United States Patent [19]

Amtsberg

[11] **3,740,174**

[45] **June 19, 1973**

[54] **SPEED RESPONSIVE CENTRIFUGAL GOVERNOR**

[75] Inventor: **Lester A. Amtsberg,** Utica, N.Y.

[73] Assignee: **Chicago Pneumatic Tool Company,** New York, N.Y.

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[52] **U.S. Cl.** **418/43,** 137/56, 251/282

[51] **Int. Cl.** **G05d 13/34**

[58] **Field of Search** 137/53, 56, 58; 251/282; 415/36; 418/43, 44

[56] **References Cited**

UNITED STATES PATENTS

2,674,229	4/1954	Karlen	137/56 X
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Primary Examiner—Robert G. Nilson

Attorney—Stephen J. Rudy

[57] **ABSTRACT**

A speed responsive centrifugal governor controlled valve assembly illustrated as applied to a rotary grinding tool is carried by an air driven motor for regulating driving air flow to the motor accordingly as the speed and load of the motor varies. The valve is movable against the bias of a return spring relative to an axially aligned seat by means of centrifugally actuable weights. The valve is pneumatically balanced so that the force of the weights is expended solely in overcoming the bias of the return spring when moving the valve. The valve is subject to minimal contact with surrounding components and subject to circulating inlet air so as to be self-cleaning. A ring is adapted to be selectively indexed to adjust the tension of the spring.

10 Claims, 7 Drawing Figures

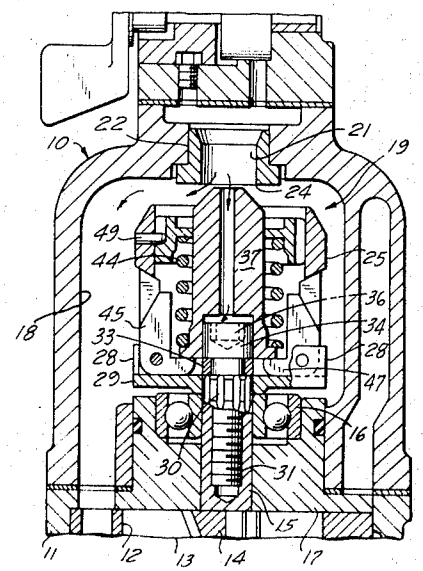


FIG.1

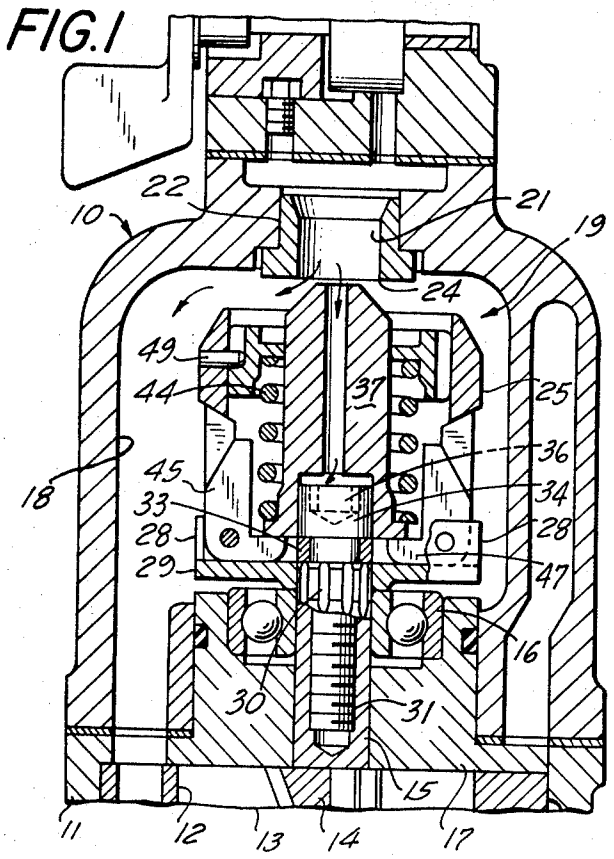
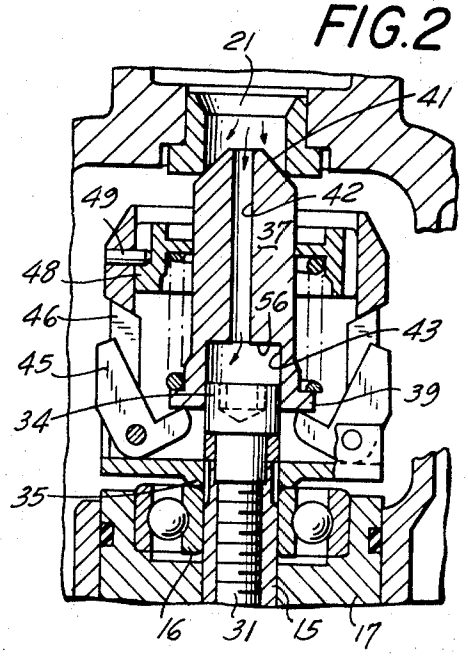


