Feb. 24, 1953 J. C. PONSTINGL 2,629,793

PNEUMATIC TIMING RELAY

Filed Jan. 19, 1949 2 SHEETS—SHEET 1

Fig.1.

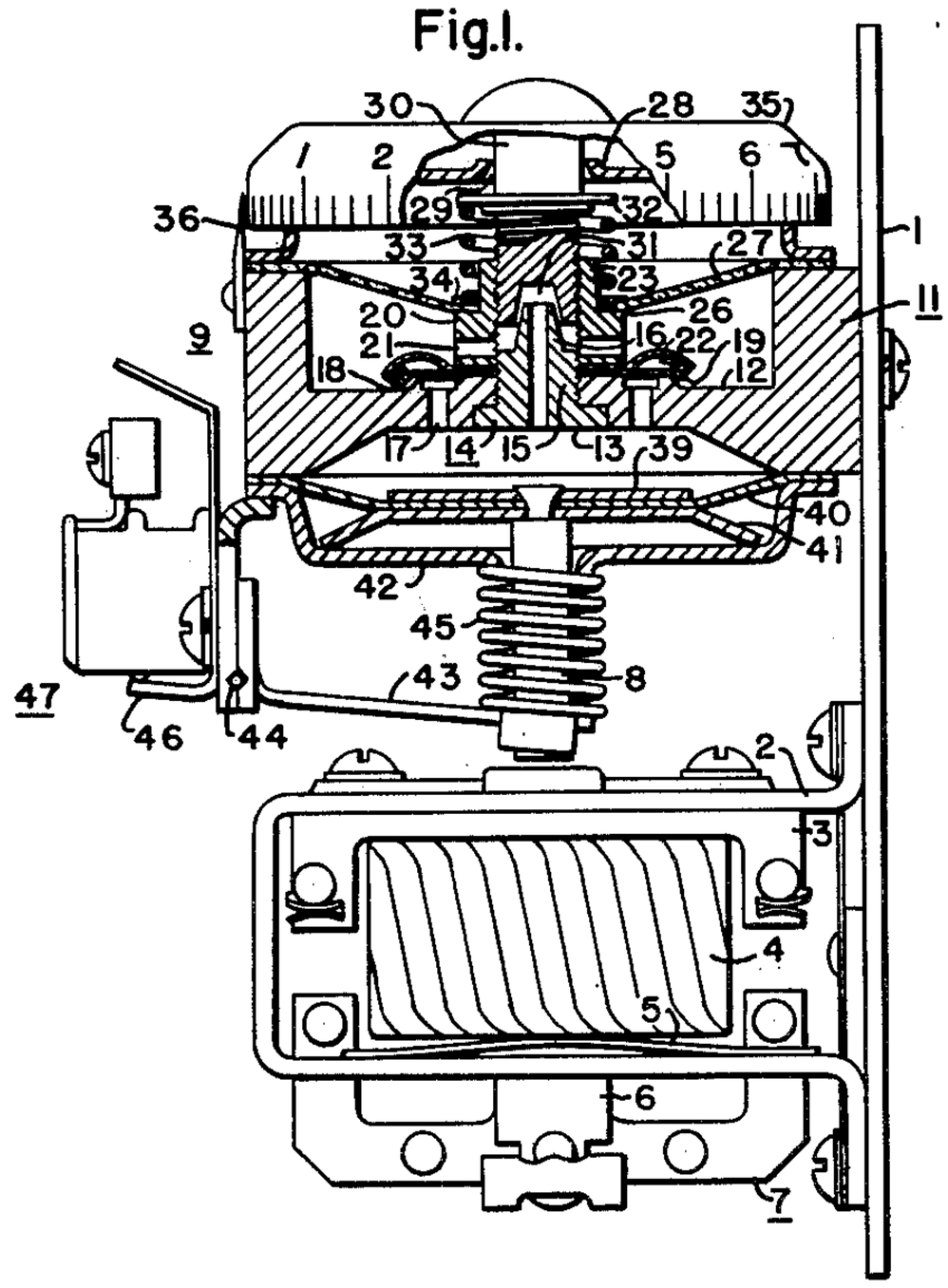

Fig.2.

