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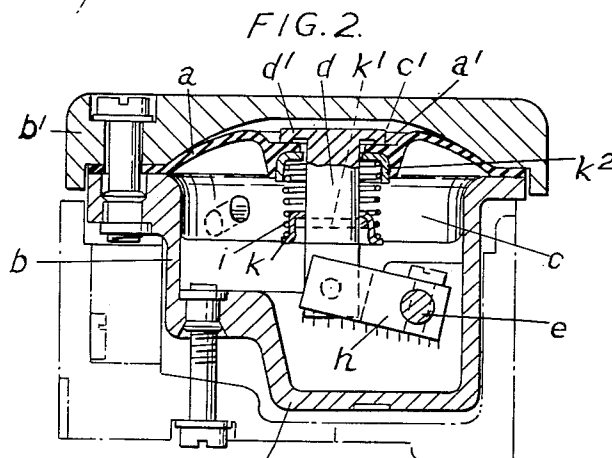
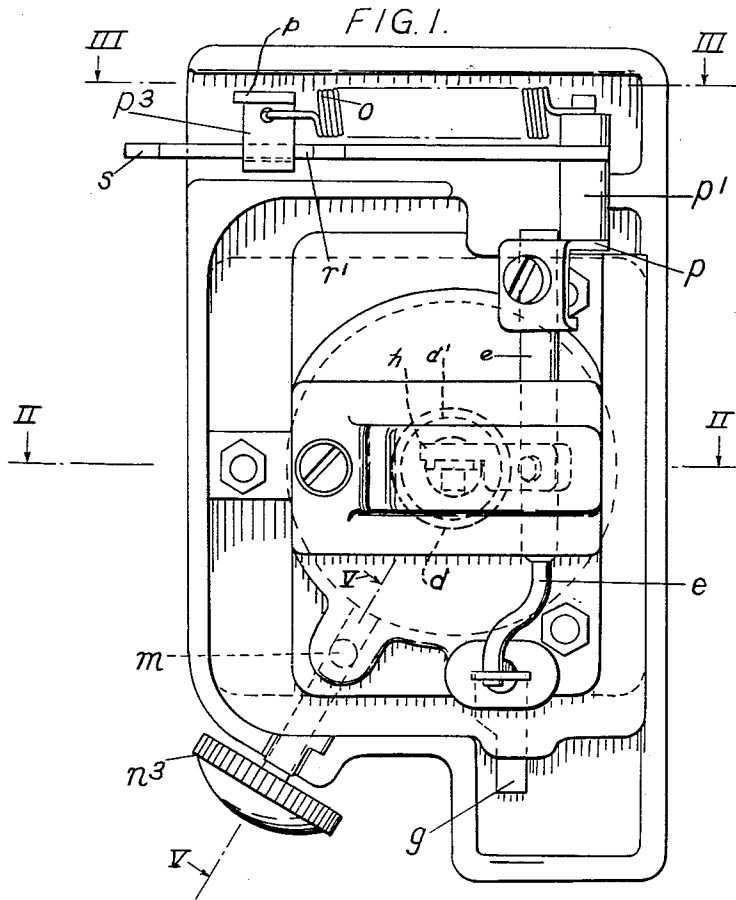
J. A. CRABTREE ET AL

