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PNEUMATIC TIMING DEVICE

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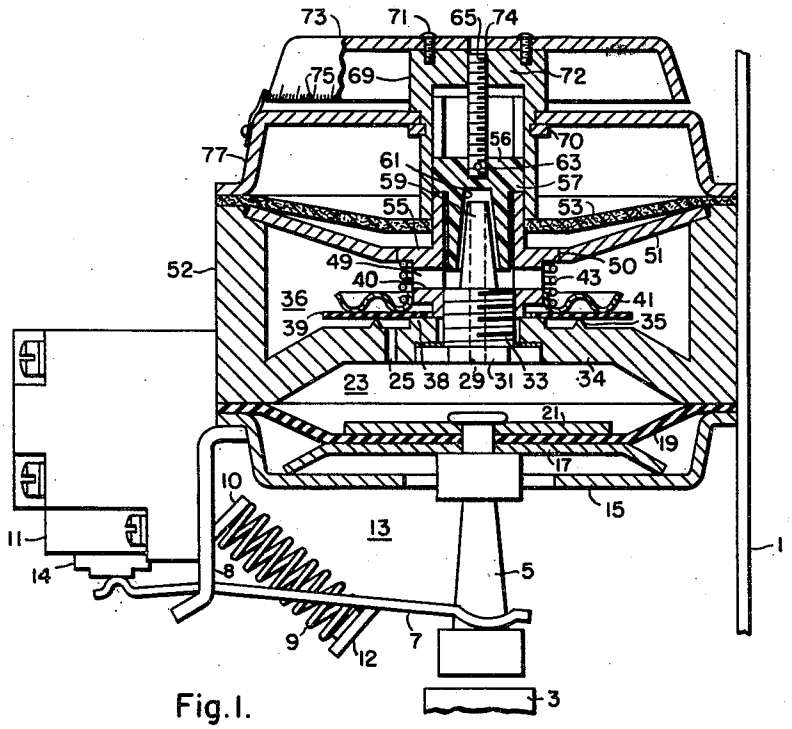


Fig. 1.

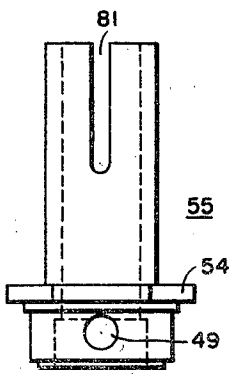


Fig. 2.

WITNESSES

Edwin E. Bassler

John B. Davidson

INVENTORS

Bruce C. Wells and

Arthur S. Nadrowski

BY

Paul C. Friedemann

ATTORNEY

United States Patent Office

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PNEUMATIC TIMING DEVICE

Arthur S. Nadrowski and Bruce C. Wells, Buffalo, N. Y., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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Our invention relates to timing relays and, more particularly, to pneumatically controlled timing relays.

In Patent No. 2,538,038, granted to J. C. Ponstingl et al., and assigned to the assignee of this invention, there is described a type of pneumatically-controlled timing device wherein delayed actuation of an electrical relay is controlled by the rate of air flow into a chamber having at least one flexible wall. A spring loaded plunger mounted on the flexible wall or diaphragm seals the chamber; the chamber is vented and its volume may be decreased by the escape of fluid from the chamber through a check valve when the plunger is externally actuated. When the external force is removed from the plunger, the spring biases the plunger towards its normal position, and the check valve is closed by reversal of the pressure drop thereacross. The rate of expansion of the chamber and the consequent rate of plunger movement toward normal position is thereafter controlled by means of an adjustable timing valve.

In the mentioned patent, the timing valve comprises a pair of metal members having matching conical faces, one of which (hereafter called the stem) is adjustable relative to the other (the stem seat) by rotation within a screw-threaded housing. The stem seat has an axial bore which opens into the aforementioned expansible chamber. As the stem is rotated, there is relative axial movement between the conical surfaces, and the restriction of air flow therebetween into the axial bore determines the rate of expansion of the expansible chamber.

This arrangement presents certain rather serious operating problems. Because of unwanted variations in the dimensions of the valve members, the machined surfaces are not exactly conical and additionally there is a lack of concentricity between the mating faces of the valve stem and the stem threads. Rotation of the stem effects irregular changes in the area of the orifices between the valve stem and seat which results in an irregular timing characteristic. Also, some difficulty may be found in obtaining very long timing intervals because of difficulty in constricting the flow of air inasmuch as the metal valve stem and seat may bind before the orifice is reduced to its smallest area. The metal parts binding against each other additionally produce small particles which often find their way underneath the check valve and change the seating thereof to further deleteriously affect the operation of the timing device.