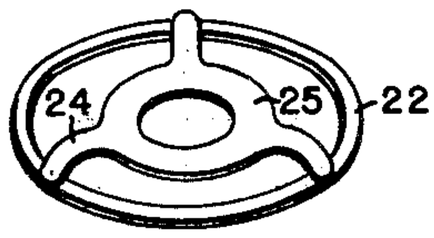

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Fig.3.

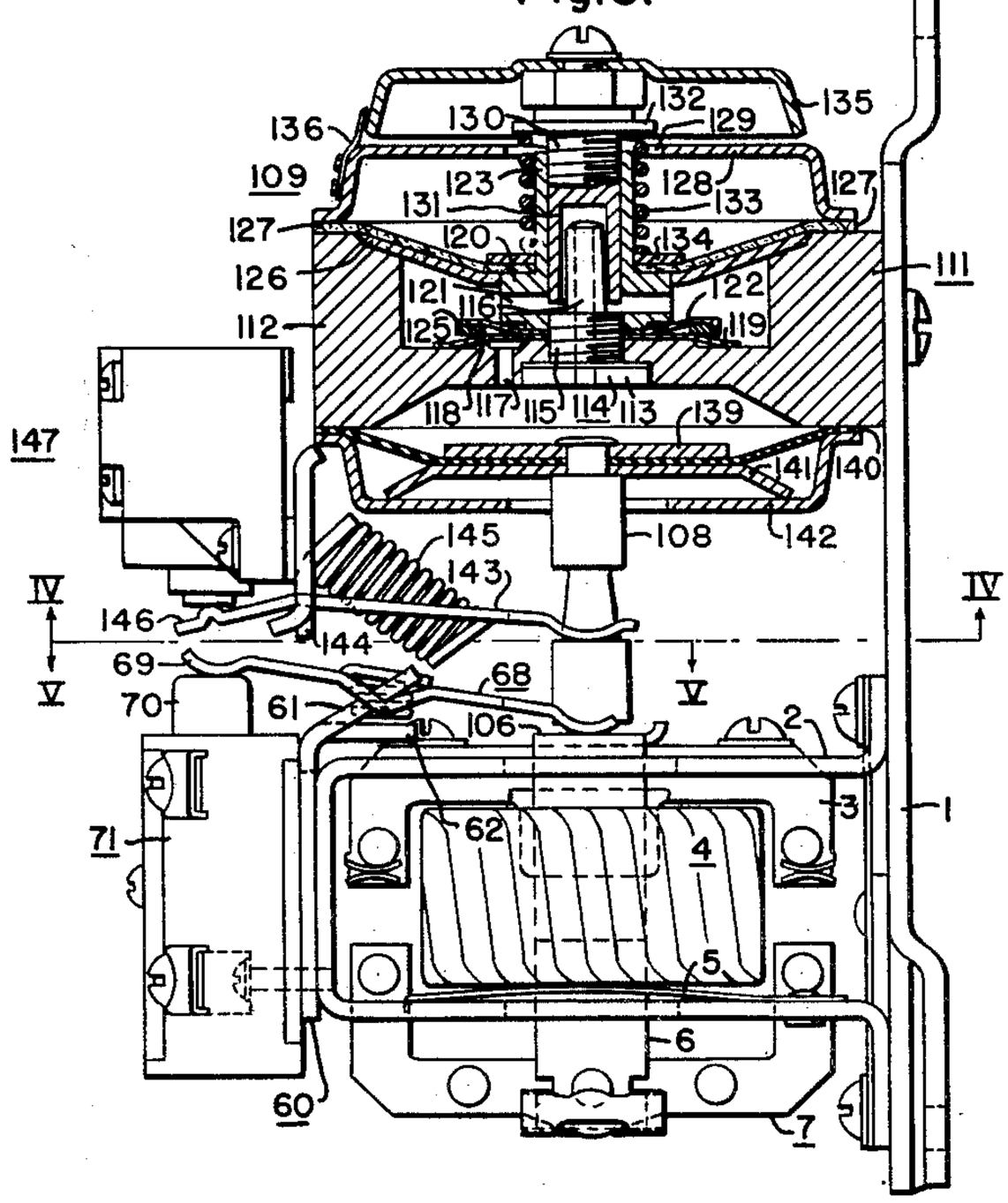


Fig.4.

