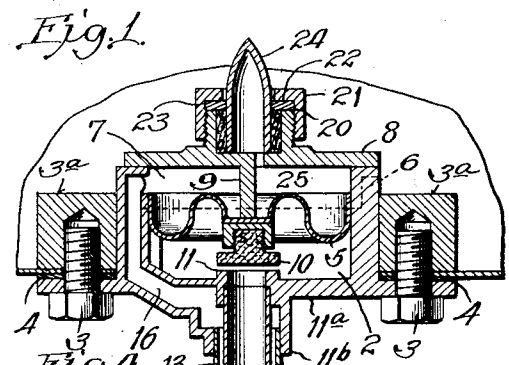
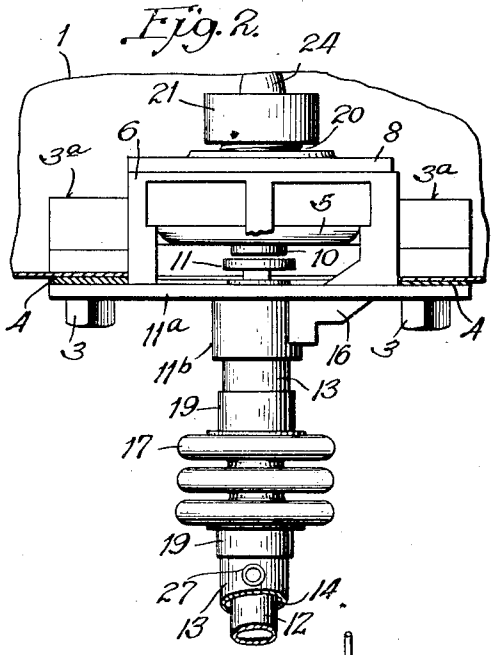
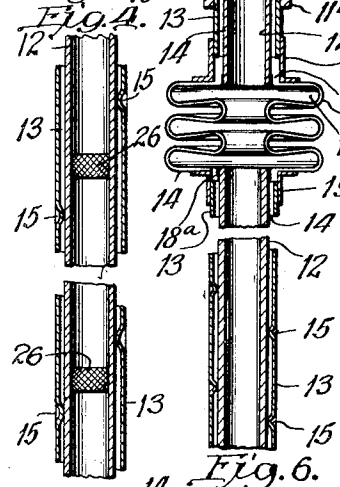
April 2, 1929. W. J. PERKINS 1,707,566

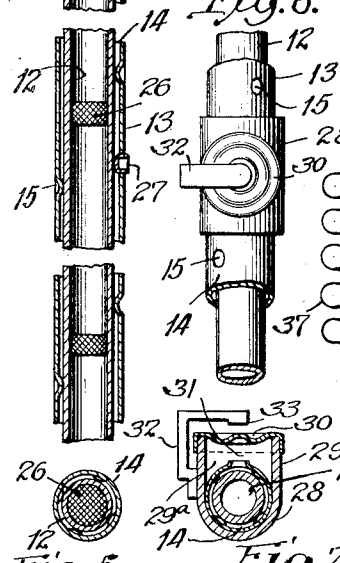
DISPENSING DEVICE

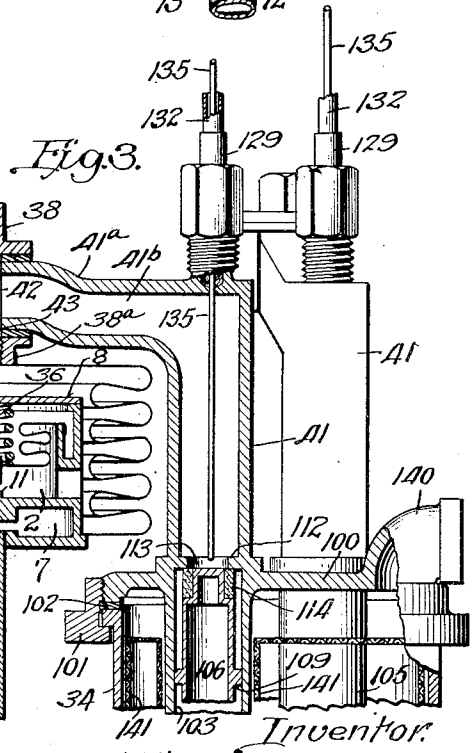
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Inventor.
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Fig. 8.

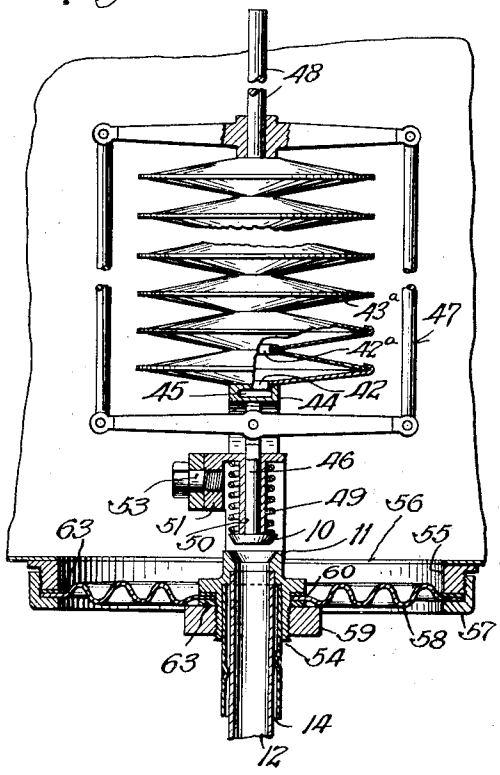


Fig. 9.

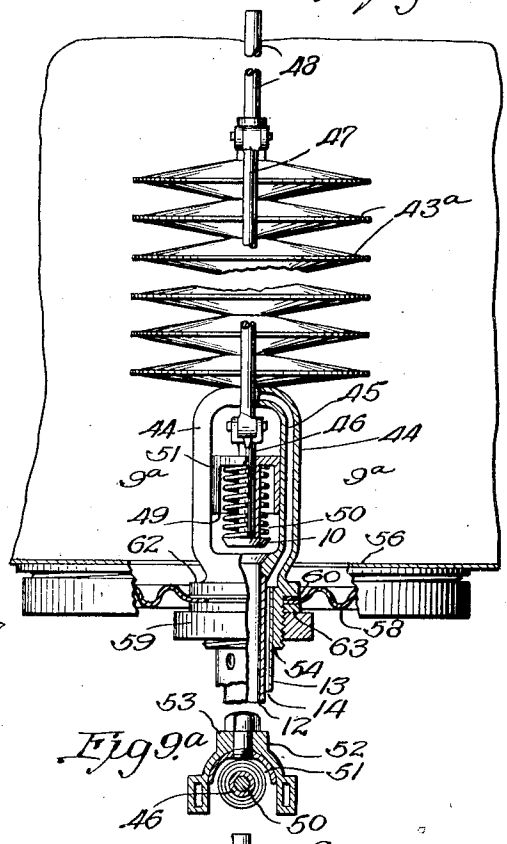
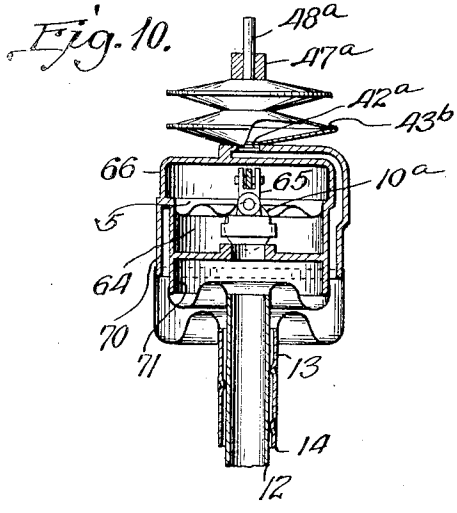


Fig. 9a

Fig. 10.



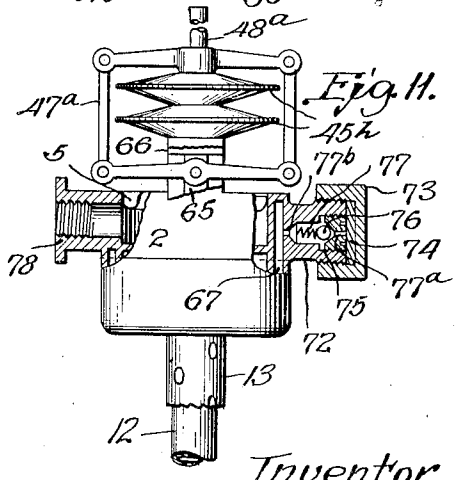


Fig. 11.

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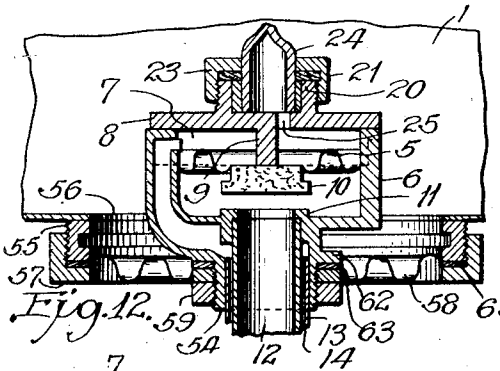


Fig. 12.

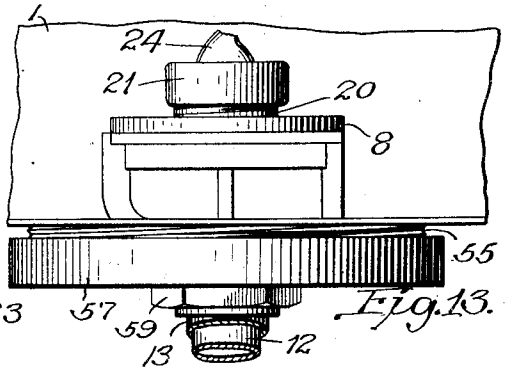


Fig. 13.

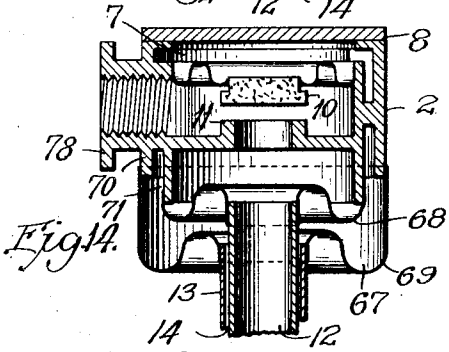


Fig. 14.

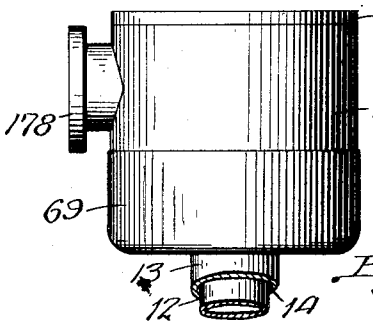


Fig. 15.

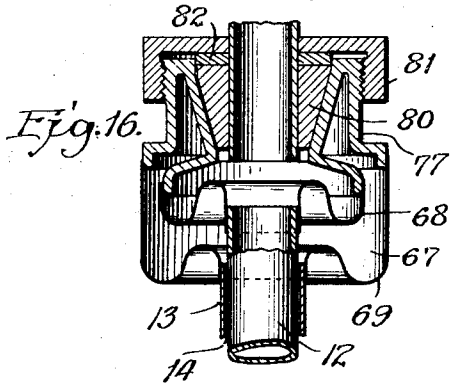


Fig. 16.

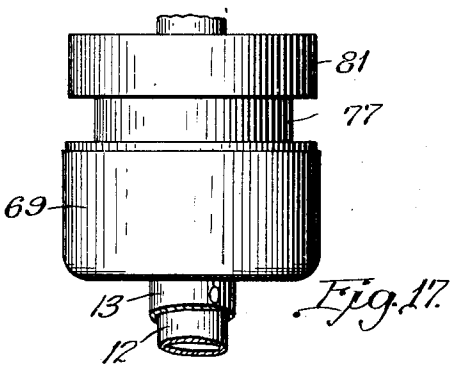


Fig. 17.

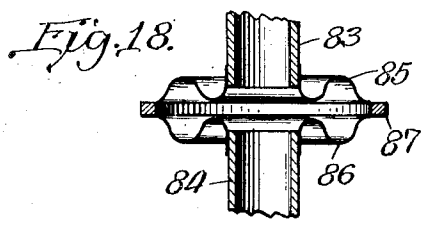


Fig. 18.

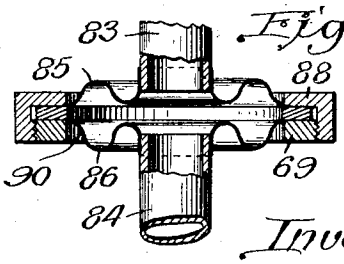


Fig. 19.

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Fig. 20.

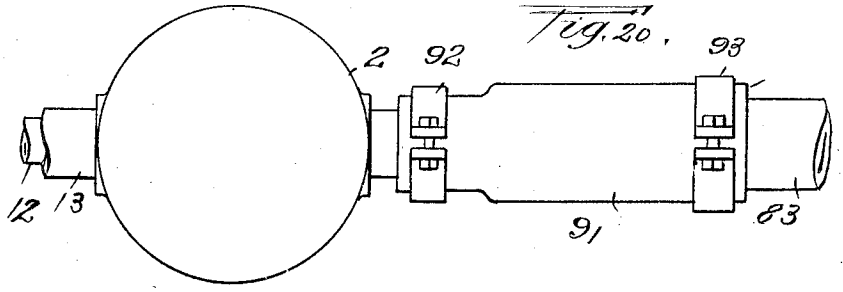


Fig. 21.

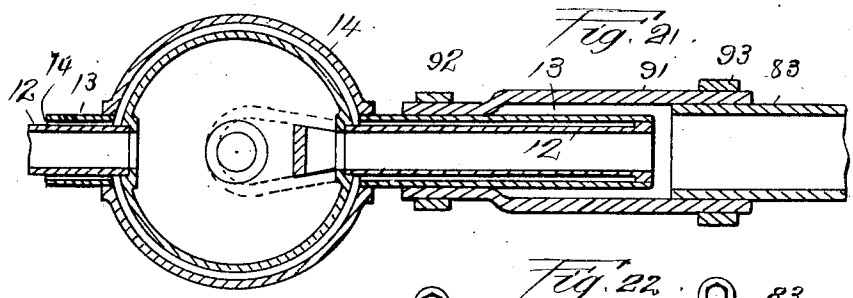


Fig. 22.

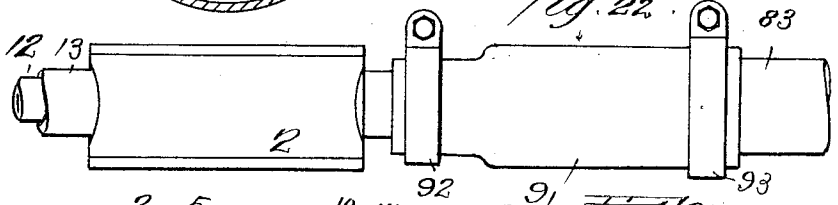
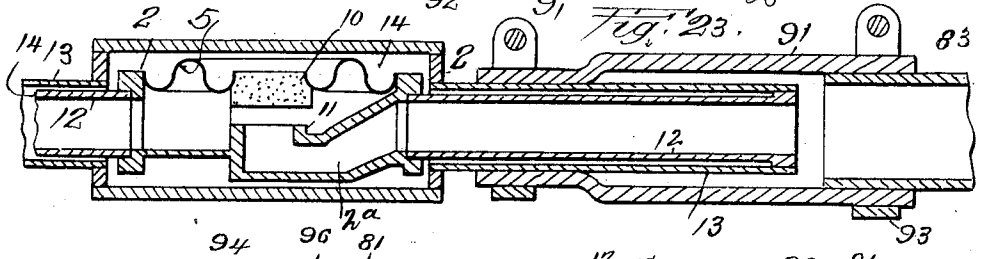


Fig. 23.



