July 14, 1953 C. A. SCHAEFER 2,645,285

TIMER

Filed April 26, 1949 2 Sheets-Sheet 1

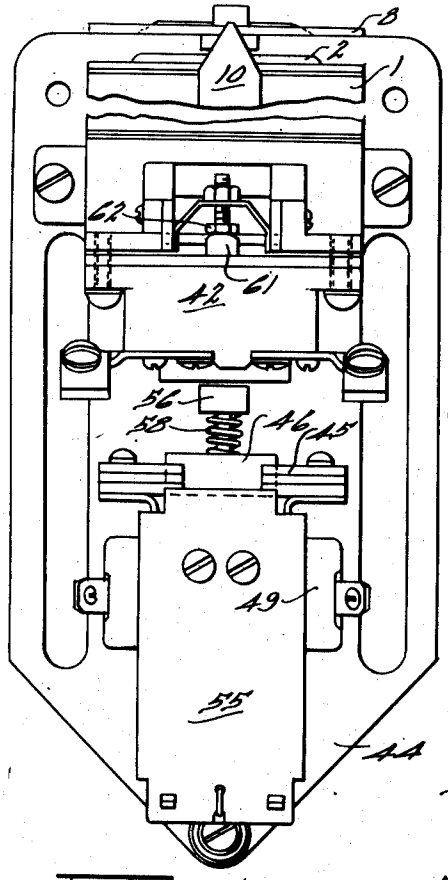


FIG. 1.

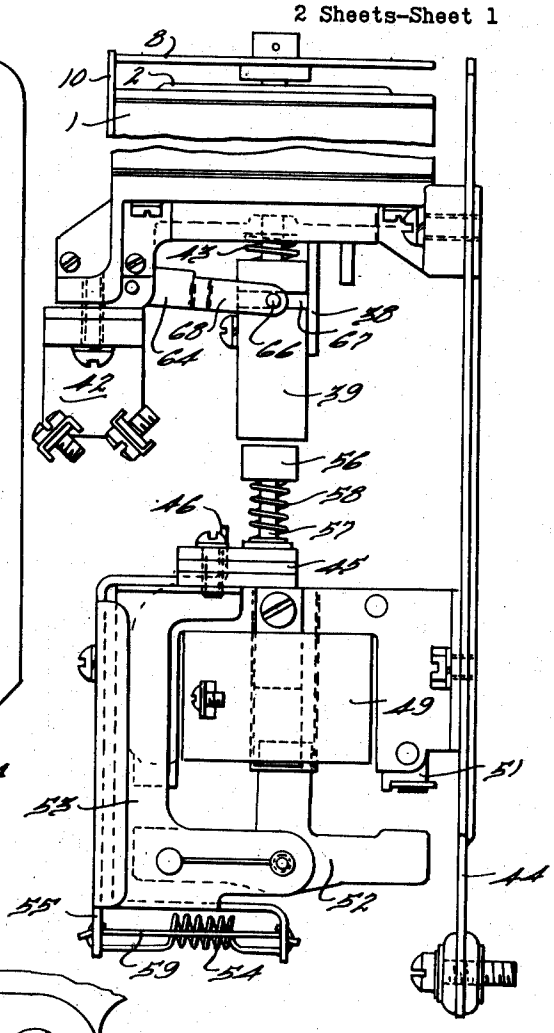


FIG. 2.

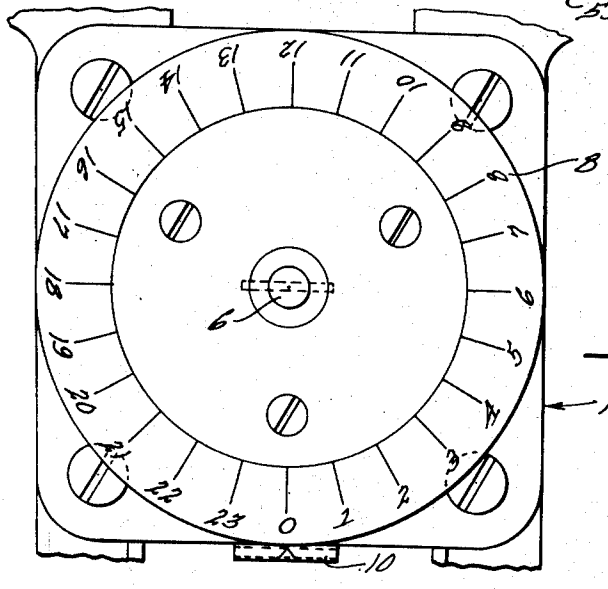


FIG. 3.

