Aug. 5, 1958 C. H. FRICK 2,845,915

FUEL CONTROL MECHANISM

Filed May 31, 1955 2 Sheets-Sheet 1

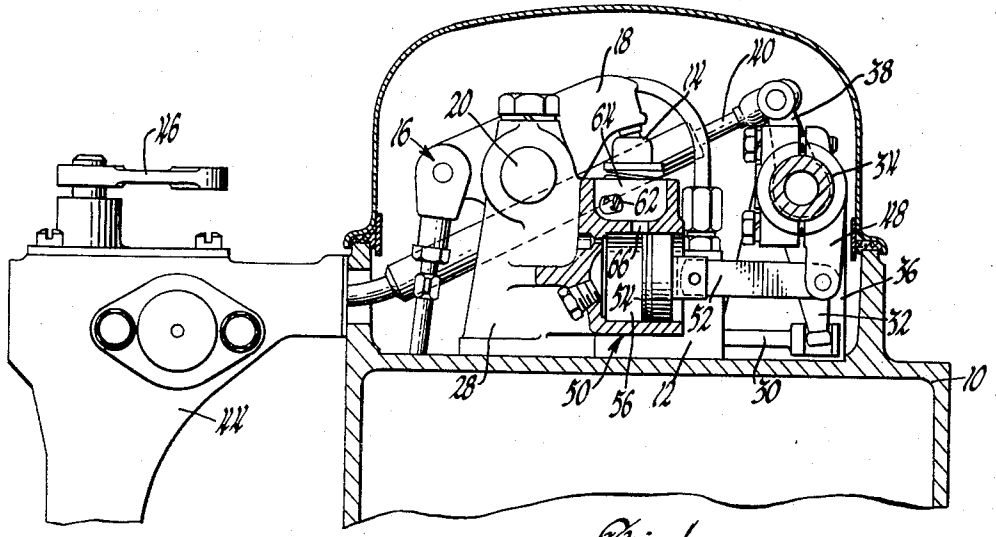


Fig. 1

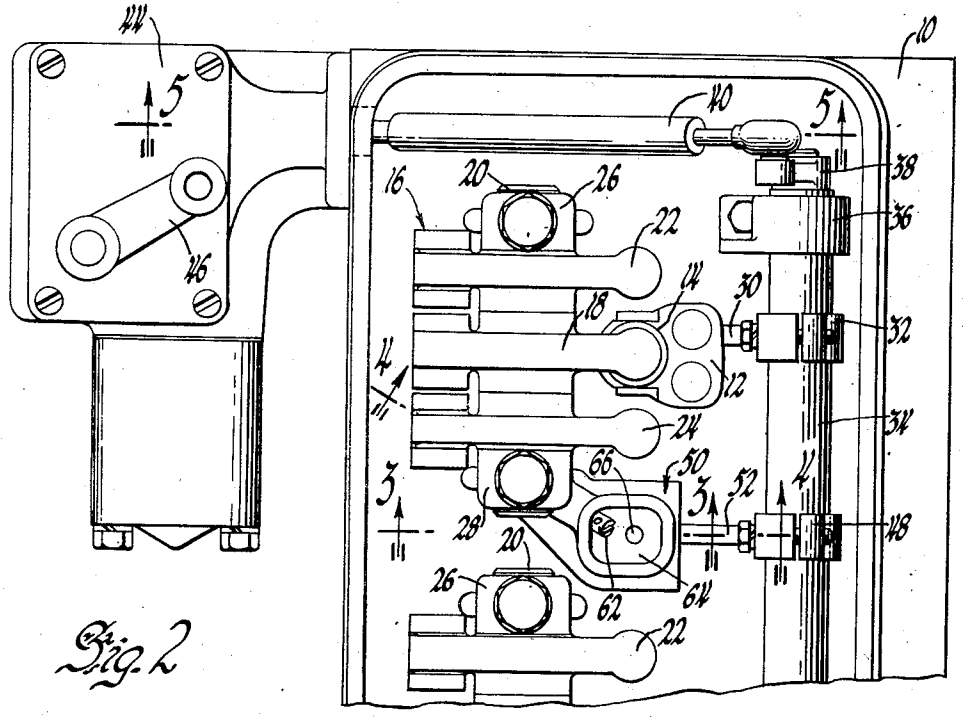


Fig. 2

INVENTOR.
Charles H. Frick
BY
L. C. Thorpe
ATTORNEY

Aug. 5, 1958 C. H. FRICK 2,845,915

FUEL CONTROL MECHANISM

Filed May 31, 1955 2 Sheets-Sheet 2

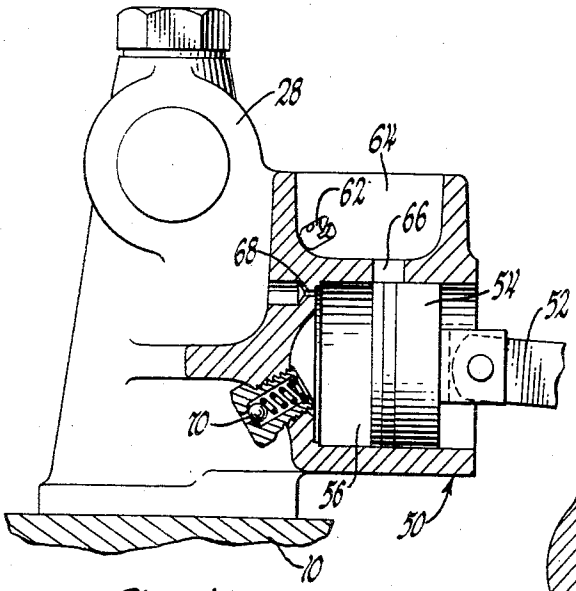


Fig. 3

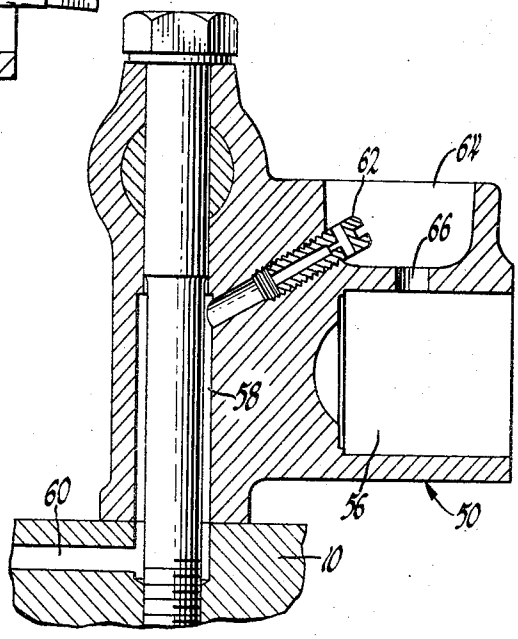


Fig. 4

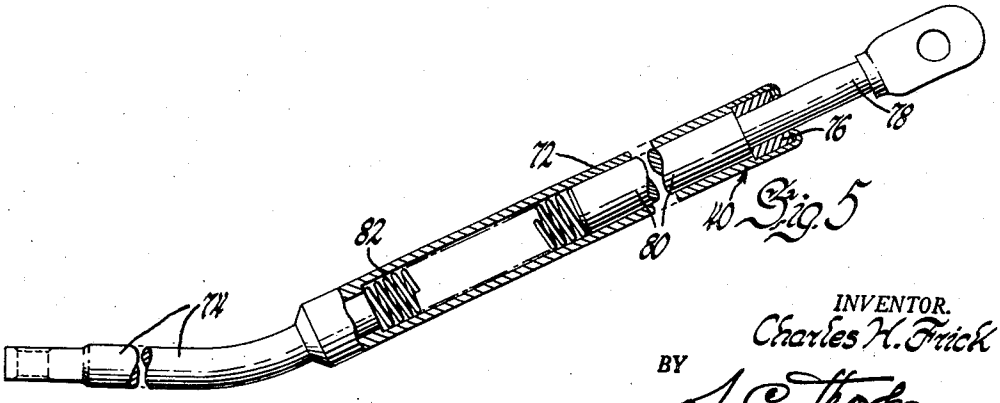


Fig. 5

INVENTOR.
Charles H. Frick
BY
J. C. Thorpe
ATTORNEY

United States Patent Office 2,845,915
Patented Aug. 5, 1958

2,845,915

FUEL CONTROL MECHANISM

Charles H. Frick, Pontiac, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application May 31, 1955, Serial No. 511,924

14 Claims. (Cl. 123—140)

This invention relates generally to a fuel control mechanism for an internal combustion engine, and more particularly to a fuel control mechanism for a fuel injection type engine.

In internal combustion engines of the fuel injection type, the mixing of the fuel and air charges generally occurs in the combustion space within the individual engine cylinders, and the manually operable throttle controls are directly operable on the fuel supply control mechanism of the engine within speed limits established by the engine governor mechanism. During periods of engine acceleration, this permits the engine to be operated at its full or wide open throttle fuel supply setting while the engine itself is still operating at a relatively low speed. However, the mixing of the fuel and air charges occurring in the individual engine