from the rotor 10, as shown in FIGURE 2. Thus, the fingers 54 normally resiliently urge the engagement member 24 toward the rotor 10, but the arms 40, as described above, normally overcome the resilient forces of the fingers 54 and force the engagement member 24 in a direction from the rotor 10. Thus, the lugs 30 of the engagement member 24 normally abut the lugs 22 of the hub 18. These conditions are present when the rotor 10 is at zero speed or revolving at a rate less than a given value.

Operation

When the control apparatus of this invention is used in association with an electric motor comprising the shaft **20** and a starting winding (not shown), one or more of the conductor members **56** is connected to the starting winding for energization thereof from a source of electrical energy. Thus, the contact fingers **54** are connected in series with the starting winding. Therefore, when the motor is started, electrical current passes through the conductor members **56** and through the contact fingers **54**. The electrical current also passes through the flange **28** of the engagement member **24** which is engaged by the contact tips **58**. Thus, the engagement member **24** serves as a conductive bridge between the contact tips **58** to complete the circuit therebetween.

As the rate of rotation of the rotor **10** and the engagement member **24** increases, centrifugal forces upon the weight members **44** increase and the weight members **44** tend to move radially outwardly. The off center attachment of each weight member **44** to its respective arm member **40** provides means for lever action of the weight members **44**. This lever action is transmitted to the arms **40**.

As the centrifugal forces upon the weight members **44** increase, the weight members **44** tend to pivot and tend to pivotally move the arms **40**. Thus, with an increasing rotational rate, the arms **40** increasingly tend to move the engagement member **24** toward the rotor **10**. As disclosed above, the resilient contact fingers **54** are engaging the engagement member **24** and are tending to move the engagement member **24** toward the rotor **10**. Thus, with an increasing rate of rotaion, there occurs a condition at which weight members **44** cause the arms **40** to instantaneously move the engagement member **24** to the position thereof shown in FIGURE 3. In this position the engagement member **24** is adjacent the rotor **10**. The resiliency of the wires of which the arm members **40** are composed permits deflection of the arm members **40** as required in movement of the engagement member **24** from the position thereof shown in FIGURE 2 to the position thereof shown in FIGURE 3.

When this snap action type of axial movement of the engagement member **24** occurs, the engagement member **24** is instantaneously moved away from engagement with the contact tips **58**, as shown in FIGURE 3. Thus, the electrical circuit between the contact tips **58** is instantaneously broken. Thus, the electrical circuit to the starting winding through the conductor members **56** is interrupted so that the starting winding is deenergized. Thus, the motor operates without the starting winding.

After the desired period of operation of the motor, the motor is deenergized and the rate of rotation of the shaft **20** is reduced and centrifugal forces upon the weight members **44** are reduced so that the weight members **44** pivotally move and return the engagement member **24** to the normal position thereof, as shown in FIGURE 2. Thus, the apparatus of FIGURES 1–5 serves as a direct switch means in the circuit to an element such as a starting winding.

Apparatus of FIGURES 6 and 7

The apparatus of this invention as shown in FIGURES 6 and 7 includes a switch member **60** which is held in a closed condition by a yoke **61** which is attached to resilient fingers **62**. The resilient fingers **62** are supported by a block **64**. Each of the fingers **62** has a contact tip **66** which is firmly engaged by an engagement member **68** which is similar to the engagement member **24** of FIGURES 1–5. However, the engagement member **68** does not need to be of conductor material. The contact tips **66** are disposed on opposite portions of the engagement member **68** to provide equal forces at diametrically opposed portions thereof. The fingers **62** are resiliently bent by the force of the engagement member **68** so that the switch **60** is normally held in a given condition of operation.

A rotor **70** has arms **72** and weight members **74** carried thereby. The rotor **70** is mounted upon a shaft **76** and is similar to the rotor **10** but does not need to be of nonconductive material. When the shaft **76** is rotated at an increasingly greater rate, in the manner discussed above, a condition occurs at which the weight members **74** pivot and instantaneously cause the engagement member **68** to move toward the rotor **70**. Thus, a snap action operation of the switch **60** occurs as the pressure of the yoke **61** against the switch **60** is instantaneously removed.