2,712,440

TIME DELAY DEVICES

Filed Aug. 16, 1950

2 Sheets-Sheet 1



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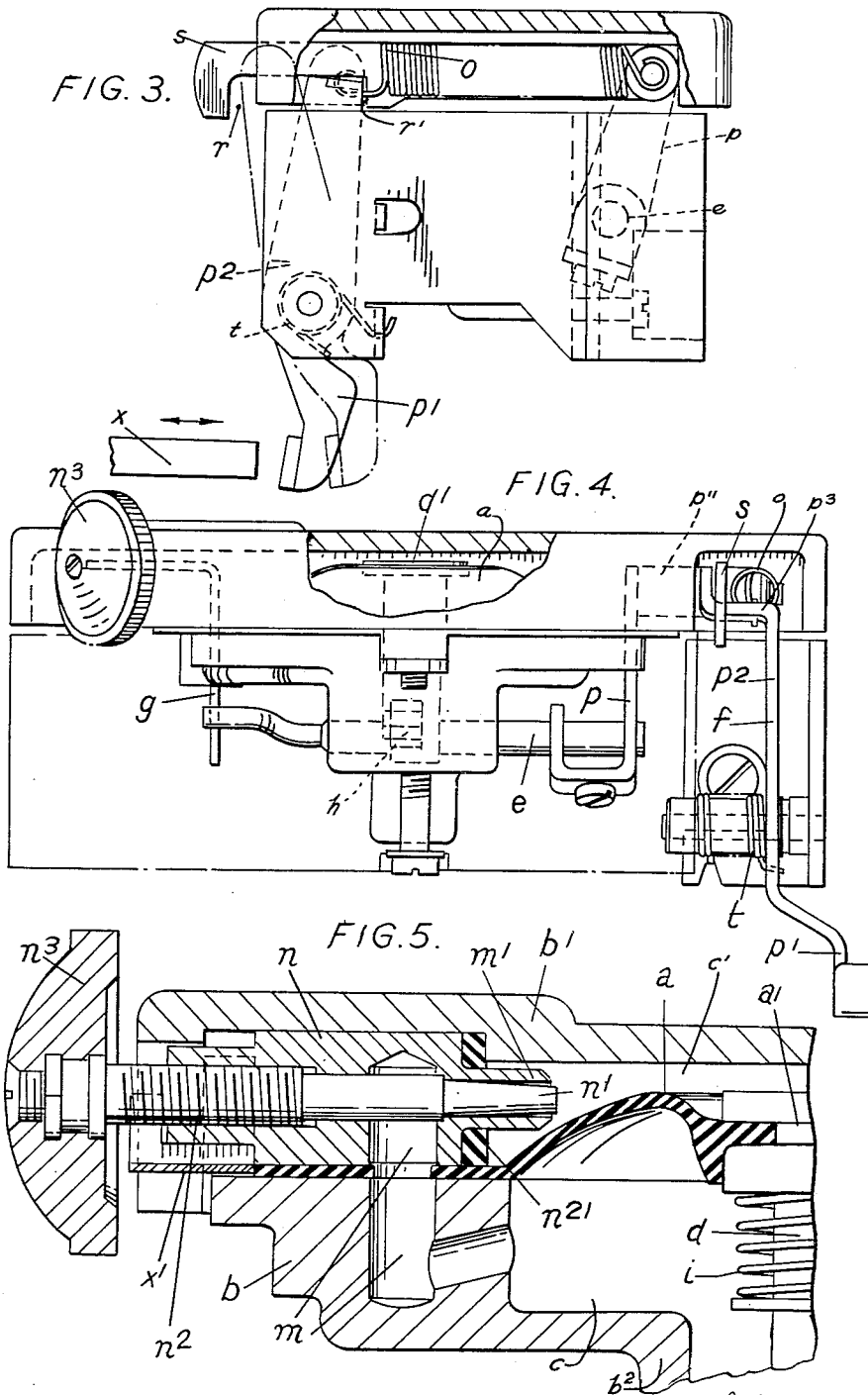
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TIME DELAY DEVICES

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8 Claims. (Cl. 267—1)

This invention relates to improvements in time delay devices of the type which may be employed in connection with electric switches and other means, and is particularly concerned with pneumatic devices for use with star-delta motor starting switches and the like. The principal object of the invention is to provide an improved construction obviating the necessity for the frequent replacement of filter devices and ensuring that the adjustment valve of the device is not liable to obstruction from dust particles or the like.

According to this invention, the pneumatic time delay device comprises a flexible and deformable diaphragm, and a closed circuit, including a throttle valve, for the passage of air from one side to the other of the diaphragm. A non-return valve may be provided for the passage of air after operation of the time delay device and for enabling the parts to return quickly to the normal position. By providing a closed circuit for the passage of the air, the admission of dust or other foreign matter is prevented, and thus any possibility of the obstruction and sticking of the valves is avoided. Variations in temperature may necessitate the supply of make-up air from the atmosphere, and this is admitted to the circuit through a long restricted passage, felt disc, or the like. Inasmuch as this make-up air is admitted at low velocity, it carries with it little or no dust, so that the felt or other material has an extended life before any replacement is necessary.