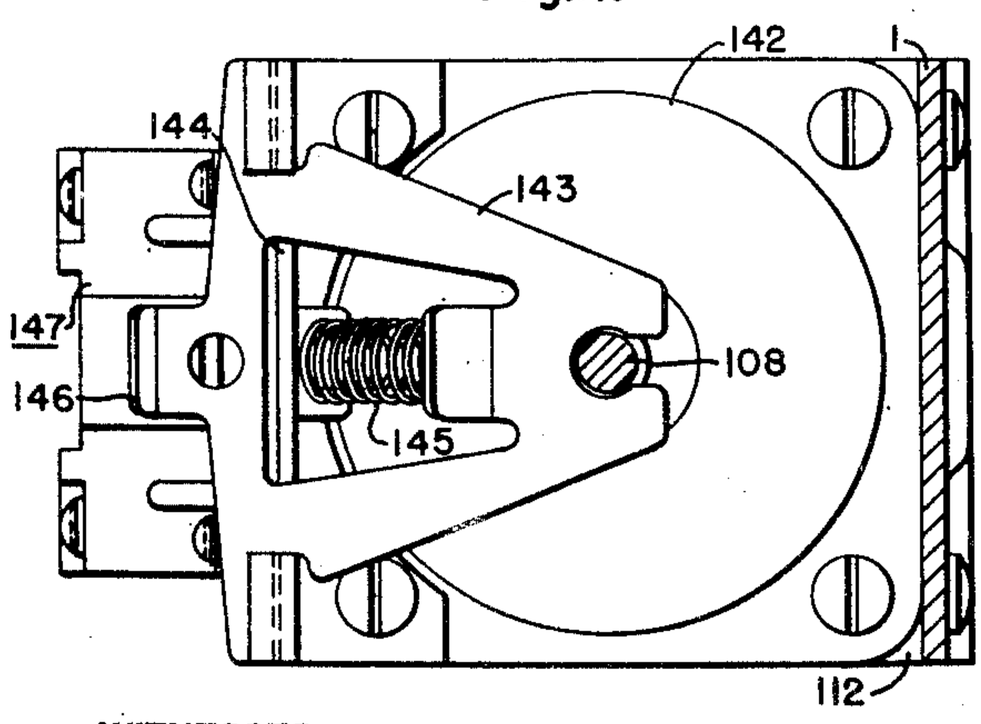
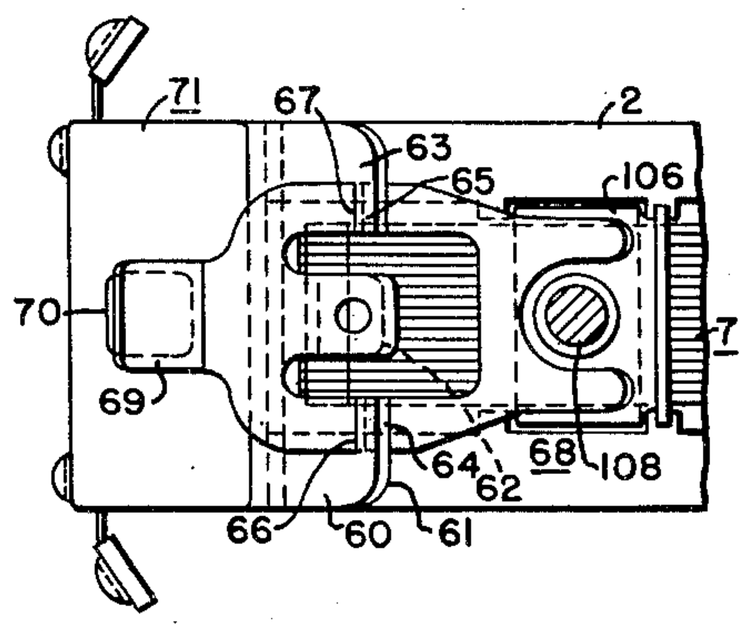


Fig.5.



