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REFRIGERATION CONTROL MECHANISM

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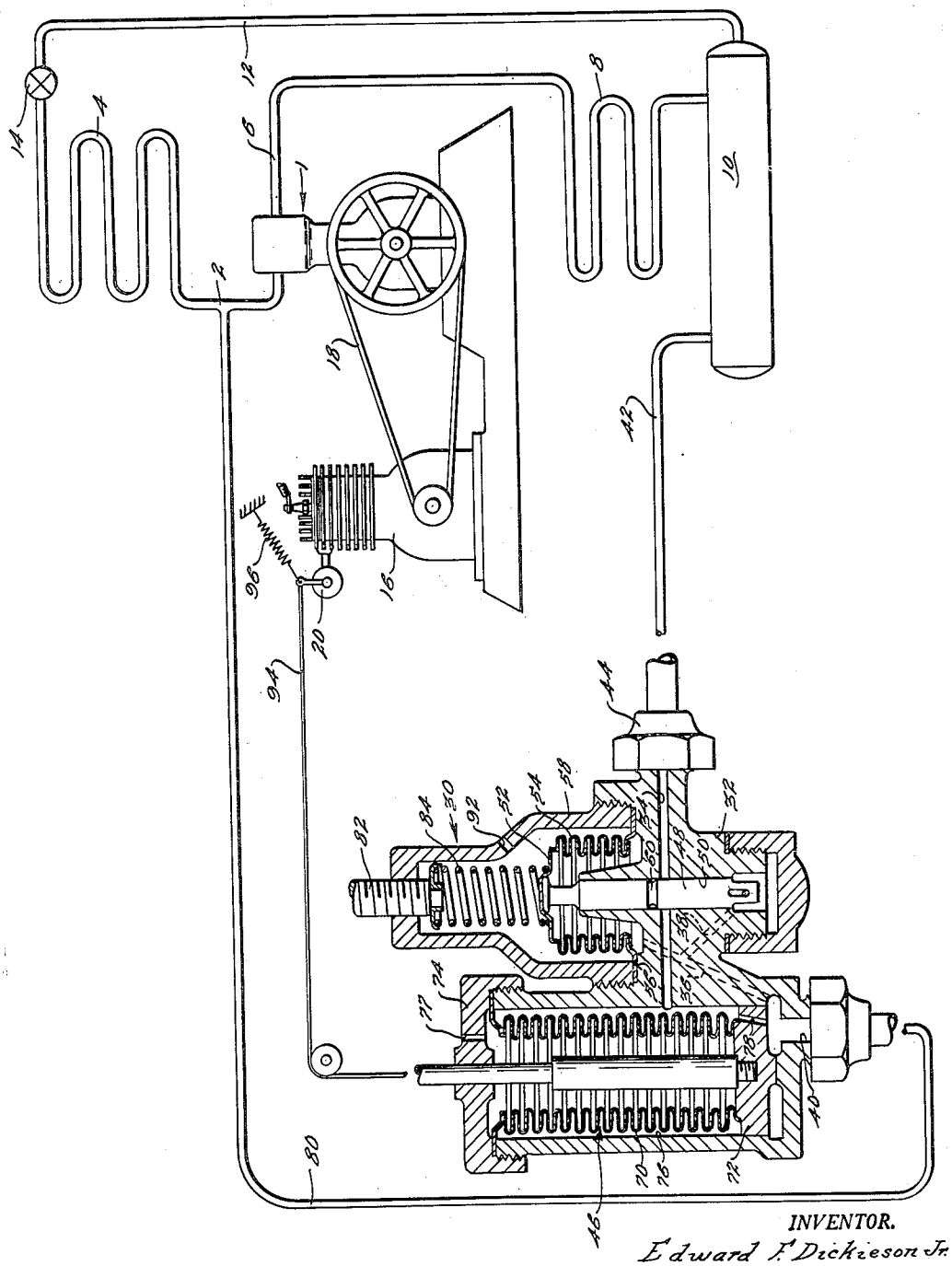

INVENTOR.
Edward F. Dickieson Jr.
BY
Barnes, Dicky - Pierce.
ATTORNEYS.

