June 23, 1953 G. T. RANDOL 2,643,310

SPEED-RESPONSIVE DEVICE

Filed June 22, 1951

Fig. 1

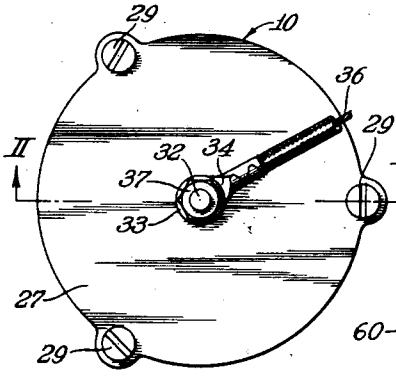


Fig. 2

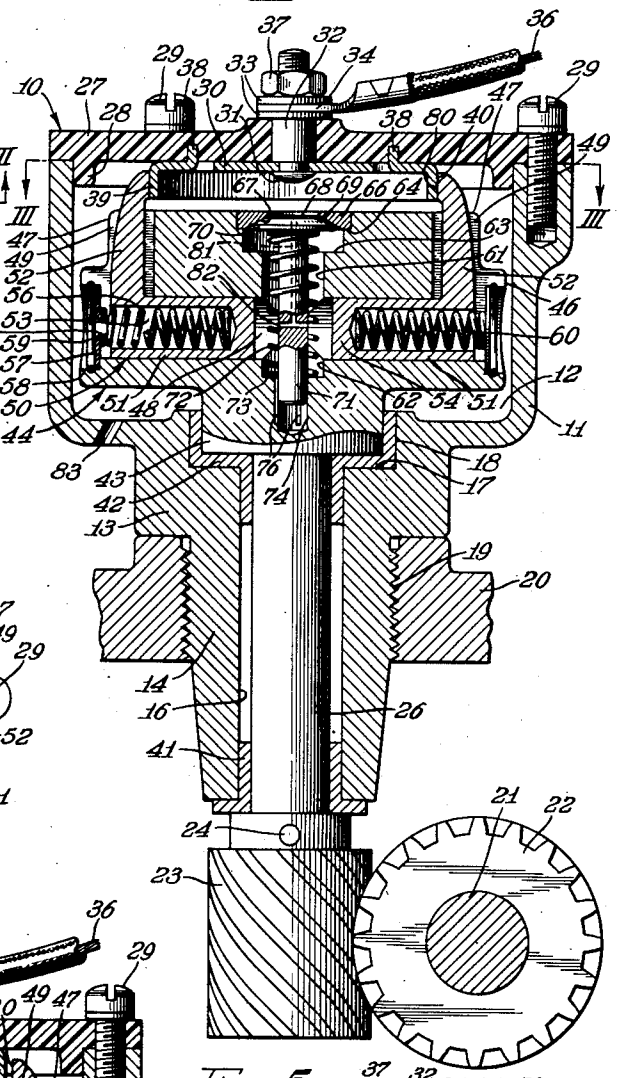


Fig. 3

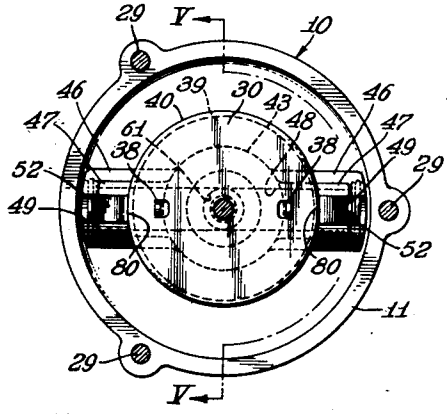


Fig. 4

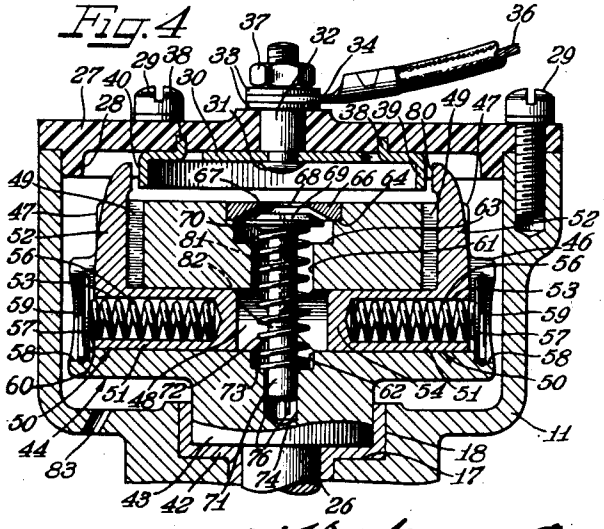
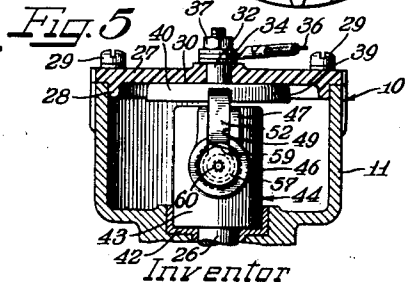


Fig. 5



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SPEED-RESPONSIVE DEVICE

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20 Claims. (Cl. 200—80)

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The present invention relates to a speed-responsive device, and more particularly to a device responsive to centrifugal force exerted upon a centrifugal-type actuating mechanism in differentially counteractive relation to energizable force-transmitting means, the device being sensitive to very slight variations in such differential forces exerted upon the actuating mechanism.

In the art of speed-responsive devices, many different types of centrifugal-type actuating mechanisms have been proposed. However, such devices are generally sensitive only to relatively great differences in rotational speeds, in an attempt to avoid excessive "hunting" or "searching" in the immediate actuating speed range. Further, the prior art devices are not actuated by speeds sufficiently low to accurately control a mechanism, such as a vehicular power-operated change-speed gearing or a friction clutch, which must be activated and/or inactivated at relatively low vehicular speeds, preferably at or immediately prior to the vehicular stalling speed. The great need for such a speed responsive control means will be appreciated when the operational desirability and safety of driving speed neutralization and/or automatic clutch disengagement at approximately the stalling speed are considered, so as to utilize the compression braking power of the engine during slowing of the vehicle substantially to a stop, as at a traffic signal or intersection. However, it will be appreciated that this specific use of a speed-responsive device of this character is only exemplary, and many other uses will suggest themselves to those skilled in the art.

