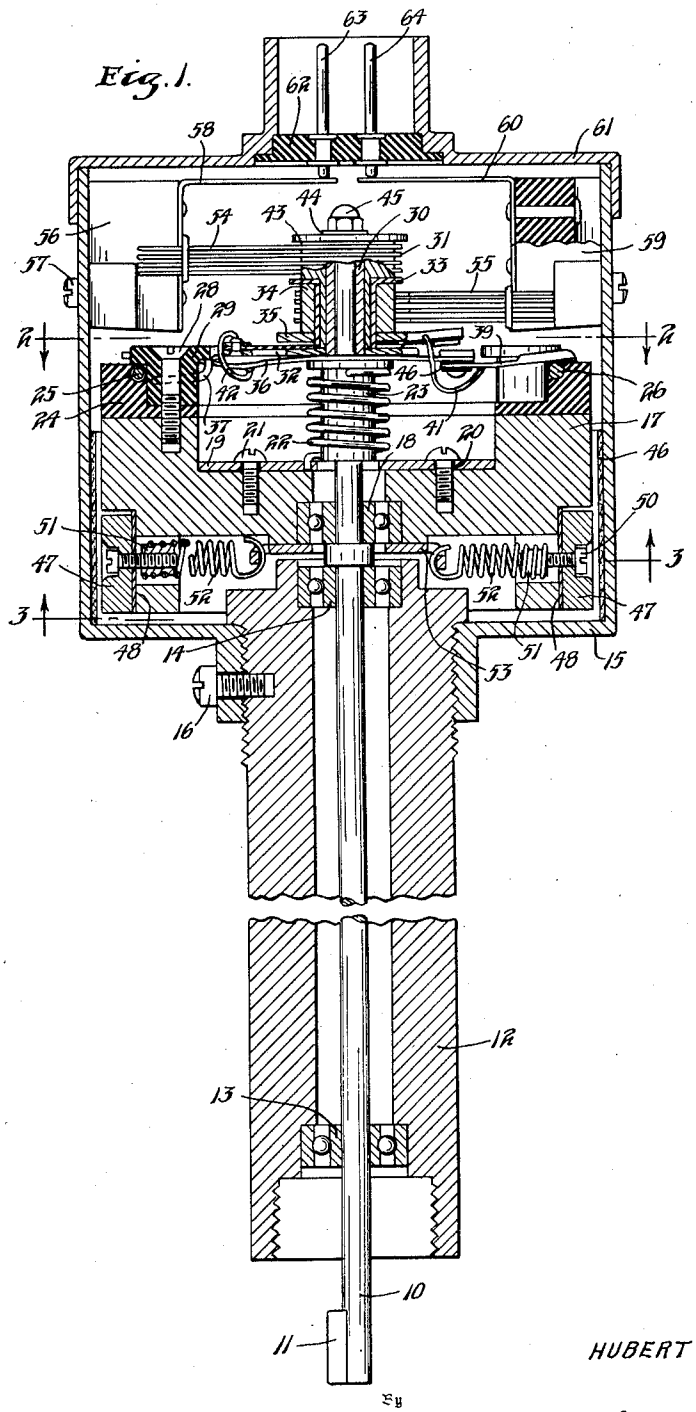
April 25, 1950 H. T. SPARROW 2,505,220

APPARATUS RESPONSIVE TO OVERSPEED AND ACCELERATION CONDITIONS

Original Filed Feb. 22, 1943 2 Sheets-Sheet 1

Fig. 1.



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Original Filed Feb. 22, 1943 2 Sheets-Sheet 2

Fig. 2.

