

July 2, 1946.

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2,402,964

DEVICE FOR SUPPLYING STARTING FUEL

Filed Jan. 11, 1943

Fig. 1

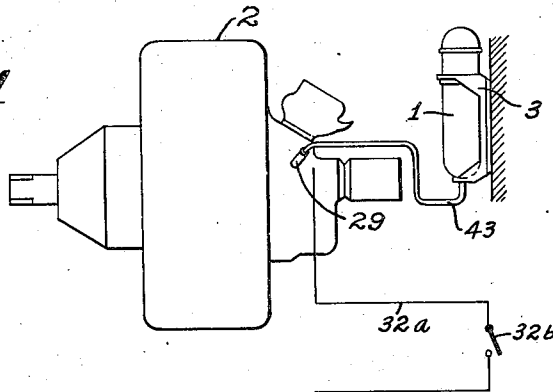


Fig. 2

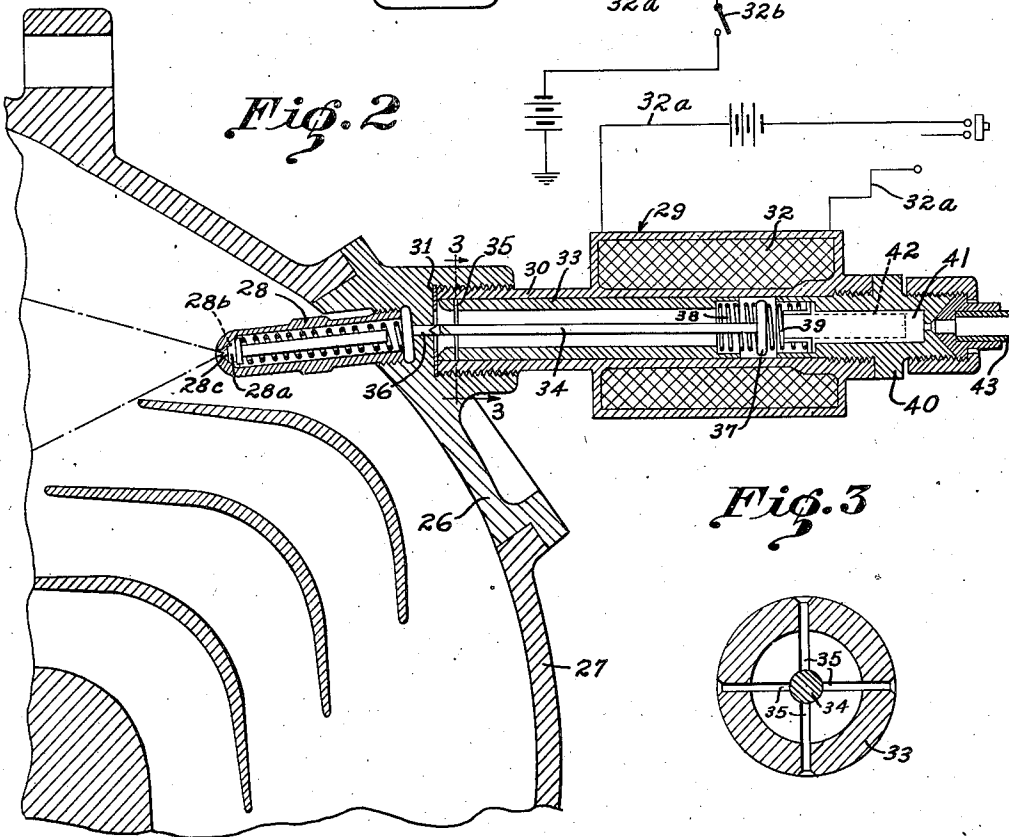


Fig. 3

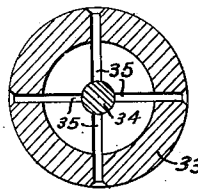
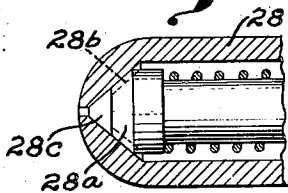


Fig. 4



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UNITED STATES PATENT OFFICE

2,402,964

DEVICE FOR SUPPLYING STARTING FUEL

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Application January 11, 1943, Serial No. 472,084
In Sweden December 1, 1941

11 Claims. (Cl. 123—180)

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The present invention refers to devices for supplying starting fuel to internal-combustion engines, particularly aircraft engines, by means of an injection nozzle opening into the inlet channel of the engine.

