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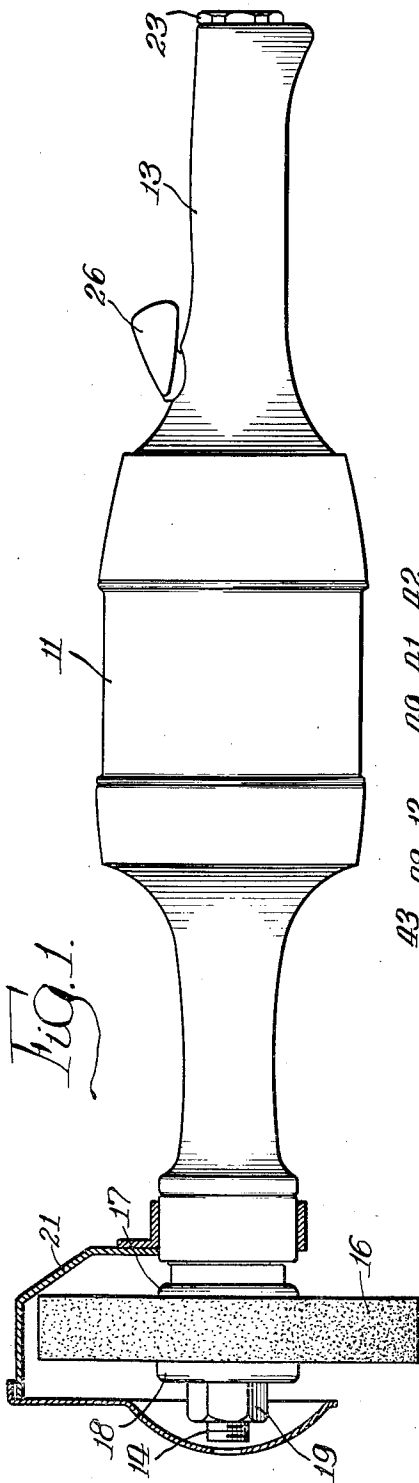
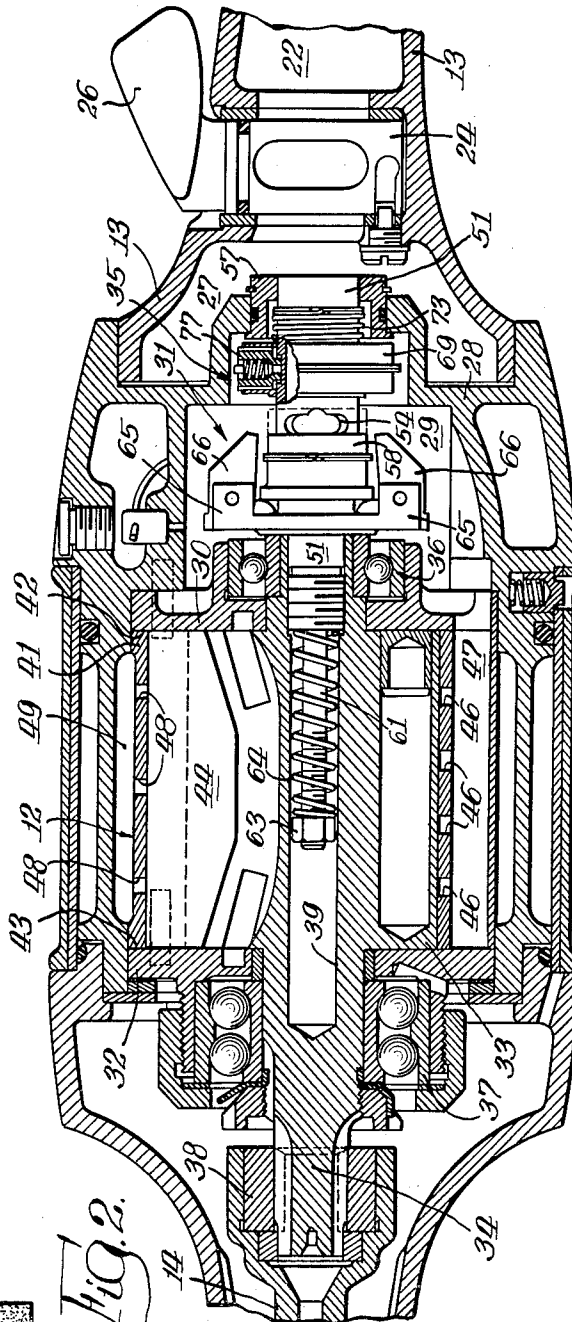
F. A. KAMAN

3,020,920

PNEUMATIC MOTOR GOVERNOR

Filed May 19, 1960

2 Sheets-Sheet 1



INVENTOR.
Frank A. Kaman
BY
Davis, Lindsay, Hilborn & Morgan
Attys.