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## REFRIGERATION CONTROL MECHANISM

Edward F. Dickieson, Jr., Detroit, Mich.; Nathalie L. Dickieson, executrix of said Edward F. Dickieson, Jr., deceased, assignor to Nathalie L. Dickieson

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This invention relates generally to control mechanism and more specifically to such a mechanism which is adapted, among other uses, to regulate the temperature maintained within an evaporating coil of a refrigerating system.

Objects of this invention are to provide a new control mechanism of the character described which is simple in operation and economical of manufacture; to provide such a control mechanism in which the power for operating the same is obtained from the differential in pressure maintained between the high and low sides of the refrigerating apparatus; and to provide such a mechanism which is adapted for controlling the speed of operation of an internal-combustion engine for driving a refrigeration compressor. Other objects of the invention will be apparent from the drawing and a reading of the specification and appended claims.

The sole figure of the drawing illustrates diagrammatically a refrigerating system embodying the invention, the control mechanism wherefore being shown in central vertical section.

Referring to the drawing by characters of reference, the numeral 1 indicates generally a refrigeration compressor having its intake or suction port connected by means of a conduit 2 to an outlet of an evaporator coil 4 and having its outlet or discharge port connected by means of a conduit 6 to the inlet of a condenser 8; the outlet of which is connected in the usual manner to a liquid receiver tank 10 having a liquid line 12 leading through an expansion valve 14 to the inlet of the evaporator 4. A gasoline motor or engine of any desired type 16 is suitably connected to drive the compressor 1 as by means of a belt 18. A throttle valve 20 is associated with the gasoline engine 16 whereby the speed thereof may be controlled.

A control mechanism generally indicated 30 comprises a valve body member 32 which is preferably a casting having refrigerant-flow passageways 34, 36, 38, and 40. A conduit 42 opens at one end into the liquid receiver 10 above the liquid level therein and is connected at its other end by means of a suitable fitting 44 to the casting 32 in open communication with one end of the passageway 34. The passageway 34 extends within the casting and opens into a cylindrical pressure chamber 46. The fluid flow through this passageway 34 is controlled by means of a rod like valve 48 reciprocably movable within a bore 50 extending transversely to and intersecting the passageway 34. The upper end of the valve member 48 is secured to an end wall 52

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carried by and sealing the upper end of a bellows member 54 having its lower open-end portion sealed against a shoulder 56 of the valve body 32 as by means of the open end of an inverted cup-shaped member 58 screw-threadedly secured to the valve body member 32. A circumferential groove about the valve member 48 provides a valve port 60 which is movable into alignment with the passageway 34 upon downward movement of the valve member 48 to permit flow of fluid through the passageway 34. Upon movement of the valve port 60 out of alignment with the passageway 34, fluid-flow therethrough is substantially prevented.

Located within the chamber 46 is a second bellows member 70 having the lower end thereof sealed in fluid-tight relation to a piston 72 which has a piston-tight sliding fit with the inner walls of the chamber 46. The upper end of the bellows member 70 is suitably secured to the upper end wall of the chamber 46 as by means of a cap nut 74 to provide an annular chamber portion 76 intermediate the walls of the chamber 46 and the exterior surface of the bellows member 70 and which chamber portion is in open communication with the outlet of the passageway 34. The cap nut 74 has an aperture 77 therethrough for conveying atmospheric pressure to the interior of the bellows member 70.

The piston member 72 has a restricted-flow passageway 78 extending therethrough which connects the chamber portion 76 with the outlet passageway 40 which opens into the lower portion of the chamber 46 below the piston member 72. The passageway 40 is connected by a conduit 80 to the evaporator 4 adjacent its outlet. It will be obvious to those skilled in the art that the conduit 80 can be connected to the conduit 2 at any intermediate point between the inlet to the compressor 1 and the outlet of the evaporator 4, provided, however, that there is no great amount of pressure drop between the evaporator and the point of connection. The passageway 36 of the valve body 32 interconnects the passageway 40 to the interior of the bellows 54. A branch passageway 38 of the passageway 36 provides a path for the fluid which escapes from the passageway 34 along the space between the valve member 48 and the bore 50 to prevent an accumulation of pressure at the lower end of the valve member 48. Evaporator pressure is transmitted to the interior of the bellows 54 by means of the conduit 80 and passageways 36 and 40.