FIG.2



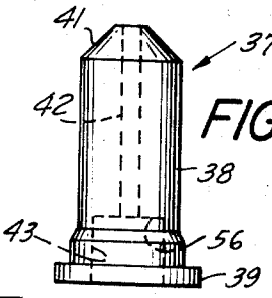
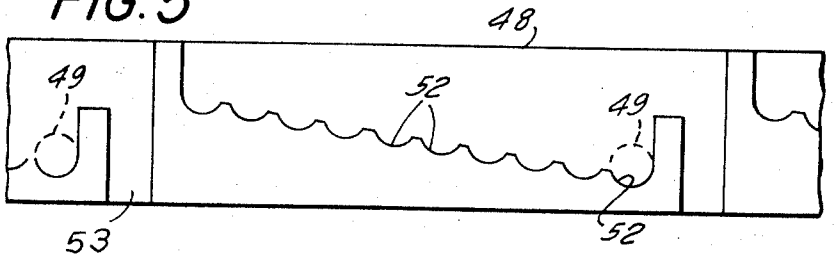


FIG.3

FIG.5



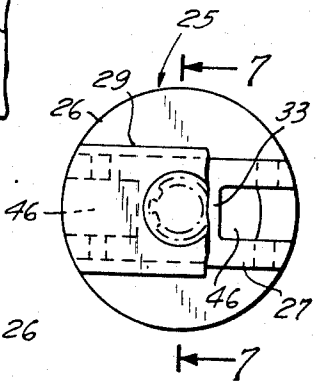


FIG.6

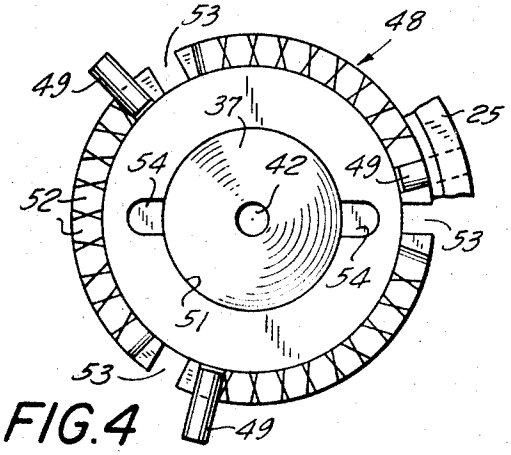


FIG.4

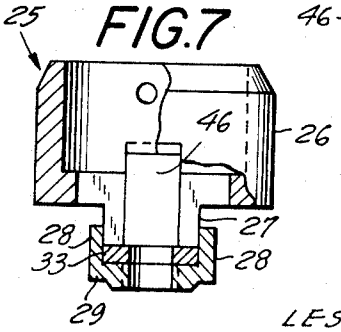


FIG.7

INVENTOR.
LESTER A. AMTSBERG

BY
Stephen J. Rudy

ATTORNEY

SPEED RESPONSIVE CENTRIFUGAL GOVERNOR

BACKGROUND OF THE INVENTION

This invention relates to speed responsive centrifugal governor controlled valves of a type having a live air supply control valve which is slidable by centrifugal flyweights against the bias of a return spring relative to an axially aligned valve seat and directly into the opposed path of live air feeding through the valve seat.

Governor controlled valves of this general nature find use in controlling live air feed to air driven motors incorporated in various types of tools such as, for example, high speed rotary grinders.

A governor controlled valve of this general nature is known, for example, from expired U.S. Pat. No. 2,674,229 wherein a valve of solid form is axially movable relative to an axially aligned valve seat to regulate flow of live air to an air driven motor. A fault of this known valve is that the valve is required to move, not only against the bias of a return spring, but also against the directly opposing force of the live air rushing through the valve seat.