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2,629,793

PNEUMATIC TIMING RELAY

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Application January 19, 1949, Serial No. 73,561

8 Claims. (Cl. 200—97)

1

My invention relates to time limit devices for movable mechanisms and more particularly to pneumatic time limit, or timing, apparatus for electromagnetic contactors and similarly operable devices. The time limit device I disclose herein is somewhat similar to the time limit device I and Ralph B. Immel, as joint inventors, disclosed in our U. S. Letters Patent No. 2,538,038, issued January 16, 1951, and entitled "Pneumatic Time Limit Contactor."

One broad object of my invention is the provision of a pneumatic timing means that shall be less expensive and more reliable than generally similar pneumatic timing means now on the market.

A more specific object of my invention is the provision of special, simple, and effective valve means for pneumatic devices of the character used for timing the operation of electromagnetic contactors or similarly operable devices.

It is also an object of my invention to provide pneumatic timing means for electric contactors, and relays, having a wide range of adjustment so that time limits of a considerable range may be employed.

Another object of my invention is the provision of a timing device that is simple in structure, reliable in operation and will provide substantially uniform timing within the range of adjustment of the timing cycle.

The objects stated are merely illustrative. Other objects and advantages will become more apparent from a study of the following specification and the accompanying drawings, in which:

Figure 1 is a side view of an embodiment of my invention with certain parts broken away to illustrate the internal structure of certain elements;

Fig. 2 is a perspective view of a detail;

Fig. 3 is a side view similar to the showing in Fig. 1 of another embodiment of my invention with the pneumatic apparatus shown on a longitudinal section;

Fig. 4 is a sectional view on section line IV—IV of Fig. 3; and

Fig. 5 is a sectional view on section line V—V of Fig. 3.

In Fig. 1 of the drawings, the base 1 represents the mounting for my device. The actuating elements include the main bracket 2 carrying the magnet 3 and the coil 4 biased against the magnet 3 by the springs 5. The coil 4 is so disposed that the core 6 of the E-shaped armature 7 is disposed axially of the coil 4. Upon energization of the coil 4 the armature moves vertically upward to engage the stem 8.

2

The pneumatic device 9 comprises a housing 11 rigidly secured to the base 1 in suitable relation to the electromagnetic elements shown. The housing is provided with a bottom 12 dished upwardly as shown. The bottom face at its central region is provided with a polygonal recess for receiving a matching head 13 of the valve sleeve 14. This sleeve has a cylindrical threaded portion 15 and an upper finger end 16 in the shape of a frustum of a cone. The axial opening is of uniform circular section for the entire length of the sleeve. The finger end 16 has a taper as shown.

The bottom 12 is provided with two or more openings 17 disposed in close proximity to the sleeve 14. The disposition of the holes, or openings 17, is preferably symmetrical with respect to the axis of the sleeve 14. An annular valve seat 18 surrounds the openings 17. An annular valve 19 of neoprene, rubber, or other rubber-like material and selected of sheet material that is quite thin and light in weight, is disposed over and thus against the valve seat 18.

A sleeve nut 20, having the inlet opening 21, internal threads as shown, and the upwardly directed stem 23, is threaded on the valve sleeve 14.

To provide for the proper seating functioning of the valve 19 on the seat 18, I dispose an annular spring 22 over the valve 19. This spring 22 is provided with the spider 24 having a central annular element 25 designed to fit snugly about the cylindrical portion 15 of the sleeve 14.

By tightening the sleeve nut 20 downwardly, the annular portion 25 is firmly gripped between the sleeve nut 20 and the valve 19. The spider portions provide a spring bias to the ring 22 so that the valve 19 in normal position seats on the valve seat 18.

The sleeve nut 20 is provided with a shoulder 26 for receiving the inner portion of the screen 27. The outer periphery of the screen 27 rests on the upper edge of the housing 11. To secure the screen to the housing, I utilize the cap 28 which is screwed down onto the housing by means of suitable bolts not shown.

The cap 28 completely covers the screen 27, except for the central opening 29 for receiving the stem 30. The central opening has ample clearance to permit free flow of air from the outside to the region above the screen 27.

The stem 30 is at its lower end threaded into the sleeve nut 20. The bottom end of the stem is provided with a conical recess 31 matching the outer conical contour of the finger end 16. By axially shifting the stem 30, the flow of fluid through the transverse openings, the recess 31,

and axial opening in the sleeve nut **20** may be restricted at will.