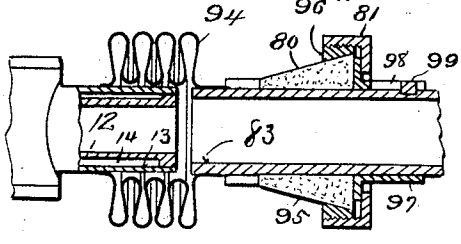


Fig. 24.

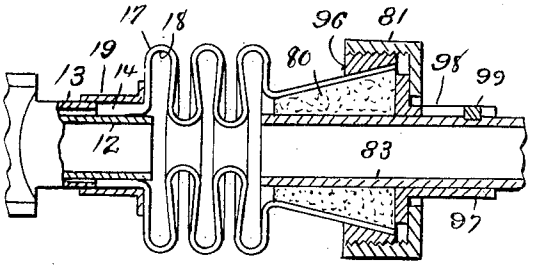


Fig. 25.

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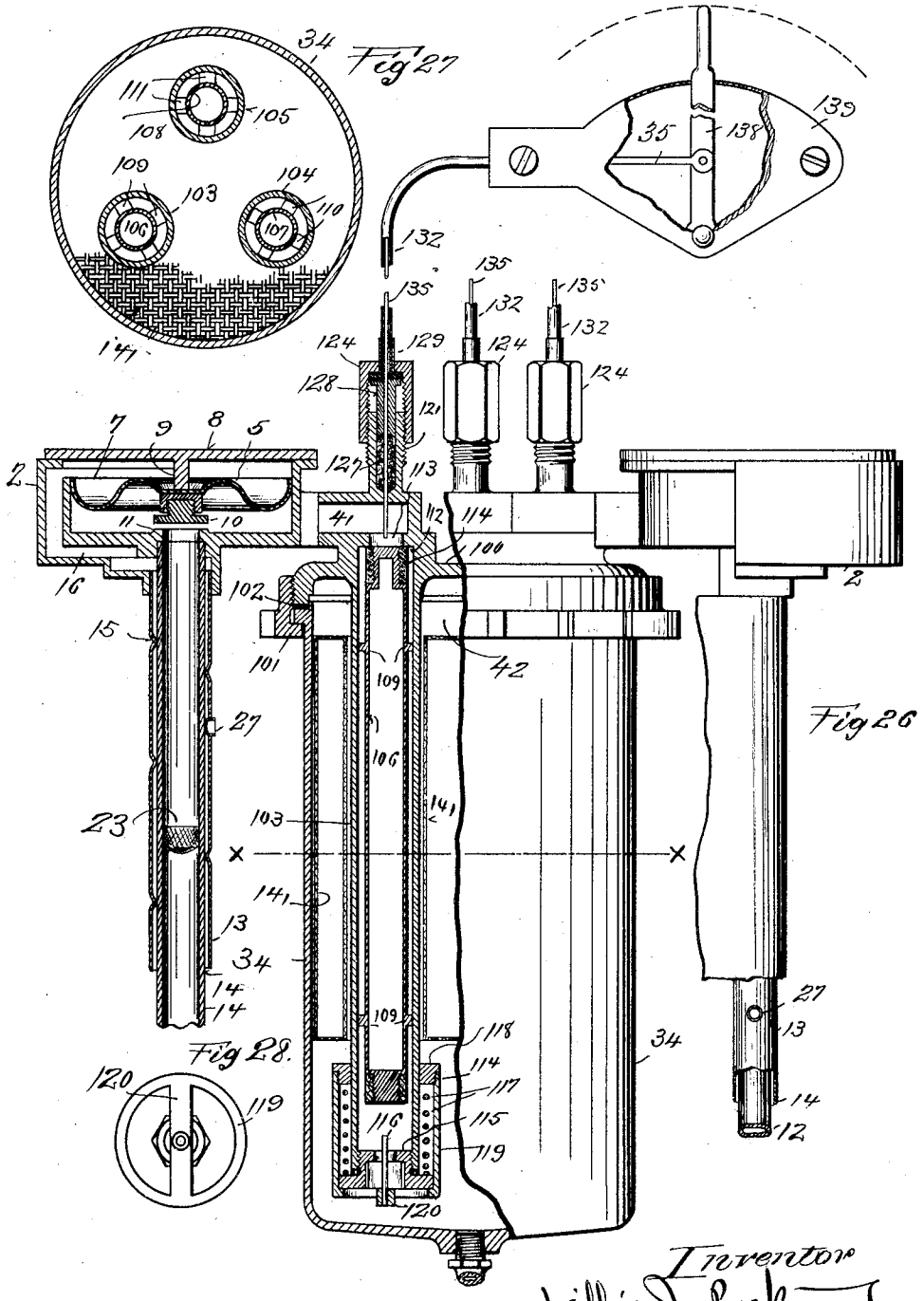
Willis J. Perkins

BY his ATTORNEYS Darby & Darby

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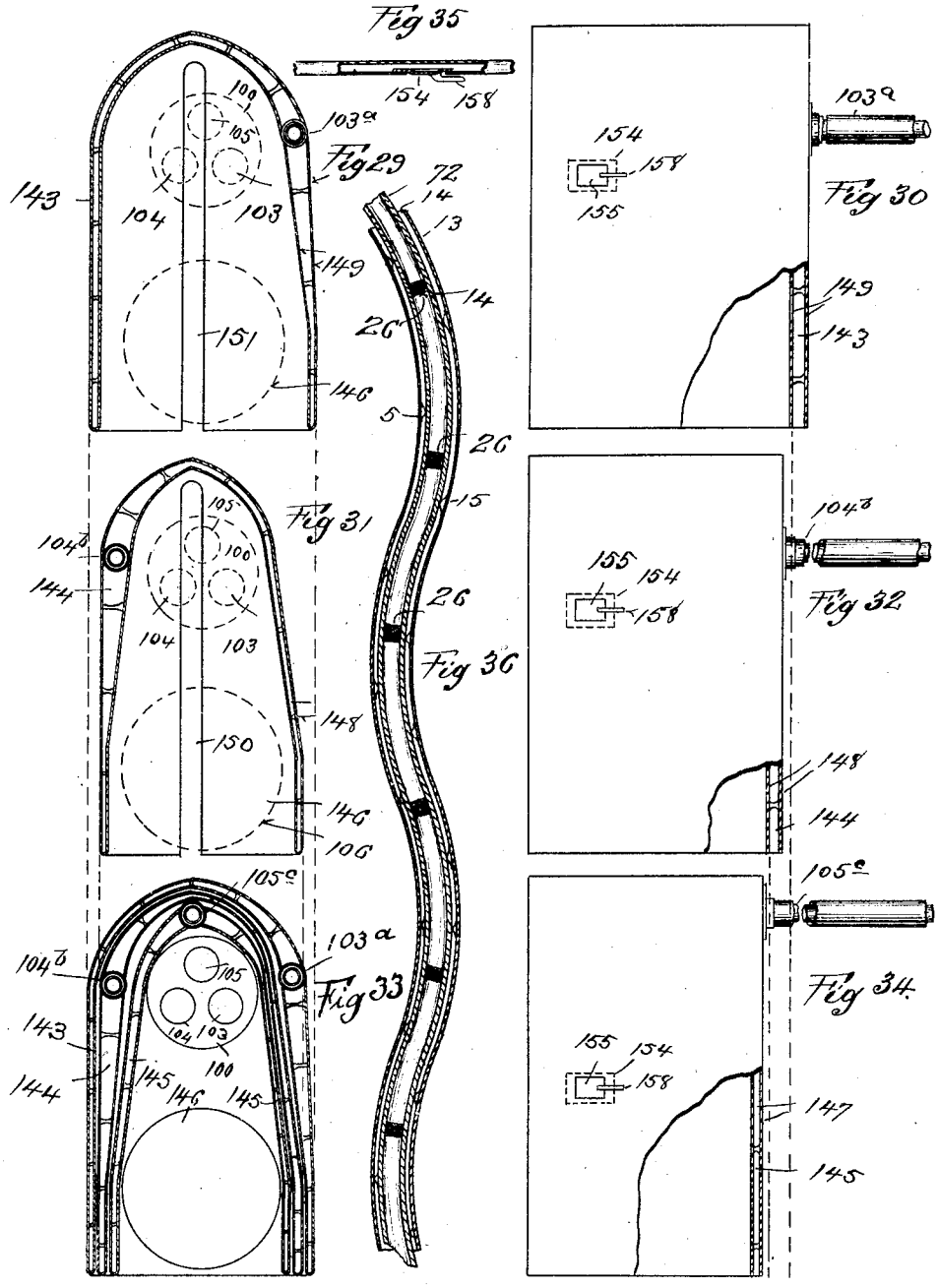


Inventor
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By his attys Darby & Darby

April 2, 1929. W. J. PERKINS 1,707,566

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Inventor

Will is J. Perkins

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Fig. 40.

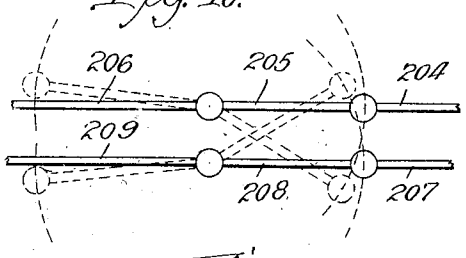


Fig. 39.

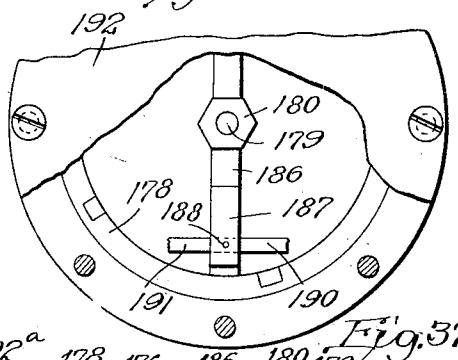


Fig. 41.

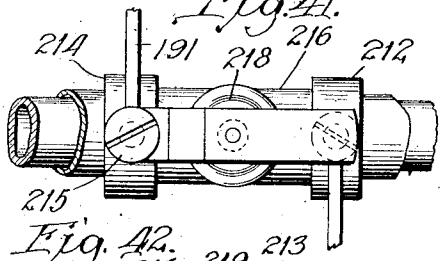


Fig. 42.

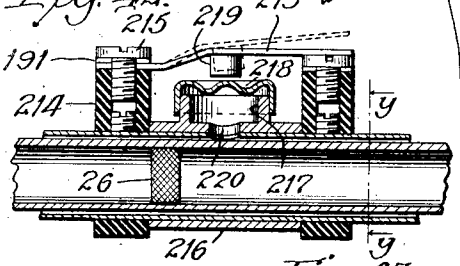


Fig. 43.

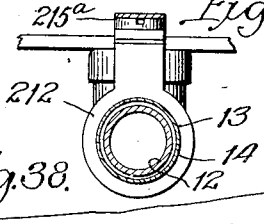


Fig. 37.

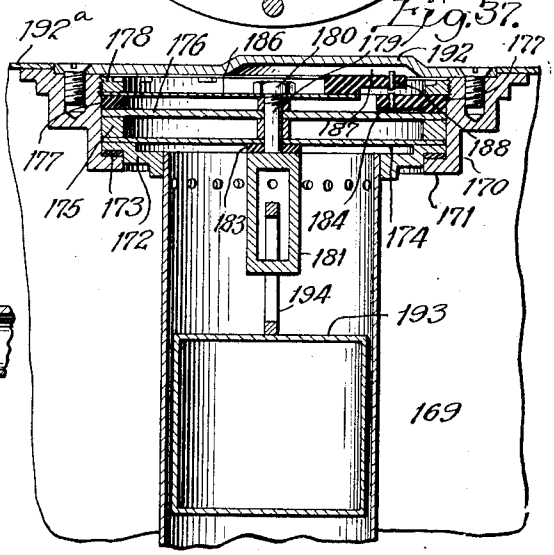
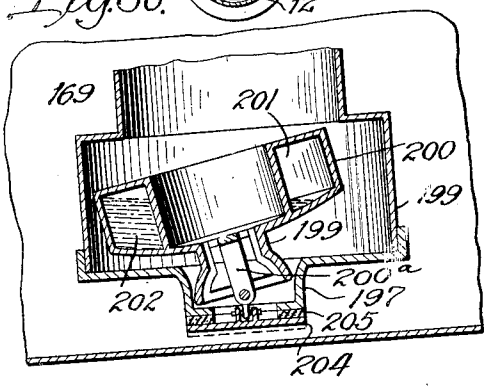
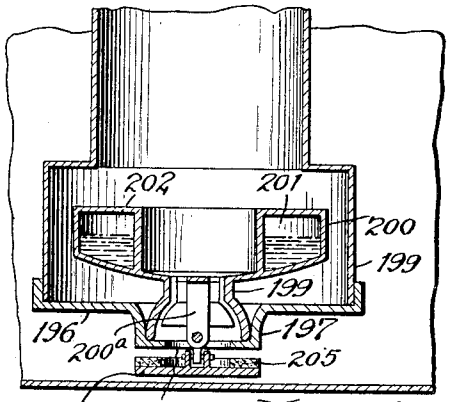


Fig. 38.





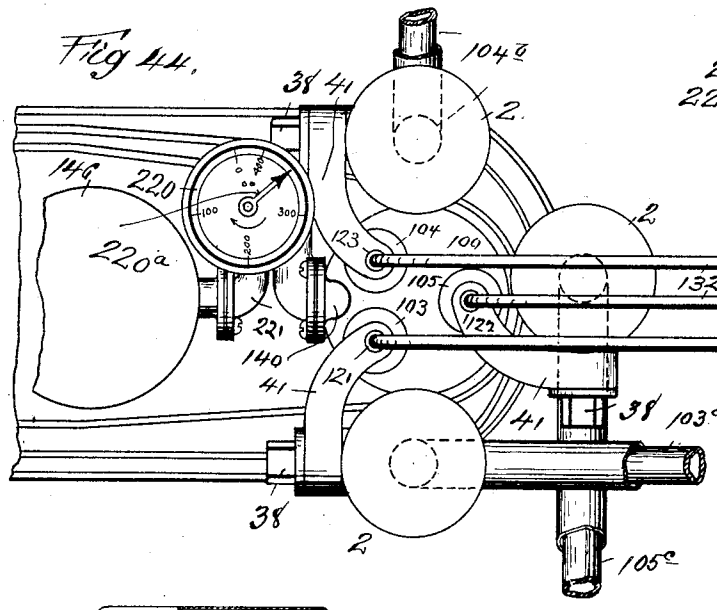
Inventor:
Willis J. Perkins
by his Attorneys Darby & Darby.

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Fig 44.



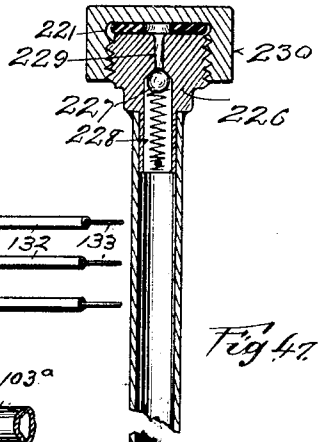


Fig 47.

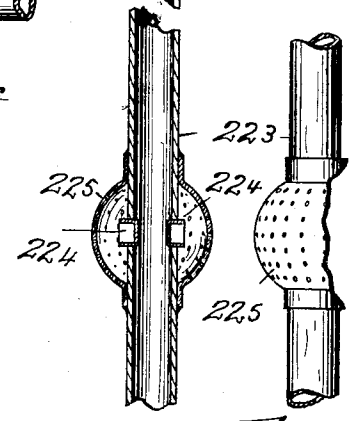


Fig 48

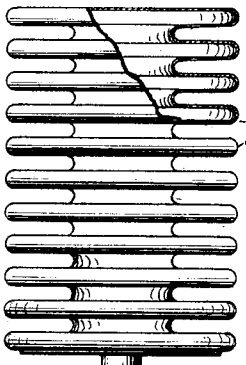


Fig 45.