It is, therefore, an important object of the present invention to provide a speed-responsive device provided with means for at least partially counter-balancing centrifugal forces exerted on the actuating mechanism thereof to provide a control which is sensitive to small differential speed changes without excessive "hunting" of the mechanism in the range of control actuation.

Another important object is the provision of governing means including centrifugal members urged in one direction by centrifugal force, in another direction by force-transmitting means, and acted upon by fluid pressure damping means to resist actuation of the members to an operated position.

Still another object is to provide a governor utilizing centrifugal force and resilient biasing means as differentially counteractive actuating media, with counter-centrifugal movement only

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of the governor actuating mechanism being resisted by fluid pressure damping means.

A further object is the provision of a speed-responsive mechanism including relatively angularly and laterally movable control elements having a plurality of operative positions, one of the positions being attainable under the influence of centrifugal force directly proportional to rotational speed and another of the positions being attainable under the influence of biasing means normally opposing centrifugal force-responsive movement, the biasing means actually and solely causing relative movement of the elements when the centrifugal forces on the members decrease below the centrifugal force-biasing means balance point.

Another object related to that next above set forth is to provide speed-responsive mechanism wherein relative lateral movement under the influence of the biasing means is modulated by and under the control of fluid pressure dashpot means.

Yet a further object of this invention resides in the provision of speed-responsive means including opposing reciprocatory pistons movable to a plurality of adjusted positions under the counteractive differential influences of centrifugal force and mechanical pressure, with movement of the pistons to one of their positions being modulated by compression dashpot means interposed therebetween.

