

April 14, 1959

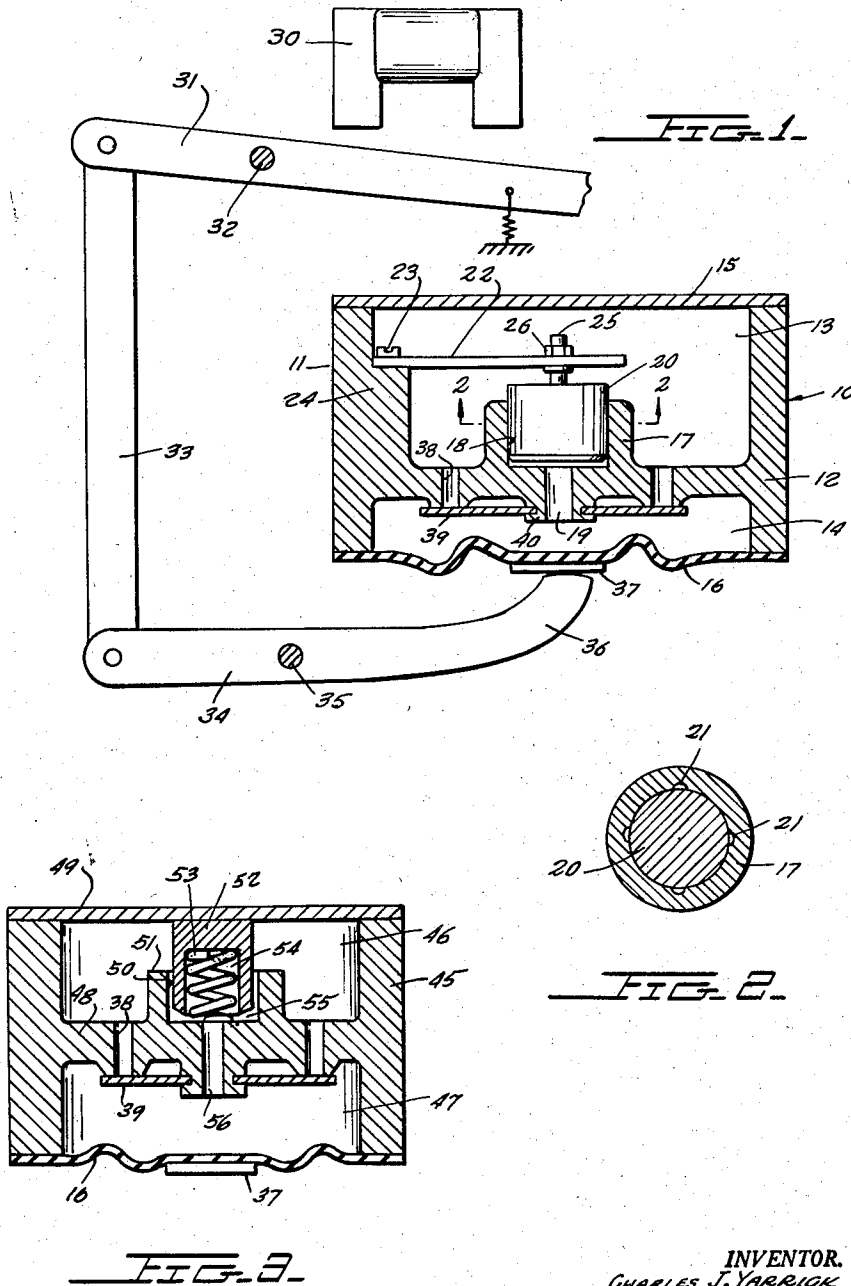
C. J. YARRICK

2,881,869

TEMPERATURE COMPENSATED TIME DELAY MEANS

Filed April 20, 1954

3 Sheets-Sheet 1



INVENTOR.
CHARLES J. YARRICK

BY

Attorneys & Fisher
ATTORNEYS

April 14, 1959