The stem **30** is provided with a shoulder against which the washer **34** is disposed. By positioning the compression spring **33** between the shoulder **32** and the washer **34**, the axial position to which the stem **30** is shifted is positively maintained and a seal is provided between the screen **27** and the sleeve nut **20** at the shoulder **26**.

To the upper end of the stem **30**, I rigidly secure the skirt **35**. The angular position of the skirt with reference to the housing **11** is thus a measure of the restriction of the flow of fluid through the recess **31**. By providing the skirt with suitable graduations, as shown, that cooperate with an index **36**, the time limit adjustment of my device may be readily determined.

The screen **27** is made of a loose felt, sturdy filter paper, or similar filtering material so as not to interfere with the free flow of air from the region above the screen to the region below the screen. My construction thus effectively prevents even the finest dust particles from getting into the region below the screen **27**, namely into the regions housing the valves for controlling fluid flow through the base of the housing **11**. Air, to get to the region above the screen **27**, must get under the skirt **35**, pass over the cap **28**, and then through the opening **29** having the upwardly flared edge shown. Any dust that might get through this circuitous path will be arrested by the screen **27** itself.

To the upper end of the stem **8**, the diaphragm **40** is secured between the washers **39** and **41**. The washer **41** is bent downwardly near its periphery so that the downwardly bent surface is parallel to the sloping surface of the hollow surface of the frame or housing **11**. This construction has the advantage of providing a cooperative action between the washer **41**, the diaphragm **40** and the sloping bottom surface of the housing such that substantially all fluid is expelled from the compression chamber upon each upward actuation of the diaphragm.

The downwardly bent portion of the washer **41** also limits the downward movement of the stem **8** by reason of the engagement of the outer periphery of the washer **41** with the cover **42**. This cover may be identical in construction to the cap **28** except that it is disposed upside down. At its four corners the cover **42** is held firmly against the outer periphery of the diaphragm **40** and the bottom of the housing to thus form a hermetic seal. The region above the diaphragm **40** is thus a compression chamber.

To better understand the utility of my device, a study of its operation may be helpful. The operation, briefly stated, is as follows:

Energization of coil **4** causes the armature **7** to move vertically upward pushing the stem **8** and assembly upwardly. The air, or other fluid when the atmosphere is not used as a medium, in the chamber is compressed above the diaphragm and the air is thus forced to flow through the openings **17**. The valve **19** lifts readily off the seat **18** to relieve the pressure. The instant the vertically upward movement of the stem **8** is completed, the valve **19**, actuated by the spring assembly consisting of the ring **22**, spider **24** moves against the seat **18**. At any time thereafter, when the coil **4** is deenergized, the armature **7** and thus the core **6** drop to the position shown. The stem **8**, however, does not follow because free flow of air to the compression chamber is not permitted.

To provide the stem with a downward bias, a compression spring **45** under a selected compression, is disposed between the bottom of the cover **42** and the washer at the bottom of stem **8**.

After the core **6** drops, the spring **45** urges the stem **8** downward, and thus actuates the diaphragm **40** to draw fluid back into the compression chamber, but the rate of the downward movement is determined by the rate at which air flows from the region above the base **12** through the channel **31**, the space between the conical projection **16** and the walls of the recess in the lower end of the stem **30**. The rate of flow is of course, determined by the axial position of the stem **30** in the sleeve nut **20**. The adjustment may be from wide open and thus substantially zero time, to a restriction such that twelve to fifteen minutes transpire before the stem **8** is again in the position shown. The graduations on the outer surface of the skirt **35**, disposed to register with the index **36** on the housing **11** may be marked to indicate the time delay that is obtained.

In the modification shown in Fig. 3, the stem **108** corresponds to stem **8** and may be actuated upwardly by any operator.

The upper end of the element **6** is provided with a contactor actuating surface **106**. The front end, assuming the left face of the showing in Fig. 3 is the front, of the bracket **2** is provided with the bracket **60** terminating at its upper end in the three arms **61**, **62** and **63**. The arm **62** is bent backwardly at right angles whereas the arms **61** and **63** are bent backwardly at about 60° from the vertical.