An additional object related to that next above is to provide differential fluid pressure dashpot means having vent valve means effective to control dashpot pressures so that effective dashpot action occurs only upon movement of the reciprocatory pistons in a single direction.

A more specific object of the present invention is the provision of speed-response means wherein centrifugal-force responsive movement of a plurality of centrifugal members is utilized to operatively energize pre-loaded compression elements which are effective, upon attainment of minimum rotational speed and resultant minimum centrifugal force, to solely cause counter-centrifugal movement of the centrifugal members, and means responsive only to such counter-centrifugal movement to damp such movement to thereby enable further reduction of the rotational speed at which actual control movement of said members occurs.

Yet another object is to provide a speed-responsive device having a pair of relatively movable contact elements, the elements being relatively rotatable about a common axis and also

relatively movable in lateral alignment into and out of engagement.

A further object related to that next above is the provision of means energized as a consequence of relative rotation of the elements to resist movement of the contact elements both into and from engagement.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

This invention (in a preferred form) is illustrated in the drawings and hereinafter more fully described.

In the drawings:

Figure 1 is a plan elevational view of a speed-responsive device of the present invention;

Figure 2 is a vertical sectional view taken along the plane II—II of Figure 1, illustrating the control elements of the device in an operated (closed) condition and the dashpot means under atmospheric conditions;

Figure 3 is a transverse sectional view taken along the plane III—III of Figure 2 further illustrating details of the contact elements when the same are positioned as shown in Figure 2.

Figure 4 is a fragmentary sectional view similar to Figure 2 illustrating the control elements in a different operated (open) condition and the dashpot means actuated (open) to facilitate relative centrifugal movement of the control elements; and

Figure 5 is a fragmentary vertical sectional view taken along the planes V—V of Figure 3 illustrating further details of the movable contact end structure.

Referring to the drawings:

In Figures 1–5, inclusive, reference numeral 10 refers generally to a speed-responsive device of the present invention particularly constructed and arranged to be actuated from one operative position to another by minimum speed, or other actuating force, variations.

The device 10 includes an exterior casing provided with an upper, generally cylindrical casing section 11 defining an open-topped inner chamber 12 overlying a lower mounting block portion 13 having an exteriorly threaded shank 14 provided with an axial bore 16. The bore 16 terminates at its upper end in a radially enlarged shoulder 17 defining an open-topped counterbore 18 in full communication with the chamber 12. The casing shank portion 14 is threadedly received by a matingly threaded aperture 19 formed in a support structure 20, which may conveniently be a transmission housing through which a transmission output or propeller shaft 21 passes. The output shaft 21, or other source of control speed, carries for rotation therewith a worm or similar toothed member 22, which member 22 meshes with a worm gear or other matingly toothed member 23. The member 23 is pinned or otherwise co-rotatably secured as at 24, to a driven shaft 26 which serves to actuate the control elements of the device, as will be hereinafter described in greater detail.

The open-topped chamber 12 of the casing is closed by an insulated cap 27 which is circular in configuration and which carries an integrally formed, depending annular flange 28 snugly fittable into the recessed casing 11 to provide a snug dust-tight closure for the chamber 12. The cap 27 is detachably secured to the casing 11 by suitable means, as by cap screws 29. The

cap inner surface carries an inwardly projecting dished contact element 30 which is fixedly secured to the cap 27 by a center rivet-head 31 forming a terminal end of a contact post 32 projecting upwardly through the cap. The contact post receives contact washers 33 thereon exteriorly of the casing for confining therebetween a contact bight 34 carried by a lead wire 36. The washers are urged toward one another and into good electrical contact with the bight 34 by a nut 37 threadedly received by the free end of the post 32.

The dished contact element 30 is retained against rotation by ears 38 struck upwardly therefrom for extension into the insulated cap 27. The depending peripheral flange 39 of the element 30 projects into the chamber 12 and the exposed exterior surface 40 of the flange 39 provides a continuous annular contact surface which cooperates with the centrifugal force-response elements of the device as will later become apparent.