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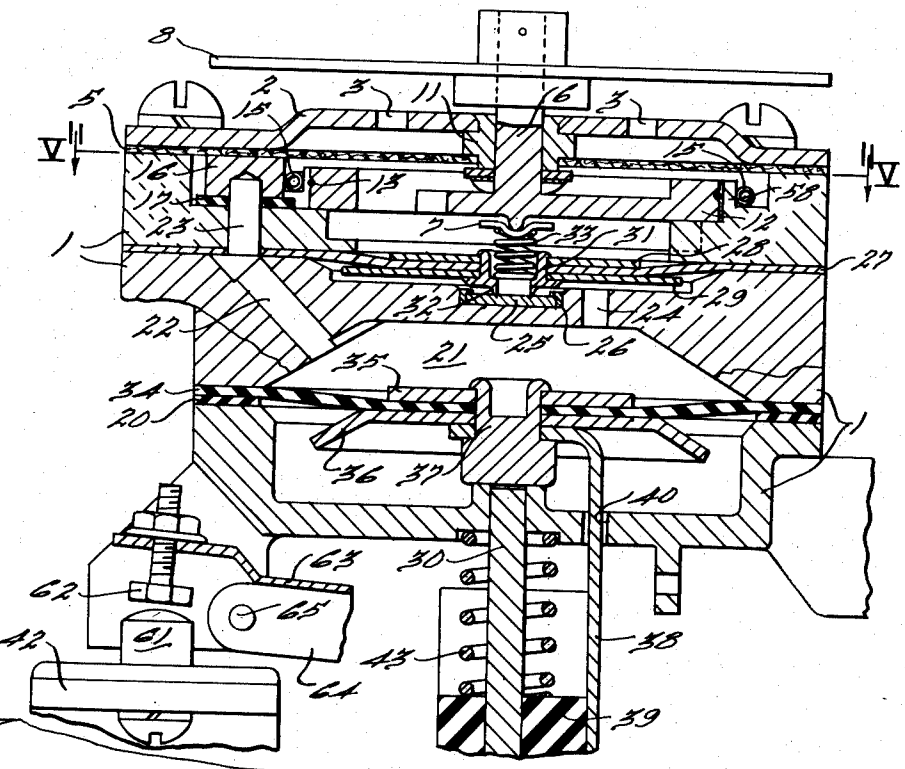


FIG. 4.

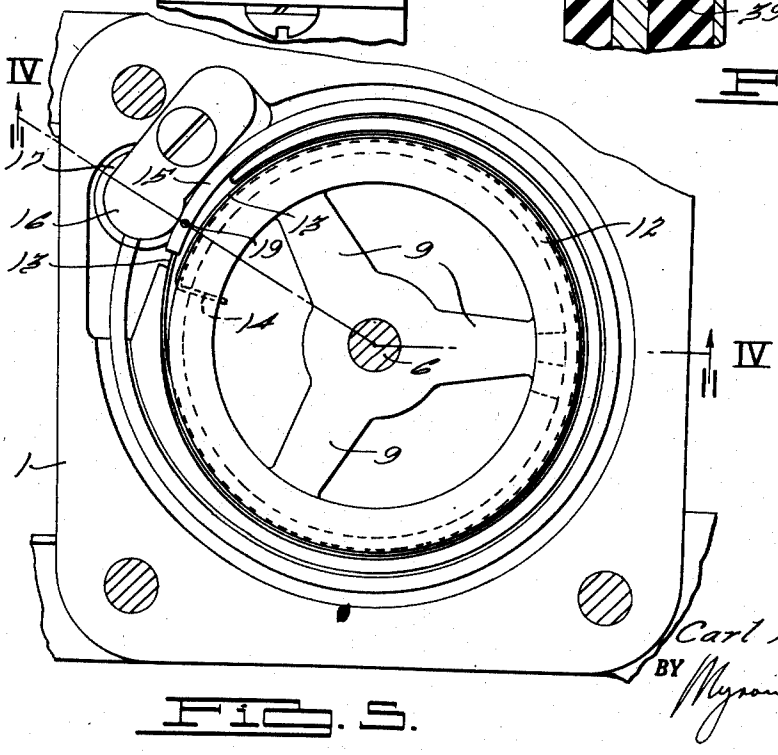


FIG. 5.