Another fault of this known device appears in the close relation of its return spring to the valve and to a surrounding stationary sleeve guide.

The general objective of the present invention is to provide a speed responsive centrifugal governor controlled valve which avoids these faults.

More particularly, an objective of the present invention is to provide a speed responsive centrifugal governor controlled valve wherein the valve is moved against a return spring by centrifugal weights relative to an axially aligned valve seat and directly into an aligned path of in-rushing air, and is pneumatically balanced so that the force of the centrifugally moving weights is spent solely in overcoming the bias of the return spring.

This objective is accomplished by providing an expansible chamber in the base of the valve and by connecting the chamber with a bore opening axially through the tip of the valve whereby pressure of inlet air entering the recess through the bore counterbalances pressure of inlet air flowing over the tip of the valve.

A further objective is to provide a valve of this nature which is self-cleaning. This is accomplished in the present invention by an arrangement whereby the valve has minimal bearing surface contact in its movement relative to neighboring components and is subject to sweeping action, not only of a guide ring, but also to the sweeping action of circulating inlet air.

The invention also represents an advance over the governor valve structure of my earlier U.S. Pat. No. 3,552,410 in that it has the stability and advantages of a substantially solid valve; it is pneumatically balanced so that it can move axially relative to its seat and directly in the face of oppositely rushing inlet air without expending the force of its actuating flyweights in overcoming opposing forces of the inlet air; and it is self-cleaning.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

FIG. 1 is a sectional view of a speed responsive centrifugal governor controlled valve embodying the invention in which the valve is shown in its normal fully open condition relative to its seat;

FIG. 2 is a fragmentary showing similar to FIG. 1 but showing the valve moved into closing contact with its seat by centrifugal weights;

FIG. 3 is a detail of the valve member;

FIG. 4 is a detail of the top end of the spring adjusting ring as engaged by the latch pins and as disposed about the valve;

FIG. 5 is a developed view of a segment of the spring adjusting ring showing the staircase arrangement of one of the groups of latch pin retaining notches;

FIG. 6 is a detail of the bottom of the governor body and its retainer, the retainer being broken away in part; and

FIG. 7 is a section taken on line 7—7 of FIG. 6 with some portions shown in full.

DESCRIPTION OF PREFERRED EMBODIMENT

This invention is illustrated in the accompanying drawing as embodied in a pneumatically powered high speed tool such as a rotary grinder. Only so much of the tool is shown as is needed to provide an adequate understanding of the invention.

The tool includes a general housing **10** having a motor section **11** which provides a motor chamber **12** in which a conventional air driven rotary motor **13** of the slidable vane type is operable. The rotor **14** of the motor has a front end shaft (not shown) which is drivingly connected with a spindle carrying a grinding wheel. An axially extending upper or rear end shaft **15** of the rotor is supported in a bearing member **16** of a bearing block **17.** The bearing block closes over the rear end of the motor chamber; and it is rigidly secured to the general housing.

The rotor shaft **15** extends axially beyond the bearing **16** into a chamber **18** wherein a speed responsive centrifugal governor controlled valve assembly **19** is mounted to the shaft for rotation with the motor as a unit. The governor assembly functions to regulate flow of operating air from an inlet passage **21** to the motor, accordingly, as the load and speed of the motor varies. In doing so, it serves to control over-speeding of the motor and prevents its operating speed from exceeding a predetermined rate.

The inlet passage **21** extends axially through a bushing **22** fitted in a top end wall of the governor chamber **18**; and it opens into the governor chamber through an annular valve seat **24** defined at the inner end of the bushing. Inlet pressure air entering the governor chamber flows from the latter through connecting passages to the motor chamber **12** to operate the motor.

The governor assembly **19** includes a supporting cage or body **25** (FIGS. **1, 2, 6, 7**) having a cylindrical upper portion **26** of cup-form and a lower depending relatively narrow rectangular portion **27.** The latter portion is seated between the side walls **28** of a retainer **29.** The retainer is of U-form in cross section. The rotor shaft **15** has a splined driving connection **30** with the retainer; and the retainer, together with the governor body **25,** is rigidly clamped to the rotor by means of a bolt **31.** The shank of the bolt passes through a bottom wall **33** of the governor body and is threaded into an axial bore of the rotor to effectively clamp the head **34** of the bolt against the wall **33.** The bolt is tightened by applying a wrench to a socket **36** formed in its head. An annular boss **35** at the underside of the retainer bears upon the inner race of the bearing **16** as the governor body and retainer rotate as a unit with the rotor.