An adjusting screw 82 is screw-threaded

through the base portion of the inverted cup-shaped member 58 and adjustably positions one end of a spring 84 held under compression between the screw 82 and the end wall 52 of the bellows 54. By suitable adjustment of the screw 82 the proper tension may be placed on the spring 84 so that the bellows 54 will control the position of the valve member 50 to permit fluid-flow through the passageway 34 to control the engine 16 to maintain the desired temperature of the evaporator 4.

It is believed that the remainder of the details of construction may best be understood by reference to a description of operation which is as follows: A gasoline engine 16 is started by suitable means (not shown) and drives the compressor 1 by a belt 18. As the compressor 1 is driven, vaporous refrigerant is withdrawn through the conduit 2 from the evaporator 4, compressed and discharged through the conduit 6 into the condenser 8 wherein it is condensed into a liquid which liquid then flows into the liquid receiver 10. Liquid from the receiver 10 flows through the conduit 12 and into the inlet of the evaporator 4 through the expansion valve 14 which proportions the flow of liquid refrigerant to the evaporator 4 is a well-known manner. This liquid admitted to the evaporator 4 vaporizes thereby withdrawing heat from the evaporator 4 and flows in vaporous form through the conduit 2 to the compressor 1. This operation is continued as long as refrigeration is desired.

High-pressure vaporous refrigerant is transmitted by the conduit 42 to the passageway 34. The pressure of the vaporous refrigerant of the evaporator is transmitted through the conduit 39 to the passageway 40 and therefrom through the passageway 36 to the interior of the bellows 54. If the pressure of the refrigerant in the evaporator 4 indicative of a temperature higher than that desired is present, the pressure within the bellows 54 will hold the valve member 48 in the position shown with the valve port 60 out of registry with the passageway 34 so that substantially no refrigerant flows through the passageway 34. Since no refrigerant is flowing through the passageway 34, there will be no pressure drop between the chamber portion 76 and the passageway 40, and the position of the piston 72 will be upwardly from that shown in the drawing. If Freon 12 is used as the refrigerant the pressure of the refrigerant in the passageway 40 at such time will always be greater than atmospheric pressure which is present within the bellows member 70 due to its constantly open communication therewith through the passageway 77. If the pressure of the selected refrigerant at the desired evaporator temperature is below that required to raise the piston member 72 to actuate the throttle valve 20 a spring may be utilized either within the bellows 70 or below the piston member 72 whereby required differential forces on the member 72 may be obtained. The spring 96 may be used for this purpose or may be used in conjunction with the spring just described.

As the pressure of the evaporator 4 decreases toward the desired pressure, atmospheric pressure which is present within the interior of the inverted cup-shaped member 58 due to the passageway 92 through one wall thereof and the spring 84 will cooperate to move the valve member 48 downwardly and bring the valve port 60 into partial registry with the passageway 34, allowing flow of vaporous refrigerant from the receiver 10 through the conduit 42 and passageway 34 into the chamber portion 76. The fluid-flow passageway 78 is of predetermined size and permits a predetermined flow of refrigerant therethrough, depending upon the pressure differential between the passageway 40 and the chamber portion 76. If the fluid flow through the passageway 34 permitted by the valve port 60 is less than the fluid-flow capacity of the passageway 78, substantially no pressure differential will exist across the piston member 72 and it will remain in its set position. As the pressure within the evaporator 4 continues to be reduced, the valve port 60 will be brought into more complete registry with the passageway 34, allowing a greater fluid-flow through the passageway 34. The pressure within the chamber portion 76 therefore begins to build up because the fluid-flow thereinto is greater than a fluid-flow capacity through the passageway 78 with the pressure difference then appearing between the chamber portion 76 and the passageway 40. This increase in pressure between the chamber portion 76 and the passageway 40 will tend to move the piston member 72 downwardly, which movement is transmitted through suitable mechanism such as is diagrammatically shown as a cable 94 to move the engine throttle 20 toward closed position to decrease the speed of the gasoline engine 16. This reduction in speed of the engine reduces the speed at which the compressor 1 is driven, and therefore its capacity, and the rate at which heat is being extracted from the evaporator 4.

