July 12, 1966 J. S. BERNARD 3,260,211

MULTIPLE PUMP APPARATUS

Filed Aug. 16, 1965

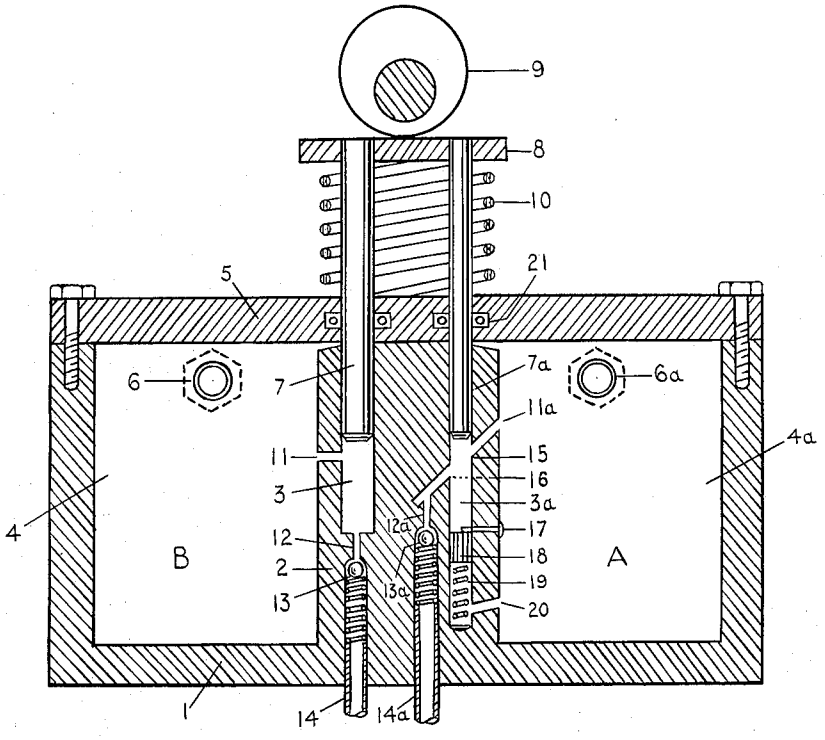


Fig. 1

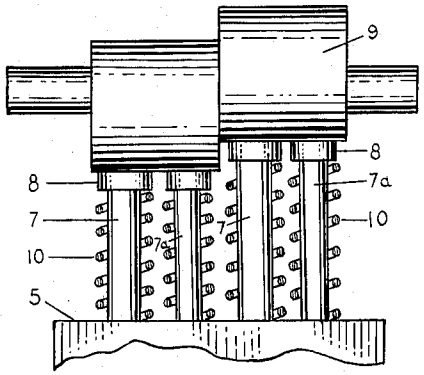


Fig. 2

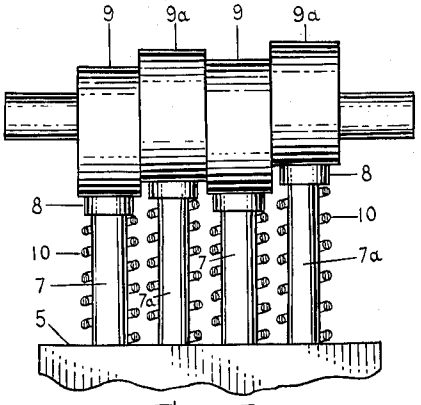


Fig. 3

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MULTIPLE PUMP APPARATUS

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3 Claims. (Cl. 103—4)

This application is a continuation-in-part of my co-pending application, Serial Number 262,633, which was filed March 4, 1963.

This invention relates to pumping apparatus which pump and deliver liquids by means of reciprocating plungers or pistons, and particularly to pumps of this class which pump and deliver two or more liquids during each apparatus stroke cycle.