The shaft 26 is journalled for rotation within plain or sleeve-type bearings, one bearing 41 being press-fitted within the bore 16 at the lower extremity thereof and the other bearing 42 being seated in the counterbore 18 against the shoulder 17 above described. The shaft 26 carries at its upper end an enlarged boss 43 either formed integrally therewith or pinned thereto for co-rotation, and the boss 43 forms a part of a rotor indicated generally at 44. The rotor 44 is generally cylindrical in shape (Figure 3) and is provided with oppositely directed, radially extending embossments 46 having upper web portions 47 joining the embossments 46 to the rotor proper.

The diametrically opposed embossments 46 are joined by a single continuous cross-bore 48 extending diametrically through the rotor and axially through the embossments. The embossments are each provided with slots 49 communicating with the cross-bore 48 at the outer radial ends of the cross-bore, the slots 49 thus extending axially of the rotor and normal to the axis of the cross-bore 48, and the slots actually being formed in the upper web portions 47 hereinbefore described.

The bosses 46 are each adapted to receive, within the respective cross-bore portions thereof, a movable contact element 50 which is reciprocable axially within the cross-bore 48, the reciprocation of the elements 50 being radial with respect to the rotor 44. More particularly, the elements 50 each comprise a piston portion 51 snugly received by the cross-bore and a projecting contact arm portion 52 adapted to project radially of the piston portion and through the slots 49 axially of the rotor into proximity with the fixed contact flange 39.

The piston portions 51 of the movable elements 50 are provided with axially extending recesses 53 having closed inner ends 54 against which are bottomed compression spiral springs 56. The outer ends of the springs 56 are bottomed against circular washers 57 retained in shallow counterbores 58 formed in the outer end of the bosses 46 (Figure 2). The washers 57 are retained in the counter-bores 58 by lock rings 59, and the washers are provided with inwardly projecting central nipples 60 so as to positively guide the springs 56 for compressive and expansive movements.

The cross-bore 48 communicates with a second bore 61 extending axially of the rotor 44 inwardly

from the free upper surface thereof to intersect the cross-bore **48** and to project therebeyond, as at **62**. The outer or upper end of the bore **61** is countersunk to provide an inner radial shoulder **63** and is again countersunk to provide an outer, radially larger shoulder **64** against which is press-fitted or otherwise secured a valve seat insert **66** having an inner, inwardly divergent, frusto-conical valve seating face **67** surrounding a central air escape port **68**.

The valve seating face **67** is adapted for coaction with a peripheral correspondingly frusto-conical valve face **69** carried by a check-valve **70** having a stem **71** depending axially into the axially aligned bores **61** and **62**. The valve stem **71** is surrounded by a spiral compression spring **72** bottomed against a shoulder **73** defined by the inner end of the bore **62** and a smaller axially aligned bore **74** extending therebeyond. The free lower terminal end of the valve stem **71** is projected into the bore **74** for guiding the check-valve face **69** into proper seating relationship with its fixed cooperating face **67**. A plurality of semi-circular air flutes **76** are formed in the surface of the bore **74**, and of such length as to maintain the lower end of said bore vented to the cross-bore **48** whereby compression or suction action on the lower end of the valve stem **71** is prevented during check-valve actuation. Thus, the stem is guided by the bore **74** for axial movement to carry the valve head **70** into and out of engagement with the valve seat **67** either under the influence of or against the compression of the spring **72**.

The valve **70** and the stem **71** thereof are provided with an open-ended axially extending air-bleed passage **81** communicating at its inner end with a radial passage **82** communicating with the interior of the bores **48** and **61** in the area of junction thereof. The passages **81** and **82** thus provide restricted means for air to escape from the bores without passing through the valve opening **68**. The interior of the casing **11** is vented to the atmosphere through the opening **83** therein.