The principal object of the invention is to provide an improved device of the type indicated which can be relied upon to facilitate the starting of internal-combustion engines even in cool weather when the need for supplying a starting fuel is greatest.

Another object of the invention is to provide a device of the type indicated by which a special fuel, which has a sufficiently high vapor pressure even at low temperatures to form a combustible mixture with air and which is therefore suitable for the starting of internal-combustion engines, can be supplied to the latter.

A further object of the invention is to provide a device of the type in question which is capable of proportioning the injected quantity of fuel so that the engine receives neither too much nor too little fuel.

A still further object of the invention is to provide a device of the type in question which can be electromagnetically controlled from the cockpit of an aeroplane, by means of a single and light mechanism.

Further objects and advantages of the invention will appear from the following description thereof.

The invention is illustrated in the accompanying drawing in a preferred embodiment. In the drawing

Figure 1 is a diagrammatic view showing how the fuel supply device of the invention is used in an internal combustion engine.

Fig. 2 is a vertical section through a unit composed of a remote controlled valve and an injection nozzle, said unit being inserted in the wall of the inlet channel of an engine.

Fig. 3 is a detailed cross-sectional view of the core and valve needle on the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary axial sectional view of the nozzle head.

The device illustrated in Fig. 1 consists of a starting fuel tank with associated mounting and coupling means and a valve and nozzle unit 29 which is mounted on the inlet-pipe of the engine 2 and is connected with the fuel tank through a pipe or hose conduit 43. The fuel tank may be mounted at any suitable place on the aeroplane or other vehicle with which the engine is associated. In multi-engine aircraft a starting fuel tank may be provided for every engine, whereby long pipings are avoided. The fuel employed can be chosen at will to suit various conditions, but it should be such that it has a relatively high vapor pressure also at low temperatures. If desired, a fuel having a vapor

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pressure which at ordinary temperatures substantially exceeds the atmospheric pressure may be used. The tank is filled for example to two thirds with the fuel, while the remaining volume is filled with a suitable inert gas under pressure, e. g. carbon dioxide or nitrogen gas.

The fuel tank consists of a closed cylindrical vessel 1, which is made to endure a considerable overpressure. The tank standing vertically is carried by a bracket 3, to which it is removably fastened.

The valve and nozzle unit, which is illustrated in Figure 2, consists of a fitting 26 which is inserted in a hole in the wall of the inlet channel 27 of the engine, preferably closely in front of the fan (not shown in the drawing) which compresses and propels the fuel-air mixture to the cylinders. On the inner side of the fitting an injection nozzle or atomiser 28 is screwed in. This nozzle may be of a well-known construction and is shown as having a conical head 28a with grooves 28b therein leading to a jet orifice 28c. On the outer side of the fitting 26 a remote-controlled valve 29 is mounted. This valve which is of the electromagnetic type, consists of a cylindrical housing 30 of non-magnetic material which is screwed into a socket on the fitting 26 against a sealing packing 31 and carries the other parts of the valve. On the outer side of the housing 30 a solenoid 32 is provided, and within the housing a tubular iron core 33 is slidable. In the boring of the iron core a valve needle 34 of a considerable length in relation to its thickness is guided for axial movement by at least one circular row of pins 35 fastened in the iron core and projecting radially inwards in such a manner as to define a central guide passage for the needle 34 without blocking the boring. At its inner end the valve needle is formed with a valve cone which cooperates with a valve channel 36 which is formed in the material of the fitting 26 and leads to the nozzle 28. The valve cone is made very thin, to reduce the force which the fuel pressure exerts when the valve is closed. The opposite end of the valve needle is supported by a collar or piston-like disc 37 which is slidable in the housing 30 and is provided with holes for the passage of the fuel. The disc 37 has a certain radial play in the housing which is slightly greater than the size of the largest solid particles which may be present in the fuel even if it is strained, in order that the disc may not be jammed on account of these particles. Between this disc 37 and the adjacent end of the iron core 33 there is provided a helical spring 38 which when the valve is closed is only slightly tensioned and through which the movement of the iron core outwards at the energization of the solenoid 32 is transmitted to the valve needle 34 for opening the valve. Owing to the spring 38