Our present invention overcomes this problem by an arrangement wherein the timing valve stem is moved axially relative to its seat without rotation so as to entirely preclude the possibility of binding between stem and seat and the consequent abrasion resulting therefrom. The stem is further made of a self-lubricating resilient plastic material such as nylon or a polyethylene resin which can be deformed slightly so as to reduce the orifice area to any required value without binding or abrading the valve seat.

One object of our invention is to provide a regulating

valve for a pneumatic timing device adapted to constrict the passage of air therethrough to extremely small flow rates.

Another object is to provide a regulating valve for a pneumatic timing device having conical matching surfaces wherein the possibility of binding or abrasion of the conical surfaces is reduced to a minimum.

Another object is to provide a regulating valve for a pneumatic timing device, the calibration of which is regular and will not change during use because of abrasion of the component parts thereof.

Other objects and features of our invention will become apparent from a study of the following detailed description thereof when taken in connection with the accompanying drawings, in which:

Figure 1 is a cross-sectional side view of a preferred embodiment of our invention;

Fig. 2 is a side view of a valve housing utilized in the embodiment of our invention depicted in Fig. 1, wherein certain features of the valve housing are shown more distinctly than in Fig. 1.

The timing relay components are shown assembled on a support, generally designated by the reference numeral 1, which may be of metal or any other material capable of carrying the load of the respective items. The actuating means for the relay is generally designated by the block 3 and may be any device well known to the art, such as the electromagnetic actuator illustrated and described in the aforementioned patent to Ponstingl et al. Switch 11 is controlled by movement of a spring-loaded diaphragm and plunger assembly, generally designated 13, which forms part of the pneumatic timing device. Switch plunger 14 is connected to the plunger 5 of the pneumatic timing device by means of a lever 7 which is pivotally mounted on a bracket 8 physically attached to the switch 11 and timing device 13. The plunger 5 is spring loaded to the non-operating position illustrated by means of a compression spring 9 disposed between spring seats 10 and 12 which are physically affixed to bracket 8 and lever 7, respectively.

Cup-shaped member 52 having a re-entrant bottom section 34 is secured to support 1 so as to be substantially coaxial with the line of action of the actuating device 3. The re-entrant bottom section 34 forms one wall of a chamber 23, the other wall being provided by a flexible diaphragm 19 which is clamped about the lower marginal edge of cup-shaped member 52, by means of a bottom cap 15. Plunger 5 is secured at its upper end to diaphragm 19 by means of a pair of sealing plates 21 and 17 and projects through an axial hole drilled in bottom cap 15 towards actuating device 3. Chamber 23 is vented to the atmosphere through a plurality of holes 25 by means of a check valve 36. This check valve comprises a spring-loaded diaphragm 39 of rubber or similar material, which is seated on circular raised surface 35 forming part of the bottom of cup-shaped member 52 and on a raised shoulder 38 formed about a central opening in the bottom of the cup. The holes 25 are drilled through the re-entrant member 34 between the raised surfaces 35 and 38. The diaphragm 39 is spring-loaded against shoulder 35 by means of a compression spring 43 positioned between a downwardly directed spring seat formed by shoulder 50 of the valve housing or sleeve nut 55 and the inner valley of the corrugated washer 41 which bears against diaphragm 39. The inner edge of washer 41 bears against shoulder 40 of the valve housing and is snugly fitted thereabout. Shoulder 40 is spaced from diaphragm 39 and restrains the diaphragm against appreciably axial movement.

The timing valve assembly comprises a valve member 31 having a threaded body portion 33 which projects

upwardly through the central opening in the re-entrant member 34. Beyond the threaded body section, this member terminates in a truncated conical extension 59. A hole 29 extends axially through the member from the truncated termination of the conical section 59 to the chamber 23.

A valve housing 55 threads over the threaded section 33 of the valve member 31, the bottom face seating on the raised surface 38 to positively secure and locate the timing valve housing. As shown in Fig. 2, this housing is provided with two opposite slots 81 extending from the upper edge thereof to about half way down the length of the housing. A hole 49 is drilled through the housing immediately above the upper end of threaded section 33 of valve member 31 to provide communication between the interior of the cup-shaped member 52 and the interior of valve housing 55.