cylinders at such low speeds is relatively inefficient compared to the mixing which occurs at the higher engine speeds. Consequently, such operation results in a concentration of relatively overrich fuel-air mixture within the portions of the individual engine cylinder combustion chambers adjacent the fuel injectors. These concentrations of overrich mixture burn relatively inefficiently with resultant fuel loss, carbon deposits, progressive operational deterioration, increased maintenance, and excessive exhaust smoking.

To the layman, the results of such operation are observable in the form of exhaust smoke puffs which emit from rapidly accelerating diesel powered vehicles such as transit buses when the operator floors the accelerator control pedal after each stop as he races to maintain a tight schedule. In certain areas having particular atmospheric conditions which are conducive to the accumulation of smog, this operational feature of diesel engines has resulted in local legislation bringing such engines within the purview of local smoke prevention measures. As a result of such legislation, it has generally been found necessary to utilize exhaust scrubbers which are relatively expensive and difficult to mount and maintain in existing vehicles. The invention contemplates a simple mechanism adaptable to all existing engines and effective to eliminate this smoking problem.

It is therefore a primary object of the invention to provide an engine fuel supply control mechanism with means for preventing full throttle engine operation at relatively low engine speed.

A further object of the invention is to provide an engine fuel supply control mechanism with means which will permit relatively rapid initial fuel-increasing response followed by a period of retarded advance of the fuel control mechanism to its full throttle fuel-supplying operative condition when a manually operable fuel control of the engine is advanced rapidly from idle to full throttle position while the engine is operating at relatively low speeds.

In accordance with the invention, the foregoing objects are achieved by providing a fuel injection control mechanism with a fluid dashpot mechanism which is

operable to retard the rotation of an injector control tube and the movement of fuel supply controlling injector racks connected thereto to thereby control the fuel input to the engine from idle to full throttle position when an accelerator control is rapidly actuated while the engine is operating at relatively low speeds. The fluid dashpot mechanism is so constructed and arranged as to permit an initial period of relatively rapid advance of the injector control tube to provide a relatively rapid initial increase of the fuel supplied to the engine followed by a period of retarded advance between an intermediate and the full throttle fuel-supplying operative positions of the control tube and racks. Such operation permits the engine to have desirable low-speed acceleration characteristics while the subsequent period of retardation obtained by the use of the fluid dashpot mechanism prevents the concentrations of overrich mixture which normally occur from full throttle engine operation at relatively low engine speeds as discussed above.