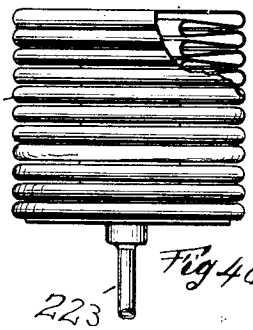
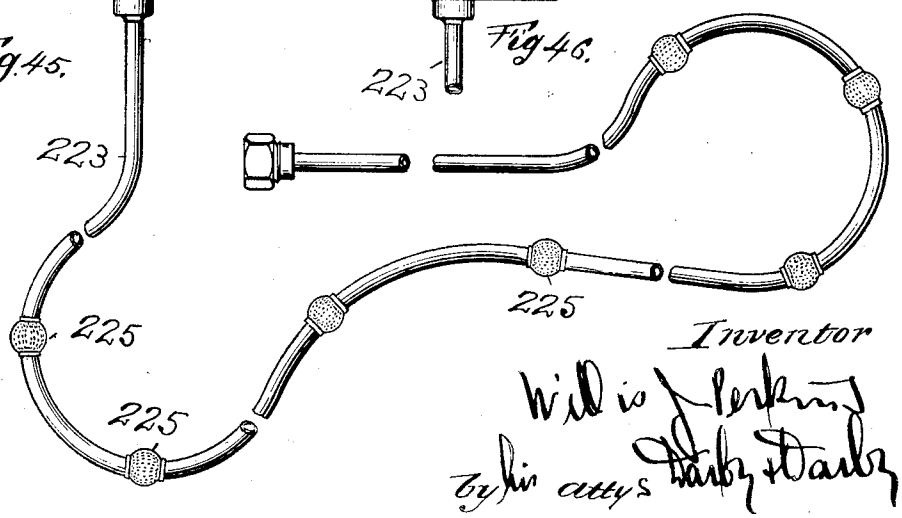


Fig 46.



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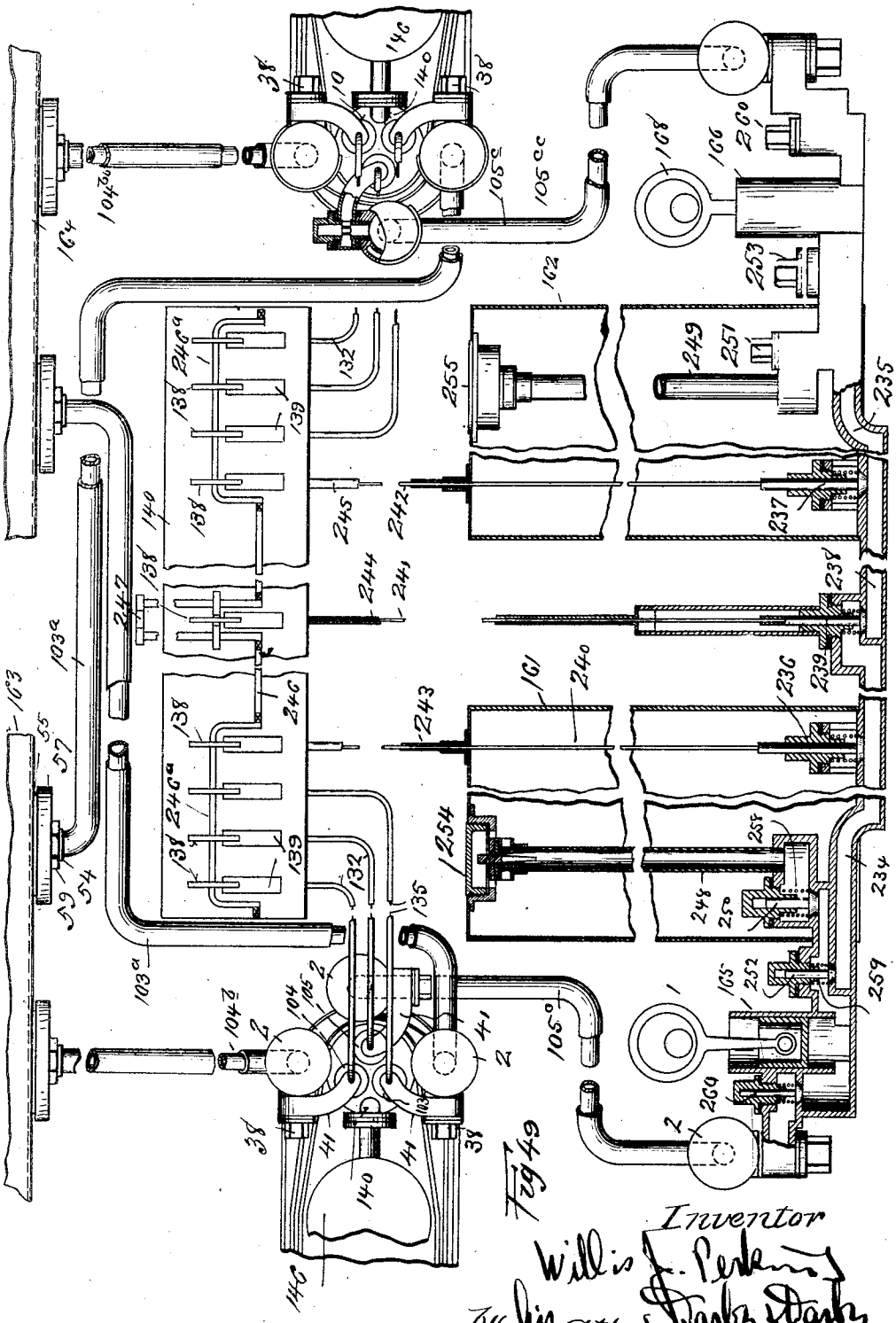


Fig 49

Inventor
Willis J. Perkins
By his attys Darby & Darby

Patented Apr. 2, 1929. 1,707,566

UNITED STATES PATENT OFFICE.

WILLIS J. PERKINS, OF GRAND RAPIDS, MICHIGAN, ASSIGNOR TO FRANCES W. PERKINS, OF GRAND RAPIDS, MICHIGAN.

DISPENSING DEVICE.

Application filed July 22, 1922. Serial No. 576,730.

This invention relates to fuel distributing systems for internal combustion engines, and particularly to fuel distribution to engines, such as are employed in connection with aircraft, submarines, or the like.

The object of the invention is to provide means which are simple and efficient for preventing leakage in systems of fuel distribution to internal combustion engines, due to defects developed in or injury to the pipes or other parts through which the distribution of the fuel medium is effected.

A further object is to provide simple and efficient safeguards against explosions, fire, waste, or other hazard, caused by leaks in fuel distributing systems or installations employed in connection with internal combustion engines of whatever type, or wheresoever used, and especially such engines as are employed in aircraft, submarines, or the like, or in any system where distribution is effected of any inflammable or poisonous gases or liquids, through conveying or distributing pipes.

A further object is to provide means which are simple and efficient for controlling the fuel distribution to internal combustion engines.

A further object is to provide a controlling means of the nature referred to wherein individual as well as collective control of the various units of a fuel distributing system for aircraft and other internal combustion engines may be conveniently accomplished.

A further object is to provide means in a distributing system of the nature referred to, to automatically cut off the delivery of the fuel medium from the supply reservoir or tank in case of defects developed in or injury to the distributing pipes or other parts of the system.

A further object is to provide a distributing system of the nature referred to wherein provision is made of means to avoid injury to the pipes and other parts of the system due to the vibrations and strains to which the same are subjected in use.

A further object is to duplicate the non-leak pipes employed in a fuel or other distributing system of the nature referred to in order to increase the reliability of the system and prevent interruption of its proper functioning in case of injury to or defect developed in one of the duplicated pipes. In other words it is among the objects of my invention to constitute an automatically safeguarded pipe an independent unit of the system and to insure, by duplicating such units, against stoppage or interruption of the system.

Other objects of the invention will appear more fully hereinafter.

The invention consists substantially in the construction, combination, location, and relative arrangement of parts, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally pointed out in the appended claims.

Referring to the drawings,—

Fig. 1 is a view in longitudinal central section of the tank end of a distributing pipe connection showing the application thereto of a safety structure embodying the principles and for attaining the objects and purposes of my invention.

Fig. 2 is a view in elevation of the structure shown in Fig. 1, including the application of an automatically acting low temperature fusible element for controlling the safety, function and operation of the system.

Fig. 3 is a view in longitudinal central section, similar to Fig. 1, showing a modified arrangement for automatically controlling the carbureter connection of a distributing pipe, and also showing a portion of a multiple valve distributing device employed in connection with the multiple pipe system forming the basis of my invention.

Fig. 4 is a broken detail view in longitudinal central section of a pipe protected in accordance with the principles of my invention.

Fig. 5 is a view in transverse section of the structure shown in Fig. 4.

Fig. 6 is a broken detail view in plan of a portion of protected pipe showing the application thereto of an automatic indicating device in accordance with the principles of my invention.

Fig. 7 is a view in cross section through the indicating device and pipe section shown in Fig. 6.

Fig. 8 is a broken detail view, partly in elevation, and partly in central longitudinal section, of a portion of tank or reservoir, showing the application thereto of a structure of automatic cut-off to a protected distributing pipe delivering therefrom, and embodying the principles of my invention.

Fig. 9 is a similar view taken at right angles to that of Fig. 8.

Fig. 9ª is a detail view in section on the line 9ª, 9ª, Fig. 9.

Fig. 10 is a broken detail view partly in longitudinal central section, showing one form of cut-off device and flexible or vibration absorbing connection for the carbureter, tank, distributor, or pump end, of a protected pipe, and embodying the principles of my invention.

Fig. 11 is a similar view of the structure shown in Fig. 10, taken at right angles thereto.

Fig. 12 is a broken detail view in central longitudinal section, showing another form of automatic tank or terminal cut-off and flexible or vibration absorbing connection for a protected pipe, and embodying the principles of my invention.

Fig. 13 is a view in exterior elevation of the structure shown in Fig. 12, a portion of the tank being shown in section.

Fig. 14 is a view similar to Fig. 12 showing another form or automatic carbureter, distributor and pump cut-off and yielding or vibration absorbing terminal connection embraced within the scope of my invention.

Fig. 15 is a view in exterior elevation of the structure shown in Fig. 14.

Fig. 16 is a broken detail view in central longitudinal section showing a modified form of terminal connection for a distributing pipe, and embraced within the scope of my invention.

Fig. 17 is a view in exterior elevation of the structure shown in Fig. 16.

Fig. 18 is a broken detail view in central longitudinal section illustrating one form of yielding or vibration absorbing connection intermediate the adjacent ends of pipe sections.

Fig. 19 is a view similar to Fig. 18, showing another form of flexible or vibration absorbing connection and means to facilitate the assembly or disassembly of the same.

Fig. 20 is a broken detail view in plan of a form of renewable flexible connection for the adjacent ends of protected pipe sections included within my invention.

Fig. 21 is a view in central longitudinal section of the structure shown in Fig. 20.

Fig. 22 is a view in side elevation of the same.

Fig. 23 is a view similar to Fig. 21 taken in a plane at right angles thereto.

Figs. 24 and 25 are views similar to Fig. 16, showing other modified structures of flexible terminal connections included within the scope of my invention.

Fig. 26 is a view, parts in elevation, parts in longitudinal central section, and parts broken out, showing the assembly of a multiple of distributing pipes connected to a carbureter, with automatic safety cut-off devices therefor, and means to manually control the float valves of the distributor, in accordance with my invention.

Fig. 27 is a view in transverse section on the line x, x, Fig. 26.

Fig. 28 is a detached detail view in end plan of the bottom end of a distributor tube employed in the distributing chamber, as shown in Figs. 26 and 27.

Fig. 29 is a view in sectional plan showing a form of protecting outer casing for shielding a carbureter and distributor, and distributor pipe, and embodying the principles of my invention.

Fig. 30 is a view in elevation, partly broken out and in section, of the structure shown in Fig. 29.

Fig. 31 is a view similar to Fig. 29 showing an intermediate protecting casing for a carbureter and distributor, and a distributor pipe.

Fig. 32 is a view similar to Fig. 30, of the structure shown in Fig. 31.

Fig. 33 is a view similar to Figs. 29 and 31, showing an assembly of an inner, and outer, and an intermediate protecting casing for a carbureter and distributor, and distributing pipes.

Fig. 34 is a view similar to Figs. 30 and 32, of the inner protecting casing shown in assembled relation in Fig. 33.

Fig. 35 is a broken detail view in longitudinal section showing the application of a safety fusible releasing element employed in connection with the protecting casings of Figs. 30, 32 and 34.

Fig. 36 is a view in longitudinal central section showing an arrangement of protected distributor pipe especially desirable where the pipe is installed horizontally.

Fig. 37 is a view showing a portion of an auxiliary tank, and also showing in central longitudinal section an automatically operating apparatus to control the operation of the pumps or other parts by the level of fuel medium in the auxiliary tank.

Fig. 38 is a fragmentary sectional view of the lower portion of the structure shown in Fig. 37, in tilted position.

Fig. 39 is a broken view in top plan of the structure shown in Fig. 37, a portion of the cover being broken away to show the automatic switch.

Fig. 40 is a view in diagram showing a switch system and arrangement for shifting automatic control from one auxiliary tank to another.

Fig. 41 is a broken detail view in top plan showing a switch device applied to a distributing pipe and adapted to be brought into operation automatically in case of injury to the distributing pipe or other associated parts.

Fig. 42 is a view in longitudinal central section of the structure shown in Fig. 41.

Fig. 43 is a view in transverse section on the lines *y*, *y*, Fig. 42.

Fig. 44 is a view in top plan of a carbureter and distributor arrangement assembled within protecting casings, and including an automatic fluid measuring and recording means, in accordance with my invention.

Fig. 45 is a detached view in elevation, parts broken out and parts in section, of a fire extinguishing apparatus suitable for use in securing the safety features of my invention.

Fig. 46 is a fragmentary view, partly broken out and partly in section, showing in collapsed condition a structure of pressure service means forming part of the fire extinguishing devices of Fig. 45.

Fig. 47 is a broken detail view in central longitudinal section of a portion of conveying pipe for a fire extinguishing medium, including an automatically releasable spraying element employed in connection therewith.

Fig. 48 is a broken detail view in outside elevation of a portion of the pipe and spraying element shown in Figs. 45 and 47.

Fig. 49 is a view, somewhat diagrammatic, partly in elevation, and partly in central longitudinal section, illustrating a multiple tank, carbureter, distributing and control system embodying the principles of my invention, with the fundamental elements of the system shown in assembled relation in a typical and illustrative installation.

The same part is designated by the same reference numeral wherever it occurs throughout the several views.

In the practical operation of aircraft, whether of the heavier than air, or lighter than air, or any other type, as well as submarines, or other water craft, land vehicles, or power installations of whatever type, kind or location, employing internal combustion engines, the danger is frequently incurred of failure, or loss of efficiency of the engine, and sometimes of disastrous and fatal fires and explosions through leakage at some point in the fuel distributing system caused by defects of or injury to the pipes, tanks, pumps, carbureter, or other part or parts composing the system. In the case of aircraft, for example, when employed in warfare, an enemy shot may perforate the fuel storage tank, a distributing pipe, the pump, carbureter, or other part of the fuel distributing or power installation, with the result that a leak of the fuel medium takes place which not only means waste and loss of power but is liable to be ignited, causing an explosion or a conflagration. Many instances have occurred where an aeroplane has been brought down in flames due to such an incident. What is true, in this respect of aircraft, employed for war purposes, is also equally true of aircraft employed in peace-time pursuits, for commercial, governmental or other purposes, due to defects in installation or construction, or to the action of vibration and strain to which the fuel distributing system and the pipes and other parts thereof are subjected when the air craft is in flight. Moreover, such leakage, even if hazardous and disastrous ignition or explosion does not take place, impairs the efficiency of the engine, and through waste and loss of fuel medium frequently interrupts, partially or entirely, the operation of the engine, and where this occurs in flight of an aircraft, a dangerous and often fatal accident results.

Again, the efficient control of the fuel medium supply to the engine is of great importance to enable the aviator or engineer in charge to meet the exigencies arising in practical operation. Such a control, in order to secure the greatest degree of efficiency and safety against hazard and accident, should be of such nature and character, and so collocated as to be constantly under the manual supervision of the aviator or engineer, and to be capable of effecting the control of fuel medium supply to any one or more or all of the engines of the power plant, individually or collectively, and from any one or more of a plurality of storage tanks or reservoirs.