It will be seen from Figures 2 and 4 that the contact arm portions **52** of the elements **50** terminate in inwardly directed arcuate contact faces **80**, and these faces are adapted to cooperate with the exterior peripheral contact surface **40** of the contact member **39** upon reciprocation of the pistons **50** by differential counteractions of centrifugal force and pressure of the springs **56**.

Operation

To better comprehend the operation of the present invention, let it be assumed that the rotary shaft **21** is the propeller shaft or output shaft of an automotive transmission, so that the rotational speed of the shaft is directly proportional to the road speed of the vehicle. Further let it be assumed that the conductor **36** forms a part of a control circuit for an automotive clutch which is automatically engageable and disengageable in response to the flow of electric current through the conductor.

When the switch contact elements are closed, as when contact faces **80** of the arms **52** contact the peripheral face **40** of the element **30**, current flow through the conductor is grounded through the entire assembly **10**, and direct current flow through the assumed control circuit can occur. When the contact elements are open, as in Figure 4, no current flow can occur. Thus, it will be appreciated that the present invention provides means for controlling current flow through the conductor **36** and an assumed control circuit associated therewith.

When the shaft **21** is rotated at a speed sufficient to generate a substantial centrifugal force sufficient to throw the elements **50** radially outwardly against the compression springs **56**, the pistons will assume the radial positions illustrated in Figure 4 and the contact faces **40** and **80** of the elements **30** and **50**, respectively, will be separated. Thus no current flow through the contact elements is possible. The washers **57** will serve to limit outward movement of the elements **50** and the outward centrifugal force-responsive movement will serve to compress the springs **56**.

As the rotative speed of the shaft **21** decreases, the ratio of the spring compressive force to the outward centrifugal force will increase until such time as the forces become balanced. After this counterbalancing action occurs, further decrease in speed produces a differential counteraction between the centrifugal and spring forces whereby the elements **50** will be moved inwardly until the springs **56** force the contacts closed. Obviously, the exact moment of contact element contact may be primarily controlled by the compressive strength of the springs **56**.

The pistons **51** fit quite snugly in the bore **48**, and the pistons in combination with the valve **70** provide a dashpot means for modulating element closure in order that the same may be more precisely controlled. More specifically, the dashpot means functions to control the rate of piston inward movement to final element-engaged position, without interfering with radially outward, contact-breaking piston movement.

As the pistons move radially outwardly, a vacuum is created in the bores **48** and **61** by virtue of the enlarged area between the pistons. This vacuum draws the valve **70** open against the action of the spring **72** before the vacuum becomes sufficient to substantially interfere with outward piston movement. Thus, there is no interference of differential pressure with outward piston movement, since air at atmospheric pressure is introduced into the potential vacuum area by the valve opening movement. This condition of venting the bores **48** and **61** to atmospheric conditions is specifically shown in Figure 4.

On the other hand, as the centrifugal forces upon the elements lessen and the spring-centrifugal force ratio increases, the pistons **51** are forced into the damping chamber defined by the bores **48** and **61**. Thus, the size of the chamber is decreased and air therein, originally under atmospheric pressure, is placed under compressive greater-than-atmospheric pressures, since the valve **70** is closed by the spring **72** as soon as the air pressures in the chamber and the casing **11** are equalized. This superatmospheric air pressure will resist further inward movement of the pistons **51**, and, although a portion of the air will be bled off through the bleed passages **81** and **82**, these passages are restricted so that the air pressure in the chamber is only slowly lessened.

The resulting substantial impedance of inward piston movement will damp final relative contacting movement of the faces or surfaces **40** and **80**, so that closing movement of the elements will be substantially delayed so as to occur only after the speed of the shaft **21** has dropped well below that speed necessary to generate sufficient centrifugal force for resisting the spring contact-closing force. In other words, the fluid pressure

damping structure provides means for delaying switch closing movement until a substantially non-rotational condition of the shaft 21 exists, while rapid centrifugal force-responsive switch opening movement is possible.