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22 Claims. (Cl. 161—1)

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This invention relates to automatic timing mechanisms having adjustable time delay means for varying the operation of the mechanism.

In earlier devices of this type, it was frequently the practice to provide a tapered needle valve threaded at the outer end and movable toward or away from a valve seat, tapered or otherwise, to control the time required for a given volume of air to enter into a chamber, the rate of entry of the air into the chamber controlling the rate of movement of a diaphragm. The relationship between the time required for a given amount of air to enter the chamber and the setting of the threaded needle valve in relation to the valve seat was substantially hyperbolic.

One object of the invention is the provision of an improved adjustable timing mechanism wherein the relationship between the delay time and the setting of the timing controller is substantially linear.

Another object of this invention is the provision of an improved adjustable timing device in which the time delay is controlled by variations in the resistance to the flow of air through a capillary tube.

Another object of this invention is the provision of an adjustable timing device in accordance with the preceding object in which the time delay is varied by varying the distance a slender rod or filament is projected within a capillary tube through which the timing air flows.

Another object of the invention is the provision of an adjustable timing device in accordance with the preceding object in which the capillary tube is substantially circular in form and the slender rod or filament is flexible and carried by a rotating member which controls its insertion and withdrawal from the tube.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawings illustrating certain preferred embodiments in which:

Figure 1 is a front elevational view of an electrical relay incorporating the timing mechanism of the present invention.

Figure 2 is a side elevational view of the relay of Figure 1 on a larger scale.

Figure 3 is an enlarged partial plan view of the timing mechanism.

Figure 4 is an enlarged vertical sectional view with the upper portion taken on the plane IV—IV of Figure 5 and with the lower portion on a plane at right angles to the front face.

Figure 5 is a detailed sectional view along the line V—V of Figure 4.

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The device of the present invention, as specifically shown in the drawing, comprises a segmented base 1 having lower, middle and top portions defining chambers for the operating mechanism to be subsequently described, and topped by a cover piece 2 provided with relatively large holes 3 communicating the chamber in the top base portion with the atmosphere through a filtering felt diaphragm 5. A rotatable timing wheel 12 is disposed within the chamber in the top base portion and is connected by spokes 9 to a shaft 6, the upper portion of which extends through a bushing 11 in the cover 2. The exterior portion of the shaft 6 is provided with a selector disk 8 carrying time indicia which may be set with respect to a reference marker 10.

The periphery of the wheel 12 has a generally V-shaped notch in which there is mounted a slender rod or filament 13 which is held to the wheel 12 by a retaining wall 58, an integral part of the top portion of the segmented base 1. A small radial hole 14 is provided in the wheel 12 for anchoring one end of the filament 13. A length of capillary tubing 15 is provided, one end of which receives the free end of the filament 13, the tubing 15 being adapted to receive varying lengths of the rod or filament 13 upon rotation of the wheel 12.

The opposite end of the capillary tubing 15 is sealably connected into a block 16 mounted through a sealing gasket 17 to the top portion of the base 1. Within the block 16, this opposite end of the tubing 15 connects to a passageway 23 which also extends through the top portion of the base and communicates with a passageway 22 extending through the middle portion of the base and communicating with a chamber 21. Near that end of the capillary tubing 15 which receives the free end of the filament 13, there is provided a small hole 19 in the tubing through which communication is provided, through tubing 15 and passageways 23 and 22, to the chamber 21.

A thin, flexible diaphragm 27 is disposed between the top and middle portions of the base and carries stiffening washers 28 and 29 which surround a ferrule 31 of substantially rigid material which is provided through the center of the diaphragm 27.

The lower portion of the ferrule 31 is provided with a thin, circular valve seat 32, a spring 33 being provided between the ferrule 31 and a washer 7 to bias the valve seat 32 toward engagement with valve disk 25 which, with an associated retainer 26, rests in a suitable recess in the upper edge of the middle base portion. This middle portion has a hole 24 therethrough which pro-

vides for free passage of air from the chamber 21 to the space beneath the diaphragm 27.

It will be seen that when the valve seat 32 is in contact with the valve disk 25, no air may pass from the space above the diaphragm 27 into the space 21 except through the capillary tube, that route having been previously described, while with the seat 32 moved upwardly, free access is provided through the open center of the ferrule 31.