In order to enable the invention to be readily understood, reference will now be made to the accompanying drawings, illustrating by way of example, one construction for carrying the invention into effect, in which drawings:

Figure 1 is a plan view of the time delay device of the present invention.

Figure 2 is a sectional view of said device on the line II—II of Figure 1.

Figure 3 is a sectional view of said device on the line III—III of Figure 1.

Figure 4 is a side elevation of said device, with a part in section.

Figure 5 is a sectional view of said device, on an enlarged scale, on the line V—V of Figure 1.

Referring to the drawings, a flexible and deformable rubber diaphragm *a* has a central concave part and a flat marginal part of rectangular shape gripped firmly between two flat mouldings *b* *b*¹ of insulating material. The latter are centrally enlarged to form air chambers *c* *c*¹ on each side of the concave part of the diaphragm *a*. The lower moulding *b* has a hollow depending portion *b*² in which is disposed the stem *d* of a non-return disc valve *d*¹ controlling an opening *a*¹ in the diaphragm *a*.

Extending through bearings in the walls of the depending part *b*² is an oscillatable spindle *e*, one end of which is adapted to be actuated by the armature *x* of an electromagnet through mechanism *f* as hereinafter described, and the other cranked end of which operates a switch mechanism (not shown) through an L-shaped arm *g*.

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The short length of the spindle *e* which is disposed inside the moulding is connected to one end of a short radial arm *h*, the other end of which arm is pivotally connected with the valve stem *d*. A helical compression spring *i* is operative for normally maintaining the valve *d*¹ closed, this spring being disposed between washers, the innermost *k* of which is held in position by a pin *k*¹, while the other *k*² is seated in a central cup formed in the underside of the central portion of the diaphragm *a*.

Aligned ducts *m* in the mouldings *b* *b*¹ and a port *m*¹ in a valve body *n* in the moulding *b*¹, enable air to pass from the lower chamber *c* to the upper chamber *c*¹ when the diaphragm *a* is pulled downwards by the depression of the stem *d* caused by turning of the spindle *e*.

The rate of flow of air through the ducts *m* *m*¹ is controlled by a throttle valve which is adjustable for the purpose of varying the speed of descent of the diaphragm *a*. This throttle valve consists of a screw *n*² having a conical end *n*¹ which can be introduced into the duct *m*¹ to a variable extent for adjustment of the area of the free opening. The throttle valve is adjustable by a rotatable knob or handle *n*³. The throttle valve is mounted in a separate valve body *n*, and the marginal part of the diaphragm *a* and a washer *n*²¹ provide a fluid-tight seal. A resilient clip *x*¹ is adapted for seating the valve body *n* and for frictionally holding the screw *n*² in its rotationally adjusted position. The screw *n*² may extend through a rubber washer which provides a fluid-tight seating for preventing the ingress of air from the external atmosphere.

Upon energization of the electromagnet, the armature *x* associated therewith is attracted, and a tension spring *o* is then permitted to turn an actuating arm *p* and the spindle *e* on which said arm is mounted. The said armature *x* acts on one arm *p*¹ of a two-armed lever, the other arm *p*² of which is disposed in an elongated slot *r* in one end of a slidable bar *s*, the other end of which is pivotally connected to the cranked end *p*¹¹ of the actuating arm *p*. A spring *t* disposed around the pivot axis of the aforesaid two-armed lever is operative for turning the said lever so that the bent end *p*³ thereof is engaged with the end *r*¹ of the slot *r* in the bar *s*. The spring *o* is connected between the bent end *p*³ and the cranked part *p*¹¹ of the arm *p*. When the lever *p*¹ is turned by the armature *x* against the action of the spring *t*, the tension of the spring *o* is increased because the upper end of arm *p*² thereof is moved to the left, as seen in chain lines in Figure 3. In moving away from the end *r*¹ of the slot *r*, the bent end *p*³ permits the bar *s* to move to the left due to the tension of the spring and thereby turn the spindle *e*. This causes the short arm *h* to depress the stem *d* of the non-return valve *d*¹, which produces downward movement of the diaphragm *a* at a rate dependent on the rate of air flow from the bottom chamber *c* to the top chamber *c*¹ as determined by the setting of the throttle valve. Consequently, the time occupied in operating the arm *g* of the associated switch mechanism is delayed to a variable extent.