In addition to the close control of contact-closing movement at extremely low rotational speeds, final closing movement occurs as a result of the sole effort of the springs 56 as modulated by the fluid pressure damping means. Thus, a final, sharp closing movement of the contact elements is obtained at a predetermined slow rotational speed. The inward closing movement of the pistons is substantially entirely radial, and electrical arcing across contacts is thus prevented. A minimum of relative rotational movement between the contacting surfaces 40 and 80 occurs, so that it is practical for the first time to utilize relatively rotatable electrical contact surfaces in a speed-responsive device with a negligible wear factor.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention as defined in the claims appended hereto.

I claim as my invention:

1. A speed-responsive device comprising a shaft adapted to be rotated at varying speeds, a rotor rotatable with said shaft and having a radial cross-bore therein, a fixed contact element located in spaced relation to said rotor, a piston movable in said cross-bore in response to rotational speeds of said rotor, said piston being movable radially outwardly of said rotor by centrifugal forces generated upon rotor rotation, a contact element movable with said piston into and out of contact with said fixed element, and spring means urging said piston radially inwardly in opposition to said centrifugal force.

2. A speed-responsive device comprising a shaft adapted to be rotated at varying speeds, a rotor rotatable with said shaft and having a radial cross-bore therein, a fixed contact element located in spaced relation to said rotor, a pair of opposed pistons reciprocally movable in said cross-bore in response to rotational speeds of said rotor, said pistons being moved radially outwardly of said rotor by centrifugal force generated upon rotor rotation, contact arms carried by said pistons and projecting therebeyond for movement into and out of contact with said fixed element, and spring means acting directly upon said pistons to bias the same radially inwardly in opposition to said centrifugal force.

3. A speed-responsive device comprising a rotary shaft adapted to be driven at varying speeds, elements disposed in a common plane on said shaft for movement radially outwardly therefrom in response to centrifugal forces developed upon rotation of said shaft, means operative in the plane of movement of said elements for opposing radially outward movement thereof and effective to force said elements radially inwardly upon a decrease in centrifugal force, fluid pressure damping means in direct fluid communication with said elements for modulating inward radial movement of said elements under the force of said first named means, and means for driving said rotary shaft at varying speeds.

4. A speed-responsive device comprising a rotary shaft adapted to be driven at varying speeds, diametrically opposed elements disposed in a common plane on said shaft for movement radially outwardly therefrom in response to centrifugal forces developed upon rotation of said shaft, means operative in the plane of movement of said elements for opposing radially outward movement thereof and effective to force said elements radially inwardly upon a decrease in centrifugal force, and fluid pressure damping means interposed between said elements for modulating inward movement of said elements under the force of said first named means, said fluid pressure damping means including a fluid pressure chamber of varying volume with the volume thereof decreasing as said elements are forced radially inwardly, and restricted bleeding passages providing a sole exit for fluid under pressure in said chamber.

5. A speed-responsive device comprising a rotary shaft adapted to be driven at varying speeds, elements on said shaft for movement radially outwardly therefrom in response to centrifugal forces developed upon rotation of said shaft, means operative in the plane of movement of said elements for opposing radially outward movement thereof and effective to force said elements radially inwardly upon a decrease in centrifugal force, and fluid pressure damping means for modulating inward movement of said elements under the force of said first-named means, said fluid pressure damping means including a fluid pressure chamber of varying volume with the volume thereof decreasing as said elements are forced radially inwardly, valve means controlling venting of said chamber to the atmosphere and operated to a closed position when atmospheric or superatmospheric conditions exist in said chamber, and a bypass exit of relatively small capacity for accommodating the escape of fluid under pressure from said chamber despite the closed position of said valve means.

6. A speed-responsive device comprising a rotary shaft adapted to be driven at varying speeds, a rotor rotatable with said shaft, a fixed contact element concentric with but axially spaced from said rotor, a plurality of movable contact elements radically disposed in a single plane about the axis of said rotor and normally bridging the axial space between said rotor and said fixed element, said movable elements being reciprocable radially of the axis of said rotor in response to centrifugal forces generated upon rotation thereof, and means effective to hinder movement of said movable elements in both radial directions to thereby vary the rate of speed-responsive movement thereof.