As the pressure within the evaporator 4 is decreased to the desired pressure, the valve port 60 will be brought into complete registry with the passageway 34 and permit the maximum fluid flow from the liquid receiver 10 through the passageway 34 into the chamber portion 76 whereby a sufficient pressure differential across the piston member 72 will exist to move the piston 72 downwardly into engagement with the lower end wall of the chamber 46. This downward movement of the piston 72 moves the engine throttle to engine idle position whereby the compressor 1 will be running at minimum speed and transferring very little refrigerant from the evaporator 4 to the condenser 8 thereby maintaining fluid pressure in the evaporator 4 at the desired low value. Preferably the speed at which the engine 16 drives the compressor 1 under these conditions is such that the compressor 1 will operate the refrigerating system at a capacity which is insufficient to satisfy the normal heat leakage into the space in which the evaporator 4 is located.

As the pressure within the evaporator 4 begins to increase slightly due to an increase in temperature in the space in which the evaporator 4 is located, the pressure within the passageway 40 will increase, causing an increase in pressure within the bellows member 54 which moves the valve port 60 out of complete registry with the passageway 34. This movement of the port 60 reduces the flow of high pressure fluid from the receiver 10 to the chamber portion 76. This reduced fluid flow cannot maintain the pressure drop across the passageway 78 present with full opening of the passageway 34 and the piston 72 will move upwardly under the influence of the spring 96 permitting the throttle 20 to move toward open position to increase the engine speed. If this rise in pressure within the evaporator 4 is sufficient, the valve port 60 will be brought completely out of registry with the passageway 34 substantially completely stopping flow of fluid to the chamber portion 76 whereby fluid in the

portion 76 bleeds out through passageway 78 so that there is no pressure drop across the passageway 78 between the chamber portion 76 and passageway 40. As the pressure differential across the piston 72 decreases, the piston 72 will move upwardly under the influence of spring 96 and allowing the spring 96 to move the engine throttle toward open position to increase the speed at which the engine drives the compressor 1. It will now be understood that as the refrigerant pressure within the evaporator 4 increases, the bellows 54 will be expanded throttling fluid flow through the passageway 34 to the chamber portion 76 whereby a decreased differential across the piston member 72 will exist causing the piston member to move upwardly and increase the speed of operation of the motor 16.

It will be appreciated from the foregoing that many modifications and changes may be made in the specific embodiment shown in the drawing which is to be taken as illustrating rather than limiting the invention which is to be limited only by the scope of the appended claims.

What is claimed and is desired to be secured by United States Letters Patent is as follows:

1. A refrigerating system comprising an evaporating means for liquid refrigerant, a condensing means for gaseous refrigerant, means providing a regulated flow of liquid refrigerant from said condensing means to said evaporating means, pump means for transferring gaseous refrigerant from said evaporating means to said condensing means, means regulating the pumping capacity of said pump means, a second fluid flow means connecting said condensing means with said evaporating means, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a controlling means arranged to respond to a temperature condition of said evaporating means for controlling said valve, a pressure sensitive means responsive to a differential in pressure between the pressure in said evaporating means and the pressure at the outlet of said valve, and means interconnecting said pressure sensitive means and said capacity regulating means whereby the capacity of said pump means is regulated.

2. A refrigerating system comprising an evaporating means for liquid refrigerant, a condensing means for gaseous refrigerant, means providing a regulated flow of liquid refrigerant from said condensing means to said evaporating means, a compressing means for transferring gaseous refrigerant from said evaporating means to said condensing means, driving means for said compressing means, means regulating the speed at which said driving means actuates said compressing means, a second fluid flow means connecting said condensing means with said evaporating means, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a first pressure sensitive means connected to respond to the pressure in said evaporating means for controlling said valve, a second pressure sensitive means responsive to a differential in pressure between the pressure in said evaporating means and the pressure at the outlet of said valve, and means interconnecting said second pressure sensitive means and said speed regulating means whereby the speed of said compressing means is regulated.

3. A refrigerating system comprising a low side including an evaporating means for liquid refrigerant, a high side including a condensing means for gaseous refrigerant, means providing a regulated flow of liquid refrigerant from said high side to said evaporating means, a compressing means for transferring gaseous refrigerant from said low side to said high side, driving means for said compressing means, means modulating the speed at which said driving means actuates said compressing means, a second fluid flow means connecting said high side with said low side, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a first pressure sensitive means connected to respond to an operating condition of said evaporating means for controlling said valve, a second pressure sensitive means responsive to a differential in pressure between the pressure in the portion of said low side at which said second flow means is connected and the pressure at the outlet of said valve, and means interconnecting said second pressure sensitive means and said speed regulating means whereby the speed of said compressing means is modulated in accordance with said evaporating means operating condition.