C. J. YARRICK

2,881,869

TEMPERATURE COMPENSATED TIME DELAY MEANS

Filed April 20, 1954

3 Sheets-Sheet 2

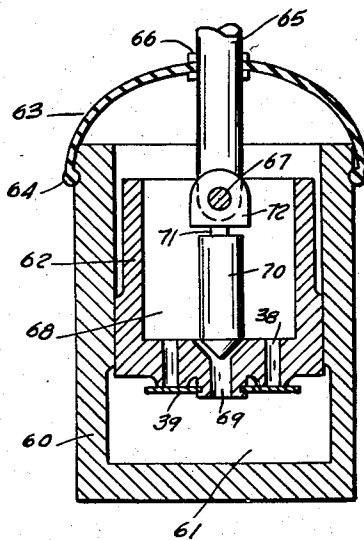


FIG. 4.

FIG. 6.

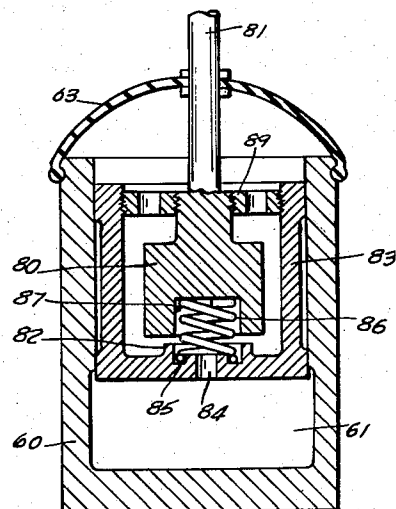
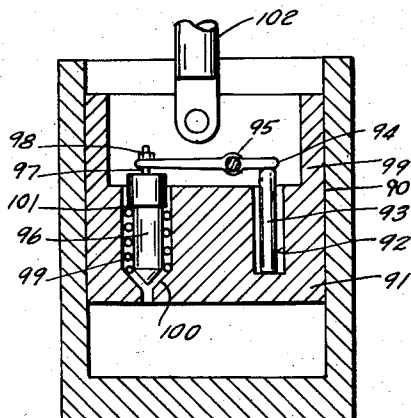


FIG. 5.