The lower boundary of the chamber 21 is defined by a flexible rubber diaphragm 34 mounted with a sealing gasket 20 between the middle and lower portions of the segmented base 1. The central portion of the diaphragm 34 is provided with stiffening washers 35 and 36 to which is mounted a movable bracket 38 by a riveted or spun over element 37 whose lower, head portion functions as an abutment stop engaging a boss on the lower portion of the base. The vertical part of the bracket 38 passes through a hole 40 in the lower portion of the base 1 and carries a block 39 which is guided for rectilinear movement by a post 30 fixedly mounted in the lower base portion. A spring 43 about post 30 biases the block 39 and the parts connected thereto into their lowermost positions.

The present invention illustrated has an operator for an electric switch shown generally at 42 as a self contained electric switch of standard form having suitable cooperating switching contacts (not shown). The switch operator at 61 is engaged by an adjustable abutment 62 mounted upon the extension of a bridging portion 63 connecting spaced arms 64 pivoted to a part integral with the lower portion of the base at 65 and with one of the arms 64 having an extension 68 provided with a sliding pivotal connection with the block 39 by means of the pin 66 and slot 67.

Associated with the timing mechanism in the specific embodiment shown, there is an electromagnetic operator comprising an E-shaped field magnet 51 provided with an energizing coil 49 and adapted to attract a T-shaped armature member 52. The armature 52 is mounted upon U-shaped brackets 53 which are guided for vertical movement behind a front plate 55 by slots in the insulating platform 45 rigid with the brackets 53, which slots receive an upstanding flange 46 rigid with the front plate 55. Mounted on the platform 45 is a post 57 having a head 56 mounted thereon for limited relative movement therebetween, and with the head 56 biased upwardly with respect to post 57 by the spring 58. The relative motion between head 56 and post 57 insures sealing of the armature 52 against the field magnet 51 with the block 39 in its uppermost position. The armature 52 and its associated structure are biased downward not only by gravity, but by the spring 54 connecting flanges on the front plate 55 and on the U-shaped brackets 53 and with the flanges spaced apart by a link 59 pivotally connected thereto. The base containing the timing and switch operating mechanism and the electromagnetic operator are mounted together as shown in cooperating relation upon the mounting plate 44.

The operation of the timing relay is as follows:

Energization of the solenoid 49 causes the armature 52 to move upwardly, raising head 56 on post 57 to raise block 39 against the bias of spring 43. Raising of block 39 rotates arm 64 in a counterclockwise direction as viewed in Figure 2 to move switch operator 61 downwardly and operate switch 42 in one direction. The upward movement of the bracket 38 lifts the diaphragm 34 from the lowered position shown in Figure 4 to its upward position with chamber 21 at a minimum volume. The air which was in the chamber is forced rapidly through the hole 24 by this action and, acting upon the large area of the diaphragm 27, lifts the valve seat 32 from the valve disk 25, the air thereby being admitted to the space above the diaphragm 27 and escaping to the outer atmosphere through the felt diaphragm 5 and the holes 3 of the outer cover 2. After this air has been forced out, the valve seat 32 recloses upon the valve disk 25 under the bias of spring 33. It will be seen that, due to the large effective area of the valve diaphragm 27, the force required to open the valve is very small, giving improved operation when the timing unit is used with a small operator. Further, the large area of the valve diaphragm 27 also serves to cause a relatively large force to be exerted by the small valve seat 32 upon the valve disk 25 during the timing period when the chamber 21 is under a partial vacuum.

The timing period is initiated by deenergization of the coil 49. The armature 52 then falls to its lowered position due to the action of gravity and the bias of spring 54, and the head 56 is pulled away from the block 39. The diaphragm 34 is urged downward by the action of the spring 43 forcing the block 39, which is coupled to the diaphragm 34 by the bracket 38, away from the base 1. However, the only air which can enter the chamber 21 to permit the controlled downward movement of the diaphragm 34 is that which passes through the hole 19 in the capillary tube 15 and through the capillary tube and the passageways 23 and 22. The diaphragm can move only at a rate consistent with the time required for the space above it to fill with air. Thus, the rate of descent of the diaphragm 34 from its upward position to the lowered position shown in Figure 4, and the consequent movement of the block 39 and the switch actuating levers 68, 64, is directly dependent upon the amount of air which can flow through the capillary tube during a given period of time. This period of time is determined by the length of the rod or filament 13 which lies within the operative portion, that portion between the small hole 19 and the block 16, of the capillary tube 15. In such a tube, the frictional resistance to the flow of air through that portion in which the filament lies is so large that the rate at which the air flows is directly proportional to the length of filament within the tube.