The foregoing and other objects, advantages and features of the invention will be more thoroughly understood from the following description of a preferred embodiment thereof in which reference is made to the attached drawings, in which:

Figure 1 is a transverse sectional view of a portion of an engine showing the preferred embodiment of the invention;

Figure 2 is a top elevational view of a portion of the engine shown in Figure 1;

Figure 3 is a fragmentary sectional view taken substantially on the line 3—3 of Figure 2;

Figure 4 is a fragmentary sectional view taken substantially on the line 4—4 of Figure 2; and

Figure 5 is a sectional view taken substantially on the line 5—5 of Figure 2.

Referring more particularly to the drawings, Figures 1 and 2 show an engine cylinder head **10** having unit injectors **12**, only one of which is shown, mounted therein. Each injector has a plunger **14** operable to supply the fuel charge to its respective engine cylinder. Each injector plunger is actuated by conventional mechanism, generally indicated at **16**, including a rocker arm **18** having one arm thereof in thrust engagement with the injector plunger. The rocker arm **18** is pivotally mounted on a shaft **20** between two rocker arms **22** and **24** which are operable to actuate the engine valves. The rocker arm shaft **20** is supported above the cylinder head by suitable brackets **26** and **28** spaced longitudinally of the cylinder head.

Each of the unit injectors **12** is provided with a control rack **30** which is reciprocable transversely of the engine to control the quantity of fuel supplied to the engine cylinder by each stroke of the injector pluiger **14**. One end of each injector rack is pivotally connected to a lever **32** which is adjustably secured to a common control tube **34** extending longitudinally of the engine. The control tube **34** is rotatably journaled in suitable mounting brackets **36**, only one of which is shown. A lever **38** secured to one end of the tube **34** is pivotally connected to one end of an actuating link member **40**. The opposite end of the link **40** is connected to suitable throttle control linkages (not shown) of a limiting speed governor **44** similar to that shown and described in United States Patent 2,270,100, Centrifugal Governor, and issued to H. G. Adler and J. C. Evans. The governor linkages are in turn connected to the manually operable accelerator control lever **46**.

In accordance with the invention, the means providing for retarding the fuel-increasing rotation of the injector control tube and consequently the movement of the injector racks connected thereto comprises a dashpot mechanism **50** including a lever **48** which is adjustably secured

at one end to the control tube. The distal end of the lever 48 is pivotally connected to one end of a link 52, the opposite end of which is pivotally connected to a piston 54. The piston 54 is reciprocably mounted in a dashpot cylinder 56 formed integrally of the rocker arm mounting bracket 28. The bracket 28 is provided with a lubricant supply passage 58 which is connected to the engine lubricant pressure supply through the passage 60 formed in the engine cylinder head 10. A portion of the supplied lubricant is bled from the passage 58 through an adjustable orifice or valve 62 to a cup formed in the mounting bracket 28 above the cylinder. The cup 64 is connected to the cylinder by a hole or port 66 formed intermediate the ends of the cylinder and controllable by the piston 54. The head end of the dashpot cylinder 56 is provided with a restricted orifice 68 and a one-way spring-biased check valve 70.

As best seen in Figure 5, the fuel control actuating link 40 between the governor and the control tube assembly includes a sleeve 72 embraceably secured to a rod 74 at the governor-connected end thereof. At its opposite end, the sleeve 72 is beaded inwardly to mount a bushing 76 reciprocably mounting a reduced diameter center portion of a second rod 78 having a plunger portion 80 reciprocably mounted within the sleeve and adapted to be pivotally connected at its opposite end to the control tube actuating lever 38. A helical spring 82 is interposed between the plunger 80 and the end of the sleeve mounting the rod 74 and tends to maintain the plunger 80 in abutment with the stop formed by the bushing 76.