INVENTOR.
CHARLES J. YARRICK

BY

Petrolink & Faber
ATTORNEYS

April 14, 1959

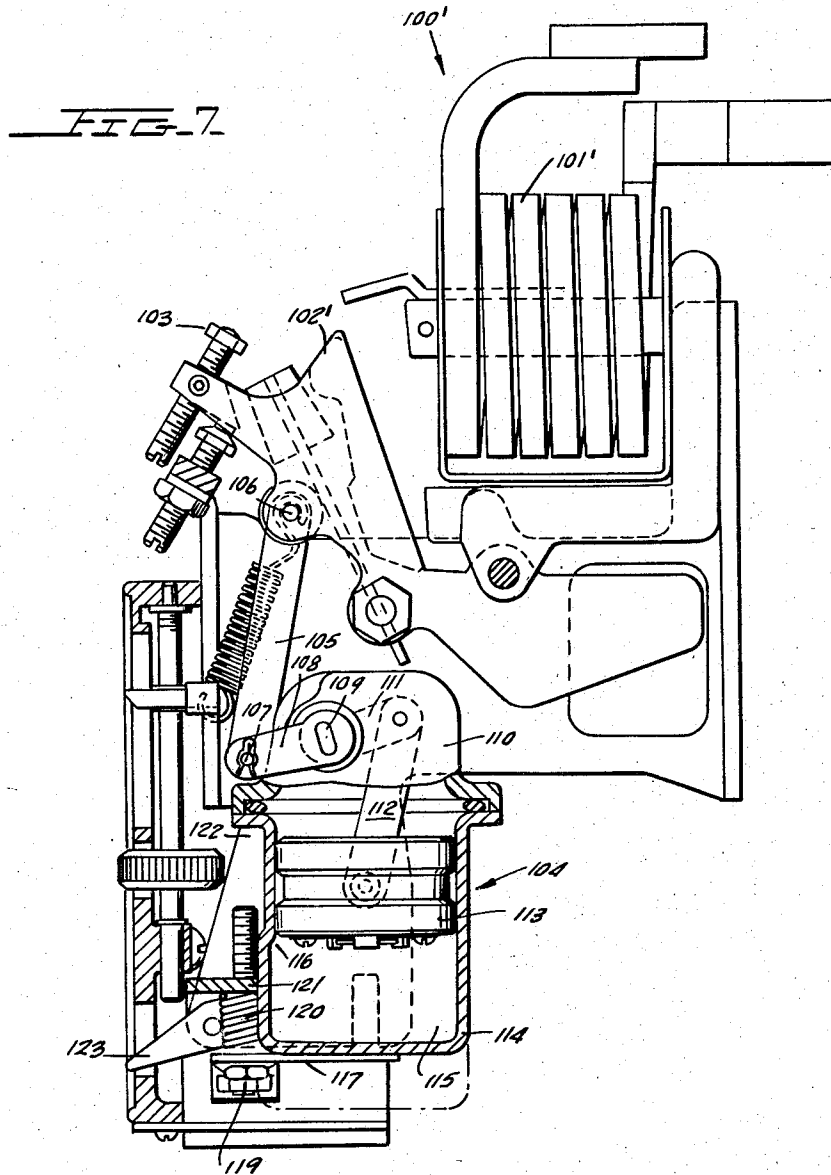
C. J. YARRICK

2,881,869

TEMPERATURE COMPENSATED TIME DELAY MEANS

Filed April 20, 1954

3 Sheets-Sheet 3



INVENTOR.
CHARLES J. YARRICK

BY

Astrolink & Fisher
ATTORNEYS

1

2,881,869

TEMPERATURE COMPENSATED TIME DELAY MEANS

Charles J. Yarrick, West Collingswood, N.J., assignor to I-T-E Circuit Breaker Company, Philadelphia, Pa.

Application April 20, 1954, Serial No. 424,416

3 Claims. (Cl. 188—94)

This invention relates to a temperature compensated time delay device.

In oil-type time delay devices, the delay is obtained by the displacement of oil from one chamber into another. The device may comprise a bored cylinder and a slidable piston wherein the oil is displaced from one side of the piston to the other side. Likewise, the device may be formed of a cylinder having two separated chambers with an oil passageway provided between the chambers so that pressure exerted upon the oil in one chamber would cause displacement of the oil, through the passageway, to the other chamber.

Such a type time delay device is commonly used in the circuit breaker art to provide for selective tripping. In the transmission of electrical power, a circuit breaker is normally provided at each of the sections of the transmission line. Thus, a circuit breaker would be provided at the power station, another at the distribution center, another at the locality in which the power is used, etc. Thus, by selective tripping, it is meant that in the event of an overload, first the local circuit breaker would open. Should the overload then persist, the next circuit breaker in the transmission chain would open, and so forth.

As is apparent, the opening of each circuit breaker must be accurately timed. Were it otherwise, the premature opening of a circuit breaker at a remote main point of distribution might unnecessarily inconvenience a large number of power users. Likewise, the slow opening of a breaker might cause damage to parts of the transmission system.

In such a use of a multiplicity of circuit breakers, each with its accurately calibrated time delay device, a problem which has constantly arisen is the effect of variations of temperature upon each time delay device. Since oil viscosity changes with temperature variations, the difference in ambient temperatures at each circuit breaker location, as well as the heat generated when a circuit breaker is opened, causes differences in the desired time of successive operation of the chain of circuit breakers.

To solve this problem, the art has attempted to resort to oils which have only slight reactions to temperature changes. Thus, silicon oil whose viscosity varies a relatively small amount has been substituted for the ordinary oils previously used. However, even such substitutions are far from satisfactory since the viscosity of this oil is still affected by temperature and since this oil is quite expensive.

Thus, it is an object of my invention to provide an oil type time delay device, wherein ordinary oils may be used, but whose time delay remains constant regardless of temperature variations.

Another object of my invention is to provide an oil-type time delay device wherein the delay is caused by forcing oil, under pressure, through a passageway whose size is regulated in response to temperature changes.