Thus, it is understood that the apparatus of this invention may directly or indirectly control operation of another element in accordance with the rate of rotation of a rotor member.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. In control apparatus, a rotor provided with a rim portion, a rotatable engagement member adjacent the rotor coaxial therewith and axially movable toward and away from the rotor, the engagement member having a hub portion, a plurality of U-shaped resilient wire members, each of the wire members having the two ends thereof in engagement with the engagement member adjacent the hub portion thereof, each of the wire members having a midportion in pivotal engagement with the rotor adjacent the rim portion thereof, each wire member thus being generally angular with respect to the axis of rotation of the rotor and engagement member, the engagement member thus being connected to the rotor by the wire members, the engagement member thus being rotatable with the rotor, each of the U-shaped wire members having all portions thereof substantially coplanar and having spaced-apart bent leg portions, a plurality of weight members, there being one weight member rigidly attached to each of the wire members so that the wire member angularly moves with movement of the weight member, each weight member having an extending portion which is movable outwardly from the axis of rotation of the rotor when the rotor rotates above a given rate, such outward movement of said extending portions of the weight members causing angular movement of the wire members so that the angle of force of each wire member upon the engagement member is changed and there is relative movement between the engageemnt member and the rotor.

2. In control apparatus, a rotor provided with a plurality of openings adjacent the periphery thereof, there being a notch in the rotor adjacent each of said openings, the rotor having a hub, an engagement member encompassing the hub and axially movable with respect thereto, abutment means carried by the hub and limiting axial movement of the engagement member, the engagement member having an axial portion, the axial portion being provided with a plurality of pairs of grooves, a plurality of arm members, there being one arm member for each of the openings of the rotor, each arm member including an elongate resilient wire angularly disposed between the rotor and the engagement member, each wire being bent so that the ends thereof are within one of the pairs of grooves of the axial portion of the engagement member, the mid-portion of each of the wires being pivotally disposed within one of said notches in one of said openings, each resilient wire thus applying pressure upon the engagement member urging the engagement member in a direction away from the rotor, a plurality of weight members, there being one weight member rigidly carried by

each arm member and disposed within one of said openings of the rotor, each weight member having an extending portion which moves radially outwardly when the rate of rotation of the rotor exceeds a given value, the outward movement of the extending portion of the weight member causing pivotal movement of the wire which supports the weight member, such angular movement of the wire causing a change in the pressure of the wire upon the engagement member so that the engagement member is moved with respect to the rotor.

3. In control apparatus, a rotor provided with a rim portion, an engagement member adjacent the rotor coaxial therewith and axially movable toward and away from the rotor, a plurality of U-shaped resilient wire members, each of the wire members having the two ends thereof in pivotal engagement with the engagement member adjacent the axis of rotation thereof, each of the wire members having a mid-portion in pivotal engagement with the rim portion of the rotor, each of the wire members thus being angularly disposed between the rotor and the engagement member, the engagement member thus being connected to the rotor by the U-shaped wire members, the engagement member thus being rotatable with the rotor, a plurality of weight members, there being one weight member for each of the wire members, each weight member being rigidly carried by its respective wire member so that angular movement of the weight member causes angular movement of the wire member, each weight member having an extending portion which is radially movable outwardly fhom the axis of rotation of the rotor when the rotor and the engagement member rotate above a given rate, such radial movement of said extending portions of the weight members causing angular movement of the weight members thus causing angular movement of the wire members so that the angle of force of the wire members upon the engagement member is changed and thus the total resilient force of the wire members upon the engagement member is changed.

4. In control apparatus:

a first rotor,

a second rotor, the rotors being substantially coaxial, the rotors being relatively axially movable,

means limiting relative axial movement of the rotors,

an elongate bent wire member intermediate the rotors and in resilient engagement therewith so that the resilient wire member urges movement of the rotors one from the other, the wire member being generally within a plane which is angular with respect to the axis of rotation of the rotors, the rotors rotating one with the other,

a weight member firmly carried by the wire member so that movement of the weight member causes movement of the wire member, the weight member having an extension portion which moves radially outwardly as the rotors reach a rotational rate greater than a given value, such outward radial movement of the extension portion of the weight member causing the wire member to angularly move so that there is a change in the angle of the plane of the wire member with respect to the axis of rotation of the rotors so that the second rotor is moved closer to the first rotor.