The air flows to the upper chamber *c*¹ above the diaphragm *a* until end *r*¹ of slot *r* in bar *s* is brought into abutment with the bent end *p*³, or until the associated electromagnet is de-energized. The return spring *t* then returns the parts quickly to their normal position. During this return movement air is permitted to pass rapidly from the upper chamber *c*¹ to the lower chamber *c* through the non-return valve *d*¹.

Temperature variations may cause "breathing" of the air within the circuit, which may necessitate the admission of make-up air to the circuit, which circuit is otherwise closed. This make-up air may be admitted through a small opening in the lower moulding *b*, this opening being covered by a layer of felt or the like which acts as

a filter for preventing entry of dust or other particles which might cause sticking or clogging of the valves.

Having thus described our invention we claim:

1. A pneumatic time delay device comprising a housing having a closed air chamber therein; a flexible diaphragm mounted in said housing and extending across said chamber to divide the same into two sections; means for flexing said diaphragm toward one end of said chamber; means for flexing said diaphragm toward the opposite end of said chamber; an air passage extending from one side to the other of said diaphragm for passage of air between the two sections of said chamber; and a throttle valve controlling flow of air through said air passage, said throttle valve comprising a separate valve body member removably mounted within a wall of said housing and having a bore therethrough, a portion of which bore constitutes a part of said air passage, said valve body member having a valve seat therein, and means at the exterior of said housing for operating said throttle valve to vary the rate of flow of air through said passage from one side of said diaphragm to the other side thereof, said last mentioned means including a valve stem having a valve portion thereon, said valve stem being adjustable by said means at the exterior of said housing to vary the position of said valve portion with respect to said valve seat.

2. A pneumatic time delay device as defined in claim 1 in which the means for flexing the diaphragm toward said one end of said chamber comprises a stem connected to the diaphragm, an oscillatable spindle, and a connection between said stem and said spindle for moving said stem and diaphragm toward said one end of said chamber when said spindle is oscillated in one direction.

3. A pneumatic time delay device as defined in claim 1, in which a non-return valve is mounted on the diaphragm, said non-return valve being closed as said diaphragm is moved toward said opposite end of said chamber.

4. A pneumatic time delay device as defined in claim 1, in which the means for flexing the diaphragm toward said one end of said chamber comprises a stem connected to the diaphragm, and in which a non-return valve is mounted on the diaphragm and is maintained in closed position by said stem as said diaphragm is flexed toward said opposite end of said chamber.

5. A pneumatic time delay device comprising a housing having a closed air chamber therein; a flexible diaphragm mounted in said housing and extending across said chamber to divide the same into upper and lower sections; means for flexing said diaphragm downwardly from a position within the upper section toward a position within the lower section against the pressure of the air

beneath said diaphragm, said means including an oscillatable spindle, a pair of actuating levers operatively connected to said spindle with the first of said actuating levers operatively connected to said diaphragm, and a tension spring operatively connected to the second of said actuating levers which spring when tensioned oscillates said spindle to flex said diaphragm downwardly; means for flexing said diaphragm upwardly from a position within the lower section toward a position within the upper section; an air passage extending from one side to the other of said diaphragm and connecting said upper and lower sections; a throttle valve controlling the flow of air through said passage between said lower section and said upper section; means at the exterior of said housing for operating said throttle valve to vary the rate of flow through said air passage; and a non-return valve mounted on said diaphragm and maintained in closed position as said diaphragm is flexed downwardly and in open position as said diaphragm is flexed upwardly.

6. A pneumatic time delay device as defined in claim 5, in which the means for flexing the diaphragm upwardly includes a return spring effective on the second of said actuating levers and acting through said spindle and actuating levers to flex said diaphragm upwardly from a position within the lower section to a position within the upper section.

7. A pneumatic time delay device as defined in claim 5, in which the means for flexing the diaphragm downwardly against the pressure of the air beneath said diaphragm is operatively connected to the second of said actuating levers for oscillating the spindle, and in which a return spring is effective on said second of said actuating levers and acts through said spindle and actuating levers to flex said diaphragm upwardly from a position within the lower section to a position within the upper section.

8. A pneumatic time delay device as defined in claim 7, in which the means operatively connected to said second of said actuating levers for oscillating said spindle to flex said diaphragm downwardly comprises a tension spring.

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