As the diaphragm 34 moves downwardly, block 39 will move downwardly therewith and will rotate arm 64 in a clockwise direction. The abutment 62 permits the switch operator 61 to move upward until the switch 42 operates to end the timed period, which in the specifically shown embodiment of the invention is the period between deenergization of the coil 49 and reverse operation of the switch 42.

For any setting of the selector disk 8 and the associated timing wheel 12, the amount of air which can pass through the capillary tube (and subsequently into the chamber 21 to control the movement of the diaphragm 34) during a given period is fixed due to the fact that for any such setting, a particular length of the wire 13 will lie within capillary tube 15. Consequently, for a particular setting of the selector disk 8 and the associated timing wheel 12, the time delay before

the switching mechanism 42 is operated is definite and constant.

It will be obvious that the timing device of the present invention may be utilized in any arrangement in which a timed period is desired and it may be used with any type of operator and for timing in any direction with or without switch operation.

It will also be understood that for limited arcs of the capillary 15 and the rod or filament 13, both may be rigid; but, to secure the longest representative arc, and hence the greatest length of insertion of the rod or filament into the capillary tube, the rod or filament is preferably of material such as a metal wire or plastic filament having endwise rigidity but flexible in a transverse direction so that the rod or filament may be easily threaded into the tube.

It will be seen that the timing device of the present invention provides not only a linear relationship between the timing period and position of the controlling wheel, but that also the entire operating range of the device may be secured with a single turn of the adjusting dial, thus providing easy adjustment and calibration.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means biasing said first mentioned means for movement in one direction, means for moving said first mentioned means in the opposite direction against said biasing means, means including a capillary tube of a generally circular form communicating with said chamber through which fluid passes as the chamber volume is varied, means providing for free passage of fluid as said first mentioned means moves in the opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in said one direction to determine the timing period, and a flexible elongated filament adjustably insertable into said capillary tube to vary the timing period by varying the resistance to flow of fluid between the inner surface of said capillary tube and the outer surface of said filament.

2. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means biasing said first mentioned means for movement in one direction, means for moving said first mentioned means in the opposite direction against said biasing means, means including a capillary tube of a generally circular form communicating with said chamber through which the fluid passes as the chamber volume is varied, means providing for free passage of fluid as said first mentioned means moves in the opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in said one direction to determine the timing period, a flexible elongated filament adjustably insertable into said capilliary tube to vary the timing period by varying the resistance to flow of fluid between the inner surface of said capillary tube and the outer surface of said filament, and a rotatable wheel having one end of said filament mounted thereon so that rotation of the wheel effects insertion and withdrawal of the filament from the tube.

3. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means biasing said first mentioned means for movement in one direction, means for moving said first mentioned means in the opposite direction against said biasing means, means including a capillary tube of a generally circular form communicating with said chamber through which the fluid passes as the chamber volume is varied, means providing for free passage of fluid as said first mentioned means moves in the opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in said one direction to determine the timing period, a flexible filament insertable into said capilliary tube, a rotatable wheel for varying the timing period by adjustably inserting said filament within said capillary tube, and means for carrying said filament upon said wheel.

4. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means biasing said first mentioned means for movement in one direction, means for moving said first mentioned means in the opposite direction against said biasing means, means including a capillary tube of a generally circular form communicating with said chamber through which the fluid passes as the chamber volume is varied, means providing for free passage of fluid as said first mentioned means moves in the opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in said one direction to determine the timing period, a flexible filament insertable into said capillary tube, a rotatable wheel for varying the timing period by adjustably inserting said filament within said capillary tube, means for carrying said filament upon said wheel, and means including indicia for selectively positioning said rotatable wheel.

5. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means including a capillary tube in a generally arcuate form communicating with said chamber, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in at least one direction to determine a timing period, a rod in an arcuate form adjustably insertable into said capillary tube, rotatable means carrying said rod and varying the timing period by adjustably inserting said rod within said capillary tube.

6. In a timing device, a chamber, means movable to effect expansion and contraction of the volume of said chamber, means biasing said first mentioned means for movement in one direction, means for moving said first mentioned means in the opposite direction against said biasing means, means including a capillary tube in a generally arcuate form communicating with said chamber through which fluid passes as the chamber volume is varied, means providing for free passage of fluid as said first mentioned means moves in said opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said first mentioned means moves in said one direction to determine the timing period, a rod in an arcuate form adjustably insertable into said capillary tube to vary

the timing period by varying the resistance to flow of fluid between the inner surface of said capillary tube and the outer surface of said rod and rotatable means carrying and moving said rod.