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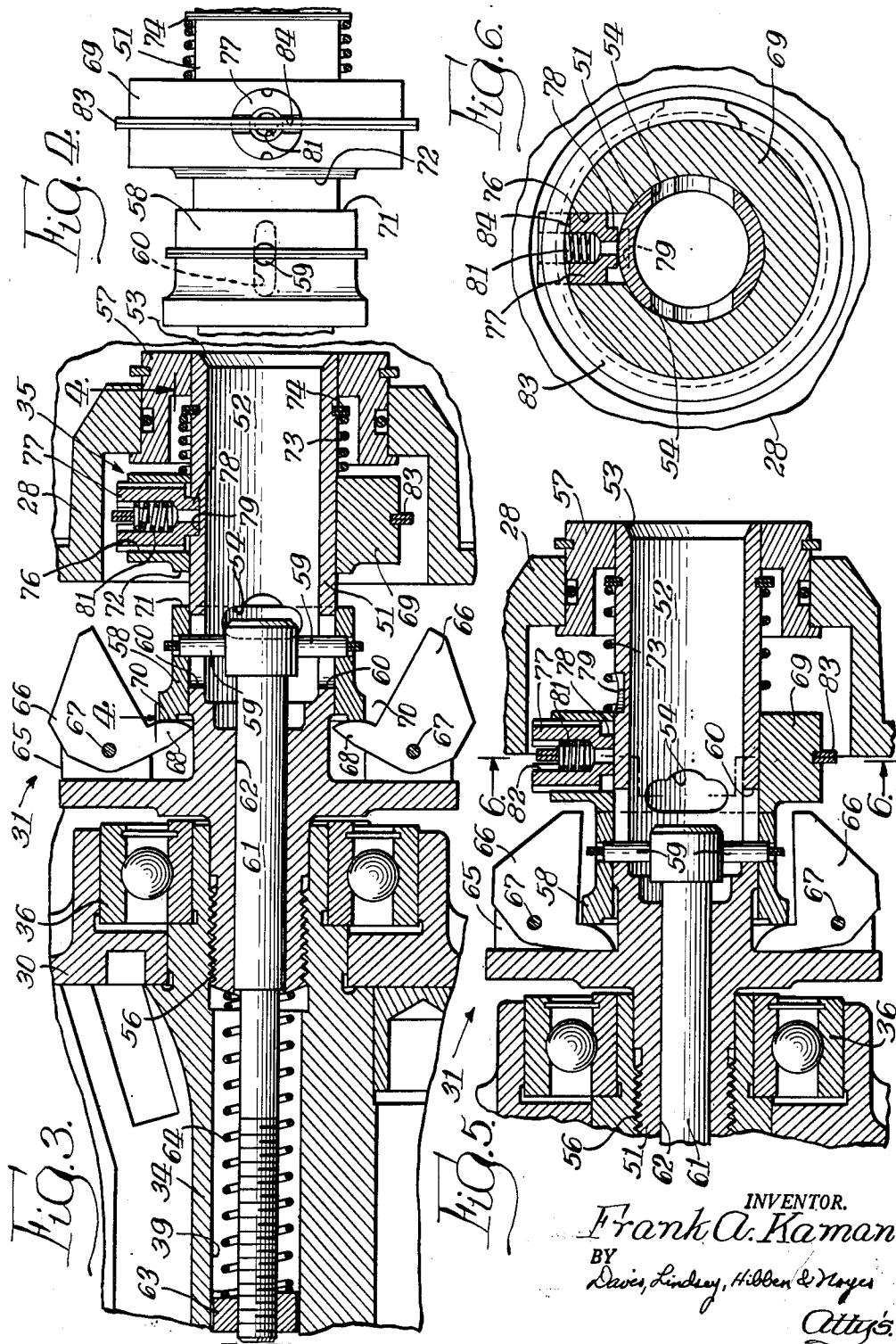
F. A. KAMAN

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INVENTOR.
Frank A. Kaman
BY
Davis, Lindsey, Hidden & Noyes
Attys.