A valve stem 56 having a pair of opposing flanges 57 and a tapered recess 61 which matches the truncated conical section 59 of valve member 31 is disposed immediately above valve section 31 with the flanges thereof fitting into the slots 81 in valve housing 55. This valve stem 56 is made of a material such as nylon 10001 (copolymer amide of adipic acid with sebacic acid and hexamethylene diamine) which is slightly resilient having a compressive strength of 4,000 to 6,000 p. s. i., a modulus of elasticity of 5×10^4 to 5×10^6 p. s. i., and a flexural strength of 8,000 to 20,000 p. s. i., and is self-lubricating when in sliding contact with an adjacent metal member.

The timing valve housing is locked by means of a spanner strip 51 provided with a central opening 50 corresponding to the marginal edge of shoulder 54 of the valve housing. The outer ends of spanner strip 51 are seated in suitable recesses in the upper end of cup-shaped member 52 to prevent rotation. Strip 51 permits adequate air flow around its lateral edges to permit air to be vented thereabout to the atmosphere. It is preferable that the air be filtered and for that purpose a screen 53 is provided which fits over the top of member 51 and extends about the upper marginal edge of cup-shaped member 52. The screen is secured in this position by cap 77.

Fitting snugly about valve housing 55 is a sleeve member 69 which is connected at its upper end to dial 73 by means of studs 71, and which is slidingly secured to top cap 77 by means of the retaining washer 70. This sleeve 69 has a solid end section 72 through which is drilled an axial threaded bore 74. A threaded stem 65 secured to the upper end of valve member 56 by means of roll pin 63 threadedly engages this axial bore hole 74 so that rotation of dial 73 and sleeve 69 will raise stem 65 and valve member 56 without rotation thereof, rotation being prevented by the flanges 57 and slots 81 which have been described above.

In operation, actuating device 3 drives plunger 5 vertically upward in response to an external signal, expelling air from chamber 23 through check valve 36. Upon cessation of the actuating signal, actuator 3 will drop; plunger 5 will remain in a suspended position due to the immediate reversal in pressure across check valve 36, but will be biased toward its normal position by lever 7 and spring 9. Air will thereupon enter chamber 23 through bore hole 49, the adjustable orifice between valve member 56 and conical section 59 and the axial hole 29 through valve member 31; plunger 5 will slowly fall in accordance with the rate of flow of air into chamber 23. The rate of flow of air is adjusted by rotating dial 73, thereby raising or lowering valve member 56 in accordance with the direction of rotation of the dial. The rate of fall of plunger 5 will be determined by the rate of flow of air through the orifice and switch 11 will be actuated when plunger 5 reaches its normal position. The calibrating marks 75 on dial 73 provide an indication of the length of time required for plunger 5 to travel from its actuated position to its normal position.

From the above description, it is apparent that the valve member 56, being allowed to move vertically without rotation, makes possible a very regular timing characteristic inasmuch as inescapable machining variations are no longer important insofar as the calibration of the valve is concerned. Air flow through the valve may be reduced to practically zero inasmuch as the plastic material is adapted to deform slightly and conform to the shape of the conical valve seat. Since there is no relative rotation of valve members, the possibility of small particles being ground from one or the other of the valve members is practically non-existent so that this cause of faulty valve operation is virtually eliminated.

The invention is not to be restricted to the specific structural details or arrangement of parts herein set forth as various modifications thereof may be effected without departing from the spirit and scope of this invention.

We claim as our invention:

1. In a pneumatic device in combination: a horizontally disposed cup-shaped member having an upwardly dished bottom; a flexible diaphragm secured at its periphery to the bottom edge of the cup-shaped member to thus, with the upwardly dished bottom, form a compression chamber; a diaphragm actuating element secured to the diaphragm to bias the diaphragm and provide a maximum volume for the compression chamber; a projection projecting upwardly from the bottom, said projection having a relatively small axial opening, a threaded cylindrical portion near its base, and a tapered upper end; a valve supporting surface disposed about said projection; an annular valve seat disposed about and spaced from said surface, said bottom being provided with an opening between said surface and said valve seat; a flexible check valve diaphragm having an opening, said check valve diaphragm opening fitting about said threaded cylindrical portion and said check valve diaphragm seating on said surface and on said valve seat; a sleeve nut threaded on said threaded cylindrical portion and having a bottom face portion overlapping said check valve diaphragm; spacing means spacing said bottom face portion of said sleeve nut above said check valve diaphragm in a position limiting axial displacement of said check valve diaphragm; said sleeve nut being provided with a flange having a downwardly directed spring seat disposed above said check valve diaphragm, said sleeve nut being provided with a radial channel so disposed below said spring seat that the channel, in use, falls directly above said threaded cylindrical portion, a washer disposed on said check valve diaphragm; a compression spring disposed between said spring seat and said washer to thus bias said check valve diaphragm against said surface and said valve seat; a stem having flanges adapted to engage slots cut into said sleeve nut at the upper end thereof, said stem at its bottom end being provided with a tapered recess matching said tapered projection; means adapted to raise said stem without rotation thereof, and means secured to said stem for coacting with said cup-shaped member for indicating the position of said stem with respect to said tapered projection.