The governor assembly **19** further includes (FIGS. 1–3) a valve **37** which is located axially of the governor body and is movable through an open top end of the latter into the inlet passage **21** to and from closing condition relative to the valve seat **24.** The valve has an elongated cylindrical body **38,** the diameter of which is greater than that of the valve seat opening. It has a peripheral flange **39** about its base; and it terminates at its upper end in a rounded tip **41,** here shown as coned. A bore **42,** extending axially through the valve, opens into a coaxial recess **43** of larger diameter formed in the base end of the valve. Except for the narrow bore and the recess, the valve is otherwise solid. The recess, which is relatively shallow, is designed to slidably receive the head of bolt **31.**

The valve is movable against the bias of a return spring **44** from a normal open condition (as in FIG. **1**) to a closing condition contacting the valve seat (as in FIG. **2**) by means of a pair of centrifugally operable flyweights **45.** Each weight is pivoted in a separate bifurcation **46** of the governor body upon a pin fixed in the opposed side walls **28** of the retainer; and each weight has a foot portion **47** underlying the flanged base **39** of the valve.

The return spring **44** encircles the body of the valve and is tensioned between an overhead tension adjusting ring **48** and the underlying flange **39** of the valve.

The adjusting ring **48** (FIGS. **1, 2, 4, 5**) is slidably received into the body of the governor through the open top end of the latter. It is releasably retained therein in seated relation upon the spring **44** by means of a group of radially extending pins **49** fixed in the side wall area of the governor body **25.** The ring **48** has an axial opening **51** through which the upper cylindrical portion of the body of the valve slidably projects. The pins, of which there are three, are spaced angularly equally apart at the same level in overlying relation to the ring.

The ring includes three separate groups of notches **52** extending about its upper surface. The notches in each group extend in staircase array, there being in each group a notch of low level and succeeding notches of progressively higher levels. Each pin occupies a notch corresponding in level to that occupied by the other pins.

The tension of spring **44** may be adjusted as desired by depressing the ring **48** below the level of the pins **49** and then indexing it in one direction or the other relative to the pins so as to reengage the pins with selected notches of a desired level. The ring may be released free of the governor body for replacement or otherwise by indexing the ring until each pin is registered with a separate slot **53** extending lengthwise of the peripheral wall of the ring. When this position is obtained, the ring may be slipped upwardly free of the assembly. Sockets **54** are provided in a central web of the ring for engagement by a spanner wrench to effect rotative indexing of the ring.

The valve **37** is biased at all times by the spring **44** in seated relation upon the foot portions **47** of the flyweights. In the normal open condition of the valve, as in FIG. **1,** the foot portions of the weights are held seated by the spring load upon the floor or upper surface of the retainer **29.** In this normal condition of the valve, a portion of its cylindrical body projects beyond the ring, and its coned end extends to a level slightly below that of the valve seat. The end of the valve is truncated to define a minor diameter which is relatively smaller than the diameter of the valve seat; the major diameter of the coned end is greater than the diameter of the valve seat.

The inlet passage **21,** the valve **37,** and the rotor shaft **15** are in axial alignment with one another. This alignment of the valve is maintained by means of the inner wall of the central opening **51** of the adjusting ring **48** against which wall the cylindrical upper body area of the valve bears. This alignment is further maintained by means of the cylindrical peripheral surface of the bolt head **34** which is slidably received in the recess **43** of the valve. The periphery of the bolt head cooperates with the surrounding wall of the recess to guide the valve in its movement.

The head of the bolt extends only partway into the recess so that in the normal open condition of the valve some clearance, as appears in FIG. **1,** remains between the top end of the bolt head and the opposed back wall **56** of the recess. This clearance defines an expansible pneumatic counterbalancing chamber which connects by means of the bore **42** through the coned end of the valve. This construction is of decided advantage in that pressure of inlet air entering the recess acts upon the back wall **56** of the recess to counterbalance opposing pressure of inlet air acting over the coned end **41** of the valve. The stationary head of bolt **31** serves as a closure blocking escape of air from the bottom end of the recess. The surface area of the back wall **56** of the recess corresponds substantially to that of the coned end **41** of the valve. By means of this arrangement, a pneumatically balanced condition of the valve is obtained. When the weights **45** respond centrifugally to the speed of the motor to slide the valve toward its seat, the energy of the moving weights will be spent solely in overcoming the resistance of the spring in moving the valve. The energy of the inlet air flow will not be spent in resisting movement of the valve or in providing an unbalanced static pressure upon the valve as occurs in the known prior art construction of U.S. Pat. No. 2,674,229.