4. An apparatus for use in controlling a refrigerating system having an evaporator and a liquid receiver and means controlling the flow of vapor outwardly of the evaporator, a casing having a first connection adapted to be connected in open fluid conducting relation with the evaporator and a second connection adapted to be connected in open communication with the receiver, a pressure sensitive device carried by said casing in open communication with said first connection whereby it is sensitive to the fluid pressure in the evaporator, a fluid pressure actuator carried by said casing and having an actuating portion movable in response to change in fluid pressure in said actuator to exert a controlling force, means providing an adjustable flow fluid passageway connecting said second connection with said actuator, said last-named means being operatively connected for actuation by said pressure device, said actuating portion being adapted to actuate said vapor controlling means to cause a greater flow of the vapor outwardly of the evaporator upon increase in pressure thereof above a predetermined pressure.

5. A refrigerating system comprising an evaporating means for liquid refrigerant, a condensing means for gaseous refrigerant, means providing a regulated flow of liquid refrigerant from said condensing means to said evaporating means, means for transferring gaseous refrigerant from said evaporating means to said condensing means, regulatable means independent of such flow means for regulating the transfer rate of said transferring means, a second fluid flow means connecting said condensing means with said evaporating means, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a controlling means arranged to respond to a temperature condition of said evaporating means for controlling said valve, a pressure sensitive means having a movable element responsive to the pressure at the outlet of said valve, and means interconnecting said element of said pressure sensitive means and said transfer rate regulating means whereby movement of said last-named element regulates the transfer rate of said transfer means.

6. A refrigerating system comprising an evaporating means for liquid refrigerant, a receptacle for liquid refrigerant, means providing a regu-

lated flow of liquid refrigerant from said receptacle to said evaporating means, variable rate means for removing gaseous refrigerant from said evaporating means, means regulating the rate at which said removing means removes gaseous refrigerant, a second fluid flow means connecting said receptacle with said evaporating means, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a controlling means arranged to respond to an operating condition of said evaporating means for controlling said valve, a pressure sensitive means responsive to a differential in pressure between the pressure in said evaporating means and the pressure at the outlet of said valve, and means interconnecting said pressure sensitive means and said rate regulating means whereby the capacity of said removing means is regulated.

7. A control apparatus comprising a casing having a fluid flow passageway with an outlet adapted to be connected to a source of low pressure fluid and an inlet adapted to be connected to a source of high pressure gaseous fluid and a valve means controlling flow of gaseous fluid through said passageway between such sources, means for controlling said valve means and responsive to the pressure at said outlet, a pressure responsive means mechanically independent of said valve means and sensitive to the pressure of the fluid in said passageway on the outlet side of said valve means and having a portion movable in response to changes in said gaseous fluid pressure passed by said valve means, and a control actuating member movable by said movable portion of said valve means and operable to apply power to a control device for actuation thereof.

8. A refrigerating system comprising an evaporating means for liquid refrigerant, a container for high pressure refrigerant, means providing a regulated flow of liquid refrigerant from said container to said evaporating means, apparatus for removing gaseous refrigerant from said evaporating means, means independent of said flow means for regulating the rate at which said apparatus is operable to remove gaseous refrigerant, a second fluid flow means connected to receive fluid from said container, control apparatus controlling flow of fluid through said second flow means and responsive to an operating condition of said evaporating means, a power actuator controlled by said apparatus and receiving a portion of its energy from said container, and power applying means interconnecting said actuator and said rate regulating means for actuation of said rate regulating means by said actuator.