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PNEUMATIC MOTOR GOVERNOR

Frank A. Kaman, Aurora, Ill., assignor to Thor Power Tool Company, Chicago, Ill., a corporation of Delaware

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This invention relates to pneumatic motors and, more particularly, to an overspeed safety control for pneumatic motors.

Pneumatic motors of various types are widely used in industry for powering different kinds of rotating machinery. Such motors are usually provided with governors for keeping their operating speed substantially constant and for preventing, as much as possible, the inherent tendency of such motors to run away or overspeed. It has been found, however, that governors may suddenly fail, such as when a part breaks, or may gradually fail due to wear, the presence of dirt, or other factors resulting from operation. Either form of failure is, of course, a source of danger both to the machinery and to an operator since the motors are then uncontrolled and speed up to a very great number of revolutions per minute at which disintegration of the rotating driven parts may occur.

The primary object of the present invention is to provide a novel overspeed control device for pneumatic motors.

Another object of the invention is to provide a novel overspeed control device which can be used in conjunction with a governor and which will prevent overspeed in the event the governor fails.

A further object of the invention is to provide a novel overspeed control of the foregoing character which acts quickly and positively to terminate fluid flow to the motor in the event motor speed reaches a predetermined maximum.

Another object of the invention is to provide a novel overspeed control device which, upon acting, disables its associated motor until the device is manually reset, thus clearly indicating to an operator a malfunction of its associated motor.

A still further object of the invention is to provide a novel governor and overspeed device for an air motor driven grinding machine.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a grinding machine having a pneumatic drive motor embodying features of the present invention;

FIG. 2 is a fragmentary longitudinal sectional view of the motor in the machine shown in FIG. 1;

FIG. 3 is an enlarged view of part of the structure shown in FIG. 2 showing the relative position of parts as they might appear during operation;

FIG. 4 is a view taken along line 4-4 in FIG. 3;

FIG. 5 is a view similar to FIG. 3 showing the relative position of parts as they would appear following overspeed operation, and

FIG. 6 is a cross-sectional view taken along 6-6 in FIG. 5.

The objects of the present invention are accomplished by providing a novel overspeed safety device which may be used in combination with a governor and which is operable to cut off fluid flow to a pneumatic motor upon the occurrence of overspeed operation due to governor failure. The overspeed safety device has a support that defines a passage adapted to interconnect a fluid source and the motor. On the support is mounted a movable closure element which is biased by a spring or the like for movement in a direction to effect closure of the passage

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in the support. Normally such movement of the element is prevented by a latching mechanism. However, the latching mechanism is speed responsive and is operable to release the closure element when the speed of the motor reaches a predetermined maximum. Thereupon, the closure element is moved to effect closure of the passage.

The support for the overspeed safety device may also carry mechanism adapted to maintain motor speed substantially constant during operation. In this event, a second movable closure element is mounted on the support. Operably associated with the second closure element is speed responsive means for shifting the closure element toward and away from a position closing the passage as motor speed increases and decreases, respectively. This decreases and increases air flow to the motor and tends to maintain motor speed constant.

An industrial grinder is a good example of a machine in which pneumatic motors are frequently employed. FIG. 1 of the drawings shows such a grinder having a conventional form of air motor which, in the present instance, is provided with an overspeed safety control device embodying the present invention. The grinder shown in FIG. 1 is a straight form of hand grinder having a housing 11 which encloses an air motor of the usual type, indicated generally at 12 in FIG. 2. From one end of the housing 11 extends a handle 13 and from the other end extends a drive shaft 14 on which is mounted a conventional circular grinding wheel 16. The grinding wheel 16 is secured to the shaft 14 by a pair of collars 17 and 18, disposed on opposite sides of the wheel 16, and a nut 19 threaded on the other end of shaft 14. A sheet metal safety hood 21 encloses the end of the shaft 14 and most of the periphery of the grinding wheel 16.