In the normal open condition of the valve, as in FIG. **1,** the end of the valve defines with the valve seat an annulus progressively widening into the governor chamber **18** about the coned surface of the valve. Inlet air flows freely around this coned area of the valve into the governor chamber from where it flows to the motor chamber **12** to operate the motor. Inlet air also flows through the valve bore **42** to the recess **43** to obtain a pneumatically balanced condition of air forces acting upon opposite areas of the valve.

As the weights respond centrifugally to increasing speed of the motor, they swing outwardly to slide the valve against the force of the return spring relative to the bolt head and relative to the adjusting ring into the inlet passage **21.** In this action, the valve is moving directly into the axial path of inlet air rushing through the inlet passage. Its coned end moves through the valve seat into the inlet passage to progressively restrict the flow of inlet air to the governor chamber. The flow of inlet air becomes blocked as the coned surface of the valve contacts the valve seat. The valve remains at all times in a pneumatically balanced condition.

As the volume of air flow through the valve seat to the motor is progressively blocked, the speed of the motor is retarded accordingly. As the speed of the motor is retarded, the spring **44** relaxes or expands to return the valve and the weights toward their original condition. In this manner, overspeed of the motor is

checked and its speed is maintained at a predetermined desired maximum. This maximum may be varied by making selective adjustments in the tension of the spring.

It is also to be noted that the spring 44 has a diameter which is greater than that of the main body portion of the valve and is also amply spaced clear of the surrounding body of the governor. This enables inlet air flowing in the governor chamber and passing through the bifurcations 46 of the governor body to circulate about the spring and body of the valve to prevent any dirt from possibly accumulating thereon. It is to be further noted that as the valve slides relative to the ring, the inner wall at 51 of the ring brushes over the body of the valve to clean its surface. The valve, accordingly, is in effect self-cleaning.

What is claimed is:

1. A pneumatic tool including an air driven rotary motor, an air feed port for conducting operating air to the motor, a governor controlled slide valve axially aligned with the port and movable toward and away from the port, and speed responsive centrifugal governor means coupled to the motor for governing the directional movement of the valve; wherein the valve has a free end axially cooperable with the port to restrict air flow from the port to the motor, the valve has a recess in its bottom end, means rotatable with the motor for guiding the valve in its directional movement is received into the recess, and a passage leading through said free end of the valve connects axially with the recess for conducting a stream of air flowing from the port to the recess, the guiding means blocking escape of the air from a bottom end of the recess; wherein a spring biases the valve axially away from the port to a normally open condition; wherein the governor means includes centrifugally actuable weights having foot portions underlying the bottom end of the valve; and wherein the motor has a rotor shaft end, the governor means includes a cylindrical body of cup-form having a bottom wall attached to the shaft end and having a side wall disposed in coaxial spaced surrounding relation to the valve, and a ring slidably received in the cup of the body has an inner diameter wall slidably collaring the valve.

2. A pneumatic tool as in claim 1, wherein the valve has a peripheral flange resting upon the foot portions of the weights, the spring surrounds the valve in abutting relation at one end with the ring and in abutting relation at its opposite end with the flange, and abutment means fixed in the body of the governor means overlies the ring.

3. A pneumatic tool as in claim 2, wherein the governor means is disposed in a chamber for relative rotation, with which chamber the port has communication, openings are provided in the body of the governor means, and the spring has a clearance between it and the main body of the valve permitting live air circulating from the port through the chamber and openings to flow in the clearance about the main body of the valve.

4. In a pneumatic tool including an air driven rotary motor and an inlet port for conducting operating air to the motor, the improvement comprising: a governor controlled slide valve having a substantially solid body axially aligned with the inlet port, a spring externally of the valve biasing it away from the inlet port to a normally open condition, a governor body coupled for rotation with the motor having centrifugally operable flyweights for moving the valve against the bias of the spring toward the inlet port, a restricted port extending axially through a top end of the valve communicating with a cylindrical recess axially of the bottom end of the valve for obtaining a balance of pneumatic pressure at opposite end areas of the valve, a bolt having a shank threadedly coupling the governor body to the motor and having a relatively short cylindrical head projecting with a slide fit into the recess for guiding the valve at its lower end in its axial movement relative to the inlet port, the recess having an axial depth slightly greater than the axial dimension of the bolt head, and a ring having rotation with the governor body slidably collaring the upper end of the valve for guiding the valve at its upper end in its axial movement and for cleaning the surface of the valve as the valve moves relative to the ring.