A further object of my invention is to provide a time delay device having an oil passageway whose size is thermally regulated to permit a consistent rate of oil flow

2

regardless of the change in viscosity of the oil due to temperature changes.

An additional object of my invention is to provide a time delay device having two chambers separated by a partition through which an oil passageway is provided, and wherein the size of the orifice of said passageway is responsive to temperature changes.

Still another object of my invention is to provide a time delay device having an cylinder divided into two chambers by a slidable piston. In addition, an oil passageway in said piston connecting the two chambers is provided with thermally responsive means to regulate the flow of oil and to keep the rate of flow the same regardless of viscosity changes in the oil.

Further, it is an object of my invention to provide a time delay device formed of two chambers separated by a partition having an oil passageway therethrough, and a valve comprising a material having a high coefficient of thermal expansion adapted to constrict a portion of said passageway in accordance with decreases in oil viscosity due to temperature changes.

Other objects and advantages of my invention will become apparent from the following description.

In the accompanying drawings forming a part of the specification and showing several preferred forms of this invention:

Figure 1 shows a cross-sectional view of one form of time delay device operatively connected with a circuit breaker tripping armature.

Figure 2 is a view taken on line 2—2 of Figure 1.

Figures 3 to 6 are each cross-sectional views of different structural modifications of my invention.

Figure 7 is a side sectional view of a dashpot having means to compensate for ambient temperature and illustrates both the control of the dashpot over the armature of the over-current relay and the adjustment means for the dashpot.

Referring first to the modification shown in Figure 1, wherein a time delay device is generally designated as 10. The device comprises a cylinder 11 divided by a partition 12 into an upper chamber 13 and a lower chamber 14. A cover plate 15 seals the end of the upper chamber and a flexible diaphragm 16, formed of rubber or the like, seals the lower chamber.

Integral with the partition 12 is a cylindrical flange 17 which forms a cylindrical socket 18 within the chamber 13. This socket connects with an oil passageway 19 which opens into the lower chamber.

A cylindrical metering plug 20 slidably fits within the socket and is spaced from the bottom of the socket as shown in the drawing. As can be seen in Figure 2, oil channels 21 are cut in the socket to permit the passage of oil through the socket around the metering plug.

Within the chamber 13, a bi-metal strip 22 is secured by screw 23 to flange 24 formed integral with the chamber wall. The free end of strip 22 is fastened to a threaded rod 25 by means of a nut 26 or the like. The rod itself is rigidly fastened to metering plug 20.

In conditions of operation, the cylinder is filled with sufficient oil to cover the bi-metal strip. When the temperature of the oil rises, the strip bends to push plug 20 closer toward the bottom of the socket. Thus, it is apparent that the space between the plug and socket bottom decreases at the same time as and in direct proportion to the decrease in viscosity of the oil due to temperature rises.

In Figure 1, the time delay device is shown connected with a circuit breaker tripping armature. Since the circuit breaker forms no part of this present invention, the parts thereof will only be briefly reviewed.

When an overload occurs in the circuit, electromagnet 30 is energized and attracts tripping armature 31 thereto,

3

The tripping armature 31, which is pivoted at 32, is pivotally connected to a second link 34 pivoted at 35 and having a turned up end 36 adapted to press against strike plate 37. It is to be noted that said strike plate is permanently secured to flexible diaphragm 16.

The opposite end of tripping armature 31, not shown, is adapted to release a latch to allow trip mechanism to open the circuit breaker.

The tripping armature's movement towards the electromagnet 30 is restrained by the linkage 33—34. Thus, the pressure caused by a link 34 against strike plate 37 forces the diaphragm 16 to move upward and thereby tends to reduce the volume of lower chamber 14 of the time delay device. Consequently, the oil in the lower chamber is forced through passageway 19, through the space between the metering plug 20 and the bottom of socket 18, and then through oil grooves 21 into the upper chamber 13.

It can be seen that should the oil become heated it will run more freely due to decreased viscosity. However, under such circumstances, bi-metal strip 22 will bend and plunge the plug 20 deeper into its socket thereby reducing the space between the plug and socket bottom. This constriction of the space will slow down the flow of oil whereby the flow will always be the same as the calibrated flow of unheated oil.