The arms **61** and **63** are provided with the inwardly directed palms **64** and **65**, respectively. The corners of the palms **64** and **65** are disposed to fall in the bearings **66** and **67** in the lever **68**. The lever **68** at its rear end is provided with bifurcations which contact the surface **106** without interferring with the free operation of the stem **108**, all shown in Figs. 3 and 5. The forward end of the lever **68** is provided with the arcuate end **69** for operating the push button **70** of the contactor **71**. This contactor is provided with one switch that closes the instant the coil **4** is energized to actuate the lever **68** and thus the push button **70** is actuated vertically downward. Upon deenergization of the coil **4**, the reverse operation of the switches takes place without delay.

The pneumatic device **109** is very similar in structure and function to the pneumatic device **9**. As a matter of fact, the elements designated by the reference characters **111**, **112**, **113**, **114**, **115**, **119**, **120**, **121**, **122**, **123**, **125**, **127**, **128**, **129**, **130**, **132**, **133**, **134**, **135** **136** and **139** to **146**, inclusive, in function and very nearly in construction, conform to the elements correspondingly numbered as **11**, **12**, **13**, etc., to **46**.

The construction of the element **116** and the shape of the recess **131** do not, as to length and depth, conform to the elements **16** and **31**. The finger element **116** is considerably elongated and the recess **131** is made proportionally deeper than recess **31**. The taper is not necessarily different than the taper of element **16**. The greater elongation provides for a wider range of manufacturing tolerances and thus provides a less expensive piece of apparatus and an improved apparatus. The greater elongation provides for a much finer degree of adjustment of the time limit of the device.

The stem **130** is longer than stem **30** and the

skirt 135 is disposed so that its outer bottom edge coacts with the cap 128 and particularly the index 136 on the cap 128. The sleeve 123 is elongated to receive the longer stem 130. This construction makes it possible to obtain a much finer degree of adjustment for the time limit of the pneumatic device.

The spider 126 is in the shape of a wrench at its central opening snugly fitting over the sleeve nut 123. The sleeve nut at the periphery coacting with the spider 126 is either square, hexagonal, or some other irregular shape with the spider having a corresponding opening to thus hold a fixed position circumferentially of the nut 123. The outer ends of the sleeve 126 are disposed in suitable notches in the vertical walls of the housing 111. The spider, in addition to holding the nut 123 in position, provides a support for the filter, or felt 127.

The function of the elements 143 to 147, inclusive, is very similar to the function of the elements 43 to 47, respectively, but the construction is in some respects very different to provide greater ease in assembly and greater life in use.

While I have shown but two embodiments of my invention, I am aware that the scope of my invention is not limited to the particular showings made. Other embodiments falling well within the spirit of my invention will readily occur to those skilled in the art, particularly after having had the benefit of my disclosure. My invention is thus to be limited only by the scope of the claims hereto appended.

I claim as my invention:

1. An automatic timing relay comprising, in combination, an actuating coil, an armature operable by said coil, a frame having a recess therein, a flexible diaphragm secured to the frame over the recess to form a closed chamber of variable volume as the diaphragm is moved toward and away from said recess, an actuating member secured to the diaphragm, said armature being disposed to operate said actuating member, means for biasing the armature to a position to give said chamber its maximum volume, the operation of the armature causing said chamber to be reduced to its minimum volume, a check valve and conduits therefor in the frame providing for free emission of the air in the chamber upon operation of the armature but to seal off the air flow into the chamber upon deenergization of said coil, an element in the frame wall having an outer end in the shape of a truncated cone, said element being provided with an axial opening placing the interior of the chamber in fluid communication with the outside, a stem on the frame mounted in axial alignment with the element, said stem being provided with a recess in the end adjacent to the element having the end shaped like a truncated cone, the shape of the recess matching the outer end of the element, the spacing between the walls and bottom end of the recess and outer end of the element having a selected value to thus control the flow of fluid from the outside into the chamber to thus provide a definite time delay for the movement of the armature to its biased position.