The prior case dealt with the use of a primary and a secondary piston encased in the same pump cylinder bore and the operation of this arrangement to effect the sequential delivery of a first and then a second liquid. The present invention deals with an arrangement which is capable of effecting either the simultaneous or the sequential delivery of two liquids.

The basic difference between this and my prior invention is that the prior apparatus employs an auxiliary piston to effect two pumping and delivery actions from the same cylinder bore, whereas the auxiliary piston of the present apparatus is utilized to effect a single pumping and delivery stroke from one cylinder bore while a simultaneous pumping and delivery stroke is being performed in a second pump cylinder.

The present apparatus is primarily designed to deliver two different grades of fuel to a main cylinder or to an auxiliary pre-combustion chamber of an internal combustion engine. In the intended application a high test gasoline will be delivered to a pre-combustion chamber and be ignited therein and a second fuel of a much lower grade will be injected into the burning first fuel charge as it is being passed from the pre-combustion chamber into the main cylinder of the engine.

The pump will also have many other useful applications as it may serve to pump and deliver a wide variety of liquids and, as hereinafter described, the pump can be designed to deliver these liquids in any predetermined sequence. Therefore, whenever it is necessary or desirable to deliver two liquids and precisely time their delivery, the inventive concepts herein advanced may be utilized.

The invention will be more readily understood by reference to the accompanying drawing, wherein:

FIGURE 1 shows an end view of a pump cylinder block and a piston cylinder combination suitable for pumping and delivering two liquids simultaneously;

FIGURE 2 shows an alternate means for reciprocating the pistons in unison; and

FIGURE 3 shows a means whereby the pistons may be reciprocated in a staggered sequence.

The apparatus of FIGURE 1 has an outer casing or housing **1** sectioned and formed in a convenient manner so as to provide two chambers **4** and **4***a* which are separated one from the other by the cylinder block **2**. A cover **5**, resting on the upper center portion of the block **2** and bolted or otherwise affixed to the side and end walls of the casing **1** may satisfactorily serve to seal the two chambers **4** and **4***a* and thereby prevent the fuels or liquids to be contained therein from leaking therefrom and/or mixing with one another.

Liquid ducts **6** and **6***a* are to be extended from the receptacles and would connect to independent sources of liquid (not illustrated). These ducts are to be adapted to bring a first liquid into the area A and a second liquid into the area B. These liquids would fill their respective receptacles to a level sufficient to submerge the intake ducts **11** and **11***a*.

A pair of cylinder bores **3** and **3***a* are to be provided in the block **2** for each engine cylinder or for such other intended points of delivery for the liquids A and B. One cylinder bore **3** would preferably extend through the block and have a lateral fuel intake duct **11** for communicating the bore **3** with its liquid chamber **4**. The intake duct **11** may be arranged in the block so as to intersect the bore **3** within the inward and the outward reciprocating limit of the plunger **7** as shown in the illustration. In this case the plunger **7** will act as a valve for closing the intake duct **11**. When the plunger **7** is utilized as the means to seal off the intake duct **11** all downward plunger movement below the lowermost portion of the intake duct is effective in forcing the liquid B through the duct **12**, around the check valve **13**, and through the delivery duct **14**. It will be noted that an adjustable reciprocating means **9** would allow the effective stroke of the plunger **7** to be altered and thus variable amounts of the liquid B could be pumped and delivered.

Another obvious manner of entering fuel into the bore **3** would be to provide a check valve (not illustrated) of any suitable design in the intake duct **11** and if such check valve arrangement were provided the point of intersection of the duct **11** with the bore **3** could be positioned below the lowermost reciprocating limit of the plunger **7**. However, providing a check valve means in the intake duct **11** and positioning its point of intersection with the cylinder **3** below the reciprocating limit of the plunger **7** will only permit constant amounts of the liquid B to be pumped and delivered as all plunger movement would be effective.