2. In a pneumatic device in combination: a horizontally disposed cup-shaped member having an upwardly dished bottom; a flexible diaphragm secured at its periphery to the bottom edge of the cup-shaped member to thus, with the upwardly dished bottom, form a compression chamber; a diaphragm actuating element secured to the diaphragm to bias the diaphragm and provide a maximum volume for the compression chamber; a projection projecting upwardly from the bottom, said projection having a relatively small axial opening, a threaded cylindrical portion near its base, and a tapered upper end; a valve supporting surface disposed about said projection; an annular valve seat disposed about and spaced from said surface, said bottom being provided

with an opening between said surface and said valve seat; a flexible check valve diaphragm having an opening, said check valve diaphragm opening fitting about said threaded cylindrical portion and said check valve diaphragm seating on said surface and on said valve seat; a sleeve nut threaded on said threaded cylindrical portion and having a bottom face portion overlapping said check valve diaphragm; spacing means spacing said bottom face portion of said sleeve nut above said check valve diaphragm in a position limiting axial displacement of said check valve diaphragm; said sleeve nut being provided with a flange having a downwardly directed spring seat disposed above said check valve diaphragm, said sleeve nut being provided with a radial channel so disposed below said spring seat that the channel, in use, falls directly above said threaded cylindrical portion, a washer disposed on said check valve diaphragm; a compression spring disposed between said spring seat and said washer to thus bias said check valve diaphragm against said surface and said valve seat; a stem having flanges adapted to engage slots cut into said sleeve nut at the upper end thereof, said stem at its bottom end being provided with a tapered recess matching said tapered projection; means adapted to raise said stem without rotation thereof, said stem being composed of a copolymer amide of adipic acid with sebacic acid and hexamethylene diamine, and means secured to said stem and coacting with said cup-shaped member for indicating the position of said stem with respect to said tapered projection.

3. In a pneumatic device in combination: a horizontally disposed cup-shaped member having an upwardly dished bottom; a flexible diaphragm secured at its periphery to the bottom edge of the cup-shaped member to thus, with the upwardly dished bottom, form a compression chamber; a diaphragm actuating element secured to the diaphragm to bias the diaphragm and provide a maximum volume for the compression chamber; a metallic projection projecting upwardly from the bottom, said projection having a relatively small axial opening, a threaded cylindrical portion near its base, and a tapered upper end; a valve supporting surface disposed

about said projection; an annular valve seat disposed about and spaced from said surface, said bottom being provided with an opening between said surface and said valve seat; a flexible check valve diaphragm having an opening, said check valve diaphragm opening fitting about said threaded cylindrical portion and said check valve diaphragm seating on said surface and on said valve seat; a sleeve nut threaded on said threaded cylindrical portion and having a bottom face portion overlapping said check valve diaphragm; spacing means spacing said bottom face portion of said sleeve nut above said check valve diaphragm in a position limiting axial displacement of said check valve diaphragm; said sleeve nut being provided with a flange having a downwardly directed spring seat disposed above said check valve diaphragm, said sleeve nut being provided with a radial channel so disposed below said spring seat that the channel, in use, falls directly above said threaded cylindrical portion, a washer disposed on said check valve diaphragm; a compression spring disposed between said spring seat and said washer to thus bias said check valve diaphragm against said surface and said valve seat; a stem having flanges adapted to engage slots cut into said sleeve nut at the upper end thereof, said stem at its bottom end being provided with a tapered recess matching said tapered projection; means adapted to raise said stem without rotation thereof; said stem comprising a non-metallic, slightly deformable, self-lubricating organic solid having a flexural strength of 8,000 to 20,000 pounds per square inch, a compressive strength of 4,000 to 6,000 pounds per square inch, and a modulus of elasticity of 5×10^4 to 5×10^6 pounds per square inch; and means secured to said stem for coacting with said cup-shaped member for indicating the position of said stem with respect to said tapered projection.

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