7. A speed-responsive device comprising a rotary shaft adapted for rotation at varying speeds, a rotor rotatable with said shaft and having a cross-bore extending radially therethrough, a plurality of reciprocatory pistons radially slidable in opposing ends of said cross-bore and defining a fluid-tight air chamber therebetween, said pistons being moved radially outwardly by centrifugal forces developed upon rotation of said shaft at speeds equal to or above a predetermined value, means urging said pistons radially inwardly when said shaft rotates at speeds equal to or less than a second predetermined value, valve means operable to an open position when said pistons are moved outwardly and operable to a closed position thereafter so that atmospheric pressure is maintained in said chamber, and means by-passing said valve means and affording only restricted bleeding of air from said chamber during inward movement of said pistons to modulate the rate of such inward movement.

8. A speed-responsive device comprising a plurality of relatively movable contact elements,

means for causing longitudinal reciprocatory movement of one of said elements while imparting rotary movement thereto about an axis normal to the direction of reciprocatory movement, fluid pressure damping means comprising at least one of said contact elements and energized as a result of reciprocatory movement of said one of said contact elements to impede relative movement of said contact elements, valve means including a movable element for controlling energization of said last-named means, and means for imparting rotary movement to said elements.

9. A speed-responsive means comprising a plurality of relatively movable contact elements, one of which is movable longitudinally into and out of contact with the other, means for rotating said one element about an axis displaced from the one element itself so as to cause said longitudinal movement, and a fluid pressure chamber, the volume of which varies in direct relation to movement of said one element with movement of said one element toward said other element generating super-atmospheric pressures therein to modulate further movement of said one element.

10. In a speed-responsive device, a plurality of relatively movable contact elements, a fixed contact, means for relatively moving said elements in a common plane into and out of engagement with said fixed contact, means for rotating said elements relatively about a common axis normal to the aforesaid common plane thereof, and means energized as a consequence of relative rotation for resisting relative movement of said elements both from and into engagement with the said fixed contact.

11. In a speed-responsive device having a plurality of radially movable contact elements responsive to centrifugal forces exerted thereon, means for damping radial movement of said elements by fluid pressure including a fluid-tight compartment therebetween, pistons formed integrally with said elements for movement therewith to vary the volume of said compartment, and means controlling the ingress and the egress of atmospheric air and super-atmospheric air to and from said compartment respectively.

12. In a speed-responsive device having a plurality of radially movable contact elements responsive to centrifugal forces exerted thereon, spring means acting on said elements to urge the same to an adjusted radial position, and means for damping radial movement of said elements by fluid pressure including a fluid-tight compartment therebetween, pistons formed integrally with said elements for movement therewith to vary the volume of said compartment, and separately effective atmospheric vent ports of different sizes to promote rapid ingress and relatively slow egress of air.

13. In a speed-responsive device having a plurality of contact elements movable radially by differential counteractions of centrifugal and compressive spring forces, means for modulating radially inward element movement including means defining an air chamber between said elements, means movable radially with said elements into and out of said chamber to vary the volume thereof, and a restricted air escape port for slowly bleeding air from said chamber as the same is compressed therein by movement of said last-mentioned means thereinto.

14. In a speed-responsive device, a rotor adapted to be rotated about a longitudinal axis at varying rotational speeds and having a radially extending open-ended bore therethrough, said rotor also having an axial recess communicating with said bore, a plurality of opposed pistons projecting into the open ends of said bore for radially outward movement therein due to centrifugal forces generated upon rotation of said rotor, spring means acting on said pistons to oppose radially outward movement thereof and being operatively energized during such movement to urge said pistons radially inwardly against centrifugal force, and valve means modulating radially inward piston movement including a valve located in said axial recess and controlling venting of said bore to the atmosphere and a restricted bypass incorporated in said valve to afford a sole outlet for air from said bore upon radially inward movement of said pistons.