7. In a timing device, a base, a chamber within said base, means including a capillary tube controlling the communication between said chamber and the atmosphere during the timing period, adjustable means varying the resistance to air flow through said capillary tube, airtight means defining at least part of one side of said chamber, means for varying the position of said airtight means to vary the chamber volume, and means operating in response to the position of said airtight means to determine the timing period.

8. In a timing device, a base, a chamber within said base, means including a capillary tube controlling the communication between said chamber and the atmosphere during the timing period, adjustable means including a thin rod or filament extending into said capillary tube for varying the resistance to air flow through the tube, airtight means defining at least part of one side of said chamber, means for varying the position of said airtight means to vary the chamber volume, and means operating in response to the position of said airtight means to determine the timing period.

9. In a timing device, a base, a chamber within said base, a rotatable member, a flexible rod or filament mounted upon said rotatable member, means including a capillary tube of a generally circular shape controlling the communication between said chamber and the atmosphere during the timing period, said capillary tube being adapted to receive said filament or rod upon rotation of said rotatable member, airtight means defining at least part of one side of said chamber, means for varying the position of said airtight means to vary the chamber volume, and means operating in response to the position of said airtight means to determine the timing period.

10. In a timing device, a chamber, a flexible diaphragm defining at least part of one side of said chamber and movable to effect expansion and contraction of the volume of said chamber, means biasing said diaphragm for movement in one direction, means for moving said diaphragm in the opposite direction against said biasing means, a capillary tube communicating with said chamber through which fluid passes as the chamber volume is varied, means providing for free passage of fluid as said diaphragm moves in the opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said diaphragm moves in said one direction to determine the timing period, means operating in response to the position of said diaphragm, and a filament adjustably insertable into said capillary tube to vary the timing period by varying the resistance to flow of fluid between the inner surface of said opening and the outer surface of said filament.

11. In a timing device, a chamber, a flexible diaphragm defining at least part of one side of said chamber and movable to effect expansion and contraction of the volume of said chamber, means biasing said diaphragm for movement in one direction, means for moving said diaphragm in the opposite direction against said biasing means, a capillary tube in a generally circular form communicating with said chamber, the plane of the tube being substantially parallel to the diaphragm, means for limiting the path for passage of fluid into said chamber to said capillary tube as said diaphragm moves in at least one direction to determine the timing period, means operating in response to the position of said diaphragm, and a flexible filament adjustably insertable into said capillary tube to vary the timing period by varying the resistance to flow of fluid between the inner surface of said opening and the outer surface of said filament.

12. In a timing device, a chamber, a flexible diaphragm defining at least part of one side of said chamber and movable to effect expansion and contraction of the volume of said chamber, means for moving said diaphragm in opposite directions, a capillary tube in a generally circular form communicating with said chamber, means for limiting the path for passage of fluid into said chamber to said capillary tube as said diaphragm moves in at least one direction to determine the timing period, means operating in response to the position of said diaphragm, a filament insertable into said capillary tube, a rotatable wheel for varying the timing period by adjustably inserting said filament within said capillary tube, and means for carrying said filament upon said wheel.

13. In a timing device, a chamber, a flexible diaphragm defining at least part of one side of said chamber and movable to effect expansion and contraction of the volume of said chamber, means biasing said diaphragm for movement in one direction, means for moving said diaphragm in the opposite direction against said biasing means, a capillary tube in a generally arcuate form communicating with said chamber through which fluid passes as the chamber volume is varied, means providing for free passage of fluid as said diaphragm moves in said opposite direction, means for limiting the path for passage of fluid into said chamber to said capillary tube as said diaphragm moves in said one direction to determine the timing period, a filament adjustably insertable into said capillary tube, a rotatable wheel for varying the timing period by adjustably inserting said filament within said capillary tube, and means for carrying said filament upon said wheel.