In addition, it is exceedingly desirable for safety operation, to provide means to visually reveal at all times to the aviator or engineer in charge of the power plant, the amount of fuel medium he has remaining and available for power supply purposes.

It may sometimes be desirable to arrest the operation of an engine, or of a pump, or other working part of the power plant, in case of an accident or injury to some part of the system, and to effect such arrest instantly and without effort or action on the part of the aviator or engineer in charge.

It is also desirable, in case of leakage of fuel medium occurring in some part of the fuel supply system, and ignition thereof, to provide means which act automatically to extinguish the resulting fire so as to protect the power plant, the air craft, or other vehicle, or installation, and the persons in charge thereof.

It is among the special purposes of my present invention to provide means which are simple and efficient for securing the advantages and benefits above pointed out, and others to be hereinafter more fully set forth.

Among the important and fundamental features of my invention I propose to provide means which act automatically to instantly close one or both of the ends of a fuel or other distributing pipe, or unit section thereof, in case of injury to such pipe or section through service, accident, act of war, or other cause, thereby cutting off the

supply of the fuel medium thereto or therefrom, or both. I also propose, in accordance with my invention, to install the distributing pipes or pipe sections, so automatically protected, in independent detachable and replaceable units so that in case of injury in any particular section or unit, the injured member may be easily and quickly removed and replaced. I also propose to provide means to similarly close one or both ends of the distributing pipe or pipe section in case of fire in the neighborhood thereof, or in case of injury to or fire in the neighborhood or vicinity of the carbureter, pump, tank, or other coordinating essential element of the distributing system of the power plant. I also propose to provide means to dilute any escaping or leaking fuel medium, or to mix therewith a suitable fire extinguishing medium and to apply or spray such extinguishing material at proper points to safeguard the power plant, or its parts or surroundings from the effects of fire. I also propose, in accordance with my invention to provide means which are simple and efficient for confining, or partially confining, any leakage from a fuel medium or other distributing pipe, due to fracture, puncture, or other injury thereof, to substantially confine the contents of that portion of the pipe in the immediate vicinity of the fracture, perforation, or injury. I also propose to provide means which are simple and efficient for automatically controlling the operation of the distributing pump through the mean level of the fuel medium, and means to visually indicate at all times the amount of operating medium available in the distributing tanks or other reservoirs containing the same. I also propose, in accordance with my invention, to provide means to visually or otherwise indicate the condition and efficiency of the automatic means employed to cut off fuel medium supply, and means to concentrate at a single point control devices for manually controlling the fuel distribution in the system. I also provide means to prevent injury to the fuel distributing pipes and their related parts, due to the vibrations caused by operation of the power plant.

In connection with that feature of my invention which has to do with the automatic closing of one or both ends of a distributing pipe, in case of a fracture, perforation, or other injury to the pipe, or to the storage tank, pump, carbureter, or other vital element in the power plant, I provide a double wall or protecting casing for such pipe, tank, pump, carbureter, or the like, and maintain a power medium in the intervening space. This power medium may be either a vacuum or a pressure medium such as compressed air, or other suitable medium, and I utilize the breaking of the vacuum, in the one case, or the escape of such medium, or pressure, in the other case, to effect automatically the actuation of closure or cut-off valves, and indicating devices. Where pressure medium is employed, it is desirable to use a fire extinguishing medium to provide the power medium. Carbon tetrachloride, or a mixture of the same with a solution of carbon disulphide, is suitable for this purpose. The advantage of using a fire extinguishing medium under pressure is that only are the automatic devices put into operation by the release of the pressure and escape of such medium, due to an injury, perforation, fracture, or other cause, but such escaping medium, in large volume, mixes with the escaping fuel medium in relatively small volume, thereby destroying, impairing, or retarding the inflammable character of the latter, and hence affording protection against damage from fire. Moreover, in case of injury to, or perforation of both the wall of the protected part and that of the protecting casing or envelope, the pressure medium will escape from its containing space not only into the air but also into the interior of the protected pipe or part containing the fuel medium, and by reason of the preponderance of the pressure of the pressure medium over that of the fuel medium the escape of the latter through the fracture or perforation is retarded sufficiently to enable the cut-off valves to accomplish their closing function. A further advantage in the use of a power medium in liquid form rather than a vacuum, is that it is easier and more practical to maintain a liquid power medium hermetically sealed under pressure in the space enveloping a pipe or other part to be protected, than it is to maintain a vacuum or air pressure in such space. In its broadest scope my invention, however, is not to be limited or restricted to the use of a liquid or gaseous form of power force medium, and in the accompanying drawings I have shown arrangements for use with either vacuum or pressure media of various kinds.

In Figs. 1 and 2 I have shown a structure of tank end connection of a distributing pipe and an automatically acting closure or cut-off valve therefor which is arranged for vacuum operation. In these views a fragmentary section 1 of the storage tank is shown. Extending into the tank 1 is an annular ring 6, which may be held in place in any suitable manner. In the arrangement shown this ring is held by bolts 3 which pass through a flange forming part of the base portion 11^a of the cup-shaped member of which the annular ring 6 forms the wall. This flange fits against the exterior surface of the tank and is clamped thereagainst by the bolts 3, to the inner threaded ends of which are applied the nuts 3^a. If desired,

a leak proof packing or gasket 4 may be interposed between the flange and the exterior wall of the tank. The interior space 2 of the cup member 6 constitutes what I will call a valve chamber in which is mounted and operates an automatic cut-off or closing valve 10. This valve may be of any suitable material and structure. I have found that a cork valve is suitable. The valve is secured to the central portion of a flexible member 5, shown in this instance as a spring metal diaphragm of disk shape, which is hermetically attached at its periphery by soldering, brazing, welding, or otherwise, to the upper portion of the inner wall surface of ring 6. The flexible member 5 constitutes a yieldable wall or partition between the valve chamber 2, and a chamber 7 which is formed by a cap or cover 8, the latter being soldered or otherwise secured to the upper edge of ring 6. A stop 9 connected to or forming part of the cover 8 serves to limit the lift of the diaphragm 5, and to determine the normal space of separation of the valve 10 and its seat 11 with which it cooperates when in closed or cut-off position. The end of a distributing pipe 12 is secured within a central boss in the base member or portion 11^a of the cup 6, and in communication through the opening of valve seat 11 and valve chamber 2, with the interior of the tank or reservoir 1. A second pipe 13 encloses the distributing pipe 12, but is of larger internal diameter than the external diameter of pipe 12, thereby providing a space or chamber 14 therebetween. The two pipes 12, 13, may be maintained in spaced apart and coaxial relation in any simple or convenient manner. I have shown centering indentations 15 in the outer pipe 13, for this purpose. The end of the exterior pipe 13 is received and secured within an enlarged boss 11^b of the base plate 11^a, and the space 14 between the two pipes 12, 13, is in communication with chamber 7 through a passage 16. By maintaining a uniform or constant degree of vacuum within the space 14, it will be readily seen that the flexible member 5 is maintained at its upper limit of play against the back stop 9, thereby holding the valve 10 raised from its seat 11, and hence the fuel medium contained in the tank or reservoir is free to flow from the tank into and through the distributing pipe 12, as the operation of the power plant may require. If, however, through accident or otherwise, the pipes 12, 13, either or both, should become fractured, perforated, or otherwise injured, so as to cause a break of the vacuum within the space 14, the power medium which theretofore maintained the flexible member 5 in its upper limit of play is destroyed or broken, and instantly the valve 10 is seated upon its seat 11, thereby closing communication between the tank and distributing pipe and cutting off flow of fuel medium to the latter.

As is well known, it is a customary practice to employ soft copper tubing for the fuel distributing pipes of internal combustion engines. In the case of high powered engines, such, for example, as those employed in aircraft, the fuel distributing pipes are subjected to inevitable and frequently violent vibration. This tends to crystallize the distributing pipes, rendering them brittle and easily breakable, and also impairs or weakens, and frequently breaks their connection to the fuel tank, or other relatively fixed parts of the power plant, thereby giving rise to highly objectionable and dangerous leakage of the fuel medium. This means waste of fuel, impairment of the efficiency of the engine, and extreme danger to the power plant and the persons occupied therein, of the escaping fuel becoming ignited and causing disastrous fire. Moreover, by reason of the extreme variations in temperature, to which aircraft in service is subjected, the pipes and other connections are subjected to maximum expansion and contraction, which, likewise, is liable to injure or destroy the connections of such pipes or parts, and cause leakage with like objectionable results. In accordance with my invention I propose to avoid these objections and dangers, and in carrying out my invention I propose to employ means to absorb and take up the vibrations, and to compensate for expansion and contraction to which the distributing pipes and other parts are subjected. One arrangement for accomplishing these purposes is shown in Figs. 1 and 2, wherein expansible members are interposed at one or more convenient points in the length of the pipes. It is necessary, of course, that such expansible members, do not interrupt the continuity of flow of fuel medium through the distributing pipe, nor the enclosed vacuum or power medium space surrounding such pipe. I have found that the desired results may be secured by employing a structure consisting of spaced apart fluted double spring cylinders 17, 18, called sylphons, so disposed and arranged as to continue the power medium or vacuum space 14 in the space between their concentric spaced apart walls. The inner sylphon member 18 is secured hermetically at its opposite ends by brazing, soldering, or otherwise, to the adjacent ends of the interrupted pipe 12, as indicated at 18^a, while the outer sylphon member 17, in like manner, is secured hermetically at its opposite ends to the interrupted ends of pipe 13, as indicated at 19. Any undue or violent vibration or movement of expansion or contraction to which the pipe is subjected is thus taken up and absorbed in the sylphon spring members 17,

18, without interfering with the flow of fuel medium, or of the proper functioning of the safety power medium or vacuum controlled devices.

In order to afford protection against fire, it is desirable to provide means for releasing the power medium within the space 14, whether that power medium be vacuum or pressure, and to effect such release automatically. I therefore propose to employ at various points throughout the protected portions of the system means which are controlled by heat to effect automatically the release of the power medium which controls the seating or closure of the cut-off valves 10. In Figs. 1 and 2 I have shown one arrangement and disposition of such heat-controlled releasing means associated with the pressure or vacuum space 7, 16 and 14. In this arrangement a fusible plug or member 24 is mounted within the bore of a boss formed on the cover 8, said bore being in communication through an opening 25 with the space 7, so that the fusible member 24 serves to close said space and seal the vacuum or pressure maintained therein. The fusible member 24 may be securely held and seated in the bore of boss 20 in any suitable manner. I have shown a simple arrangement for this purpose wherein a sealing medium 23 is packed around the fusible member within the boss 20, and a retaining cap nut 21 applied to the boss engaged around the fusible member and retains the sealing medium in place. If desired, a gasket 22 interposed between the cap nut and boss serves to force the sealing medium tightly against the fusible member when the cap nut is screwed home on the boss.

In order to localize the leakage of fuel medium from a distributing pipe to that portion of such medium which is contained in the pipe in the immediate vicinity of a rupture or perforation in the pipe, I propose to employ means distributed at various points along the length of the pipe, and inside the same, to check and prevent the free passage of the fuel medium therethrough when the pipe is injured and its end closed as above described. For this purpose, and in one illustrative arrangement for attaining the desired end, I employ what I will call surface friction valves 26, which are disposed inside the pipe 12 at various points along the length thereof, as shown, for example, in Figs. 4 and 36. These devices are formed of fine wire screening having a mesh proportional to the viscosity of the fuel medium to be distributed through the pipe. It is preferable, of course, to construct these devices of such material as will not be affected by the action of the fuel medium. I have found that Monel metal is satisfactory for the purpose when gasoline is the fuel medium. These devices, or "valves", so-called, should have such an area of mesh opening as not to interfere with the proper feed or supply of fuel medium through the pipe when the engine is in normal operation, but which will arrest or restrain the flow of the medium when through injury to the pipe the closure valve related thereto is closed. In this way leakage and waste of the fuel medium is confined to that portion of such medium contained in that length or portion of the pipe between adjacent "surface friction valves" where a break, rupture or puncture of the pipe occurs.

When the pipes 12, 13, are installed in horizontal position, it is preferable, for greater efficiency in the functioning of the "surface friction valves" 26, that the pipes be formed into a series of reverse curves, as shown in Fig. 36. The purpose of this is to maintain a fuel fluid level in the pipe bearing against the full diametrical area of each of the said "valves", thereby obtaining the same fluid checking and stopping action as in the case of a vertically disposed pipe.

While I regard the so-called "friction valves" 26 as of advantage in attaining a greater degree of safety of the system, they are, by no means vital, and may be omitted, if desired. Should it be found that their use materially interferes even slightly with the proper supply of fuel medium to the engine in normal operation, such interference would be so slight as not to be of consequence, but even such interference can be minimized to a degree of inconsequence, if not entirely removed, by employing a pipe 12 of slightly increased diameter.

As above indicated, heat-controlled releasing devices for the power medium, whether vacuum or pressure, in the space 14, may be distributed at various points throughout the system in order to secure efficient protection against fire. In Figs. 2 and 4, I have shown fusible elements 27 inserted in openings in the outer pipe 13 for this purpose. The fusible elements of whatever nature and wherever located throughout the system should be of such nature as to melt at comparatively low temperatures, and when such elements, or any one of them melts, the power force in the space 14 is released and the cut-off valves 10 are automatically seated or closed, thereby cutting off the further supply or flow of fuel medium from the tank or reservoir through related parts.

It is desirable to provide means to visually indicate, on inspection of the plant, or by ground mechanics after landing, in the case of aircraft, that an injury has occurred, and that the supply of fuel medium has been cut off by the closing of the valves. For this purpose I propose to employ indicator means, or tell-tales, so arranged and associated as to be influenced into indicat-

ing condition by the release of the power force in the space 14. Many different structures and arrangements of indicating devices may be used for this purpose. In Figs. 6 and 7 I have shown a simple and efficient arrangement illustrative of the principle involved, especially suitable where the power force employed in the space 14 is vacuum. In this arrangement a sleeve 28 is applied around and soldered, or otherwise secured, to pipe 13 at some convenient point in the length thereof. The sleeve is formed with a laterally extending flange portion 29 forming a chamber 29a. This chamber is in communication through opening 31 in pipe 13 with the vacuum space 14, and is closed by a flexible spring diaphragm or member 30, which is applied over and brazed or otherwise secured to the flange 29. An arm 32 carried by the sleeve 28 extends over to form an abutment or back stop for the spring diaphragm in case the vacuum within space 14 should become broken. As long as the vacuum is maintained in space 14 the diaphragm is drawn and held inwardly away from stop arm 32, leaving a space 33 between the end of said arm and the diaphragm. Should the vacuum be broken, however, the spring diaphragm will move outwardly into abutment with said arm, thereby visually indicating, on inspection, that by reason of rupture, or other cause, at some point in the system, the power medium has been released and the cut-off valves have become closed, enabling a mechanic to locate and repair the injury or to replace the injured member.

In Fig. 3 I have shown a modified arrangement for controlling the cut-off valve 10, in accordance with my invention, by the release of the power medium in the space 14. In this arrangement a multiple fold cylindrical spring diaphragm 35 is soldered, or otherwise secured, to the inner wall of valve chamber 2. This diaphragm 35, as in the arrangement shown in Fig. 1, carries the valve 10. However, an auxiliary coil spring 36, arranged within chamber 7, is employed, in the arrangement shown in Fig. 3, to act upon the diaphragm 35, in opposition to the action thereon of the vacuum. With this arrangement, when the vacuum in space 14 and chamber 7 is broken, through injury, rupture, or other cause, at any point in the system, the tension of auxiliary spring 36, reinforces that of the spring diaphragm 35, to cause valve 10 to instantly close upon its seat 11. In this case I have shown the automatic cut-off valve 10 as applied to the carbureter end of the distributing pipe, but it is to be understood that the arrangement shown in Fig. 1 for the tank end of the pipe may also be used for the carbureter end, and, in like manner, the arrangement shown in Fig. 3 for the carbureter end may be used for the tank end of the pipe. In the case of the distributer connection of the distributing pipe, a multiple fold cylindrical expansible spring member 37, surrounds the exterior wall of the cup forming the valve chamber 2, and is secured at one end thereof to the lower or base portion of said wall. The other end of said member 37 is secured to a nut 38a threaded onto the end of a hollow bolt 38, mounted in an extension 41a of a distributer casing 41. To provide leak proof joints in the assembly of the parts, suitable gaskets 40, may be interposed, respectively, between the head portion of the bolt 38, and the extension 41a and between the nut 38a and said extension. The valve chamber 2, in this instance, receives the fuel medium delivered thereunto from the pipe 12, when the valve 10 is raised, and said chamber is in communication through the bore of member 37, the passage 43, through bolt 38, openings 42, and passage 41b, to the casing or bowl 34 of the distributer to be hereinafter more fully described.