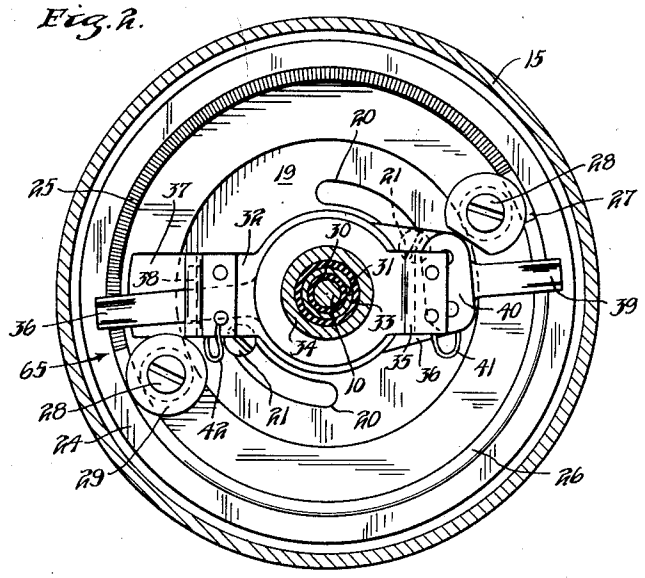
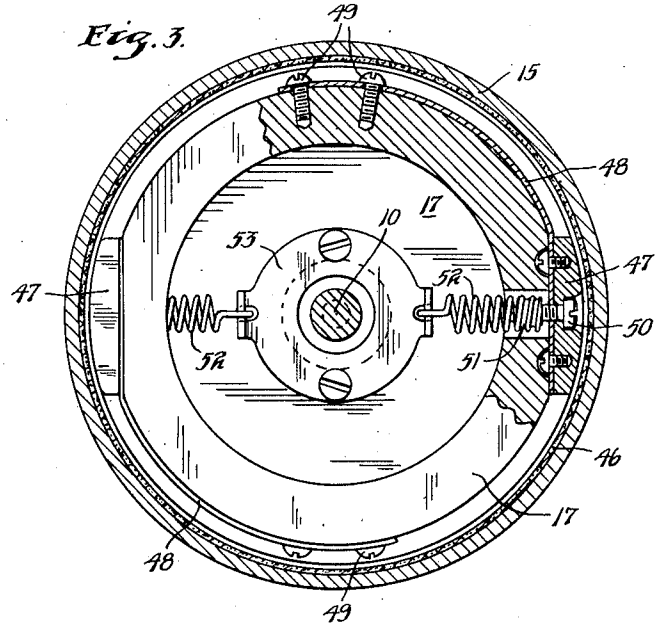


Fig. 3.



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2,505,220

APPARATUS RESPONSIVE TO OVERSPEED AND ACCELERATION CONDITIONS

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Original application February 22, 1943, Serial No. 476,797. Divided and this application December 5, 1946, Serial No. 714,219

11 Claims. (Cl. 201—48)

1

The present application is a divisional application of my co-pending application for Control apparatus, Serial No. 476,797, filed February 22, 1943, now Patent No. 2,477,668, issued August 2, 1949. This co-pending application is directed to a system to control the discharge pressure of an exhaust driven turbine compressor associated with an internal combustion engine. In this system, it is desirable to provide some apparatus which will limit the speed and acceleration of the turbine in order to prevent malfunction of the system. My present invention is directed toward apparatus of this type which will give an indication to the control system of the amount of acceleration or overspeed present at the turbine compressor so that the system may apply corrective action to that condition to prevent damage to the turbine or the internal combustion engine.

As it is desirable to limit the rate of increase in the discharge pressure of the turbine compressor, it is necessary to limit the acceleration of the compressor as the rate of change of discharge pressure is a function of turbine acceleration. With my present invention it is possible to give an indication to the control system which will cause a change in the amount of exhaust gas used to drive the compressor and thereby limit acceleration to a predetermined safe value.

When a condition of overspeed results in an exhaust driven turbine compressor there is danger of the turbine being damaged due to the centrifugal forces acting upon it. With the subject apparatus connected in the control system of my aforementioned co-pending application it is possible to change the power supplied to the turbine and decrease its speed and prevent the existence of a dangerous condition.

Inasmuch as a condition of overspeed and excess acceleration are both the result of excess motivating power supplied to the turbine compressor it is desirable to provide a single indication to the control circuits, as are shown in my co-pending application, to decrease that excess power by an amount called for by the subject acceleration and overspeed apparatus.

Although my apparatus is directed toward a specific control system it will be obvious to those skilled in the art that this apparatus may be applied to any device where it is necessary to control acceleration and velocity.

