Jan. 17, 1933. W. P. SILLINCE 1,894,834

PUMP MECHANISM FOR EFFECTING A PRESSURE FEED OF LIQUIDS

Filed Feb. 16, 1931 4 Sheets-Sheet 1

Fig. 1.

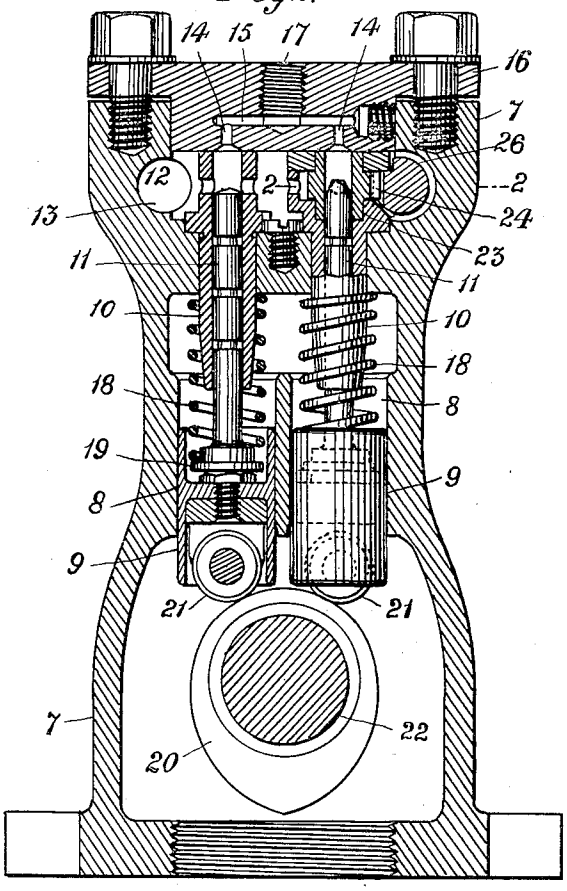

Fig. 2.

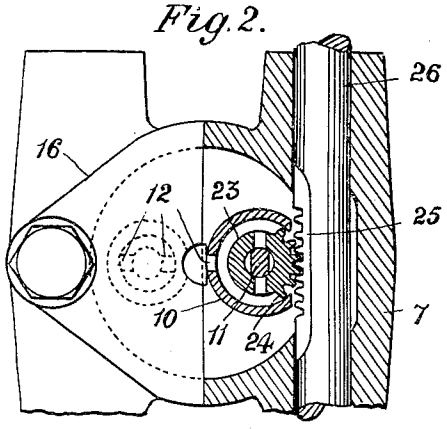

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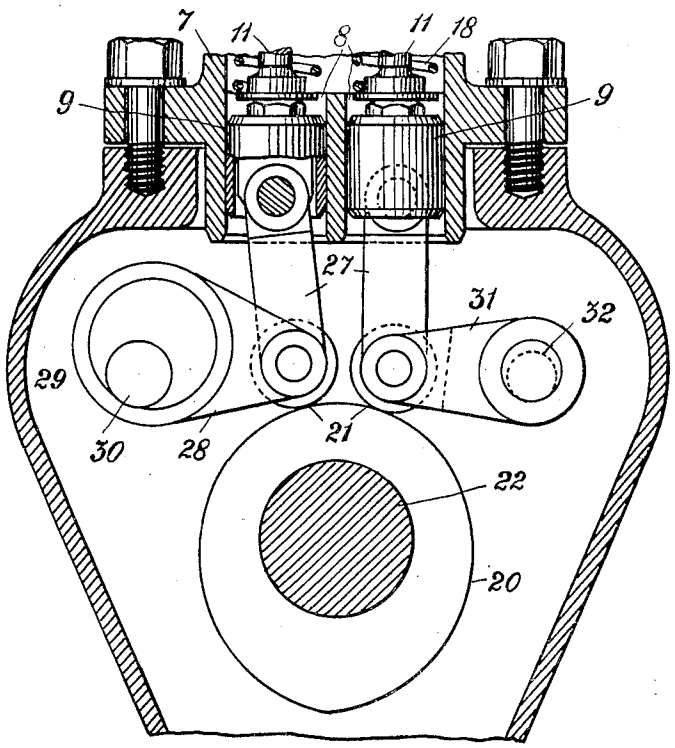
Fig. 3.