The handle 13 is adapted to connect the grinder to an air source. As is fragmentarily shown in FIG. 2, the handle 13 is hollow and forms a longitudinally extending air passage 22. At the outer end of the handle 13, the air passage 22 is provided with a fitting 23 for connecting the passage 22 to an air hose or the like which, in turn, is connected to a source of compressed air. In the inner end of the handle 13 is mounted a conventional form of a manually operated shut-off valve 24 having an operating trigger 26 located outside the handle 13 for manual manipulation. When the valve 24 is open, air in the passage 22 passes through the valve 24 into a chamber 27 formed at the rear end of the housing 11 by the bell-shaped end of the handle 13 between the valve 24 and a transversely extending wall 28 of the housing unit.

A second chamber 29, located between the wall 28 and the rear end plate 30 of the air motor 12, is normally in flow communication with the chamber 27 through a governor, indicated generally at 31 in FIG. 2, and to be described in more detail hereinafter. An end plate 32 is disposed in the housing 11 forwardly of the end plate 30 and these plates, 30 and 32, define the ends of the chamber in which the air motor rotates. The air motor 12 has a rotor 33 journaled in a pair of anti-friction bearings 36 and 37 mounted in the end plates 30 and 32, respectively, and having its forward end 34 connected by a coupling device 38 to the drive shaft 14.

The rotor 33 operates in a chamber defined by an eccentrically disposed cylindrical sleeve 41 extending between and in fluid tight engagement with the two end plates 30 and 32. Vanes 44 are mounted in generally radial slots in the rotor 33 in a manner so that the vanes will move outwardly into tight engagement with the sleeve 41 in the usual manner, as a result of centrifugal force developed during operation of the motor. Compressed air enters the air motor chamber through a plurality of inlet openings 46 provided in the bottom of the sleeve 41, as seen in FIG. 2, and a passage 47 extending

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longitudinally along the outside of the sleeve 41 and through the end plate 30 connects the openings 46 to the second air chamber 29.

Air is exhausted from the motor 12 through a plurality of exhaust openings 48 into an exhaust chamber 49, from which it is exhausted through the housing 11. The exhaust openings 48 are formed in the top of the sleeve 41 on the opposite side of the motor from the inlet openings 46, as seen in FIG. 2.

Air motors of the type above described are capable of developing extremely high and dangerous rotative speeds when they are not connected to a load. In the present environment, for example, the grinding wheel 16 offers very little resistance to rotation of the motor 12 when the surface of the grinding wheel 16 is not in contact with a work piece, the motor may develop speeds, during periods of idle operation, sufficient to cause the grinding wheel 16 to burst or disintegrate as a consequence of centrifugal force. To maintain the motor speed substantially constant during operation there is provided a governor 31 which also includes an overspeed safety control device 35 for stopping and, preferably, disabling the motor 12 in the event the governor mechanism fails for any reason and motor speed is allowed to exceed a predetermined maximum. Hence, the hazard of overspeed operation is greatly reduced, if not eliminated, by the addition of the overspeed device 35.

FIGS. 3, 4, 5 and 6 show the structure of the governor 31 and the overspeed safety control mechanism 35 in larger scale. As shown in FIG. 3, the governor 31 has an elongated tubular support 51 on which the various elements of the governor and overspeed control device are assembled. The support 51 includes an internal passage 52 extending longitudinally of the support 51 for establishing flow communication between the chamber 27 and the second chamber 29. The support 51 is open at its right end 53, as seen in FIGS. 3 and 5, and has a pair of radially directed outlet ports 54 spaced forwardly from the open end 53. As shown in FIG. 2, all air entering the motor through the openings 46 must first pass through the passage 52 of the support 51.

The governor 31 is of the type which rotates in unison with a rotatably driven member of the motor it governs. In the present instance, the governor 31 and the overspeed control device 35 are connected to and rotate in unison with the rotor 33. For this purpose, the forward end of the support 51, opposite the inlet port 53, is formed to extend into an axial bore 39 of the rotor 33 where it is secured by threads 56. The open, rearward end of the support 51 is rotatably supported by a bearing member 57 secured in the cross wall 28. Thus, the support 51 is held in axial alignment with the rotor shaft 34 and is connected for rotation in unison therewith.