5. In a pneumatic tool as in claim 4, wherein the valve has a main cylindrical body portion which the ring slidably collars, and has a coned top end the minor diameter of which is enterable into the inlet port and the major diameter of which is greater than that of the inlet port so as to be seatable over the latter during axial movement of the valve.

6. In combination with a pneumatic tool having an air feed port opening axially through a valve seat into an inlet chamber and having axially aligned with the port the rotor shaft of an air motor operating in a rotor cylinder with which the inlet chamber connects, a cylindrical substantially solid slide valve disposed in axial alignment between the rotor shaft and the valve seat, a spring surrounding the valve biasing it away from the seat to a normally open position, a centrifugal governor having a body fixed to the rotor shaft and carrying centrifugally operable flyweights having cooperation with the valve for moving the valve toward the valve seat against the bias of the spring, a cylindrical recess axially of the bottom end of the valve from which axially extends a restricted passage through a top end of the valve for obtaining a balancing of pneumatic pressures at opposite end areas of the valve, a bolt having a shank threadedly fixing the body of the governor to the rotor shaft formed with a relatively short cylindrical head slidably received in the recess as a closure to the recess and for guiding the valve at its lower end in its axial movement, the recess being only slightly greater in its axial dimension than the axial dimension of the bolt head, the valve having a tapered end engageable with the valve seat, and the axial distance over which the valve is movable from its normal position to its seating position being less than the axial dimension of the bolt head so that the valve never leaves the bolt head during its movement.

7. The combination as in claim 6, wherein a ring rotatable with the body of the governor slidably collars the upper end of the valve just below the taper for cleaning the surface of the valve and for guiding the valve at its upper end during relative axial movement of the valve.

8. A speed responsive centrifugal governor controlled valve assembly comprising a slide valve, a governor body having a cylindrical side wall in surrounding coaxial spaced relation to the valve and having a mounting wall, centrifugally operable flyweights carried by the governor body having foot portions underlying a bottom end of the valve for sliding the valve outwardly of the governor body, a cylindrical recess pro-

vided axially of the bottom end of the valve connected with a relatively restricted passage opening axially through a top end of the valve, a spring surrounding the valve in spaced relation to the side wall of the governor body biasing the valve inwardly of the governor body upon the foot portions of the flyweights; and axially spaced means for guiding the valve in its movement axially of the governor body comprising a ring fitted in the interior of the governor body slidably collaring the valve adjacent its upper end, and bolt means for fixing the mounting wall of the governor body to a rotor shaft, the bolt means having a cylindrical head projecting axially above the mounting wall and slidably received in the cylindrical recess.

9. A speed responsive centrifugal governor controlled valve assembly as in claim **8**, wherein the valve comprises a uniform cylindrical body which the ring collars, a radial flange terminating the bottom end of the body which rests under the bias of the spring upon the foot portions of the flyweights, and a taper terminating the top end of the body, the surface area of the taper corresponding substantially to that of a back wall of the cylindrical recess.

10. In a speed responsive centrifugal governor assembly adapted for attachment axially thereof to a rotor shaft, including a cylindrical tubular body open at its top end and having a bottom wall end adapted axially thereof to be clamped to a rotor shaft, a cylindrical slide valve disposed axially of the interior of the body, a spring arranged coaxially between the valve and a surrounding wall of the body biasing the valve axially inwardly of the body, centrifugally operable flyweights carried by the body for moving the valve axially outwardly of the body against the bias of the spring, and a headed bolt for rigidly clamping the bottom wall end of the body axially to a rotor shaft, wherein the valve has a substantially solid cylindrical body comprising a main elongated portion terminating at its bottom end in a radial flange abutting under bias of the spring upon the flyweights, a taper terminating its top end adapted for seating engagement with a live air supply port, and a restricted passage extending through the top end of the valve connected with a cylindrical recess in the bottom end of the valve for obtaining balanced pneumatic pressures at opposite ends of the valve, and the bolt having a cylindrical head slidably received in the recess for guiding the valve in its axial movement.

* * * * *