14. In a timing device, a base having a cup-shaped portion, a flexible diaphragm, a chamber formed by said cup-shaped portion and said diaphragm, a capillary tube in an arcuate form, means mounting said tube in said base in a plane substantially parallel to said diaphragm, apertures within said base communicating one end of capillary tube with said chamber, means communicating another portion of said capillary tube with the atmosphere, a wheel, a filament, means mounting said filament upon said wheel, means mounting said wheel to said base such that said filament is substantially coplanar with said tube, one end of said filament being inserted within one portion of said tube whereby adjustable lengths of said filament are positionable within said tube by rotation of said wheel, means for effecting movement of said diaphragm to vary the volume of said chamber, means responsive to diaphragm movement, means permitting free movement of said diaphragm as it moves in one direction, and means limiting the rate of movement of said diaphragm in the opposite direction to a rate proportional to the rate of air flow through said capillary tube.

15. The device defined in claim 14, in which

said base comprises a plurality of sections, said cup-shaped portion being in a first of said sections, said wheel being mounted to a second of said sections, one of said apertures being formed in said first section and another of said apertures being formed in said second section.

16. The device defined in claim 14 in which said base comprises a plurality of sections, said cup-shaped portion being in a first of said sections, said wheel being mounted to a second of said sections, one of said apertures being formed in said first section and another of said apertures being formed in said second section, and in which a second diaphragm is interposed between said base section having the cup-shaped portion and said base section mounting said wheel, said second diaphragm having an opening registering with said apertures within said base.

17. The device defined in claim 14 in which said base comprises a plurality of sections, said cup-shaped portion being in a first of said sections, said wheel being mounted to a second of said sections, one of said apertures being formed in said first section and another of said apertures being formed in said second section, and in which a second diaphragm is interposed between said base section having the cup-shaped portion and said base section mounting said wheel, said second diaphragm having an opening registering with said apertures within said base, and in which said means permitting free movement of said diaphragm as it moves in one direction includes said second diaphragm, a valve seat carried by said second diaphragm, and an opening communicating said chamber and said second diaphragm.

18. The device defined in claim 17, in which said valve seat is biased toward closed position by a spring interposed between said valve seat and said wheel, said wheel having an upstanding shaft, a selector disk carrying indicia being mounted upon said shaft.

19. In a timing device, a base comprising a plurality of base sections, a first of said sections having a cup-shaped portion, a flexible diaphragm, means mounting portions of said diaphragm to portions of said cup-shaped portion whereby a chamber is defined by said cup-shaped portion and said diaphragm, a capillary tube in a generally circular form, means mounting said tube to a second of said base sections, a rotatable wheel having a peripheral notch therein, a filament, means mounting said filament to said wheel, said filament being disposed in said notch, means mounting said wheel to said second section such that said filament is substantially coplanar with said tube, one end of said filament is substantially coplanar with said tube, one end of said filament being inserted within said tube whereby adjustable lengths of said filament are positionable within said tube by rotation of said wheel, a centrally disposed shaft on said wheel, a cover mounted to said second base section, said cover having means engaging said wheel, an aperture in said second base section communicating with one end of said capillary tube, an aperture in said first base section communicating said chamber with said aperture in said second base section, means for effecting movement of said diaphragm, means responsive to diaphragm movement, means permitting free movement of said diaphragm as it moves in one direction and means limiting the rate of movement of said diaphragm in the opposite direction to a rate proportional to the rate of air flow through said capillary tube.

20. In a timing device having a chamber defined by a base and a diaphragm and means for effecting movement of said diaphragm to vary the volume of said chamber, the combination of means for determining the rate of air flow into said chamber as said diaphragm is moved to determine the timing period comprising an elongated opening of uniform cross section in a plane generally parallel to the plane of said diaphragm, means communicating a first portion of said opening with the atmosphere, means including apertures within said base communicating a second portion of said opening with said chamber, an elongated filament having a cross section which is substantially uniform, and means for effecting the insertion of adjustable lengths of said filament between said first and second portions of said opening to vary the timing period.

21. The device defined in claim 20, in which said elongated opening is in arcuate form, and said means for effecting the insertion of adjustable lengths of said filament includes a rotatable wheel mounted to said base, said filament having one portion connected to said wheel and one end inserted within said opening.

22. The device defined in claim 20, in which said elongated opening is in arcuate form, and said means for effecting the insertion of adjustable lengths of said filament includes a rotatable wheel mounted to said base, said filament having one portion connected to said wheel and one end inserted within said opening, and in which said means communicating a second portion of said opening with said chamber also includes a block sealably mounted to said base, and means sealably joining said second portion of said opening to said block, said block having a passageway therein aligned with said base aperture.

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