It is therefore an object of the present invention to provide an apparatus that is modulatingly responsive to a condition of acceleration.

A further object of the present invention is to provide an apparatus that is modulatingly responsive to the velocity of a rotating shaft once a predetermined velocity has been reached.

2

Another object of the present invention is to provide a device with a single controller to indicate a condition of acceleration or overspeed.

A still further object is to provide an accelerometer having a mass resiliently mounted on a rotating shaft such that the rate of change of the velocity of the rotating shaft will cause a displacement of the mass according to the magnitude of that rate of change and further means responsive to the speed of the shaft for causing displacement of the mass independently of the rate of change of the velocity.

Other objects and advantages of the present invention will become apparent from a consideration of the appended specification, claims and drawings, in which:

Figure 1 illustrates a cross sectional elevation of the acceleration and overspeed apparatus showing in detail the general construction of my invention.

Figure 2 is a cross sectional view taken along the line 2—2 of Figure 1, looking in the direction of the arrows.

Figure 3 is a cross sectional view taken along the line 3—3 of Figure 1, looking in the direction of the arrows.

Referring now to Figure 1, there is shown the apparatus of the present invention that could be connected to an exhaust driven turbine compressor as shown in my parent co-pending application, by an elongated shaft 10, provided with a key 11 at its lower end, for operative engagement with an extension on a turbine shaft, not shown, whose speed and acceleration must be controlled. The shaft 10 passes through a protecting sleeve 12, and is journaled in bearings 13 and 14 at the opposite ends of the sleeve 12. The upper end of the sleeve 12, as it appears in the drawing, is threaded on its outer surface for engagement with internal threads in an aperture located centrally of a generally cylindrical housing 15. A set screw 16 is provided to lock the housing 15 on the sleeve 12.

Within the housing 15 a generally cylindrical mass 17 is rotatably mounted on the shaft 10 by means of a bearing 18. The mass 17 has a central cup-shaped recess in its upper surface, on the bottom of which is a disk 19. The disk 19 is provided with a pair of arcuate slots 20, which are diametrically spaced. A pair of screws 21 pass through the slots 20 and threadedly engage holes in the mass 17. The construction is such that the disk 19 may be rotated relative to the mass 17

to an extent determined by the length of the slots 20, and may be locked in any angular position within its range of movement by tightening the screws 21.

The disk 19 is provided with an aperture near its center to receive one end of a coil spring 22, which encircles a sleeve 23 of insulating material fixed on the shaft 10. The other end of the coil spring 22 engages a suitable aperture in the sleeve 23. The spring 22 resiliently connects the shaft 10 and the mass 17, so that as long as the shaft rotates at a constant speed, the mass 17 likewise rotates at the same constant speed. Upon acceleration or deceleration of the shaft 10, the mass 17, because of its inertia, does not change its speed as fast as the shaft 10, and the mass 17 therefore changes its angular position relative to the shaft 10. The spring 22 permits such a change in the relative angular positions of the shaft 10 and the mass 17.

On the upper surface of the peripheral shoulder of the mass 17 is mounted an annular insulating member 24. Molded in the upper surface of the insulating member 24, at its inner periphery, is a semi-circular slidewire resistance element 25. Diametrically opposite the resistance 25, and molded in a similar manner in the upper surface of the insulating member 24, is a contact member 26. One end of the contact member 26 may be in direct electrical contact with one end of the resistance element 25, as indicated at 65 in Figure 2. The opposite end of the contact member 26 is electrically separated from the opposite end of resistance 25 by means of an insulating spacer 27. If the resistance 25 is to be used as a potentiometer resistance, rather than a rheostat resistance, both ends of the resistance 25 should be insulated from corresponding ends of the contact member 26.

The insulating member 24, the resistance 25, and the contact member 26 are fixed to the mass 17 by means of screws 28, which pass through flanged insulating sleeves 29, and through apertures in the insulating member 24 into threaded engagement with the mass 17. Portions of the flanges on the sleeves 29 overlie portions of the contact member 26, the resistance 25, and the insulating member 24, holding them fixed in position on the mass 17.