Due to this constriction, any ordinary oil can be used, and the metering plug pre-adjusted to give the proper space for that particular oil. The adjustment of the metering plug can be accomplished by rotating nut 26 on the threaded rod 25. Of course any other suitable adjusting means may be substituted.

After the pressure of link end 36 has been removed from the strike plate, the diaphragm 16 will lower and the volume of chamber 14 will return to normal. To insure a rapid return of the oil to chamber 14, return ports 38 are provided. A thin circular plate valve 39 mounted in a groove in hub 40 is adapted to close the ports when pressure is applied to the strike plate. But, when the pressure is released, the plate valve flexes away from the ports and oil may rapidly flow from chamber 13 to chamber 14.

Referring next to the embodiment shown in Figure 3, here again is shown a cylinder 45 separated into an upper chamber 46 and a lower chamber 47 by partition 48. The upper chamber is capped by a cover plate 49 and the lower chamber by diaphragm 16 identical to the diaphragm shown in Figure 1.

A socket 50 is formed on partition 48 by cylindrical flange 51. Within the socket is a plug 52 formed of a material, such as aluminum, which has a high coefficient of thermal expansion whereas the remaining portions of the time delay device are made of a material having a relatively low thermal coefficient of expansion, such as brass. The plug is biased against the cover plate by a spring 53 located in a recess 54 formed in the plug.

When the oil in the cylinder is heated, the plug 52 expands and reduces the size of gap 55 formed by the end of the plug and the bottom of the socket.

An oil passageway 56 in the partition opens into the socket. The plug is spaced a sufficient distance from the inner walls of the socket flange to permit the flow of oil from chamber 47 into chamber 46, when pressure is applied to strike plate 37.

Return ports 38 and valve plate 39 provide a quick return for the oil when pressure is released.

Next, in reference to the modification shown in Figure 4, a cylinder 60 is formed with bore 61 within which a piston 62 is slidably fitted. A boot 63 of rubber or a similar flexible material covers the top of the cylinder and is retained thereon by means of an integral bead 64 entering a bead channel extending around the periphery of the cylinder.

A piston rod 65 extends through an opening in the top of the boot and is secured within said opening by snap

4

rings 66 or by any similar conventional fasteners. The piston rod connects with piston pin 67 so that the piston may be moved up or down by a force exerted upon the piston rod.

The piston itself is formed with a hollow chamber 68 communicating with the upper portion of the cylinder bore. Also, a countersunk hole 69 connects said hollow chamber with the lower portion of the cylinder bore. Thus, a downward movement of the piston will cause oil to be displaced from the lower part of the bore to the hollow chamber 68 and upper part of the cylinder bore.

When the piston is returned to its normal upward position, disk valve 39 opens the quick return ports 38 to permit a rapid return of the oil.

In order to regulate the flow of the oil through hole 69, a needle valve 70 fits into the countersunk portion of the hole and is spaced from the wall thereof. This needle valve, which is formed from a material having a relatively high coefficient of thermal expansion, connects at its upper end to a rod 71. The rod is in turn connected to a bracket 72 mounted upon piston pin 67.

Thus, it is apparent that a change in temperature of the oil will cause the needle valve to expand or contract to regulate the space between the valve and countersink. In this manner thinning of the oil due to temperature rise will be compensated for by a comparable constriction of the space through which the oil must flow.

The modification shown in Figure 5 is similar to that of Figure 4 with the following exceptions. A metering block 80, integrally formed on the piston rod 81, is spaced from a cylindrical flange 82 on piston 83 to form a metering orifice. The flange surrounds oil passageway 84. Between the passageway and flange is a circular groove 85 into which the end of spring 86 is rested. The top of the spring nests in a hole 87 cut in the bottom of the metering block 80.

The upper end of the metering block is threadably engaged in an opening in a perforated plate 89. The plate in turn is threaded into the top of the piston. Thus, the initial distance which the block is spaced from flange 82 may be set by rotating either the perforated plate 89 or the piston rod 81. Consequently, an extremely fine adjustment may be made.