In operation when the engine is running, a portion of the oil being delivered by the passage 58 for the lubrication of the rocker arm journals and bearings will be metered through the adjustable valve plug 62 into the cup 64. When the engine is being operated at or near idle speeds, the control tube 34, the lever 38, the link 52, and the piston 54 will be in the position shown in Figure 1. In this position of the piston 54, the oil delivered to the cup 64 will be permitted to drain through the port 66 into the cylinder 56. When the governor-mounted accelerator control lever 46 is actuated rapidly in a speed-increasing direction, the throttle control linkages through the governor mechanism 44 will tend to advance the link 40 and thereby rotate the throttle control tube 34 in a clockwise fuel-increasing direction, as seen in Figure 1. This tendency to rotate the control tube 34 will be unretarded by the dashpot piston 54 as long as the port 66 is open; the reciprocation of the piston 54 merely forcing a portion of the entrapped fluid from the cylinder back into the cup 64 through the port 66. However, once the port 66 has been closed by the movement of the piston to the position shown in Figure 3, the tendency to rotate the fuel control tube in a fuel-increasing direction towards its full throttle position will be retarded by the dashpotting action of the piston as it forces the fluid entrapped in the cylinder through the orifice 68. The pressure of the entrapped fluid in the cylinder 56 will maintain the one-way check valve against its seat.

It will be noted that the position at which the port 66 opens or closes relative to the position of the fuel injector racks 30 may be varied by the adjustment of the throttle delay dashpot lever 48 on the control tube 34. The rapid initial fuel increase permitted by this feature of the dashpot mechanism 50 serves to insure the delivery of sufficient fuel to initiate the acceleration of the engine, and the subsequent period of retardation obtained by the use of the fluid dashpot mechanism prevents rotation of the injector rack control tube in a fuel-increasing direction faster than the accelerating engine can efficiently utilize the supplied fuel.

The yieldable link 40 between the governor and the control tube assembly permits the accelerator control lever 46 on the engine governor mechanism to be advanced rapidly to its maximum or wide-open throttle position by absorbing the delay in injector rack movement imposed by the dashpot mechanism 50. When the accelerator control lever 46 is returned from its full throttle to idle position, this movement is positively transferred through the fuel control link 40 since the plunger 80 will be in abutment with the bushing 76. This causes the control tube actuating lever 38 to rotate the control tube in a counterclockwise fuel-decreasing direction. Such rotation of the control tube causes the throttle delay lever and the link 52 to withdraw the piston toward the open end of the dashpot cylinder. Air passing through the orifice 68 and the one-way ball check valve 70 insures that the fuel-decreasing movement of the injector control tube will not be retarded by the dashpot means.

While the foregoing description and figures have been confined to one embodiment, it will be apparent to those skilled in the art that numerous modifications may be made without departing from the spirit thereof. Accordingly, it is to be understood that the foregoing is to be considered as illustrative only and in no way restrictive; reference being had to the appended claims to determine the scope of the invention.

I claim:

1. In a fuel injection type internal combustion engine, fuel control mechanism including fuel injection means for each engine cylinder, a member movable between an idle speed position and a wide-open throttle position and operable to control the fuel supply action of each injection means, governor means operable on said fuel control member to regulate the fuel supplying movement of said member to limit the maximum and minimum speeds of the engine, manually operable throttle control means associated with said governor means and operably connected to said member for actuating said member between idle and wide-open throttle positions to control the speed of the engine between said governor-established speed limits, and dashpot means independent of said governor means and operably connected to said fuel control member to retard the movement of said fuel control member from its idle fuel supply position to wide-open throttle position when said engine is operating at a relatively low speed and said throttle control means is actuated from its idle position to its wide-open throttle position.

2. The combination as set forth in claim 1 in which said dashpot means includes a cylinder, a piston reciprocably mounted in said cylinder and operably connected to said member, a fluid supply cup mounted above said cylinder and connectable thereto through a port controlled by said piston, means for supplying a portion of the engine lubricating oil supply to said cup, said cylinder having a bleed orifice in the head end thereof for slowly bleeding oil entrapped in said cylinder when said port is closed by said piston and permitting air to enter said cylinder when said piston is reciprocated in the opposite direction.