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PUMP MECHANISM FOR EFFECTING A PRESSURE FEED OF LIQUIDS

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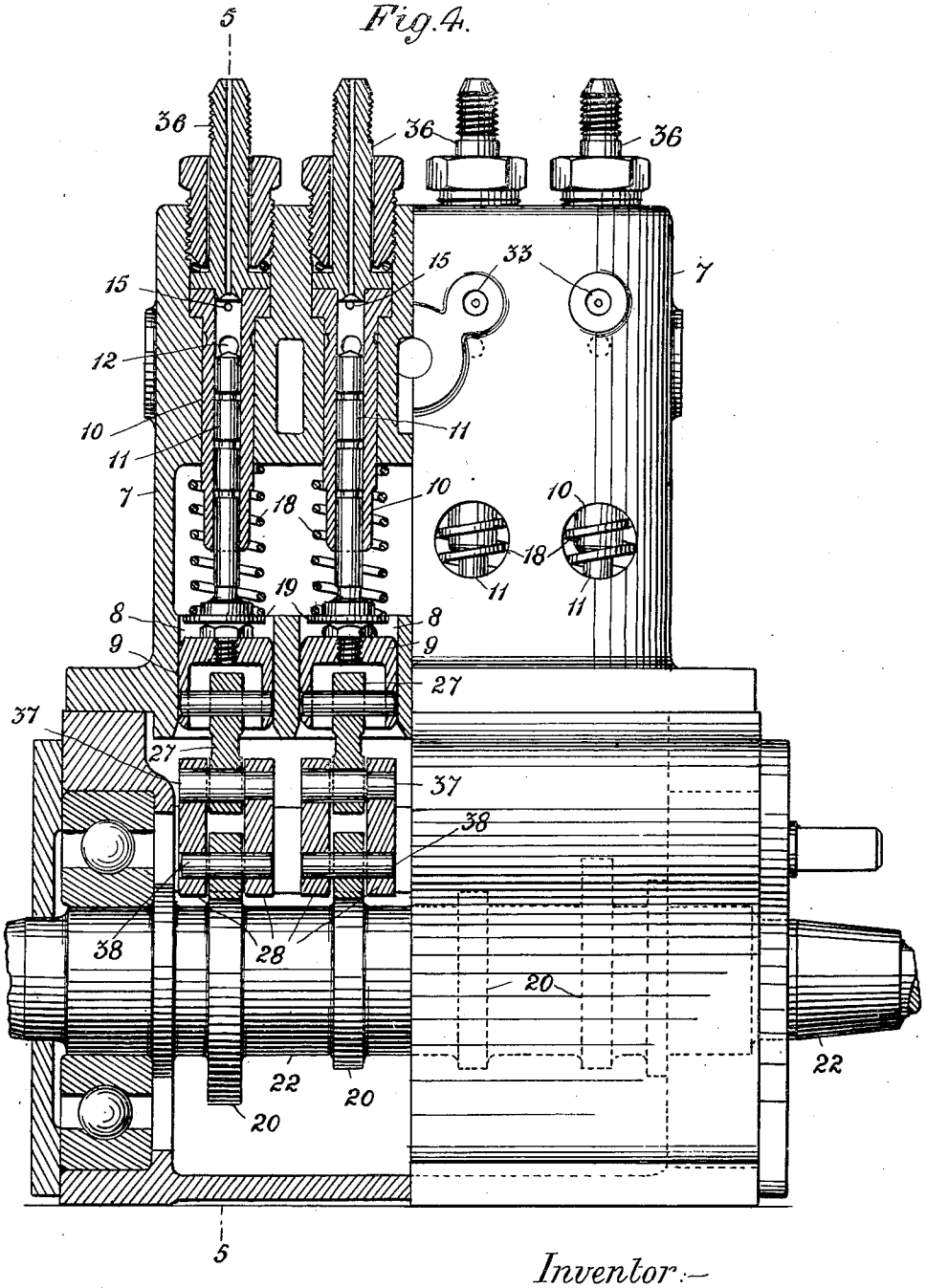
Fig. 4.