Fixed on the shaft 10 above the insulating sleeve 23 is an insulating sleeve 30. Outside the sleeve 30 is a second sleeve 31, of electrically conductive material. The sleeve 31 has a portion of wide diameter, which serves as a current conducting slip ring and a portion of reduced diameter which serves to electrically connect the slip ring with a plate 32, of electrically conductive material. The plate 32 is apertured to receive the lower end of the sleeve 30, and is thereby fixed for rotation with the shaft 10. Outside the reduced lower portion of the conductive sleeve 31 is a flanged sleeve 33 and in electrically conducting contact with slip ring 34, is an electrically conductive plate 35, which is apertured to receive the sleeve 33, and is held thereby in fixed relation with the shaft 10.

A contact member 36 of electrically conductive, flexible material is loosely carried by but insulated from the shaft 10 between the plate 32 and the upper end of sleeve 23 which may be of insulating material. The contact member 36 is insulated from both the shaft 10 and the sleeve 23. The plate 32 has an offset portion 37. That portion of the plate 32 connecting the offset portion 37 with the main body of the plate is apertured, as indicated at 38 in Figure 2, to permit the contact member 36 to pass through. The aperture 38 is wider than the contact 36 so that a certain amount of lost motion is permitted between contact member 36 and plate 32. The extremity of contact member 36 is downwardly convex, so as to provide a suitable surface for sliding along the resistance 25. Diametrically opposite the end of contact member 36 which engages resistance 25, the contact member 36 carries a second contact member 39. The contact member 39 is insulatingly supported on the contact member 36, as indicated at 40. The contact member 39 is electrically connected to the conductive plate 35, by means of a pig tail connection 41. Similarly, the contact member 36 is connected to the conductive plate 32 by a pig tail connection 42.

From the foregoing description, it should be apparent that the contact member 26 is electrically connected through contact member 39, pig tail connection 41, and plate 35 to slip ring 34. On the other hand, the resistance element 25 is electrically connected through contact member 36, pig tail connection 42, and plate 32 to slip ring 31. At any instant, the angular position of contact members 36 and 39 is determined by the angular position of shaft 10. The angular position of resistance 25 with respect to contact member 36 is determined by the angular position of mass 17 with respect to shaft 10, which is a measure of the acceleration or deceleration of the shaft 10. Therefore, it will be seen that a variable portion of resistance 25 is connected between the slip rings 31 and 34, depending upon the angular acceleration of the shaft 10.

The various sleeves 30, 31, 33 and 34 and the plates 32 and 35 are held in assembled relation on the shaft by an insulating plate 43, a washer 44 and a nut 45.

The inner surface of the lower portion of casing 15 is provided with a lining 46 of cork or other suitable friction material. Diametrically opposite portions of the mass 17 are cut away to receive a pair of weights 47. As indicated in Figure 3, each weight 47 is carried at the end of an elongated flexible guide member 48, which closely engages the surface of mass 17 for approximately one-fourth of its periphery. The opposite end of the member 48 is fixed to the mass 17 by screws 49, shown in Figure 3.

A screw 50 passes through a center aperture in each of the weights 47, a registering aperture in the flexible member 48, and a registering aperture in the mass 17. A nut 51 carried by each screw 50 holds one end of one of a pair of tension springs 52. The other end of each of the tension springs 52 is hooked through a suitable aperture in a floating ring 53. The apertures in the ring 53, which receive the ends of the springs 52, are diametrically spaced.

The weights 47 are free to move radially of the shaft 10, but are restrained from such movement by the springs 52. When the velocity of the shaft 10 reaches a predetermined value, which is established by the tension of springs 52, the weights 47 are moved outwardly against the springs 52 by the centrifugal force acting on them. When this occurs, the weights 47 engage the friction surface 46, thereby applying a braking torque to the mass 17, and changing the angular position of the mass 17 relative to that of shaft 10 in the same manner as if the rela-

tive angular positions of the mass 17 and shaft 10 had been changed by an acceleration of the shaft 10. Therefore, it may be seen that the amount of resistance connected between the slip rings 31 and 34 depends not only upon the acceleration of the shaft 10, but on its velocity after that velocity reaches a predetermined value.