As above indicated it may be preferred to employ a power medium under pressure to control the automatic operation of the cut-off valves 10, whether at the tank or the carbureter end, or both, of the distributing pipe sections. When a pressure medium instead of a vacuum is employed for this purpose, it is preferable to use a liquid or gas of fire extinguishing character, in order to thereby afford a more efficient protection against fire through the ignition of any escaping or leaking fuel medium resulting from a rupture or other injury in the fuel distributing system. Many different structures and arrangements for accomplishing this may be employed. In Figs. 8, 9 and 9a, I have shown one simple and efficient arrangement adapted to be applied to the tank end connection of a fuel feed pipe. It is to be understood, however, that my invention is not to be limited or restricted in its broadest scope to the structure and details of this form of arrangement.

In the illustrative arrangement shown, I employ a series of connected expansible and collapsible bellows-like members 43a of spring material, which are in communication with each other through the central openings 42a. These members are hermetically sealed and are designed to contain a suitable fire extinguishing medium, which is held and maintained therein under a desired discharging pressure, which is rendered permanent by the spring tension of the sealed members 43a, which I will refer to as "wafers." At one end the series of expansible members or wafers 43a are attached to a terminal member 44. This member is formed into a yoke, the central bore or channel 45 of the legs of which communicates with the closed wafers 43a, through the open-

ing 42, see Fig. 8. The number of members or wafers 43^a and the total volume of their enclosed and hermetically sealed space is determined by the quantity of fire extinguishing medium it is desirable to employ in connection with the distributing pipe units 12, 13, connected thereto, or associated therewith. In practice I prefer to locate this container structure for the fire extinguishing medium within the tank 1. This removes the container structure from all target area in the case of military airplanes employed in warfare, and it eliminates flight resistance.

In the arrangement shown in Figs. 8 and 9, the cut-off valve 10 is formed or connected with a stem 46, which is pivotally connected to a yoke structure 47, which encompasses the series of wafers 43^a. A rod 48 is rigidly attached to the upper wafer or member 43^a and slides through the upper cross member of the yoke structure 47, thereby constituting a guide for the collapsing and expanding movements of the wafer members. A compression spring 49 is interposed between the valve 10 and the upper portion of a sleeve 50, through which the valve stem 46 slides. This sleeve is provided with a semi-circular supporting portion 51, to which the yoke 44, or a lateral extension 52 thereof, is connected. Thus the sleeve 50 is stationarily mounted and held, being, in the particular form shown, secured to the yoke 44 by the bolt 53. When the wafer members 43^a are distended by pumping or otherwise, forcing the fire extinguishing medium thereinto, the yoke structure 47 is raised, thereby raising the valve 10 from its seat 11, and against the tension of spring 49. When, however, the fire extinguishing medium contained in the expanded members or wafers 43^a is discharged, or partially discharged therefrom, in case of injury to either of the pipes 12 or 13, or both of them, or to the related parts connected therewith, thereby forming an outlet for the escape of the fire extinguishing medium, the wafers or members 43^a by reason of their inherent tension force or compel the discharge of the fire extinguishing medium through the outlet, and thereupon said wafers or members collapse on each other, thereby lowering the yoke structure 47 and permitting the tension of spring 49 to instantly become effective to cause valve 10 to seat upon its seat 11, thereby cutting off any further escape of fuel medium from the tank through pipe 12.

I will now describe a convenient arrangement for mounting and inserting the fire extinguishing medium container structure within, and securing the same in place inside of the tank, and also a structure for flexibly attaching the tank end of the distributor pipe and its protecting casing to the tank so as to absorb or take up shocks or vibrations and prevent injury to such connection. The wall of the tank 1 is formed with an opening 56 therein of sufficient area to permit the yoke 47 and the wafer structure to be inserted therethrough into the interior of the tank. Suitably brazed, or otherwise secured, to the exterior of the tank, and surrounding the opening 56 therein is a ring 55. To the exteriorly threaded surface thereof is applied a screw cap 57. A flexible diaphragm 58 is clamped at its peripheral edge between the cap 57 and ring 55. If desired, and in order to prevent leakage at this joint a gasket 63 may be interposed between the peripheral edge of the diaphragm 58 and the ring 55. The diaphragm 58 is formed with a central opening therethrough, through which is received the outer end of a sleeve 54 forming the end of the yoke 44. The sleeve 54 is formed with a lateral flange 62 designed and arranged to bear upon the upper boundary edge of the central opening of the diaphragm 58, and against which said diaphragm is clamped and held by means of a ring 59 screwed onto the exteriorly threaded extremity of the sleeve 54. If desired, and in order to provide a leakage proof joint between these parts, suitable gaskets or collars 60, 61, may be interposed between the spring diaphragm 58 and the collar 62 and nut 59. The passage 45 of the yoke 44 communicates with the space 14 between the pipes 12, 13, as clearly shown in Fig. 9.

In practice I prefer to employ a slightly different method of connection of the fire extinguishing medium container to the distributor, carbureter, or pump end of the telescoping double distribution pipes 12, 13. Such a preferred structure is shown in Figs. 10 and 11. In this case two expansible spring wafer members 43^b are employed, though, obviously, my invention is not to be limited or restricted in respect to the number of such wafers since the number and extinguishing medium carrying volume thereof may be varied according to the conditions and requirements. A similar yoke structure 47^a and guide rod 48^a are employed as that above described with reference to Figs. 8 and 9. The function of the spring wafer members 43^b and of their encompassing yoke structure 47^a, namely, to maintain the valve 10^a raised from its seat 11^a, is the same as that above described with reference to the wafers and yoke structure of Figs. 8 and 9, the valve 10^a being pivotally connected through lug 65 with the yoke structure 47^a. The valve 10^a is attached to a spring disk 5, similar in all respects and in function to the spring disk 5 shown in Figs. 1 and 2. This spring disk forms a partition wall for a gasoline chamber 64. The tension of spring disk 5 is such as to normally maintain the valve

10^a seated upon its seat when the wafer members 43^b are collapsed. When, however, the wafer members 43^b are expanded by pumping thereinto the fire extinguishing medium under the desired pressure, the valve 10^a is raised from its seat and the lug 65 which connects the valve to the yoke structure 47^a strikes the undersurface of the yoke 66, thereby forming a stop therefor to determine the extent of the lift of valve 10^a. The yoke 66 has formed therein a passageway 67 which communicates at one end with the interior of the wafer members 43^b through opening 42^a, and also with the space 14 between the pipe sections 12, 13, and which I have referred to as the power medium space. The lug 65 and its position as revealed visually through the side openings of the yoke member 66 indicates relatively the efficiency of the fluid or liquid power medium in the space 14, and the proportionate amount of fire extinguishing medium contained in the combined expansible wafers 43^b, any space intervening between the lug 65 and the underpart of the cross portion of yoke 66 indicating at once whether or not an injury has occurred to the power medium area 14 or the related distributing pipe sections, and the extent of such intervening space indicating whether or not the injury is a major or a minor one. In order to absorb any movement of the pipe sections, due to expansion or contraction, shock vibration or otherwise, I employ the fluted spring diaphragm or disk members 68, 69. The inner spring disk member 68 is brazed, or otherwise secured, at its peripheral edge to the inner wall 71 of the valve chamber 2, and is formed with a central opening therethrough to receive the extremity of the inner distributing pipe 12, said disk being brazed or otherwise secured to said pipe. The outer spring disk member 69 is likewise provided with a central opening therethrough which receives the extremity of the outer protecting pipe member 13, to which said disk is brazed or otherwise secured. The other end of said outer disk member 69 is likewise secured in spaced relation with respect to the inner disk 78 to the outer wall 70 of the casing of the valve chamber, the two disk members 68, 69, being so relatively disposed that the space between them constitutes a continuation of the space 14 between the pipe sections and the passage 47 into the expansible wafer members 43^b.

The power medium, in this case the fire extinguishing medium, may be supplied to the system and into the space 14, 67, and to the interior of the spring wafers 43^b, in any suitable or convenient manner. I have shown in Fig. 11 one convenient arrangement for accomplishing this purpose wherein the valve casing is formed with an exteriorly threaded boss or extension 72, a threaded cap 73 being applied to the threaded portion of said extension or boss. If desired a gasket 74 may be interposed between the cap 73 and the end surface of the boss or lug 72 to form a tight joint. A valve seating member or plug 75 is screwed into the interior bore formed through the lug 72. A suitable valve 76 shown in this instance in the form of a ball valve is yieldingly held to the valve seat member 75 in any convenient way, as for instance by means of a spring 77 so as to close from the interior an opening or passage 77^a through the valve seat member 75. The bore of the boss or extension 72 also communicates through a passage 77^b with the passage 67. With this arrangement, in order to fill or recharge the power force area, including of course the space 14 between the pipes 12 and 13, the space between the diaphragm 68, 69, the passage 67, and the collapsible wafer members 43^b, with fire extinguishing medium, the cap 73 is first removed and the end of a suitable force pump delivery pipe is applied to the boss 72, said pump delivering from a suitable source the fire extinguishing medium. By operation of the pump the medium is forced through the passage 77^a, unseats the valve 76, and delivers the fire extinguishing medium through passage 77^b into the power force area. This action causes the valve 10^a, and any other valve associated in the system, as for instance, the valve 10 at the tank end of the connection, to be lifted as the power medium area receives under pressure the fire extinguishing fluid, and after the wafer members 43^a, 43^b, expand under the force of the pressure by which such medium is forced into this area. This action proceeds until the desired degree of pressure is attained, which condition will be indicated by the engagement of the parts with their respective stops. The check valve 76 operates to retain the fluid or liquid under pressure within the power medium area. The pump is then disconnected and the screw cap 73 again applied upon the boss 72.

The valve casing 2 may be connected to a carbureter, a distributor, pump, or the like, in any suitable or convenient manner. For this purpose I have shown a boss 78 formed on the valve chamber 2 which has a bore which communicates with the gasoline chamber 64 therein, and by means of the boss the desired attachment may be made, as, for example, through the member 38 shown in Figs. 3, 44 and 49, with suitably interposed gaskets 39, 40, to form a leak-proof joint.

It will be understood that the inherent spring tension of the expansible spring wafer members 43^a, 43^b, serve to impose a constant discharging pressure force upon the fire extinguishing medium contained therein. This force instantly acts when the power medium area becomes ruptured in

service or use, or by force, acts of war, or otherwise, at any point throughout the system, or by reason of the occurrence of fire and resulting heat of sufficient degree to cause the fusing of the fusible elements indicated at 27 in Figs. 2 and 4, and at 155, Figs. 30, 32 and 34, and wherever throughout the system such elements may be employed. Such a rupture of the power medium area and resulting expulsion of the fire extinguishing medium not only instantly cuts off the supply of fuel medium by closing the tank and carbureter or pump end connections of the intermediate piping system, but also sprays a fire extinguishing medium in case of fire over the area threatened by the fire, or, such fire extinguishing medium, if of proper character, such as the use of carbontetrachloride, or a mixture thereof with a solution of carbon disulphide, then any inflammable fuel medium which may have leaked out of the system due to such rupture instantly becomes diluted so as to lose or have destroyed its inflammable character.

In the structure shown in Figs. 1 and 2, and above described, I have shown the protected distributing pipe rigidly connected to the tank, but equipped at a suitable point in its length with an expansible connection to absorb vibrations or longitudinal expansions and contractions to which the distributing pipe may be subjected.

In Figs. 8 and 9 I have shown a modified arrangement of valve controlling devices and the pipe connection, and I have also shown therein a flexible connection of the distributing pipe to the tank. It is obvious, of course, that the flexible vibration absorbing connection of the pipe to the tank may be employed with either type or form of valve controlling device. In other words, the flexible connection of the pipe to the tank, as shown in Figs. 8 and 9, may, likewise, be applied to the form of valve actuating and controlling structure shown in Figs. 1 and 2. In Figs. 12 and 13 I have shown this application wherein ring 55 is secured to the tank 1 around an opening 56 formed in the tank wall. A cap ring 57 is screwed upon the ring 55 and serves to clamp thereagainst the peripheral edge of the flexible member or diaphragm 58, with, if desired, an interposed gasket 63 to secure a tight joint. A central opening is formed through the flexible diaphragm 58, through which extends the stem portion 54 of the valve casing 6, said stem being formed with a flange 62 against which the edge portion of the diaphragm 58 bounding the central opening therethrough is clamped by means of a clamp ring 59 and an interposed disk 63. The extremity of the distributing pipe 12 is brazed or otherwise secured within the bore of the extension 54 of the casing 6, while the protecting pipe 13 is secured at its end or extremity to the inner wall of the neck portion 54 of said casing.

In Figs. 10 and 11 I have shown a valve controlled structure for the carbureter, distributor, or pump end connection of the double telescoped distributing pipes 12, 13, as applied to a power force in the form of a liquid medium held in the system under pressure. The same method of connecting the ends of the telescoping pipes is equally well adapted for use in connection with a power force provided by a vacuum, and in Figs. 14, 15, I have shown the same arrangement and structure of distributing pipe connection as shown in Figs. 10 and 11 as applied to a vacuum system for the distributor, carbureter, or pump end of the pipes.

From the foregoing description it will be understood that a complete protected distributing pipe unit employed in connection with a vacuum power medium consists of the tank end valve casing, valve and valve control arrangement as shown for example in Figs. 1 and 12, and a carbureter, distributor or pump end structure or connection for the protected pipe unit consisting of a valve casing, valve and valve control structure, as shown for example in Figs. 14 and 15, the complete unit being equipped at one or more convenient points in its length with a tell-tale indicator device such as shown in Figs. 6 and 7, and also equipped, if desired, with cooperating surface friction valve devices distributed at suitable points within the bore of the pipe 12, as indicated at 26 in Figs. 4, 5 and 36. All fittings are soldered, brazed, or otherwise secured together. This leaves the only remaining opening in the unit at the passage 25, see Fig. 1, in the top cap 8 of the valve chamber at the tank valve end of the unit. By means of any suitable or convenient vacuum producing devices a vacuum of the desired degree of exhaustion is produced in the power medium area or space of the unit. The degree of vacuum power force produced can easily be tested out in any suitable, convenient or well known manner, until the desired vacuum is produced. The fusible sealing member 24 is then placed in position and is sealed in place in any suitable manner, and as above described. This completes a distributing pipe unit embodying the principles of my invention employing vacuum as the power medium through which the sealing action of the valves at one or both ends of the unit is controlled.

In like manner a complete protected distributing pipe unit for use in connection with a power force consisting of a liquid forced into the power force area or space and maintained therein under pressure, consists of a tank end structure such as is shown in Figs. 8 and 9, and a carbureter, distributor or pump end structure such as is shown

in Figs. 10 and 11. In this case the power medium or liquid is delivered by pump or otherwise into the power medium area or space through the connection 72 shown in Fig. 11 until the desired degree of pressure of the liquid within the system is attained.

In the case of either complete unit, provision may be made to absorb or take up longitudinal vibrations, contractions or expansions of the protected pipe members thereof by interposing at suitable points in the length of the pipe unit the sylphon device indicated at 17, in Figs. 1 and 2. If desired, however, and with or without the vibration absorbing device 17, the tank end of the pipe connection may be constructed to absorb and take up such vibrations, contractions and expansions, whether in a compressed liquid power force or in a vacuum system by the structure of flexible diaphragm connection 58 shown in Figs. 8, 9, 12, and 13.