The governor 31 maintains the rotative speed of the air motor 12 substantially constant by regulating the air flow through the passage 52 in accordance with the rotative speed of the rotor 33, the rotative speed of the support 51, of course, being the same as that of rotor. For regulating the quantity of air passing through the passage 52 and thence to the air motor 12, the support 51 is provided with an annular closure element 58 slidably mounted thereon. The support 51 is cylindrical for a portion of its length adjacent the outlet ports 54 and the closure element 58 is in the form of a sleeve having an axial length sufficient to cover and close, or partially close, the outlet ports 54. The sleeve 58 encircles the cylindrical portion of support 51 forwardly of and adjacent to the outlet ports 54 and is mounted thereon for movement toward and away from positions closing, or partly closing the outlet ports 54.

The closure sleeve 58 is continuously urged away from the outlet ports 54 so that when the motor 12 is stopped

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the ports 54 will be fully open. For this purpose the closure sleeve 58 is connected by a pair of radially extending arms 59 to the rearward end of an axially slidable elongated rod 61. The arms project through axially elongated slots 60 in the support member 51, the ends of the slots 60 forming stops for limiting the axial movement of the closure element 58. The rod 61 is co-axial with the support 51 and the rotor 33 and extends through a bore 62 in the support member 51 and into the bore 39 in the rotor 33. The rod 61 is axially slidable with respect to the support 51 and is urged constantly in a forward direction by a coil compression spring 64 disposed around the rod 61 between a nut 63 threadably secured on the forward end of the rod and the forward end of the support 51. Thus, the spring 64, acting through the rod 61 and the arms 59, continuously urges the closure sleeve 58 forwardly away from the outlet ports 54. FIG. 5 shows the closure element 58 at the position it will normally occupy when the motor is stopped.

For shifting the closure element 58 toward the positions closing or partially closing the ports 54 in response to motor speed, the governor 31 is provided with two pivoted weight elements 66, which are pivotally mounted on pivot pins 67 on opposite sides of the support 51. Each of the pivot pins 67 are fixed to and extend between a pair of spaced lugs 65 extending rearwardly of and carried by the support 51 in spaced relation therefrom. The pins 67 are located so that their associated weight elements 66 will swing outwardly by centrifugal force from the axis of rotation of the support 51 in response to the rotative speed of the support. Each weight 66 is provided with a rigidly extending arm 68, having a curved surface 70 facing an adjacent end of the closure sleeve 58 for urging the sleeve axially when the weights swing outwardly. The spring 64 causes the adjacent end of the closure sleeve 58 to bear against the surfaces 69. The nominal operating speed of the motor can be changed by adjusting the position of the nut 63 on the rod 61, thus adjusting the force exerted by the spring 64.

The previously mentioned overspeed safety control device 35 is essentially a second closure element 69 which, like the closure element 58, is in the form of a sleeve encircling the support 51 and is slidably mounted thereon. The closure sleeve 69 is located on the opposite or rearward side of the outlet ports 54 from the closure sleeve 58. Thus, the two closure elements move in opposite directions or toward each other to effect closure of the outlet ports 54. Also, the closure elements 58 and 69 have facing circumferential end edges 71 and 72 respectively, formed for mutual engagement under circumstances hereinafter described.

Normally when the motor 12 is stationary or is operating below the maximum operational speeds controlled by the governor 31, the closure sleeve 69 is located in a retracted position axially displaced rearwardly from the outlet ports 54, as shown in FIGS. 2 and 3. However, the element 69 is continuously urged forwardly by a compressed coil spring 73 toward a position in which it closes the outlet ports 54. The spring 73 encircles the support 51 and is compressed between the closure sleeve 69 and a snap ring 74 secured to the support 51 adjacent the rearward end thereof.

The overspeed device 35 has means for holding the closure sleeve 69 in its retracted position during normal operation of the motor 12 and for releasing the closure sleeve 69 from its retracted position when the rotative speed of the motor reaches a predetermined maximum. To this end, the closure element 69 is provided with a radially extending bore 76 in which is mounted centrifugally releasable latch means. The latch means, in this instance, comprises a cylindrical detent 77 slidably mounted in the bore 76. The inner end of the detent 77 is provided with a portion 78 of reduced diameter which normally projects into a circular depression 79 formed

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in the support 51. The depression 79 is circumferentially and axially displaced from the outlet ports 54.

The detent 77 is urged into the circular depression 79 of the support 51 by a spring 81 mounted in an axial bore 82 provided in the outer end of the detent 77. A snap ring 83 extends circumferentially around the closure sleeve 69 across the outer end of the detent 77 and holds the spring 81 compressed against the bottom of the bore 82. Thus, the detent 77 is forced into the depression 79 of the support 51 and normally holds the closure sleeve 69 rotatively and axially fixed with respect to the support 51.