The metering block is formed of aluminum or some other such material having a high coefficient to thermal expansion whereas the remaining parts are made of brass or other similar material which has a low coefficient of thermal expansion. By this means, the metering orifice varies with temperature variation whereby the rate of oil flow is always constant.

In the last modification, shown in Figure 6, the piston 90 is formed with a thick head section 91. In this section a hole 92 is drilled. Within hole 92 a rod 93 of material having a high coefficient of thermal expansion is secured. The rod abuts a lever 94 which is pivoted at 95.

At the opposite end of the lever 94, a needle valve 96 is adjustably secured by means of stud 97 and nut 98. The needle valve fits into an oil passageway 99 having a constricted portion 100. A spring 101 located in said passageway contacts a shoulder formed on needle valve 96, to bias the valve upward.

When the piston is pushed down by piston rod 102, oil is displaced from the lower face of the piston through the constriction and passageway 100 to the opposite side of the piston.

Increases in temperature of the oil cause the rod 93 to expand, thereby rotating the lever 94 and pushing the needle valve deeper into the passageway 99. Thus, the gap between the constriction 100 and the valve is reduced and the oil which is now thinner passes therethrough at the desired rate of flow.

In Figure 7, I have shown a time delay dashpot secured to the armature of the over-current relay of a circuit breaker. The over-current relay 100' may be of the

type shown in copending application Serial No. 254,349, filed November 1, 1951, and now Patent No. 2,792,534 and is comprised of the coil 101' and armature 102'. When the coil 101' is energized by fault current thereby moving its armature 102' from the neutral position, seen in Figure 7, to an energized position, the screw 103 will engage means to operate the trip latch of the circuit breaker.

The dashpot 104, secured to the armature 102 in a manner hereinafter described, will delay the operation of the armature 102 thereby resulting in time delay trip of the circuit breaker controlled by the mechanism.

A link 105 is pivotally secured at one end 106 to the armature 102 and at the opposite end is pivotally secured at 107 to the crank 108. The crank 108 is secured to the shaft 109, extends through and is supported by the housing 110 of the time delay dashpot 104. Crank 111 is secured to the shaft 109 within the housing 110.

A link means 112 is secured at one end to the crank 111 and at the opposite end to the piston 113.

The lower chamber 115 of the cylinder housing 114 is filled with oil. Hence, when the armature 102 is attracted toward its energized position, it will tend to move the piston 113 downwardly through the link mechanism 105, 108, 111, 112. Due to the fact that the oil in the area 115 must be displaced, the armature 102' will be moved to its energized position with time delay.

The cylinder housing 114 is provided with an enlarged cross-sectional area indicated generally at 116. Hence, after the piston 113 has been forced downwardly a predetermined distance, it will encounter the enlarged cross-sectional area and, hence, the armature 102' will complete the last portion of its movement toward energized position without time delay.

The entire housing 114 is mounted on bracket 117 which, in turn, holds and maintains the adjustment screw 119. Spring means 120, positioned concentric with respect to the center of the adjustment screw 119, is lodged between the supporting bracket 117 and a stationary bracket 121.

In the position shown in Figure 7, the cylinder of the dashpot 104 is mounted in its uppermost position thereby introducing a maximum time delay for the operation of the armature 102'. However, when the adjustment screw 119 is rotated so that it is moved downwardly, the entire cylinder housing 110, 114 will also be moved downwardly therewith.

Since the shaft 109 will also be moved downwardly, the crank 108 and 111 will be rotated in a clockwise direction thereby lowering the piston 113 with respect to the cylinder housing 114. Hence, the piston 113 will not have to be moved down as great a distance before it reaches the enlarged cross-sectional area 116 of the cylinder when the armature 112 is being moved from neutral to energized position. Thus, when the adjustment screw 119 lowers the dashpot to its lowermost position (shown by the dotted line in Figure 7), a minimum time delay will be introduced for the armature 102'.