5. Apparatus according to claim 4 in which the wire member has at least one bent portion which deflects during angular movement of the wire member.

6. In control apparatus:

a first rotor,

a second rotor, the rotors being substantially coaxial, the second rotor being axially movable with respect to the first rotor,

means limiting axial movement of the second rotor in a direction from the first rotor,

a plurality of elongate wire members, each of the wire members being intermediate the first rotor and the second rotor so that the second rotor is normally resiliently urged by the wire members in a direction away from the first rotor, there being pivotal connection between the second rotor and the wire members, the rotors rotating one with the other, each of the wire members being generally in a plane which is angularly disposed with respect to the axis of rotation of said rotors,

a plurality of weight members, there being one weight member for each of the wire members, each weight member being firmly supported by one of the wire members, each of the weight members having an extending portion which moves radially outwardly as the rotational rate of the rotors increases above a given value, such outward movement of the weight members causing a change in the angle of the plane of the wire members with respect to the rotors so that the second rotor is moved closer to the first rotor.

7. Apparatus according to claim 6 in which each wire member has at least one bent portion which compressionally deflects during angular movement theerof.

8. In control apparatus:

a first rotor,

a second rotor, the rotors being substantially coaxial, the second rotor being axially movable with respect to the first rotor,

means limiting axial movement of the second rotor in a direction from the first rotor,

a plurality of elongate wire members,

a plurality of weight members, there being one wire member rigidly attached to each weight member so that each weight member and its respective wire member comprise a unit so that movement of the weight member causes movement of the wire member, each unit being resiliently angularly disposed intermediate the rotors and pivotally joined thereto so that the unit is generally angular with respect to the axis of rotation of the rotors, each wire member being in a general plane which is angular with respect to the axis of rotation of the rotors, the wire members being compressed between the rotors so that the second rotor is resiliently urged by the compressive forces of the wire members in a direction from the first rotor, the second rotor rotating with the first rotor, the weight members being angularly movable by centrifugal forces at rotational speeds of the rotors above a given value, such angular movement of the weight members causing angular movement of the wire members to which the weight members are attached so that the angle of force of the wire members upon the second rotor changes and the second rotor is moved toward the first rotor.

9. In control apparatus:

a first rotor,

a second rotor, the rotors being substantially coaxial, the rotors being relatively axially movable,

means limiting relative axial movement of the rotors,

an elongate resilient member intermediate the rotors and in compressional resilient engagement therewith so that the resilient member urges movement of the rotors one from the other, the resilient member being generally within a plane which is angular with respect to the axis of rotation of the rotors, the rotors rotating one with the other,

a weight member firmly carried by the resilient member so that movement of the weight member causes movement of the resilient member, the weight member having an extension portion which moves radially outwardly as the rotors reach a rotational rate greater than a given value, such outward radial movement of the extension portion of the weight member causing the resilient member to angularly move so that there is a change in the angle of the general plane of the resilient member with respect to the axis of rotation of the rotors so that the

second rotor is moved closer to the first rotor, the change in the angle of the resilient member causing a decrease in the dimension of the resilient member from the first rotor to the second rotor so that an increase in compressional forces of the resilient member occurs as the second rotor moves closer to the first rotor.

10. In control apparatus:

a first rotor,

a second rotor, the rotors being substantially coaxial, the rotors being relatively axially movable,

means limiting relative axial movement of the rotors,

a plurality of resilient members intermediate the rotors and in compressional resilient engagement therewith so that the resilient members urge movement of the rotors one from the other, each of the resilient members being generally within a plane which is angular with respect to the axis of rotation of the rotors, the rotors rotating one with the other,

a plurality of weight members, there being a weight member firmly carried by each resilient member so that movement of the weight member causes movement of the resilient member, the weight member

having an extension portion which moves radially outwardly as the rotors reach a rotational rate greater than a given value, such outward radial movement of the extension portion of the weight member causing the resilient member to angularly move so that there is a change in the angle of the general plane of the resilient member with respect to the axis of rotation of the rotors so that the second rotor is moved closer to the first rotor, the change in the angle of the resilient member causing a decrease in the dimension of the resilient member from the first rotor to the second rotor so that an increase in compressional forces of the resilient member occurs as the second rotor moves closer to the first rotor.

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