keeping the disc 37 and the iron core spaced from each other, the iron core has time, before the valve needle can begin to move, to accumulate a certain amount of kinetic energy which, upon impact of the iron core against the disc, is made use of for moving the valve needle against the fuel pressure. It is therefore possible to use a smaller solenoid 32 than would be required in case the magnetic force would have to overcome the fuel pressure directly. By means of the spring 38 the valve needle is dynamically isolated from the iron core 33, so that it is not prevented owing to the inertia of the iron core from following the vibration of the stationary parts during the operation of the engine. The valve needle itself has so small a mass that the force exerted by the fuel pressure well suffices for holding the valve needle pressed against its vibrating seat irrespective of its own inertia. On account of the play of the disc 37 in the housing 30 vibrations between the latter and the disc can take place in the radial direction, but owing to the great length of the needle the amplitude of vibration corresponds to such a small angle of deviation of the needle at its seat that the sealing of the valve cone does not suffer. A second helical spring 39, which is placed between the disc 37 and a plug 40 screwed into the outer end of the housing 30 and acts on the valve needle in the direction towards its seat, serves to shut the valve when the energization of the solenoid has ceased. The plug 40 has an axial boring 41 in which a fuel filter 42 is arranged which determines the maximum size of the solid particles which can accompany the fuel through the valve and thereby, as explained above, the radial play of the disc 37. The outer end of the plug is formed as a nipple for the connection of the pipe conduit from the fuel tank 1.

The solenoid 32 is connected in a circuit 32a which can be closed and broken by a switch 32b for example from the cockpit in an aeroplane. Preferably, the solenoid is connected in parallel with the starting coil. If desired, it may instead be connected in parallel with the starting motor, the supply of starting fuel taking place automatically when the starter is pressed.

When the fuel tank 1 is mounted in place, the fuel is under pressure right up to the valve 29, and when this valve is opened by the means described above, the fuel will therefore immediately flow into the nozzle 28. The latter is dimensioned to give a suitable proportion of mixture of the starting fuel and the air drawn-in. The reduction of the pressure in the tank which takes place as the fuel is consumed does not influence the proportion of mixture to such a degree that the explosion limit is exceeded. When the fuel tank is empty it can be replaced by a new one with a turn of the hand.

It has been assumed above that the fuel tank is to be mounted on the aircraft the engine or engines of which it is to provide with additional fuel, but this is not necessary. The tank may also be mounted on a servo-carriage on the airfield and a hose conduit from the tank be temporarily connected with the nozzle on the engine by means of a coupling device such as that described.

Although the invention has been described above in connection with aircraft engines, it must not be considered limited to these. It may equally well be employed for fuel supply to other internal-combustion engines than aircraft engines, among others to engines driven by generator gas

to give assistance at the starting, hill-climbing etc.

What I claim and desire to secure by Letters Patent is:

1. A device of the type described, comprising a fuel tank, coupling means for said tank, nozzle means for introducing fuel into an engine, a conduit connecting said nozzle means with said coupling means, valve means including an axially movable valve needle and inserted in said conduit, a solenoid, an iron core movable within said solenoid, an intermediate member connecting said iron core with said valve needle for delayed transmission of movement from said iron core to said valve needle in the valve opening direction against the action of fuel pressure, and an electric circuit for energizing said solenoid.

2. A device of the type described, comprising a fuel tank, coupling means for said tank, nozzle means for introducing fuel into an engine, a conduit connecting said nozzle means with said coupling means, valve means including an axially movable valve needle and inserted in said conduit, a solenoid, an iron core movable within said solenoid, an elastic intermediate member connecting said iron core with said valve needle for building up a force on the latter in the valve opening direction to overcome the force of fuel pressure, and an electric circuit for energizing said solenoid.