In order that the detent 77 will disengage the support 51 when the rotative speed exceeds the predetermined maximum, its outer end is slotted as at 84 (see FIGS. 4 and 6) to provide clearance for the snap ring 83. When the rotative speed exceeds the predetermined maximum, centrifugal force acting on the detent overcomes the force exerted by the spring 81 and causes the detent to move outwardly from the depression 79 so as to disengage the support 51. It will be understood that the speed at which release will occur can be changed by adjusting the mass of the detent or the spring force, or both.

FIG. 2 of the drawing shows the relative positions that the parts of the governor 31 will normally occupy when the motor 12 is not being operated. It can be seen that the spring 64 pulls the closure sleeve 58 to the left or forwardly of the outlet ports 54 and against the arms 68 of the weights 66, thus causing the weights 66 to swing inwardly toward the support 51. Also, the detent 77 is engaged in the depression 79 of the support 51 and holds the closure sleeve 69 to the right or rearwardly of the outlet ports 54. Therefore, the ports 54 and the passage 52 are fully open for the free passage of compressed air.

Upon opening of the manual valve 24, compressed air passes from the handle air passage 22 through the valve 24, the chamber 27, the passage 52, the ports 54, the chamber 29, the passage 47, and the openings 46 into the motor 12, thus effecting operation of the motor. As rotative speed of the motor and the support 51 increases, centrifugal force acting on the weights 66 will cause them to turn on their pivots 67 and to swing outwardly, forcing the closure sleeve 58 to the right against the force exerted by the spring 64. The greater the rotative speed, the more the closure sleeve 58 is shifted to the right by the weights 66. Thus, the closure sleeve 58 gradually reduces the amount of air flowing to the motor 12 as the rotative speed of the motor increases. Once the motor has attained its operating speed, as determined by the adjusted tension of the spring 64, the closure sleeve 58 may shift back and forth by the opposed forces of the weights 66 and the spring 64 to maintain the speed substantially constant for various load conditions.

As long as the parts of the governor 31 continue to operate as intended and as adjusted, the motor speed will be maintained at or below the desired maximum. However, if for any reason such as breakage of the parts or sticking of the closure sleeve 58 with the ports in open condition, the governor 31 may become ineffective and as a result the rotative speed of the motor 12 will rapidly increase above the predetermined maximum set by the governor 31. As soon as the increasing rotative speed of the motor 12 and the support 51 approaches the rate predetermined for operation of the overspeed device 35, centrifugal force acting on the detent 77 of the overspeed device 35 overcomes the force exerted by the spring 81. This causes the detent 77 to move radially outwardly, releasing the closure sleeve 69 from the support 51. The spring 73 immediately shifts the closure sleeve 69 to the left until its edge 72 engages the facing edge 71 on the closure element 58. When this occurs the outlet ports 54 are fully closed either by the closure sleeve 69 alone or in cooperation with the closure sleeve 58 of

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the governor 31. The motor 12 then coasts to a stop or, at least, operates at a very slow speed, depending upon how perfectly the closure is effected. At any rate, the operator of the machine is immediately aware of the fact that the governor 31 or its associated parts are inoperative or are malfunctioning so as to cause an overspeed. The motor cannot again be operated until it has been disassembled and the closure element 69 returned to its retracted position. At the same time, the cause of overspeed can be located and corrected.

From the foregoing, it is apparent that the present invention provides a novel speed control mechanism for a pneumatic motor having, in effect, a second line of defense against overspeed. The mechanism which provides this second line of defense acts quickly and positively to terminate substantially all fluid flow to the motor in the event of motor overspeed. Moreover, the device, in effect, disables its associated motor until the mechanism has been manually reset so that an operator will be fully aware of the malfunction in the motor.

Although the invention has been described in connection with a certain specific embodiment thereof, it is to be understood that various modifications and alternative structures may be resorted to without departing from the scope of the invention, as defined in the appended claims.