It may sometimes be necessary or desirable to couple together separate lengths of the protected distributor pipes 12, 13, in such manner as to maintain continuity of the pipe 12, and in some cases it may be desired to provide a terminal connection for the protected telescoped distributing pipes 12, 13, and the power medium space or area. A suitable structure for such a terminal is shown in Figs. 16 and 17 wherein the power force area 67 terminates in a hollow union member 77. This union member is formed with a tapering central opening therethrough, within which is mounted a tapering plug 80, which may be of any suitable material, such as cork, composition, or soft metal, and which is held firmly in place within the tapering opening of the fitting 77 by means of a clamping nut 81, having a threaded flange which is screwed onto the exteriorly threaded portion of the fitting 77. The plug 80 is formed with a central bore therethrough to receive the pipe terminal connection 83. A collar 82 serves to firmly hold the plug 80 in place. The flexible and expansible members 68, 69, respectively, receive the ends of the pipes 12, 13, in the same manner above described with reference to Figs. 10, 11, 14 and 15. This structure forms a quickly detachable leak-proof terminal connection.

In some cases it may be desirable to interpose vibration or shock absorbing means in the length of a pipe terminal or connection which is unprovided with the safeguard of a telescoped pipe with an intervening power vacuum area or space between them. In Figs. 18 and 19 I have shown such a flexible connection of the adjacent or approximate ends of pipe sections. In this case the pipe sections 83, 84, in the arrangement shown in Fig. 18, are received respectively in central openings formed in the spring metal diaphragms 85, 86, and are brazed, soldered or otherwise secured therein. The peripheral edges of the spring diaphragms or plates 85, 86, are permanently joined or connected together, as, for instance, by being brazed, soldered, or otherwise secured, to an intervening ring 87.

In order to provide a connection which may be quickly assembled or disconnected, and which may be used at any desired point either in a fuel distributing system or in the water circulating system employed in connection with engines of the character referred to, or between two supply tanks or between a supply tank and pump, or in any other desired application, I have shown a simple structure in Fig. 19 wherein, instead of permanently securing together the peripheral edge portions of the spring diaphragm plates 85, 86, said edges are detachably clamped together between an annular collar 88 and a clamp ring 89, the joint being rendered leak proof in any convenient manner, as, for instance, by means of the packing gasket 90. This affords a very simple and convenient structure which permits quick and easy assembly and disconnection.

It is a common practice in air service gasoline pipe installations for air-craft engines to employ short sections of special composition rubber tubing interposed at suitable points in the fuel distributing pipe line for the purpose of taking up or absorbing the vibrations. This practice, however, is open to serious objections. Rubber is soluble in gasoline and its compounds, and the dissolved rubber, or particles of the rubber connection detached from the body thereof by the action of the gasoline, is liable to foul the strainer and clog the distributing system. Moreover, any dissolving or eating action exerted by the gasoline upon the rubber connection weakens the latter and in time requires it to be discarded and replaced, with the incident fire danger and interference with reliable operation of the engine.

However, a structure of protected distributing pipe with the cut-off valve adjunct hereinabove described is well adapted for application to the usual form or type of rubber connection, and in Figs. 20, 21, 22 and 23 I have shown an adaptation of the protected pipe system of my invention to such a rubber pipe connection, and wherein the serious objections to the use of such a flexible connection are largely minimized and reduced. In the arrangement shown the special composition rubber tube connection is indicated at 91, and is connected at its ends by suitable clamp devices such as the screw clamps 92, 93, to the ends of the pipe sections to be connected together thereby. In the adaptation of the protecting features of my invention to this type of coupling, the

valve chamber 2 is preferably disposed in line with the length of the pipe sections to be joined. In this case the connection is to be effected between a terminal pipe 83 and a protected pipe system 12, 13, the valve casing 2 being interposed between the approximate or adjacent ends of said pipe sections and in line therewith, the valve 10 and its seat 11, and spring supporting disk 5 for the valve and vacuum space 14 remaining the same as in corresponding details above described, except that in this instance the valve 10 operates transversely with respect to the length of the pipe sections. The ends of the protected pipe sections 12, 13, extend into the casing 2, at one side thereof, and a short continuing section of said pipes 12, 13, extends from the opposite side of the valve casing 2, such extension being received telescopically into one end of the rubber connection 91, the clamp member 92 serving to clamp one end of said rubber connection 91 around said pipe extensions. The other end of the rubber section 91 is clamped by clamp member 93 around the end of a pipe terminal 83. The protected pipe sections 12, 13, which extend into the rubber connection 91, are sealed together at their outer extremities so as to preserve the power medium space or area between them up to their extremities. This extremity in practice should be disposed closely adjacent the opposed open end of the terminal pipe 83. The passageway 12^a serves to preserve the continuity of the oppositely disposed protected pipe sections 12, 13, through the valve casing.

While I have shown the adaptation of a non-leak protected pipe distributing system embodying my invention to an ordinary form of rubber vibration absorbing pipe section, I prefer to dispense entirely with the use of rubber sections for vibration absorbing purposes, and to employ in lieu thereof the metal vibration absorbing devices hereinabove described, as I thereby eliminate all danger of clogging or choking the strainers or the distributing system through the corroding action of gasoline on rubber.

In Figs. 10, 11, 16 and 17 I have shown, and have described above certain forms of vibration absorbing connections. My invention in its broadest scope, however, is not to be limited or restricted to the details of structure shown in said figures. For instance, in Fig. 24 I have shown a modified arrangement of spring metal vibration absorbing structure employing a multiple fold cylindrical sheet metal spring tube 94 as applied to a terminal connection between a pipe terminal 83 and a protected pipe system 12, 13, to replace the rubber tube connection 91 shown in Figs. 21, 22 and 23. This spring metal vibration absorbing cylindrical tube at one end telescopes over and is secured to the pipe 13, and at the other end telescopes over and is secured to the approximate end of the pipe terminal 83. In order to insure a leak proof joint the end 95 of the tube 94 which telescopes over the adjacent end of the pipe section 83, is received over a tapered packing 80, which is clamped and held in place thereon by means of a clamp ring 96 correspondingly tapered and screwed into a cap member 81. A flanged sleeve 97 is fitted upon the pipe section 83, and the flange thereof is clamped against the end of the packing 80 by the clamp nut or ring 81. The sleeve 97 may be held against rotation in any convenient manner, as, for instance, by means of a key 99 secured to the pipe terminal 83 and extending into a slot 98 formed in the sleeve 97.

In the arrangement shown in Fig. 24 the automatic protection or power force space does not extend beyond the end of the pipe sections 12, 13. It may in some cases be desirable to extend this power medium protecting area or space through the flexible pipe coupling. To accomplish this, in place of the single spring metal vibration absorbing tube 84 shown in Fig. 24, I have shown a double arrangement similar to that shown in Fig. 1, consisting of the outer member 17 and the inner member 18, the latter being telescoped at one end over the end of the pipe section 12, while the corresponding end of the member 17 is connected to a sleeve 19, which telescopes over and is secured to the outer or protecting tube 13. The opposite ends of the members 17, 18, telescope over the packing member 80, and are held and clamped thereto by means of the clamp ring 96 and cap 81 having the same structure and arrangement as shown in Fig. 24. The structures shown in Figs. 24 and 25 afford a convenience in quickly assembling and disconnecting the parts.

A protected or non-leak gasoline distributing pipe system such as above described permits the duplicating of the pipes, thereby securing increased reliability in gasoline distribution and increased certainty of engine operation. Such duplication of distributing pipes, however, necessitates means for grouping the duplicate distributing pipes adjacent to the carbureter in a distributing chamber or in a specially constructed carbureter, or independent receptacle such as is indicated at 34 in Figs. 3, 26, 44 and 49, while at the same time permitting the use of any ordinary type of structure of carbureter.

Elementally safety and efficiency in gasoline distribution is secured not only by preventing leakage but also by duplicating the conveying or distributing pipes so as to insure a continued supply of fuel even though one or another of the distributing pipes may be injured or destroyed. Duplication of distributing pipes requires dis-

tributing means having a single connection therefrom to the carbureter.

In Figs. 3, 26, 27, 33, 44 and 49, I have shown a convenient form and arrangement of duplicated pipe distributing system embodying the principles of my invention as illustrative of one simple and efficient arrangement embodying the principles thereof. As shown, a distributor bowl 34 is detachably secured to a main distributor member 100. This may be accomplished in any suitable or convenient way. A simple arrangement is shown wherein a ring nut 101 engages an annular flange at the end of the bowl 34, and clamps the same to the main distributor member 100 by said ring nut screwing upon external screw threads on said member. If desired a leak-proof joint may be provided by means of a gasket 102 interposed between the annular flange or bowl 34 and the opposed surface of the distributor member 100. In the arrangement shown, to which, however, my invention is not to be restricted, three vertically depending tubes 103, 104, 105, are formed on, and preferably cast integrally with, the main distributor casting 100. These tubular members respectively open into the passages 41, to which, they respectively, are bolted, or otherwise secured, the distributing pipe terminal valve chambers 2. Loosely fitting in each of the said tubular members, and having free lengthwise movement therein, are float valves 106, 107 and 108, which are centered and guided by means of lugs 109, 110, 111, respectively, disposed at opposite ends of said float valves to permit free lengthwise movement of said valves. The area between the exterior surface of each valve and the interior bore of the tube in which it operates should be so proportioned as to be equal to or greater than the cross-sectional area of the associated non-leak distributing pipe. The inside upper end of each tubular member 103, 104, and 105, terminates in a valve seat 112, see Fig. 26. The opening 113 through this valve seat communicates with the associated passageway 41, permitting free inlet and outlet of gasoline therethrough to and from the associated distributing pipe section. The opposite ends of each float valve 106, 107, 107, are preferably armored with a suitable facing material, such, for instance as cork, as indicated at 114. The bottom end of each of the tubular members 103, 104 and 105, is interiorly screw threaded to receive the threaded end of a valve seat member 115. The flow of gasoline delivered into the tubes 103, 104, and 105, or any one or more of them, may tend to cause the float valve therein to be carried down by the force of the inflow current, thereby closing the opening through the valve seat 115. To prevent this, and if desired, I provide a spring pressed stop 116 suitably attached to a cross-bar 120, formed on or secured to a sleeve 119, which is connected to a collar 118 encircling and sliding upon the lower end of the tubular member. A spring 117 interposed between the annular flange of the valve seat member 115 and the sliding collar or ring 118 serves to yieldingly hold the stop pin 116 extended through the opening in the valve seat member 115 and into position to form an arresting stop for the valve. This structure of course permits the stop pin 116 to yield when the float valves 106, 107 and 108 are manually forced down into seating contact with the valve seat 115 to shut off the passage of gasoline from the bowl 34 into the tubular members 103, 104 and 105.

From the foregoing description it will be observed that the float valves 106, 107 and 108 serve several purposes. A description of these purposes as applied to one of said valves will serve for all of them. In the first place, the valve 106 shown in longitudinal section in Fig. 26, operates to automatically control the outlet 113 from the distributor into a connected pipe 41. Another purpose and function of the valve 106 is to determine from which tank the gasoline is to be supplied to the carbureter, and also to determine which one of the gasoline tanks connected to the distributor shall receive the gasoline being pumped. The functions of the float valve for determining which tank shall receive the gasoline being pumped, or from which tank the gasoline is to automatically flow into a carbureter, may be accomplished by manual control of the float valve. Various arrangements of devices and connections for effecting the manual control of said valves may be employed. I have shown one simple and efficient way for individually and independently controlling each float valve, and also means by which all of the float valves may be simultaneously controlled. Referring to Figs. 26 and 49, I have shown a valve control arrangement for each float valve as one simple and practical embodiment of my invention, consisting of a flexible wire member 135, which is attached at one end to a manually operable control lever 138, it being understood of course that a flexible wire connection and control lever are to be associated with each float valve. Each of the operating levers 138 is pivotally mounted in a terminal case 139 mounted upon a control board 140, see Fig. 49, arranged in a suitable and convenient position, and upon which the various manual controls may be grouped. The flexible wire connection 135 extends through a protecting tube 132. Upon the end of the protecting tube 139 is mounted a flanged sleeve 129, the flange of which bears upon the flange at the corresponding end of a sleeve 128. The flanges of the sleeves 128,

129, and the sleeve 128 also are enclosed within a hollow interiorly threaded nut or member 124 adapted to be screwed onto a hollow boss 121 formed on or carried by the pipe connections 41, each pipe connection 41 being so provided with a boss. In order to insure leak-proof joints a packing material 127 is placed within the bore of the boss 121, and the sleeve member 128 bears thereon, so that when the nut 124 is turned up, the sleeve 128 compresses and compacts the packing material 127 around the sliding wire 135. This affords a free sliding movement in the respective tubes 132 of the flexible wire member 135. The extremity of the wire 135 extends through the pipe connection 41 and into position to engage and force down the float valve 106 when the control lever 138 is operated in one direction so as to cause the float valve to seat upon the valve seat 115 at the bottom of the tubular member 103, and to firmly hold said valve against said seat when desired. By operating the lever 128 to an intermediate position, the float valve may be held or maintained in an intermediate position between the upper and lower valve seats so as to leave both the passages controlled thereby open. By this means of manual control it may easily be determined which tank the gasoline being pumped shall enter. By forcing the float valve down so as to close the passage through the valve seat 115 all flow of gasoline into the distributor, and therefore into the carbureter, is shut off.

A common outlet 140, see Figs. 3, 44 and 49, leads from the distributor bowl 34, into the carbureter indicated at 146, which outlet serves for the carbureter inlet for all gasoline passing through the distributor.

It is sometimes desirable in order to insure efficient operation of the engine to remove any foreign particles from the gasoline before delivering the same to the carbureter or to the engine. Sometimes this is accomplished by straining the gasoline before it is supplied to the tanks, in which case a special strainer is ordinarily unnecessary, particularly where the usual flexible rubber connections are not employed in the distributing pipes. If, however, it is desired to further insure against the danger of clogging the system at some point through foreign matter contained in the gasoline, a strainer indicated at 141, see Fig. 26, may be employed for this purpose, portions, or fragmentary portions, of the strainer structure being shown in Figs. 26 and 27, and in Fig. 3. This strainer fits inside of the distributor bowl 34 and around the tubes 103, 104 and 105, contained therein. In order to introduce the strainer into position within the bowl 34, said bowl is removed or detached from the casing plate 100, and the spring stops 116 and connected parts, are detached from the said tubes. Preferably a space 142 is left between the top of the strainer and the underside of the cap plate 100 of the distributor.

In the case of air craft employed in warfare, it is desirable to safeguard the carbureters, the pumps and strainers employed in the fuel distributing system so as to prevent leakage and loss of gasoline in case these members of the distributing system are punctured by a hostile bullet or fragment of shrapnel, or other missile. I have already described a system of non-leak protection in the case of the distributing pipes and their connections to the tanks, carburetors, or pumps, but in the case of the carbureters, distributors and pumps themselves, these parts offer an exposed area to gun or shell-fire both horizontally and vertically, which, if not protected against, would be just as fatal as though a pipe line is punctured or injured. And even in the case of air craft and other engine installations not required for use in warfare, the danger is often incurred of rupture or injury taking place through fracture or otherwise in case of collisions, or the like, of the tanks, the carbureters, pumps, or other major elements of the installation. In accordance with my invention, and in order to attain the highest degree of protection and safeguarding, I propose to extend the power medium area 14 of the pipe system so as to include or envelope the carbureters indicated conventionally at 146, as well as the pumps, distributors, etc. Somewhat diagrammatically in Figs. 29 to 34 I have shown the extension of the power medium area as indicated at 143, 144 and 145, so as to enclose and envelope the major parts of the apparatus. To this end I employ protecting casings having spaced apart walls, the power force spaces 143, 144, 145, being respectively provided by the spaced apart walls of said casings. In Figs. 29 and 30 I have shown the double walled outer casing 149, affording the power force space 143 in encompassing relation with respect to the distributor 100 and carbureter indicated at 146. In Figs. 31 and 32 I have shown the double walled casing 148 affording the power medium space 144 in similar encompasisng relation with respect to the distributor 100 and carbureter 146, and in Figs. 33 and 34 I have shown the inner double walled casing 147 affording the power medium area 145 as assembled with the casings 148 and 149 nested, the one into the other, all of them in encompassing relation with respect to the carbureter and distributor. The outer power medium area 143 I propose to connect with the non-leak distributing pipe 103^a, or rather with the power medium space or area of such protected pipe. In like manner I propose to connect the space 144 of the intermediate

double walled casing 148 with the power medium space of the protected distributing pipe 104^b, and with respect to the inner double walled casing I propose to connect the power medium space 145 thereof to the power medium space of the protected distributing pipe 105^c, the pipes 103^a, 104^b, and 105^c respectively, leading to the distributor tubes 103, 104, 105. In this manner efficient protection is afforded against the danger of leakage and loss of fuel or interference with the operation of the engine through puncture of the carbureter, distributor, or other vital part concerned in the distribution of the fuel, and likewise protecting these members through loss of fuel in case of the puncture or penetration thereof by an enemy bullet or shell, whether from vertical or from horizontal fire. For the purpose of permitting the assembly of the nesting casings 145, 148, 149, I provide slots 150 indicated in Fig. 31, and 151 indicated in Fig. 29, in the bottoms of the casings 148 and 149 respectively designed to receive and accommodate the distributing pipe connection 105^c of the inner casing 147.