2. An automatic timing relay comprising, in combination, an actuating coil, an armature operable by said coil, a frame having a recess therein, a flexible diaphragm secured to the frame over the recess to form a closed chamber of variable volume as the diaphragm is moved toward and away from said recess, an actuating

member secured to the diaphragm, said armature being disposed to operate said actuating member. means for biasing the armature to a position to give said chamber its maximum volume, the operation of the armature causing said chamber to be reduced to its minimum volume, a check valve and conduits therefor in the frame providing for free emission of the air in the chamber upon operation of the armature but to seal off the air flow into the chamber upon deenergization of said coil, an element in the frame wall having an outer end in the shape of a truncated cone, said element being provided with an axial opening placing the interior of the chamber in fluid communication with the outside, a stem on the frame mounted in axial alignment with the element, said stem being provided with a recess in the end adjacent to the element having the end shaped like a truncated cone, the shape of the recess matching the outer end of the element, means for adjusting the spacing by the axial movement of the stem, between the walls and bottom end of the recess and the outer end having the shape of a truncated cone to thus adjust the time delay in the movement of the armature to its biased position upon deenergization of said coil.

3. In a pneumatic time delay mechanism for electric switching means, in combination, a frame including a wall having aligned recesses in the outer surfaces of the wall, a flexible diaphragm secured over one recess, said diaphragm being impervious to fluid, an internally threaded sleeve member projecting outwardly from the base of the other recess, a threaded plug closing the base of said sleeve member, said plug having an end falling well within the sleeve and terminating in the shape of a truncated cone, said sleeve being provided with a radial opening terminating just above the base of the truncated cone shaped end of the plug, said plug having a relatively small axial opening, a stem threaded into the outer end of the sleeve closing the sleeve, said stem having a recess, in the end facing the truncated cone shaped end of the plug, fitting snugly over the projecting end of the plug when screwed down against the projecting end of the plug, an index on the frame, means mounted on the stem and coacting with the index for indicating the spacing between the walls of the recess in the stem and the projecting end of the stem, valve means in the wall adjacent the plug providing for a free flow of air from the first recess into the second recess upon movement of the diaphragm toward the base of the first recess but sealing the wall against flow of air from the second recess to the first, and electromagnetic switching means disposed to be delayed in operation by said diaphragm and the elements coacting therewith.

4. In a pneumatic time delay, in combination, a base, a diaphragm impervious to fluid hermetically secured at its periphery to the base, means for biasing the diaphragm away from the base to thus form a closed chamber of variable volume upon positive movement of the diaphragm toward the base, said base being provided with an opening therein and check-valve means associated with said opening to provide for a free-flow of fluid from the chamber upon movement of the diaphragm toward the base to tend to compress the fluid in the chamber and to prevent flow of fluid into the chamber upon movement of the diaphragm, by its biasing means, away from the base, said base being

provided with another opening, a plug in said other opening, said plug having an axial channel and an end in the shape of truncate cone projecting above the base, a stem mounted axially adjustable on the base and disposed in alignment with the plug, said stem having a recess in the end facing the projecting end of the plug and having an inner contour to mate said projecting end of the plug, whereby the adjustment of the stem with reference to the plug end adjustably varies the rate of fluid flow into the chamber.

5. Time limit means for electromagnetically actuated switches, in combination, a gas-filled collapsible bellows comprising a rigid plate structure dished out, a flexible diaphragm at its periphery hermetically secured to the surface of the plate structure adjacent the periphery, said diaphragm thus together with the dished-out shape of the plate structure forming a compression chamber, electromagnetic means for moving the diaphragm toward the plate structure to compress the gas in the compression chamber, said plate structure being provided an opening in the bottom thereof through which the gas is freely expelled upon movement of the diaphragm toward the plate structure, check valve means for sealing the opening to prevent gas from entering the compression chamber upon movement of the diaphragm away from the plate structure, a tapered stem having an axial opening, projecting from the bottom of the plate structure remote from the compression chamber, said axial opening placing the compression chamber in communication with the outside, a second stem disposed in axial alignment with the tapered stem, said second stem having a tapered recess in its end to match the tapered stem, means for axially shifting the second stem with reference to the first stem to adjustably restrict the flow of gas from the outside into the compression chamber to thus selectively delay the return of the diaphragm to its unactuated position within a selected interval of time, means for indicating the position of the second stem with reference to the tapered stem to indicate the time delay selected, and switching means actuated upon return of said diaphragm to its unactuated position.