The lower extremity of the bore **3** should contain a check valve **13**. This check valve may be adapted to seat against a discharge duct **12** of a smaller diameter than the main cylinder bore **3** as illustrated. It is desirable to have the check valve arrangement **13** as near to the intake duct **11** as the lowermost reciprocating limit of the plunger **7** will allow, but if this is not possible in a particular design the check valve may be positioned outside the block **2** in any convenient position along the delivery line **14**.

The second cylinder bore **3***a* would be parallel with the cylinder bore **3** and extended into the block **2**. The bore **3***a* is adapted to contain an auxiliary free piston **18** which has a diameter corresponding to the diameter of bore **3***a*. The free piston **18** is to be held below the lowermost reciprocating limit of the plunger **7***a* by a suitable obstruction such as the illustrated rivet **17**. A compression spring **19**, adapted to operate between the bottom of the piston **18** and the bottom of the bore **3***a*, urges the piston **18** to assume a normal position of rest against the obstruction **17**. A relief duct **20** is provided below the lowermost reciprocating limit of the piston **18** and communicates the bottom of the bore **3***a* with the liquid chamber **4***a*.

The intake duct **11***a* is extended through the bore **3***a* in a manner which provides a linear distance between the points **15** and **16** where duct **11***a* intersects and passes through the bore **3***a*. The distance between these points **15** and **16**, together with the diameter of the bore **3***a* determines the maximum amount of fuel or liquid which can be ejected from the bore **3***a*. An economical and practical means of establishing the volume limit of the pumping stroke from the cylinder **3***a* is to alter the angle of the intake duct **11***a*. In FIGURE 1 the intake duct **11***a* is extended through the bore **3***a* on a rather pronounced angle so as to better illustrate the distance between points **15** and **16**. Altering this angle will change the linear distance between these points and thus alter the volume of liquid which can be pumped from the cylinder **3***a*.

The plunger **7***a*, as it passes the point **15** on its downward stroke will begin to force the liquid A through the discharge duct **12***a*, around the check valve **13***a*, and on

through the delivery duct **14***a* to the intended delivery point for the liquid A.

When the plunger **7***a* passes the point **16** a hydraulic coupling will be established between the bottom of the plunger **3***a* and the top of the free piston **18**. The force of the pistons downward movement is transferred through the liquid coupling and acts to force the free piston **18** downward and thus forces that part of the liquid A below the piston **18** out of the bore **3***a* through the relief duct **20**.

A critical point in the construction of the apparatus is to have the diameter of the piston **18** precisely conform to the diameter of the bore **3***a* and to insure that the spring **19** is stronger than any pressure acting against the liquid in the delivery line **14**. Should the spring **19** be weaker than the resistance in the delivery line **14** the delivery of liquid A cannot be effected.

The illustrations show three means for reciprocating the plungers **7** and **7***a*. The arrangement in FIGURE 1 shows the outward extremity of the plungers **7** and **7***a* fastened onto a cap **8**. A compression spring **10**, operative between the cover **5** and the under side of the cap **8**, holds the assembly in contact with a cam **9**. Thus, whenever the cam **9** is rotated, the plungers will reciprocate in unison.

FIGURE 2 illustrates a cam **9** made large enough to catch the caps **8** of both plungers **7** and **7***a*. The elongated cam **9** will, with the aid of the springs **10**, reciprocate the plungers **7** and **7***a* in unison.

FIGURE 3 shows a means for staggering the delivery times of liquids A and B. By providing individual cams **9** and **9***a* for the respective plungers **7** and **7***a*, any delivery sequence for the liquids may be established. In this particular illustration the cam **9** will start the downward, or effective stroke of the plunger **7** prior to the cam **9***a* starting the downward stroke of the plunger **7***a*. When the intake ducts **11** and **11***a* are positioned at a uniform depth as shown in FIGURE 1 this cam arrangement will start the delivery of liquid B prior to the delivery of liquid A. It can be readily seen that, by positioning the cams **9** with respect to the cams **9***a*, any sequence of delivery for the liquids A and B may be established.