9. A refrigerating system comprising an evaporating means for liquid refrigerant, a condensing means for gaseous refrigerant, means providing a regulated flow of liquid refrigerant from said condensing means to said evaporator means, means for transferring gaseous refrigerant from said evaporating means to said condensing means, means independent of said flow means regulating the rate at which said transferring means transfers refrigerant from said evaporating means to said condensing means, a second fluid flow passageway means connected to receive refrigerant from said condensing means and connected to discharge refrigerant for flow through said transferring means back to said condensing means, control apparatus controlling flow of fluid through said second fluid flow passageway means, said control apparatus including a fluid flow controlling valve and means for controlling said valve as a function of an operating condition of said evaporating means, means responsive to a characteristic of the fluid flowing past said valve and operable to receive energy from the fluid passed by said valve to actuate said transfer rate regulating means whereby said rate regulating means is actuated to control the rate at which said transferring means transfers gaseous refrigerant to said condensing means.

10. A refrigerating system comprising an evaporating means for liquid refrigerant, a receptacle for high pressure refrigerant, means providing a regulated flow of refrigerant from said receptacle to said evaporating means, means for removing gaseous refrigerant from said evaporating means, means regulating the rate at which said removing means removes gaseous refrigerant, a second fluid flow means connected to receive fluid from said receptacle, control apparatus controlling flow of fluid through said second fluid flow means comprising a fluid flow controlling valve, a controlling means arranged to respond to an operating condition of said evaporating means for controlling said valve, an actuator actuated as a consequence of and deriving energy from the fluid flowing past said controlling valve, and means interconnecting said actuator with said rate regulating means whereby said actuator controls said rate regulating means to regulate the rate at which said removing means removes gaseous refrigerant from said evaporating means.

11. A refrigeration system, comprising a low pressure side including an evaporating means, a high pressure side including condensing means for a refrigerant, means interconnecting said high and low sides into a closed system for containing such refrigerant and including a suction return fluid conveying passageway for conveying heat laden refrigerant from said evaporating means to said condensing means, means interposed in said fluid conveying passageway for regulating the rate at which said heat laden refrigerant is transferred from said evaporating means to said condensing means, relay means deriving its output energy from said high side and connected to actuate said regulating means, and means responsive to an operating condition of said evaporator for controlling said relay means.

12. The combination of claim 11 in which said relay means is energized by said high pressure refrigerant in said high side and a fluid flow passageway is provided to conduct the refrigerant used by said relay means back to said system.

13. The combination of claim 12 in which a compressor is provided in said system for transferring refrigerant from said low side to said high side.

14. A refrigerating system comprising, a low side including an evaporating means, a high side including a condensing means, a compressor for transferring refrigerant from said low side to said high side, conduit means interconnecting said high and said low sides and said compressor into a closed system for containing such refrigerant, a prime mover for driving said compressor, compressor speed controlling means regulating the rate at which said prime mover drives said compressor to control the rate at which said compressor is effective to remove refrigerant from said evaporating means, relay means deriving its energy from said high side and connected to actuate said compressor speed controlling means to determine the speed of said compressor, and means responsive to an operating condition of

said evaporating means for controlling said relay means.

15. A control apparatus for a refrigerating system having high and low side pressure system elements comprising, a fluid conveying structure having a passageway, means for connecting a first portion of said passageway to said high pressure portion, means for connecting a second portion of said passageway to said low pressure element, valve means controlling flow of fluid through said passageway between said passageway portions, a piston member within a third portion of said passageway, said third passageway portion being located intermediate said valve means and one of said passageway portions, said piston member being constructed and arranged in said third passageway portion so as to provide a restricted fluid flow passageway in bypass relation to said piston member whereby the pressure acting on said piston member is a function of the rate at which fluid flows past the valve means.

EDWARD F. DICKIESON, JR.




## REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 346,898 | Curtis | Aug. 10, 1886 |
| 985,563 | Winkler | Feb. 28, 1911 |
| 1,987,948 | Smith | Jan. 15, 1935 |
| 2,029,203 | Soderberg | Jan. 28, 1936 |
| 2,061,599 | Smith | Nov. 24, 1936 |
| 2,165,741 | Wolfert | July 11, 1939 |
| 2,187,397 | Goggins | Jan. 16, 1940 |
| 2,205,166 | Dube | June 18, 1940 |
| 2,257,164 | Euwer | Sept. 30, 1941 |
| 2,344,215 | Soling et al. | Mar. 14, 1944 |
| 2,346,017 | Errath | Apr. 4, 1944 |
| 2,367,305 | Newton | Jan. 16, 1945 |
| 2,396,559 | Dillman | Mar. 12, 1946 |
| 2,403,818 | McGrath | July 9, 1946 |