6. An electric switch including a vertically reciprocable member, electromagnetic means for actuating said member vertically upward, switching means actuated upon vertical movement of said member to one operative position, a plate disposed horizontally above said member, said plate being dished downwardly at its edges, a diaphragm, at its edge hermetically secured to the downwardly dished portions of the plate to thus, with the dished-out portions of the plate, form a compression chamber, a connection between the member and the central portion of the diaphragm whereby vertically upward movement of the member compresses the fluid in the compression chamber, said plate being provided with a central opening and still other openings in close proximity to the central opening, a plug having an axial opening and a tapered end hermetically secured in the central opening so that the tapered end projects above the plate, annular valve means of relatively thin rubber-like material at its inner periphery hermetically secured to the plug and plate and having its actuating surface disposed over the said other openings whereby said valve

means acts effectively as a check to fluid flow from the region above the plate to the compression chamber through said other openings, a stem mounted for reciprocal movement and in axial alignment to the tapered end of the plug, said stem at the end adjacent the tapered end of the plug being provided with a tapered recess to match the tapered end of the plug, whereby flow of fluid from above the plate into the compression chamber may be restricted at will to selected values by axial movement of the stem toward the tapered end of the plug, means for indicating the axial position of said stem to thus indicate the time delay of the movement of the reciprocable member from its actuated position to its unactuated position, and means for actuating said switching means to another operative position upon return of the reciprocable member to its unactuated position.

7. An electric switch including a vertically reciprocable member, electromagnetic means for actuating said member vertically upward, switching means actuated upon vertical movement of said member to one operative position, a plate disposed horizontally above said member, said plate being dished downwardly at its edges, a diaphragm, at its edge hermetically secured to the downwardly dished portions of the plate to thus, with the dished-out portions of the plate, form a compression chamber, a connection between the member and the central portion of the diaphragm whereby vertically upward movement of the member compresses the fluid in the compression chamber, said plate being provided with a central opening and still other openings in close proximity to the central opening, a plug having an axial opening and a tapered end hermetically secured in the central opening so that the tapered end projects above the plate, a valve seat disposed about the said central opening and said other openings, an annular valve of relatively thin rubber-like material at its inner periphery hermetically secured to the plug and plate, the actuating surface of the valve being disposed against the valve seat, said valve in coaction with the seat acts effectively as a check to fluid flow from the region above the plate to the compression chamber through the said other openings, a stem mounted in axial alignment with the tapered end of the plug said stem at the end adjacent the tapered end being provided with a tapered recess to match the tapered end of the plug, whereby flow of fluid from above the plate into the compression chamber may be restricted at will to selected values by axial movement of the stem toward the tapered end of the plug, means for indicating the axial position of said stem to thus indicate the time delay of the movement of the reciprocable member from its actuated position to its unactuated position, and means for actuating said switching means to another operative position upon return of the reciprocable member to its unactuated position.

8. An electric switch including a vertically reciprocable member, electromagnetic means for actuating said member vertically upward, switching means actuated upon vertical movement of said member to one operative position, a plate disposed horizontally above said member, said plate being dished downwardly at its edges, a diaphragm, at its edge hermetically secured to the downwardly dished portions of the plate to thus, with the dished-out portions of the plate, form a compression chamber, a connection be-

tween the member and the central portion of the diaphragm whereby vertically upward movement of the member compresses the fluid in the compression chamber, said plate being provided with a central opening and still other openings in close proximity to the central opening, a plug having an axial opening and a tapered end hermetically secured in the central opening so that the tapered end projects above the plate, a valve seat disposed about the said central opening and said other openings, an annular valve of relatively thin rubber-like material at its inner periphery hermetically secured to the plug and plate, the actuating surface of the valve being disposed against the valve seat, an annular spring disposed above the valve and dimensioned to lie substantially above the valve seat and coacting with the valve to bias the valve against the seat, said valve in coaction with the seat acts effectively as a check to fluid flow from the region above the plate to the compression chamber through the said other openings, a stem mounted in axial alignment with the tapered end of the plug said stem at the end adjacent the tapered end being provided with a tapered recess to match the tapered end of the plug, whereby flow of fluid from above the plate into the compression chamber may be restricted at will to selected values by axial movement of the stem toward the tapered end of the plug, means for indicating the axial

position of said stem to thus indicate the time delay of the movement of the reciprocable member from its actuated position to its unactuated position, and means for actuating said switching means to another operative position upon return of the reciprocable member to its unactuated position.

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