The foregoing specifications clearly set forth the invention; namely, the use of an auxiliary free piston to effect the simultaneous or sequential delivery of two liquids from a pump apparatus. It is to be clearly understood that the selected embodiment in no way limits the design of an apparatus utilizing this invention and that all rights are reserved when any application falls within the scope of the claims hereinafter set forth.

I claim:

1. A dual delivery pump apparatus having a cylinder block, a first cylinder bore in said block, a first reciprocating plunger slideably received in said first bore, a liquid duct through said block and angled through said first bore between the inward and the outward reciprocating limits of said first plunger, an obstruction within and partially blocking said first bore below the innermost reciprocating limit of said first reciprocating plunger, an auxiliary free piston mounted for reciprocation within said first bore inward from said obstruction, a compression spring within said bore below said free piston, a relief duct communicating the bottom of said first bore with said first liquid and a second cylinder bore in said block vertically aligned with said first bore, there being a second reciprocating plunger member slideably received in said second bore and a cap means joining the free ends of said plungers outside of said block, said cap engaged with the apparatus reciprocating means.

2. A reciprocating piston type pump apparatus comprised of the combination of a cylinder block having a center portion containing two independent and vertically aligned cylinder bores; sealed liquid receptacles on opposite sides of said center portion; a reciprocating member having a cap with two piston extremities fastened thereto in a manner aligning said pistons with said cylinders, the free ends of said pistons being mounted for reciprocation within said cylinder; a liquid duct extending from each such receptacle and engaged with independent sources of liquid, each said liquid adapted to flow through its respective duct into its respective receptacle; an intake duct communicating one such cylinder with one such liquid and a second intake duct communicating the second cylinder with the second such liquid, said ducts engaging their respective cylinders at a point between the inward and the outward reciprocating limits of said pistons; a discharge duct in the first named cylinder below the inward reciprocating limit of said reciprocating member; a discharge duct in the second named cylinder below said cylinder's intake duct and within the inward and outward reciprocating limit of said reciprocating member; an obstruction within and partially blocking said second named cylinder below the innermost reciprocating limit of said reciprocating member; a free piston mounted for reciprocation within said second named cylinder inward from said obstruction; a compression spring within and operative between said free piston and the bottom of said second named cylinder; and a relief duct means communicating the bottom portion of said second named cylinder with its respective liquid receptacle.

3. A liquid pumping and delivering apparatus comprising the combination of a pump cylinder block; a first liquid receptacle adjoined to a side of said block, a second liquid receptacle, adjoined to said block on the side opposite from said first liquid receptacle, a first cylinder bored in said block, a first plunger member having an end portion thereof equal in diameter to and slideably received in said first cylinder, a second cylinder bored in said block parallel to said first cylinder, a second plunger member having an end portion thereof equal in diameter to and slideably received in said second cylinder, said plungers having caps outward from said block engaged with the apparatus reciprocating member, a first liquid admitting duct extended from said first liquid receptacle and engaged with said first cylinder between the inward and the outward reciprocating limits of said first plunger, a first liquid discharging duct engaged with said first cylinder inward from the innermost reciprocating limit of said first plunger, said first liquid discharging duct adapted to deliver said first liquid through a check valve means to a predetermined delivery point outside of said block, a second liquid admitting duct extended from said second liquid receptacle and engaged with said second cylinder between the inward and the outward reciprocating limits of said second plunger, a second liquid discharging duct engaged with said second cylinder, said second liquid discharging duct being engaged with said second cylinder at a point within the reciprocating range of said second plunger and inward from said second liquid admitting duct, an obstruction within and partially blocking said second cylinder inward from the innermost reciprocating limit of said second plunger, a free piston member having a diameter equal to said second cylinder and mounted for reciprocation therein below said obstruction, a compression spring within and operative between the inward extremity of said free piston and the bottom of said second cylinder and a relief duct communicating said second liquid receptacle with said second cylinder at a point below the innermost reciprocating limits of said free piston.

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