A pair of brushes 54 and 55, each of which is composed of a plurality of flexible fingers, engage the slip rings 31 and 34, respectively. The brush 54 is supported on an insulating block 56 attached to the side of casing 15 by means of a screw 57. The block 56 also carries a conducting strip 58, which is permanently held in electrically conductive relation with the brush 54. The strip 58 has a portion which extends inwardly from the block 56 toward the center of the casing 15. Similarly, the brush 55 is supported on a block 59, and held in electrically conducting relation with a conductor strip 60. The casing 15 is provided with a cover 61, which may be attached thereto by any suitable means, not shown. The cover 61 carries at its center portion an insulating plate 62 in which are suitably fastened a pair of electrical connector pins 63 and 64, of conventional form. The inner ends of the pins 63 and 64 are adapted to engage the conductor strips 58 and 60 when the cover 61 is in place on the casing 15.

It may now be seen that by connecting the electrical connector pins 63 and 64 to an appropriate circuit it will be possible to utilize the varying resistance, as measured by the relative position of the contact member 36 and the resistance element 25, in controlling the power supplied to the rotating shaft 10.

In other words, I have provided in my invention a method of varying a resistance modulatingly in accordance with the amount of acceleration or overspeed of a rotating shaft.

While I have shown a preferred embodiment of my invention, it will be readily understood that modifications thereof will readily appear to those skilled in the art, and I therefore wish to be limited only by the scope of the appended claims.

I claim as my invention:

1. Control apparatus, comprising in combination, a rotatable shaft, inertia means including a mass resiliently supported on said shaft for limited angular movement with respect thereto upon acceleration thereof, a first control member having a fixed angular position with respect to said shaft and rigidly attached thereto, a second control member movable with said means, and control means radially movable with respect to said shaft and modulatingly responsive to the relative angular positions of said control members.

2. Control apparatus, comprising in combination, a rotatable shaft, first inertia means including a mass resiliently supported on said shaft for limited angular movement with respect thereto, second inertia means including a mass resiliently centered about said shaft for radial movement with respect thereto and adapted to cause angular displacement of said first inertia means with respect to said shaft, said second means being radially slidable with respect to said first means, and control means modulatingly responsive to the diametrical positions of said first and second inertia means with respect to said shaft.

3. Control apparatus, comprising in combination, a housing for said apparatus, a rotatable shaft extending through a wall of said housing, first inertia means within said housing including a mass resiliently supported on said shaft for limited angular movement with respect thereto, second inertia means within said housing and mounted within said first inertia means and supported thereby for radial movement with respect thereto, control means, and means connecting said first and second inertia means with said control means to modulatingly operate said control means in accordance with the resultant of the diametrical positions of said first and second inertia means with respect to said shaft.

4. Control apparatus, comprising in combination, a housing for said apparatus, a rotatable shaft extending through a wall of said housing, first inertia means within said housing including a first mass resiliently supported on said shaft for limited angular movement with respect thereto, a first control device within said housing and rigidly connected to said shaft and means for operation in accordance with the relative movements thereof, second inertia means within said housing including a second mass resiliently supported within said first inertia means for radial movement with respect thereto, a second control device within said housing and mechanically connected to said shaft and second mass for operation in accordance with the relative movements thereof, and means connecting said first and second control device to produce a control effect varying in accordance with the resultant of the diametrical positions of said first and second inertia means with respect to said shaft.

5. Control apparatus, comprising in combination, a housing for said apparatus, a rotatable shaft extending through a wall of said housing, first inertia means within said housing including a mass resiliently supported on said shaft for limited angular movement with respect thereto, second inertia means within said housing and resiliently mounted within said first inertia means and supported thereby for radial movement with respect thereto, movable control means within said casing, and means mechanically connecting said first and second inertia means with said control means to modulatingly operate said control means in accordance with the resultant of the diametrical positions of said first and second inertia means with respect to said shaft.

6. Control apparatus, comprising in combination, a housing for said apparatus, a rotatable shaft extending through a wall of said housing, first inertia means within said housing including a first mass resiliently supported on said shaft for limited angular movement with respect thereto, said mass extending close to the internal surface of said housing but spaced therefrom, second inertia means within said housing including a second mass resiliently supported within said first mass for radial movement outwardly therefrom into engagement with said housing, a first control member having a fixed angular position with respect to said shaft rigidly attached thereto, a second control member movable with said first mass, and control means modulatingly responsive to the relative angular positions of said control members.