15. In a speed-responsive device, radially movable control elements actuated radially outwardly by centrifugal force, spring means operatively energized by outward movement of said elements for urging the same radially inwardly, fluid pressure modulating means in direct fluid communication with said elements and concentrically disposed with respect to the common axis about which said control elements actuate and effective for differentially accommodating outward movement of said elements and opposing inward movement of said elements to vary the rate of radially inward movement thereof, and means for generating centrifugal force on said elements.

16. In a speed-responsive device, a centrally located fixed contact element, a plurality of movable contact elements adapted for contact with said fixed contact and disposed for rotation at varying speeds about an axis common to said fixed element and said movable elements, means accommodating movement of said movable elements in a common plane radial to said axis and in accordance with centrifugal forces generated upon rotation of said movable elements, means biasing said movable elements radially inwardly toward said fixed element at rotational speeds equal to or less than a predetermined value, and means causing an appreciable time-lag in radially inward movement of said movable elements after speeds less than said predetermined value have been obtained, so that actual closing contact of said elements occurs at speed less than said predetermined value.

17. In combination with a speed-responsive device having a rotatable centrifugal element movable inwardly and outwardly with respect to its axis of rotation as a function of its speed of rotation; means biasing said element inwardly when rotating at speeds equal to or less than a predetermined value; a fluid-pressure dash pot including said element operably energizable during outward movement of said element for exerting a differential damping force directly on said element to substantially retard inward movement of said element; valve means including a movable element automatically operable for controlling operative energization of said fluid-pressure dash pot; and means for rotataing said element at different speeds.

18. In combination with a speed-responsive device having rotatable elements movable toward and away from their axis of rotation as a function of their speed of rotation, means biasing said movable elements toward their axis of rotation when rotating at speeds less than a predetermined speed, a fluid-pressure device for exerting a differential damping force on said elements to substantially impede only movement of said elements toward said axis, said device including a variable

volume air chamber, a single-acting vent valve associated with said chamber to vent the same to the atmosphere when said elements move from said axis, and a restricted by-pass for solely venting said chamber to the atmosphere upon movement of said elements toward said axis.

19. In combination with a speed-responsive device having rotatable elements movable toward and away from their axis of rotation as a function of their speed of rotation, means biasing said movable elements toward their axis of rotation when rotating at speeds less than a predetermined speed, a fluid-pressure device for exerting a differential damping force on said elements to substantially impede only movement of said elements toward said axis, said device including an air chamber, a reciprocable piston movable with each of said elements and enterable into said chamber upon movement of said elements toward said axis to substantially reduce the volume of said chamber, a single-acting vent valve associated with said chamber to vent the same to the atmosphere when said elements move from said axis, and a restricted by-pass for solely venting said chamber to the atmosphere upon movement of said elements toward said axis.

20. In a speed-responsive device; a fixed contact element; a plurality of movable contact elements coaxially disposed in radially overlapping relation with respect to said fixed contact element, said movable elements being adapted for

relative rotation and consequent relative radial movement with respect to said fixed element upon rotation at varying speeds; fluid-pressure dashpot means associated with said movable elements and operatively energizable by relative movement of said movable elements in one direction, to oppose relative movement of said last-named elements in a different direction; valve means including a movable element for controlling energization of said dashpot means; pre-energized spring means additionally energized in response to relative movement of said movable elements in said one direction, to oppose relative movement of said last-named elements in the last-named direction; and means for rotating said movable elements at varying speeds.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,265,883	Church	May 14, 1918
1,600,542	Gagg	Dec. 28, 1921
1,870,896	Danner	Aug. 9, 1932
1,873,955	Creager	Aug. 30, 1932
2,229,681	Sorensen	Jan. 28, 1941

FOREIGN PATENTS

Number	Country	Date
530,693	France	Oct. 10, 1921