3. A device of the type described, comprising a fuel tank, coupling means for said tank, nozzle means for introducing fuel into an engine, a conduit connecting said nozzle means with said coupling means, valve means including an axially movable valve needle and inserted in said conduit, a tubular non-magnetic housing, a solenoid mounted on said housing, a tubular iron core movable within said housing, said valve needle being placed within said iron core, a member on said valve needle for guiding the latter in said housing, a spring inserted in said housing between said iron core and said member to transmit movement from the core to the valve needle in the valve opening direction against the action of fuel pressure, another spring inserted in said housing and acting on the valve needle in the valve closing direction, and an electric circuit for energizing said solenoid.

4. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve member of small sealing area in relation to its length provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, an impact member provided within said housing, an elastic intermediate member between said valve member and said impact member, and means for causing said impact member by compressing said intermediate member to build up a force on said valve member sufficient to move the latter away from its seat against the fuel pressure.

5. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said

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nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, an impact member provided within said tubular housing and movable axially therein, an elastic intermediate member between said valve needle member and said impact member, and means for causing said impact member by compressing said intermediate member to build up a force on said valve member sufficient to move the latter away from its seat against the fuel pressure.

6. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, a tubular impact member provided within said housing and surrounding said valve needle member, an elastic intermediate member between said valve needle member and said impact member, and means for causing said impact member by compressing said intermediate member to build up a force on said valve needle member sufficient to move the latter away from its seat against the fuel pressure.

7. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular non-magnetic valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, a tubular iron core movable axially within said housing and surrounding said valve needle member separate from the latter, an elastic intermediate member between said valve needle member and said iron core, and a solenoid for causing said iron core by compressing said intermediate member to build up a force on said valve needle member sufficient to move the latter away from its seat against the fuel pressure.

8. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, a disc member mounted on said valve needle member at the end thereof remote from the valve seat for guiding the valve needle member in said housing, a tubular iron core movable axially within said housing and surrounding said valve needle member, an elastic intermediate member inserted in said housing between said disc member and said iron core, and a solenoid for causing said iron core by compressing said intermediate member to build up a force

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on said valve needle member sufficient to move the latter away from its seat against the fuel pressure.

9. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, a disc member mounted on said valve needle member at the end thereof remote from the valve seat for guiding the valve needle member in said housing, said disc having a radial play in said housing larger than the maximum size of any solid particles that may be contained in the fuel and corresponding to negligible vibratory angles of deviation of said valve needle member, a tubular iron core movable axially within said housing and surrounding said valve needle member, an elastic intermediate member inserted in said housing between said disc member and said iron core, and a solenoid for causing said iron core by compressing said intermediate member to build up a force on said valve needle member sufficient to move the latter away from its seat against the fuel pressure.

10. In a device of the type described, nozzle means for introducing starting fuel into an engine, means for connecting said nozzle means with a source of fuel under pressure, a tubular valve housing connected in the path of the fuel to, and in the proximity of, said nozzle means, a valve seat at one end of said housing near said nozzle means, a light-weight valve needle member provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, a disc member mounted on said valve needle member at the end thereof remote from the valve seat for guiding the valve needle member in said housing, a tubular iron core movably axially within said housing and surrounding said valve needle member, a spiral spring inserted in said housing around said valve needle member between said disc member and said iron core, and a solenoid for causing said iron core by compressing said spring to build up a force on said valve needle member sufficient to move the latter away from its seat against the fuel pressure.

11. In a device of the type described, a fitting to be mounted in an opening in the manifold of an engine, nozzle means for introducing starting fuel into the engine mounted on the inner side of said fitting, valve means provided on the outer side of said fitting and communicating with said nozzle means through a channel in said fitting, and means for connecting said valve means with a source of fuel under pressure, said valve means comprising a valve housing, a valve seat at the inner end thereof, a light-weight valve member of small sealing area in relation to its length provided within said housing and cooperating with said seat to keep the valve closed under the action of the fuel pressure, and means for moving said valve member away from its seat against the fuel pressure.

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