3. A fuel control mechanism for an internal combustion fuel injection type engine, comprising, in combination, fuel supply means, governor means operably associated with said fuel supply means to limit the maximum and minimum speeds of the engine, manual control means operably associated with said fuel control means and said governor means and actuatable to control the speed of the engine between said governor-established limit speeds, and means retarding the response of said fuel supply means when said manual control means is rapidly actuated in a speed-increasing direction.

4. The combination as set forth in claim 3 in which said last-mentioned means includes an expansible chamber fluid dashpot operably associated with said fuel supply means and comprising a cylinder, a piston reciprocably mounted in said cylinder and operably connected to said fuel supply means, fluid supply means connectable to said cylinder through a port intermediate the ends of said cylinder and controlled by said piston, said cylinder having a bleed orifice in the head end thereof for slowly bleeding oil entrapped in said cylinder when said port

is closed by said piston upon its actuation in a fuel-increasing direction and supplying air to said cylinder when said piston is reciprocated in the opposite direction.

5. Control mechanism for an internal combustion engine including fuel supply means, governor means operably associated with said fuel supply means to limit the maximum and minimum speeds of the engine, manual control means operably associated with said fuel control means and said governor means and actuatable between engine idle and maximum speed positions to control the speed of the engine between said governor-established limit speeds, and means regulating the response of said fuel supply means when said manual control means is rapidly actuated from its engine idle speed to engine maximum speed positions and operable to provide for initial rapid fuel-increasing response followed by a period of retarded fuel-supplying response to prevent an over-supply of fuel to said engine relative to the accelerating speed of said engine.

6. The combination as set forth in claim 5 in which said response-regulating means includes an expansible chamber fluid dashpot operably associated with said fuel supply means and comprising a cylinder, hydraulic fluid supply means mounted above said cylinder and connectable thereto through a port intermediate the ends of said cylinder, a piston reciprocably mounted in said cylinder and controlling said port, said cylinder having a bleed orifice in the head end thereof of a size such as to slowly bleed oil entrapped in said cylinder when said port is closed by reciprocation of said piston in a fuel-increasing direction and to permit the relatively unrestricted supply of air into said cylinder when said piston is reciprocated in the opposite direction.

7. In an internal combustion engine, fuel control mechanism including fuel injection means, a member movable between an idle speed position and a wide-open throttle position and operable to control the fuel supplying action of said injecter means, governor means operable on said fuel control member to regulate the fuel supplying movement of said member to limit the maximum and minimum speeds of the engine, throttle control means associated with said governor means and operably connected to said member for actuating said member between an idle and wide-open throttle position to control the speed of the engine between said governor-established speed limits, and dashpot means operable independently of said governor means to retard the movement of said fuel control member from its idle fuel supply position to wide-open throttle position when said engine is operating at a relatively low speed.

8. The combination set forth in claim 7 in which said dashpot means comprises a cylinder, hydraulic fluid supply means connectable to said cylinder through a port intermediate the ends of said cylinder, a piston reciprocably mounted in said cylinder and controlling said port, said piston being operably connected to said movable member, said cylinder having a bleed orifice in the head end thereof of a size such as to slowly bleed hydraulic fluid entrapped in said cylinder when said port is closed by said piston as said member is moved in a fuel-increasing direction and to permit the relatively unrestricted supply of air into said cylinder when said piston is reciprocated in the opposite direction as said member is moved in a fuel-decreasing direction.