In like manner to the extension of the power medium area through the provision of the double walled casings above described with reference to the carbureter and distributor, it is obvious that such protection may also be afforded the pump or other desired parts of the fuel distribution system.

Since any one of the connected pipes 103, 104, 105, etc., is designed to permit an ample flow of gasoline to supply the carbureter for the engine, it is obvious that even should one or two of the protecting casings 149, 148, be punctured, thereby automatically actuating the cut-off valves, there will still be remaining a sufficient supply of fuel to the engine through the unpunctured pipe remaining intact.

In order to protect the carbureters, distributors, pumps, and the like, against the action of fire, I provide suitable openings indicated at 155 in the walls of said casings, these openings being covered by a patch 154 of suitable fusible material which will fuse and melt in a comparatively low temperature, these patches being held in position by projecting lugs or arms 158 while being soldered over the openings 155. Where vacuum is employed as the power medium, these patches 154 are applied to the inner surface of a wall of the power space. This permits the exterior air pressure to force the patches inwardly to break the vacuum and to shut off the inflow of gasoline automatically in case of a fire. Where the power medium is a fluid or liquid the patches 154 should be applied to the outer surface of the casing or wall of the power medium area, thereby permitting the pressure under which the liquid or fuel is maintained within the power medium space to tend to force the patches outwardly in case of a fire, thereby releasing the power medium, and hence permitting the automatic action of the cut-off valves, and at the same time distributing a fire extinguishing medium, if such a medium is employed as the power medium.

In the case of air-craft supplied with main gasoline supply tanks and auxiliary tanks and pumps for transferring the gasoline, it is usual to employ overflow pipes from the auxiliary tanks to the main supply tanks regardless of whether the transfer pumps are hand operated or power driven. Both types of transfer pumps require intensive attention of the pilot as to the time of starting and stopping the same. If the pilot starts his transfer pump after the gasoline attains its mean low level in the auxiliary tank, the efficiency of the engine is impaired, and another danger is added to the operation of the air-craft. On the other hand, if the pilot neglects to promptly stop his pump when the mean high level in the auxiliary tank is reached, an excess overflow through the overflow pipe is liable to cause waste through the vent pipe usually employed, and also through abnormal pressure in the tank, causing the carbureter to flood, with the resulting danger of fire risk.

In accordance with my invention I propose to avoid the use of any exterior overflow pipes. As shown in Fig. 49 the auxiliary gasoline tanks 161, 162, and the main tanks 163, 164, are piped up into duplicate connection without any exterior overflow pipes. This eliminates any target area and weight as well as the danger of additional source of rupture or injury through shock, vibration, or otherwise, incident to the employment of overflow pipes.

I have shown conventionally the transfer pumps 165, 166, with their related operating eccentrics 167, 168, driven by any desired or usual independent electric or other form of motors, not shown, under the usual switch control.

In accordance with my invention, and further, for the purpose of eliminating the need for and use for an overflow pipe connection as well as to eliminate the necessity of constant attention of the pilot to the operation of the transfer pumps, I propose to employ the mean low lever of gasoline in the auxiliary tank to automatically start up the transfer pumps, and I also propose to employ the mean high level of the gasoline in said tanks to automatically stop the operation of the pumps, and I have found it desirable to accomplish such automatic control electrically by utilizing the mean high and low levels of the gasoline in the auxiliary tanks to control electric switches which are employed to control the pump action. In Fig. 37 I have shown one arrangement for

accomplishing this result, wherein a screw threaded ring 170, having an inwardly extending flange 171, is soldered, brazed, or otherwise suitably secured to the cover 192[a] of an auxiliary tank. A tube 169, which I will refer to as the gasoline mean level tube has soldered, or otherwise attached to, its upper end an outwardly extending flange member 172, which flange is adapted to rest with its connected tube 169, when installed, on the flange 171 of ring 170. If desired, a packing gasket 173 may be interposed between said flanges to make the joint leakproof. A spring metal disk 174 is soldered or brazed to the top surface of flange 172, and resting upon the peripheral portion of the disk 174 is an annular ring collar 175. Separated from the spring metal disk 174 by the collar 175 is a flexible non-metallic disk 176. A second annular ring collar 177, preferably of insulating material, is placed above and bears on the peripheral portion or edge of the disk 176. A third circular screw threaded ring nut collar 178 threads into the interior bore of the ring 170 and serves to clamp the parts together, and upon the supporting flange 171. Passing centrally through the disks 176 and 174 is a screw threaded bolt 179, to the threaded end of which is applied a binding nut 180. The lower end of this bolt is provided or formed with a rectangularly shaped opening or loop member 181, which is shouldered as indicated at 182 at its point of juncture with the bolt 179. On this shoulder is supported a packing gasket 183, on which rests a central portion of the disk 174. A collar 184 surrounds the bolt 179, and forms a spacer for the central portions of the disks 174, 176. A switch point supporting member 186 is clamped at one end between the nut ring 178 and the annular insulating ring 177, and intermediate its ends it engages over the bolt 179, being spaced apart from the disk 176 by an interposed collar 185. The binding nut 180 serves to clamp these various parts together. The switch point support 186 is preferably formed of spring metal, and carries at its free end a block 187 of insulating material in which is mounted a contact stud 188, said contact stud or terminal being electrically connected with a conductor wire 190 to form one terminal therefor. A cooperating contact stud 189 forming the terminal for a conductor wire 191 is mounted upon an insulating block 177 formed integral with the insulating ring which is clamped and held in place between the clamp ring nut 178 and the edge portion of disk 176. A cover 192, suitably secured in any convenient manner to the top of the tank, or to the frame ring member 170, as, for instance, by means of screws, as shown, or otherwise, completes the enclosure of all parts. In the gasoline mean level tube 169 is positioned a float 193, which is free to move vertically therein, a loop 194 connected to the float 193 engages in the loop member 181. The combined lengths of the openings in the loops 194, 181, determines the latitude or range of vertical movement permitted the float 193, that is, the limit of variation between the mean low level and the mean high level of gasoline in the tank. When the float 193 attains the limit of its downward movement the contact points 188, 189, are brought into contact with each other to complete an electric circuit therebetween. This is accomplished by reason of the engagement of the loop member 194 with the loop member 181. The completion of this circuit may be utilized in any well known way to start the operation of a supply or delivery pump 165, 166, or the actuating eccentric 167, 168, therefor. Likewise, when the gasoline attains its mean high level through the engagement of the yoke members 181, 194, the contact points 188, 189, are positively separated, thereby breaking any circuit connection therebetween, and this opening of the circuit may be utilized to stop or arrest the action of the transfer pump or pumps. The operation of this automatic switch device is very simple. The upward movement of float 193, as described, causes the spring disk 174 to bulge upwardly at its center post, its static spring center position thereby not only separating the contacts 188, 189, but holding them separated. The downward movement of the float pulls the spring disk 174 downwardly past its static spring center, thereby not only closing the contact points on each other but holding them closed.

The object in employing the separated disks 176, 174, is to afford a safeguard against the possibility of ignition of the gasoline through sparking at the contact terminals 188, 189.

The normal flight position of an aeroplane may be regarded as in a horizontal position, that is, level. The instant the plane flies out of level, however, a variation in the mean level condition of the gasoline contained in the tube 169 takes place, due to the rush of the gasoline into or out of said tube caused by the relative tilting of the tank. This would interfere with the proper and automatic control of the fuel delivery system and the proper functioning and operation of the motor. Various means may be employed for sealing and maintaining in the tube 169 the mean level of the gasoline in the tank. In Fig. 37 I have shown a simple arrangement for accomplishing this purpose, but do not desire to be limited or restricted to the specific details thereof. In the arrangement shown the mean level tube 169 is enlarged at its lower end and is closed by a bottom plate 196. This plate, however, is formed with a central depressed por-

tion 197, through which is formed an opening 198. The outer surface of the depressed portion 197 constitutes a valve seat. Cooperating with said valve seat is a valve 204 which is faced with suitable valve seating material such, for instance, as cork, as indicated at 205. Positioned within the enlarged chamber 199 of the tube 169 is an annular receptacle 200 having a closed annular chamber 201. The lower side of the casing 200 is formed with a supporting extension 199, which seats loosely within the depression 197 in cap plate 196. The casing 200 is pivotally connected in any suitable manner, as, for instance, by means of a link device 200^a to the valve 204. The annular chamber 201 is designed to contain a suitable free shifting medium 202. I have found that mercury is suitable for this purpose. As is well known, the fluidity of the mercury may be varied by adding nitric acid thereto. When the aircraft is flying in normal level position, the valve 204 remains open as shown in Fig. 37, for the reason that in this position the medium 202 contained in the annular chamber 201 will then level itself and maintain the casing 200 in a level position. With the valve 204 held in unseated position, the gasoline contained in the tank enters the tube 169 through the opening 198, and hence the float 193 will respond to the level of the gasoline in said tube 169. The instant the plane flies out of level, and as long as the plane remains out of level, and regardless of the angle of flight of the plane, the medium 202 in annular chamber 201, will flow by gravity to one side or the other and always to the low side of said chamber, according to the direction of tilt or angular position of the plane. This will cause the casing 200 to tilt, and in tilting it fulcrums about the lower edge of the extension 199 thereof within depression 197, thereby drawing the valve 204 into seated position. This action takes place no matter in what direction the plane may tilt, that is, whether sidewise in one direction, or the other, or fore and aft in one direction or the other, and the valve remains closed as long as the plane remains tilted, thereby cutting off the inflow and outflow of gasoline from the tank into and out of the tube 169, and hence avoiding relatively any disturbance in the mean level condition of the gasoline contained in said tube. In Fig. 38 I have shown a tilted position of the mean level maintaining device for tube 169. As above described, the main fuel supply tanks are cross connected to auxiliary distributing tanks, that is to say, where two distributing pumps are employed as indicated at 165, 166, in Fig. 49, I propose to provide controllable means whereby each pump may deliver gasoline from either the one or the other of the two main supply tanks, to either the one or the other of the two distributing tanks in the case, for example, of a four tank equipment. In such a system employing pumps connected up in the manner indicated, and actuated by electric motors which are automatically started and stopped by the mean level variations of the gasoline, it is evident that if one of the delivery pumps is put out of commission through injury or otherwise, and one of the main or distributing tanks likewise is put out of commission through injury or otherwise, if provision is made for switching in the motor of the uninjured pump to the uninjured tank automatic electrical control, I am enabled to secure a double automatic electrical efficiency and safety in the pumping distribution system. To illustrate, if pump 165, for instance, and also tank 164, see Fig. 49, should be injured for any reason, then by suitable manually controlled or operated connections which would enable the pilot or attendant to connect the uninjured pump 166, or the motor thereof, with the supply pipe lines leading to the uninjured tank 163, or said motor to the automatic electrical control thereof, or vice versa, I am enabled to attain a doubled efficiency of the equipment. Various arrangements for accomplishing this manual operation and control may be employed. As illustrative of one arrangement which is simple and efficient, I have shown diagrammatically in Fig. 40 a wire 204 leading to pump 165, or to the motor which operates said pump, and a wire 206 designed to lead to the automatic electrical control in the tank 163, with a pivotally connected switch 205 forming part of the wire connection. Likewise, wire 207 leads to the pump 166, or to its operating motor, and wire 209 leads to the automatic electric control in the tank 164 with a pivoted switch 208 completing the connection between said wires 207 and 209. With this arrangement it is obvious that the opening of switch 208 and the closing of the gap by switch 205 causes automatic electric control in the tank 163 to be switched onto pump 166. In like manner, any other desired combination between the uninjured pump and uninjured tank control thereof may be obtained. In practice this switch system is to be located on the instrument board indicated at 140 in Fig. 49. In case of puncture or injury of the protected pipe line system, or other parts of the apparatus, through the rupture or puncture of the power medium space thereof, it is desirable to provide means whereby the transfer or delivery pump 165, 166, associated with that portion of the pipe line or protected system, may be instantly arrested, otherwise danger would be incurred through the continued operation of the pump and the development thereby of abnormal pump pressure. The automatic

arrest of the pump under such conditions may be accomplished in many specifically different ways. I have shown one arrangement for accomplishing this purpose which is simple and efficient, wherein, see Figs. 41, 42 and 43, an electric switch arranged to control the circuits of the motors which operate the pumps are controlled or arranged to be operated by power medium, but at vacuum or liquid under pressure, contained in the power medium area or space of the protected parts. In the arrangement shown, the wires 190, 191, constituting the circuit wires for the pump actuating motor, are secured respectively to the insulated blocks 212, 214, which are spaced apart from each other and clamped around the outer pipe 13 of the pipe system. A downwardly tensioned metallic switch member 213 is arranged in electrical contact by any suitable means such as binding screw 215 with the conductor wire 191. By its spring tension the opposite or free end of said switch member 213 is normally held in pressure contact with the binding screw 215[a] of wire 190. Interposed between the insulating blocks 212, 214, is a sleeve 216 which encompasses the protected pipe system, said sleeve being soldered, brazed or otherwise secured, around the outer pipe 13. This sleeve 216 is provided with a laterally extending ring or flange portion 217, which is closed by means of a flexible spring metal disk 218 secured over the annular flange 217. An opening 220 through the sleeve 216 communicates between the interior of the annular flange 217 and the power force space 14. A lug 219 is carried by but insulated from the spring switch 213 which is positioned over the flexible spring cap member 218. With this structure, and with a proper power force maintained within the area 14, in case it is vacuum, acts upon the spring metal disk 218 to draw the same inwardly and hold the same away from the insulated lug 219 allowing the spring switch member 213 to rest firmly in electrical connection with wire 190, thereby completing the circuit between wires 190, 191. If, however, the vacuum is broken through a major or minor injury to the power medium maintained within the space 14, or any related space, the spring cap member 218 is released, thereby permitting its spring tension to press the same outwardly, thereby engaging lug 219 and breaking the electric circuit, thereby stopping the motor and its associated transfer or distributing pump. The above described action would be reversed in case the power force is a fluid or liquid maintained in the power area under pressure.

It is obvious that an automatic switch device of the nature and structure referred to may be located at any desired point in the system, its purpose and function being to automatically arrest the action of a distributing pump in case of injury through puncture, rupture, or otherwise at any point throughout the pipe line or distributing system associated with the same power medium area.

It is exceedingly desirable in connection with gasoline driven motor or power equipment, and especially in the case of aircraft, that the exact amount of gasoline in auxiliary or supply tanks be constantly visible, thereby enabling the attendant, pilot, or the like, in the case of an aeroplane, for example, to correctly estimate as to the necessity for replenishing his supply, or as to the possibility of continuing his flight over land or water where supplies could not be obtained, having knowledge of the consumption of fuel per hour, and the distance of travel per hour. Gasoline once admitted to the carbureter passes on therefrom to the connected engine and is consumed. Consequently a suitable meter positioned to be easily read or visible to the pilot or engineer, placed in the line of delivery of gasoline into the carbureter, would register or indicate the amount of gasoline consumed. If there is associated with such a meter means which may be set, for example, at the beginning of a flight to indicate thereon the total amount of gasoline contained in the supply tank or reservoir, with meter indicating hand set to run from total number of gallons in the tanks, as indicated on the dial, backwards toward zero, as indicated by arrow 220[b], each gallon of gasoline used leaves a record of total gallons unused. For example, if at the beginning of the operation of the plant, or of flight of an aeroplane, a total supply of 400 gallons is indicated, then as the fuel is used the meter would indicate 375, 350, 300, 200, 100, and so on, according to the amount thereof, to, say, 50 gallons is indicated as remaining, then refilling of the tanks would be necessary or desirable with a corresponding resetting of the frictionally held dial hand to the point required to indicate the total amount of gasoline contained in the tank after being refilled.