An extension means 122 is secured to the external portion of the housing 114 and has a pivotally mounted indicator 123 secured to one end thereof. Hence, as the dashpot 104 is moved from its extreme upward position, seen in Figure 7, to its extreme lower position, seen by the dotted line in Figure 7, the indicator 123 will be rotated in a clockwise direction thereby giving an external indication of the degree of magnitude of the time delay.

As heretofore fully explained, the dashpot is usually calibrated for a predetermined ambient temperature. Since the viscosity of the oil will change with a change in the ambient temperature, the calibrated time delay will change with variations in the ambient temperature.

In order to compensate for the variations in ambient temperature, that is, to compensate for the variations in the viscosity of the oil, the piston 113 is made of a high

expansive metal alloy such as aluminum and the cylinder 114 is made of a low expansion alloy such as bronze. That is, by having the internal member made of a metal having a high thermal coefficient of expansion and having the external member made of material having a low thermal coefficient of expansion, the space between these two units will decrease when the ambient temperature is increased to compensate for the decrease in the oil viscosity.

In like manner, when the ambient temperature decreases, the annular orifice between piston 113 and the cylinder 114 will increase to thereby compensate for the increase in oil viscosity.

Having fully described several operative embodiments of my invention, it is to be understood that this invention may be developed within the scope of the following claims without departing from the essential features of said invention and it is desired that the specification and drawings be read as being merely illustrative and not in a strictly limiting sense.

I claim:

1. A time delay device comprising a pair of chambers having a common partition, a fixed plate covering the opening in one chamber, and a diaphragm covering the opening in the other chamber, an opening in said partition connecting said chambers, an annular flange surrounding said opening to form a socket, a metering plug fitted within said socket, said plug abutting said plate at one end thereof and spaced from the bottom of said socket at the other end thereof to form a metering orifice, said one chamber having its walls formed of a first material and said metering plug being formed of a second material having a substantially higher coefficient of thermal expansion than that of said first material, said plug being adapted to expand and to contract in response to temperature changes to vary the size of said metering orifice.

2. A time delay device comprising a pair of chambers having a common partition, a fixed plate covering the opening in one chamber, and a diaphragm covering the opening in the other chamber, an opening in said partition connecting said chambers, an annular flange surrounding said opening to form a socket, a metering plug formed of a material having a relatively high coefficient of thermal expansion fitted within said socket, a first end of said plug abutting said plate and a second end of said plug spaced from the bottom of said socket to form a metering orifice, said plug being adapted to expand and to contract in response to temperature changes to vary the size of said metering orifice, said one chamber having its walls formed of a first material and said metering plug being formed of a second material having a substantially higher coefficient of thermal expansion than that of said first material; said metering plug being resiliently urged into contact with said fixed plate.

3. In a time delay device, an open ended housing comprising an upper and a lower chamber having a common partition; a first and a second single closure member fixedly secured to said housing and sealing said upper and said lower chambers respectively to form a closed system; said first member comprising a plate and said second member comprising a flexible diaphragm having a strike plate secured thereto; an opening formed within said partition and connecting said chambers; an annular flange fixed to said partition surrounding said opening to form a socket, valve means entered into said socket from said upper chamber and spaced from the bottom thereof; said valve means being temperature responsive to constrict or enlarge the space between said valve means and said bottom; said partition having return port means communicating with said upper and said lower chambers; and a plate valve operatively positioned to control the direction of flow through said port means; a plate valve dis-

posed within said lower chamber and secured to said partition.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 18,411	Jenney -----	Apr. 5, 1932	
348,907	House et al. -----	June 19, 1888	
893,386	Schulz et al. -----	July 14, 1908	
1,058,290	Corey -----	Apr. 8, 1913	10

5

1,355,217
1,797,799
1,890,580
1,955,565
1,972,908

Doran -----	Oct. 12, 1920
Shutts -----	Mar. 24, 1931
Kelley -----	Dec. 13, 1932
Schmidt et al. -----	Apr. 17, 1934
Shaw -----	Sept. 11, 1934

FOREIGN PATENTS

France -----	May 6, 1928
France -----	Mar. 11, 1929

642,711
661,843