9. Control mechanism for an engine, comprising, in combination, motive fluid supply controlling means, governor means operably associated with said fluid supply controlling means to limit the maximum and minimum speeds of the engine, control means operably associated with said fluid supply controlling means and said governor means and actuatable between minimum and maximum motive fluid-supplying settings to thereby control the speed of the engine between said governor-established limit speeds, and means regulating the response of said fluid supply controlling means when said control means

is actuated from its minimum to maximum fluid supplying settings, said response-regulating means including an expansible chamber dashpot comprising a cylinder hydraulic fluid supply means connectable to said cylinder through a port intermediate the ends of said cylinder, a piston reciprocably mounted in said cylinder and controlling said port, said piston being operably connected to said control means, said cylinder having a bleed orifice in the head and thereof of a size such as to slowly bleed hydraulic fluid entrapped in said cylinder when said port is closed by said piston as said control means is actuated in a fluid-supply-increasing direction and to permit relatively unrestricted supply of air into said cylinder when said piston is reciprocated in the opposite direction as said control means is actuated in a fluid-supply-decreasing direction.

10. The combination set forth in claim 9 in which the operable connection between said control means and said piston includes yieldable linkage means permitting said control means to be rapidly actuated in a motive fluid-supply-increasing direction between its minimum and maximum motive fluid-supplying settings ahead of the regulated response of said motive fluid-supply-controlling means, said linkage means being operable when said control means is actuated in a motive fluid-supply-decreasing direction to positively reciprocate said piston away from said cylinder head.

11. A dashpot comprising a cylinder closed at one end and having a port opening intermediate the ends thereof, means for supplying hydraulic fluid to said port, a piston reciprocably mounted in said cylinder to define an expansible chamber with the closed end thereof and controlling the admission of hydraulic fluid into said expansible chamber through said port, and means for slowly bleeding hydraulic fluid entrapped in said expansible chamber by the closing of said port upon reciprocation of said piston toward the closed end of said cylinder thereby retarding further reciprocation of said piston toward the closed end of said cylinder and for permitting the relatively unrestricted flow of air into said expansible chamber when said piston is reciprocated in the opposite direction thereby permitting the relatively rapid and unrestricted return of said piston in said opposite direction.

12. A dashpot mechanism comprising a cylinder closed at one end and having a port intermediate the ends thereof, hydraulic fluid supply means communicating with said port, a piston reciprocably mounted in said cylinder and controlling said port, and said cylinder having a bleed orifice therein interconnecting the interior of said cylinder with the atmosphere outside said cylinder, said orifice being of a size such as to slowly bleed hydraulic fluid entrapped in said cylinder when said port is closed by the reciprocation of said piston toward said head end thereby retarding such further movement of said piston and means to permit the relatively unrestricted flow of air into said cylinder when said piston is reciprocated in the opposite direction thereby permitting relatively unrestricted return of said piston in said opposite direction.

13. An expansible chamber device including a cylinder closed at one end and having a port intermediate the ends thereof, a piston reciprocably mounted in said cylinder and adapted to be operably connected to an actuating member, a fluid supply cup mounted above said cylinder and connectable thereto through said port, means for supplying hydraulic fluid to said cup, said port being controlled by the reciprocation of said piston to regulate the flow of hydraulic fluid between said cup and said cylinder, said cylinder having a bleed orifice in the closed end thereof interconnecting the interior of said cylinder with the atmosphere outside said cylinder and being of a size to slowly bleed hydraulic fluid entrapped in said cylinder when said port is closed by the recipro-

cation of said piston toward said head end, the location of said port permitting the relatively unrestricted reciprocation of said piston toward said head until said port is closed, and means adapted to permit relatively unrestricted flow of air into said cylinder when said piston is reciprocated in the opposite direction.

14. The device as set forth in claim 13 and including a second orifice in the head end of said cylinder and a one-way valve controlling said second orifice and operable to insure the flow of air into said cylinder and thereby the relatively unrestricted reciprocation of said

piston when said piston is reciprocated in said opposite direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,451,148	Floring	Apr. 10, 1923
1,558,590	Carlson	Oct. 27, 1925
1,714,160	Crowell et al.	May 21, 1929
2,571,571	Hanners et al.	Oct. 16, 1951
2,708,921	Links	May 24, 1955