7. Control apparatus, comprising in combination, a housing for said apparatus, a rotatable shaft extending through a wall of said housing, first inertia means within said housing including

a first mass resiliently supported on said shaft for limited angular movement with respect thereto, said mass extending close to the internal surface of said housing but spaced therefrom, second inertia means within said housing including a second mass resiliently supported on said first mass for radial movement outwardly therefrom into engagement with said housing, a first control member having a fixed angular position with respect to said shaft and rotating therewith, and a second control member movable with said first mass, one of said control members comprising an elongated electrical resistance element, and the other of said control members comprising an electrical contact slidable along said resistance element.

8. Control apparatus, comprising in combination, a rotatable shaft, inertia means including a mass resiliently supported on said shaft for limited angular movement with respect thereto upon acceleration thereof, a first control member having a fixed angular position with respect to said shaft, and a second control member movable with said mass, one of said control members comprising an elongated electrical resistance element, and the other of said control members comprising an electrical contact slidable along said resistance element.

9. Control apparatus, comprising in combination, a substantially cylindrical housing for said apparatus having a braking surface, a rotatable shaft extending through one end of said housing, first inertia means within said housing including a hollow, substantially cylindrical mass closely spaced from said housing and resiliently supported on said shaft for limited angular movement with respect thereto, said mass having a pair of diametrically spaced, radially extending openings therethrough, second inertia means within said housing including a pair of masses movable within said openings, means biasing said pair of masses to positions within said cylindrcal mass, said biasing means comprising an annular member surrounding said shaft and spaced therefrom and a pair of tension springs connected between diametrically opposite points on said annular member and said pair of masses, said masses being adapted to move against said biasing means under the influence of centrifugal force outwardly through said openings and into engagement with the braking surface of said housing, thereby braking said cylindrical mass and causing relative movement thereof with respect to said shaft, and control means carried by said shaft and said cylindrical mass responsive to the relative angular positions of said shaft and said cylindrical mass.

10. Control apparatus, comprising in combination, a substantially cylindrical housing for said apparatus, a rotatable shaft extending through one end of said housing, first inertia means within said housing including a first mass closely spaced from said housing and resiliently supported on said shaft for limited angular movement with respect thereto, said mass having a pair of diametrically spaced, radially extending openings therethrough, second inertia means within said housing including a pair of masses movable within said openings, means biasing said pair of masses to positions within said first mass, said masses being adapted to move against said biasing means under the influence of centrifugal force outwardly through said openings and into engagement with said casing, means for guiding each of said pair of masses comprising an arcuate strip of flexible material attached at one end to said first mass and at the other end to one of said pair of masses, and control means responsive to the relative angular positions of said shaft and said first mass.

11. Control apparatus, comprising in combination, a substantially cylindrical housing for said apparatus having a braking surface, a rotatable shaft extending through one end of said housing, first inertia means within said housing including a hollow, substantially cylindrical mass closely spaced from said housing and resiliently supported on said shaft for limited angular movement with respect thereto, said mass having a pair of diametrically spaced, radially extending openings therethrough, second inertia means within said housing including a pair of masses movable within said openings, means biasing said pair of masses to positions within said cylindrical mass, said masses being adapted to move against said biasing means under the influence of centrifugal force outwardly through said openings and into engagement with the braking surface of said housing, thereby braking said cylindrical mass and causing relative movement thereof with respect to said shaft, and control means responsive to the relative angular positions of said shaft and said cylindrical mass.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
261,980	Back	Aug. 1, 1882
683,688	Hollingsworth	Oct. 1, 1901
1,088,079	Leavitt	Feb. 24, 1914
1,091,181	Baldwin	Mar. 24, 1914
1,355,008	Smith	Oct. 5, 1920
1,855,333	Borovec et al.	Apr. 26, 1932

FOREIGN PATENTS

Number	Country	Date
587,055	Germany	Oct. 12, 1933