In Fig. 44 I have shown a meter 220 having dial plate graduations designed to indicate the volume of gasoline contained in a tank or reservoir, and also a dial hand or pointer 220[a], designed to be positioned at any desired point of indication with relation to the dial plate, and held in such position frictionally. If the meter were installed in a standard equipment it would ordinarily be located between the end of the supply pipe and the carbureter. In the particular arrangement shown in Fig. 44, to which, however, I do not desire to be limited or restricted, the meter is installed in the connec-

tions 221 between the combination distributor and strainer and the carbureter indicated at 146.

The danger of fire and its disastrous effects, and the provision of means to protect against such danger is of vital importance in connection with all power installations, particularly where a liquid hydrocarbon oil fuel is employed. Especially in the case of aircraft the danger of fire is perhaps more vitally important than in any other type of power installation service. Therefore all fire extinguishing means available are of relative importance in protecting the occupants of an aircraft as well as of the aircraft structure, and in safeguarding the same against the effects of a fire.

In Figs. 45, 46, 47, and 48, I have shown a form of automatic fire extinguishing device designed to be installed on an aircraft, or in association with a power plant, as a valuable part of the installation. This device is constructed on the principle of the employment of a liquid or fluid of fire extinguishing character employed as the power force in the protective system shown in Figs. 8 to 11, and hereinabove described. In the arrangement shown in Figs. 45 to 48, this principle is applied to a device which includes a lengthwise expandible and contractible spring tension metal container 222, shown in expanded or charged position in Fig. 45, and in discharged or collapsed condition in Fig. 46. This container is adapted to receive a fire extinguishing medium under pressure which is maintained under the constant or permanent spring tension of the container. The distributing pipe 223 is connected to one end of the tank or container 222. A series of low temperature fusible elements 224, see Fig. 47, are inserted at suitable points throughout the length of the pipe 223 to close openings into said pipe. These fusible elements are preferably enclosed in spraying or distributing elements 225. The free end of the pipe 223 has suitably secured thereto by soldering, brazing, or otherwise, a screw threaded valve seat 226. A check valve 227 is arranged to be normally seated against the valve seat, and held therein in any suitable or convenient manner, as, for instance, by means of a spring 228, as well as by the pressure of the medium contained in the pipe system. This check valve 227, when seated, closes an opening 229 through the valve seat member 226. A cap 230 is screwed upon the screw threaded valve seat member 226. If desired, a packing gasket 231 may be interposed between the cap 230 and the valve seat member 226. By removing the cap 220, the nozzle of a pump delivery pipe may be applied to the end of the pipe 223 for the purpose of forcing a fire extinguishing medium into said pipe and the container 222 until the desired degree of desirable pressure is attained. Any suitable fire extinguishing medium may be employed. I have found, however that carbon tetrachloride is suitable for the purpose. Since the area of an aircraft traversed by the gasoline fuel distributing pipe is limited in relation to its total fire danger area, and while the power medium space hereinabove described employing a first extinguishing fluid or liquid as a power medium constitutes an automatic fire protection for the area traversed by such pipes, nevertheless the installation of additional automatic fire protecting devices of the character provided by the pipe 223 and container 222, or any desired number of such devices in additional areas which might be exposed to a fire is of vast importance and value if proper fire protection is to be provided for the safety of passengers and crew as well as the power installation structure or aircraft. It will be understood of course that in case of fire one or more of the fusible elements 224 in the neighborhood of the fire will become fused by the heat to which it or they may be subjected, thereby releasing the fire extinguishing medium contained in the pipe and container, and permitting such medium to be sprayed through the spraying elements 225 under the force of constant pressure to which such medium is subjected by the spring tension of the container.

In Fig. 49 I have shown somewhat diagrammatically a conventional grouping of the various elements of a typical power installation embodying the several combinations thereof with an instrument board, and I have selected for such grouping a proper application of the various devices hereinbefore described and explained according to a system designed for use by the Government in connection with battleship planes with two engines, using two complete systems with suitable cross connections.

In the arrangement shown, the supply tanks 161, 162, are connected by pipes 234, 235, leading to their respective pumps 165, 166. Control valves 236, 237, associated with each tank, control the openings from said tanks into said pipes 234, 235, respectively. Preferably, and as shown, these valves, and mainly the related pipes, are located inside the tanks, thereby eliminating them from target area in the case of aircraft employed for war purposes. A pipe connection 238 intermediate the tanks 161, 162, connects said tanks. Disposed at a convenient point in the length of this connecting pipe 238 is a control valve 239. The two valves 236, 237, are normally held in open or unseated position, thereby permitting the pumping of gasoline from the respective tanks 161, 162, by the respective pumps 165, 166. Valve

239 is normally closed, thereby restricting the respective pump delivery to the respective associated tanks. In case of injury to either tank 161, 162, and loss of gasoline therefrom, the respective control valve 236, or 237, as the case may be, is closed, and the intermediate valve 239 opened, thereby permitting both pumps to deliver from the same tank. In the event that either pump 165, 166, becomes injured or put out of commission, then, by opening valve 239, the contents of both tanks 161, 162, may still be equally distributed between the auxiliary tanks 163, 164, or pumped into either one of said tanks and delivered therefrom to both carbureters, by the control system hereinabove described. Attached to the stem of each valve are control wires or connections 240, 241, 242, said wires extending through tubes 243, 244, 245, to convenient points on the control board 140 and its manually operable levers 138 by which said valves may be individually and manually unseated as exigency may require.

It may sometimes be desired to effect a collective control of all of the valve controlling levers 138. This may be accomplished in various ways. A simple arrangement is shown wherein a shaft 246 is journaled upon the instrument board 140 in suitable bearings, and is for rotative movement, said shaft being formed with angle portions 246ª arranged in suitable relation with respect to the several valve controlling levers 138 so that when said shaft is rocked, all of said levers will be simultaneously actuated. The shaft 246 may be rotated or actuated to effect the collective actuation of all of the valve controlling levers 138 in any suitable or convenient manner. I have shown a simple arrangement wherein an extension or hand lever 247 is formed integrally with or connected to shaft 246, and by means of which said shaft may be operated. The principal object of this feature of collective simultaneous control of all of the valve connections is to provide means whereby should for any reason a pilot of an airship lose control of his engine during flight, due to an accident or an act of war, all of the valves concerned in the operation of the engine may be instantly controlled from a point conveniently located with reference to the pilot or engineer, and from a single point.

I have shown an overflow pipe 248 associated with pump 165, and an overflow pipe 249 associated with pump 166. These overflow pipes are mounted within the tanks and therefore are removed from target area, and they operate through coordinating pump release valves 250 and 251 to provide an outlet for the pumps 165, 166, respectively, in case their respective outlet pipes 105ᶜ, 105ᶜᶜ, become clogged or stopped from any cause. Access to the overflow pipes 248, 249, may be obtained by means of screw threaded caps 254, 255, mounted in members secured to the inside of the upper ends of the supply tanks. Interposed in the pipe connections 234, 235, from the tanks 161, 162, to the pumps 165, 166, respectively, are relief valves 250, 251. The several valves 252, 250, 251, 253, are yieldingly held normally seated by means of springs 258, 259, and in practice I prefer to employ springs 258 for the valves 250, 251, of greater tension than the springs 259 employed in connection with the valves 252, 253. This will insure the flow of gasoline under all normal conditions to the proper tank or combination distributor and strainer, and will prevent same from passing through the pump overflow pipes 248, 249, except in case a pump outlet pipe should become stopped up or clogged, or otherwise put out of commission, as for instance, by the automatic closing of its terminal valves through injury to the related pipes or connected parts.

I also interpose between each pump 165, 166, and its delivery pipe connection 155ᶜ, 155ᶜᶜ, a normally seated valve 260, which cooperates with the valves 252, 253, in securing the above described result.

From the foregoing description, it will be seen that I provide means to safeguard and increase the efficiency of the fuel distributing system employed in connection with power plants, and particularly such power plants as are employed in connection with aeroplanes, and other installations employing internal combustion engines where the fuel medium is a liquid hydrocarbon. It will also be seen that I provide simple and efficient apparatus for affording protection and safeguarding against the results of fire through ignition of leakage of the fuel medium or from other cause. It will be seen that in case of accident or injury, or other cause, resulting in rupture, or puncture, of a fuel distributing pipe, or other cooperating and associated part of the installation, the supply of the fuel medium is instantly cut off in the engine part of the apparatus, and any leakage resulting from such accident, rupture, or the like, is confined to the immediate vicinity of the puncture or injury. It will also be seen that a structure embodying my invention not only affords a measure of safety never before attained in the respects above mentioned, but it permits the employment of a fire extinguishing medium which is released by the injury, puncture, or the like, and serves the purpose not only of being supplied or delivered within the fire area, but even where actual ignition of the leakage of fuel does not take place it serves to dilute the leakage of fuel medium by mixing therewith, thereby reducing the danger of ignition thereof. It will also be seen that I provide against danger of injury or of

possible disaster due to the shocks, vibrations and like causes resulting from the operation of the power plant. I also provide a system of control which permits the continued operation of the engine even though some one or more of the supply tanks of the distributing pipes may have been put out of commission through accident, or otherwise, and I group at a single convenient control station or point, means to manually and individually control the various elements or simultaneously control them as exigency might require, with the provision at a convenient point of means to indicate at once to the pilot or engineer the condition or amount of the fuel oil supply.

While I have described and claimed herein a non-leak safety fuel distributing system irrespective of the situation in which such a system may be employed, and I have indicated the use thereof in connection with aircraft, submarines, and the like, my invention therefore is not to be limited or restricted with respect to any particular use. In the case of aircraft of all kinds, and particularly in the case of aircraft of the dirigible balloon type, the application of a system embodying my invention will be especially valuable for the reason that the cost of an aircraft of that type is many times that of an ordinary aeroplane, and hence requires greater attention to its safety of operation. Moreover, such an aircraft ordinarily carries a larger supply of gasoline and more engines, and more widely separated engines, requiring distributing pipes of very much greater total length, as compared with the power installation on an ordinary aeroplane. Again, in a dirigible, the inflating gas of the balloon element is always in jeopardy from the inflammability of the fuel supply, and, finally, and perhaps more important than all, the safety of a larger cargo, whether of freight or of persons, is involved.

It will be understood that many variations and changes in the details of structure may readily occur to persons skilled in the art and still fall within the spirit and scope of my invention as defined in the claims.

I do not desire therefore to be limited or restricted to the exact details shown, but having now set forth the objects and nature of my invention, and various constructions embodying the principles thereof, what I claim as new and useful and of my own invention, and desire to secure by Letters Patent is,—

1. In a fuel distributing system, a distributing pipe, an enclosing casing therefor forming therewith a closed space, means for supplying and maintaining a power medium in said space, and valves respectively controlling the intake and discharge ends of said pipe, said valves being influenced into open position by the power medium and operating to close said pipe ends when the power medium is released, and a tell-tale or indicator device associated with said space and influenced into indicating position by the release of said power medium.

2. In a fuel distributing system, a distributing pipe, an enclosing casing therefor forming therewith a closed space, means for supplying and maintaining a power medium in said space, control valves at the respective ends of said distributing pipe arranged to be controlled by said power medium, and means to release said power medium.

3. In a fuel distributing system, a distributing pipe, an enclosing casing therefor forming therewith a closed space, means for supplying and maintaining a medium under pressure within said space, and valves respectively controlling the intake and discharge ends of said pipe, said valves being influenced into open position by the medium under pressure, and operating to close said pipe ends when said medium is released.

4. In a fuel distributing system, a distributing unit including telescoping pipes arranged to form a closed space between them, a valve arranged at each end of the unit to control, respectively, the intake and discharge openings therein, means to supply and maintain a power force in said space, said power medium operating to restrain said valves in unseated position, said valves automatically seating when the power medium is released from said space, and means disposed along the length of said pipe to restrain the free flow of fuel medium therethrough when said valves are seated.

5. In a fuel distributing system, a distributing unit including telescoping pipes arranged to form a closed space between them, a valve arranged at each end of the unit to control, respectively, the intake and discharge openings therein, means to supply and maintain a power medium in said space, said power medium consisting of fire extinguishing medium maintained under pressure in said space, and operating to restrain said valves in unseated position, said valves automatically seating when the said medium is released, and means disposed along the length of said unit to release the pressure medium from said space when subjected to abnormal rise of temperature.

6. In a fuel distributing system, a distributing unit including telescoping pipes arranged to form a closed space between them, a valve arranged at each end of the unit to control, respectively, the intake and discharge openings therein, an expansible and contractible resilient member associated with each end of said unit and communicating with said space, a valve connected to each resilient member, and respectively operating to control the intake and discharge ends of

said unit, and means to supply a medium under pressure to said space and resilient members.

7. In a fuel distributing system, a distributing pipe, a protecting pipe telescoped thereover but spaced therefrom to form a closed space, a valve to control the flow of fuel in said pipe, a casing in which said valve is mounted, a boss on said casing having a passage communicating with said closed space, a valve seat fitted to said boss, and having an opening communicating with said passage, an outwardly seating valve adapted to said valve seat, and means to connect a pump to said boss to deliver a medium under pressure through said opening and passage and into said closed space, said medium operating to control said first mentioned valve.

8. In a fuel distributing system, a distributing pipe and an enclosing casing therefor, forming therewith a closed space, said pipe and casing being made in sections, and a valve casing arranged in the line of said sections, and connected at opposite sides to the adjacent ends of said sections, said casing forming a continuation of said closed space, and also having a passage therethrough, a valve arranged in said casing to control said passage, means to maintain a power medium in said closed space, said valve being controlled by said power medium, a terminal pipe disposed in line with one of said pipe sections, a multiple fold cylindrical sheet metal spring tube telescoped at its ends over said pipe connection and said terminal pipe respectively and secured thereto.

9. In a fuel distributing system, a distributing pipe and an enclosing casing therefor, forming therewith a closed space, said pipe and casing being made in sections, and a valve casing arranged in the line of said sections, and connected at opposite sides to the adjacent ends of said sections, said casing forming a continuation of said closed space, and also having a passage therethrough, a valve arranged in said casing to control said passage, means to maintain a power medium in said closed space, said valve being controlled by said power medium, a terminal pipe disposed in line with one of said pipe sections, a multiple fold cylindrical sheet metal spring tube telescoped at its ends over said pipe connection and said terminal pipe respectively and secured thereto, and means to form a leak proof joint between said spring tube and said terminal connection, including a tapered packing, means for clamping the same on the terminal connection, said means also operating to clamp the end of said flexible tube on said packing.

10. In a fuel distributing system, a distributing pipe and an enclosing casing therefor, forming therewith a closed space, said pipe and casing being made in sections, and a valve casing arranged in the line of said sections, and connected at opposite sides to the adjacent ends of said sections, said casing forming a continuation of said closed space, and also having a passage therethrough, a valve arranged in said casing to control said passage, means to maintain a power medium in said closed space, said valve being controlled by said power medium, a terminal pipe disposed in line with one of said pipe sections, a multiple fold cylindrical sheet metal spring tube telescoped at its ends over said pipe connection and said terminal pipe respectively and secured thereto, and means to form a leak proof joint between said spring tube and said terminal connection, including a tapered packing and mounted on the end of the terminal connection, a slide mounted on said terminal connection and against which said packing abuts, a cap ring engaging said sleeve and a plug mounted in said cap ring and tapered to correspond to the taper of the packing, said plug operating to clamp the end of the flexible tube to said packing and the packing to the end of said terminal connection.

In testimony whereof I have hereunto set my hand on this 23d day of June A. D., 1922.

WILLIS J. PERKINS.