I claim:

1. A governor for a pneumatic motor having a rotatably driven member, said governor comprising a support adapted to be connected to said member and rotated thereby, said support having a fluid passage therein adapted to interconnect a fluid source and the motor, a pair of closure elements shiftably mounted on said support in operative relation to said passage, speed responsive mechanism connected to one of said closure elements for shifting said one element toward and away from a position closing said passage in response to variations in the rotative speed of said support, means for continuously urging the other of said closure elements from a retracted position to a passage closing position, and means for holding said other closure element at its retracted position until the member reaches a predetermined maximum rotative speed and for releasing said other closure member from its retracted position when said maximum speed is reached.

2. A governor for a pneumatic motor having a rotatably driven member, said governor comprising a rotatable support adapted to be connected to said member and rotated thereby, said support having a fluid passage therein adapted to interconnect a fluid source and the motor, said passage including an inlet port and an outlet port in spaced relation from said inlet port, a pair of closure elements shiftably mounted on said support adjacent one of said ports, speed responsive mechanism connected to one of said closure elements for shifting said one element toward and away from a position closing said one port in response to the rotative speed of the member increasing and decreasing respectively, means for continuously urging the other of said closure elements from a retracted position to a closing position with respect to said one port, and means for holding said other closure element at its retracted position until the member reaches a predetermined maximum rotative speed and for releasing said other closure member from its retracted position when said maximum speed is reached.

3. A governor according to claim 2 in which said support is elongated and tubular, said other port being in one end of said support and axially directed, said one port being intermediate the ends of said support and laterally directed, said closure elements being in spaced relation on said support and movable in opposite directions to close said one port.

4. A governor according to claim 2 in which said support is elongated and tubular, said one port being laterally directed and located intermediate the ends of

said support, said closure elements being longitudinally spaced on said support and located on opposite sides of said one port.

5 5. A governor according to claim 4 in which said support is cylindrical and said closure elements are in the form of sleeves encircling said support, said elements being slidable in opposite directions longitudinally of said support to effect closure of said one port.

10 6. A governor according to claim 5 in which said closure elements have facing radial surfaces, the radial surface on said one element bearing against the radial surface on said other closure element when said other closure element is released from its retracted position, whereby said one port is substantially closed at every axial position of said one closure element.

15 7. A governor according to claim 2 in which said holding means comprises a releasable latch coacting between said other closure element and said support to hold said other closure element at its retracted position, said latch being speed responsive and operable to release said other element when said maximum speed is reached.

20 8. A governor according to claim 2 in which said one port is said outlet port, said inlet port being axially directed.

25 9. A governor for a pneumatic motor having a rotatably driven member, said governor comprising an elongated support having one end adapted to be connected to said rotatably driven member for rotation in unison therewith and having a fluid passage therein adapted to interconnect a fluid source and the motor, said passage including axially spaced inlet and outlet ports, a pair of closure elements shiftably mounted on said support on opposite sides of one of said ports, speed responsive mechanism carried by said support and connected to one of said closure elements for shifting said one element toward and away from a position closing said one port in response to the rotative speed of said support increasing and decreasing respectively, means for continuously urging the other of said closure elements from a retracted position to a closing position with respect to said one port, and means carried by said support and responsive to the rotative speed thereof for holding said other closure element at its retracted position until said

support reaches a predetermined maximum rotative speed and for releasing said other closure element from its retracted position when said maximum rotative speed is reached.

10. An overspeed safety device for a pneumatic motor having a rotatably driven member, said device comprising a tubular shaft having one end adapted to be connected to the driven member for rotation therewith and having a passage therein adapted to interconnect a fluid source and the motor, said passage including an inlet port and an outlet port, one of said ports being laterally directed and located intermediate the ends of said shaft, a closure element for said one port, said closure element being in the form of a sleeve mounted on said shaft, means for continuously urging said closure element to a position closing said port, latch means for releasably holding said closure element rotatively and axially fixed to said shaft at a location axially displaced from said closing position, said means being responsive to the rotative speed of said shaft and operable to release said closure element upon the rotative speed of said shaft reaching a predetermined maximum.

15 11. A device according to claim 10 in which said latch means comprises a radially extending detent mounted in said closure element and having an end portion formed for engagement with said shaft in a detent receiving depression on said shaft and a spring coacting with said detents to continuously urge said end inwardly toward said shaft.

20 12. A device according to claim 11 in which said detent is an elongated weight, said end being the inner end thereof, the mass of said weight and the force of said spring being related so that said weight will move outwardly against said spring and disengage said inner end from said shaft when the rotative speed of said shaft reaches said predetermined maximum.

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