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PUMP MECHANISM FOR EFFECTING A PRESSURE FEED OF LIQUIDS

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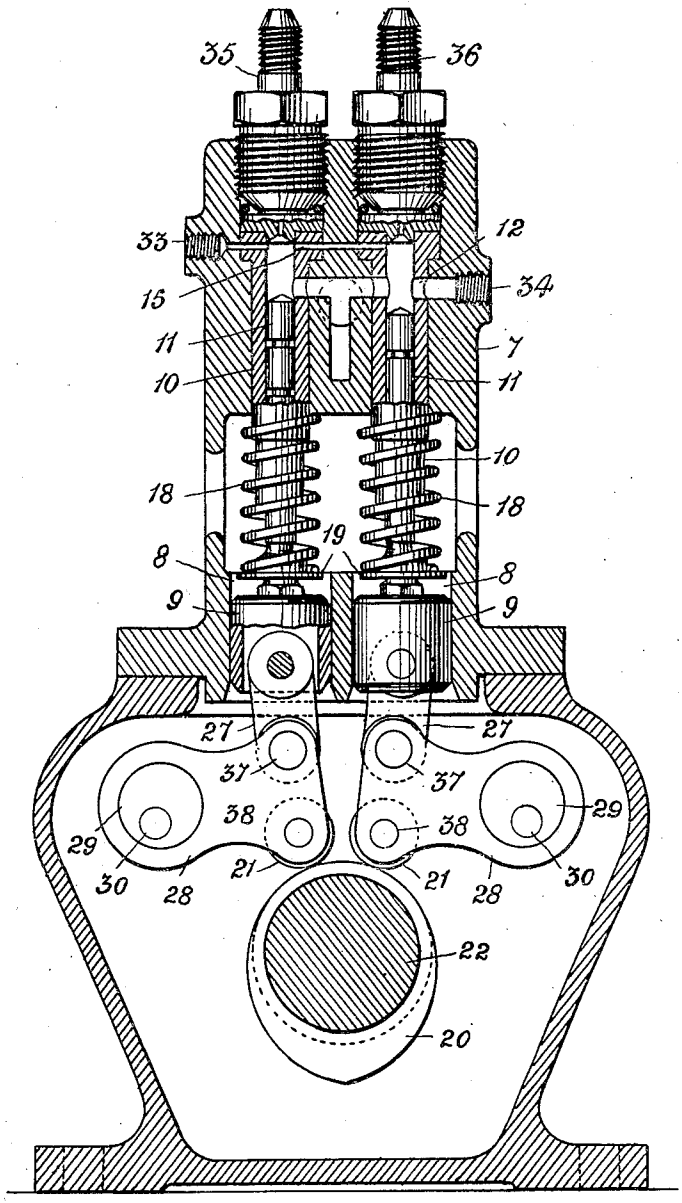
Fig. 5



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Patented Jan. 17, 1933 1,894,834

UNITED STATES PATENT OFFICE

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PUMP MECHANISM FOR EFFECTING A PRESSURE FEED OF LIQUIDS

Application filed February 16, 1931, Serial No. 516,184, and in Great Britain April 1, 1930.

This invention has reference to improvements in or relating to pump mechanism for effecting an intermittent pressure feed of liquids such for example as the pump mechanism employed for effecting and controlling the oil fuel injection to the combustion chambers, or nozzles or atomizing devices used in conjunction with the combustion chambers of engines of the Diesel or like type wherein the fuel is injected under pressure.

As is well known it is common practice in engines of the type aforesaid to employ for effecting an intermittent injection of fuel a pump, or in the case of multiple cylinder engines a plurality of pumps, according to the number of cylinders in the engine, the said pump or pumps being of the reciprocating single plunger type and having combined and co-acting therewith as a part of each pump a valve serving to control the delivery of fuel therefrom and also functioning, by acting at the appropriate time, to diminish pressure in the feed pipe, to minimize what is technically termed "dribble" in the feed of the fuel injected, mechanism being combined with the pump or pumps for effecting a rotational setting of the plunger or plungers thereof for the purpose of adjusting grooves in the acting ends of the plungers relative to the inlet ports in their barrels or cylinders and thus permitting the quantity of fuel delivered per stroke to be regulated and otherwise controlling the action of the pump or pumps.

In order to obtain a maximum of efficiency in the use of pump injection mechanism for the purpose aforesaid it is desirable that the delivery of the oil fuel to the feed pipe or other connection with the engine should take place at a high and practically uniform pressure and that cessation of pressure in the feed pipe or other connection should be instantaneous on completion of the injection operation so that "dribble" may be entirely obviated.

To attain these desiderata it is necessary that the pump plunger (or pump plungers) should have acquired a considerable speed before delivery of fuel is permitted to commence and that means be provided to maintain a constant pressure effect during injection and until the predetermined point, dependent upon the load and speed, at which delivery of the fuel is required to cease, when the pressure in the feed pipe or connection should then be caused instantly to drop preferably to about atmospheric pressure.

Further, during the suction action of the pump a comparatively long period of rest, or of relatively slow plunger motion is requisite or desirable in order that the pump passages or chambers may become filled with liquid for the subsequent delivery stroke to eject, this desideratum being particularly called for in pump feeds employed in connection with fast running engines.

These desiderata are not fulfilled by the pump feed mechanisms ordinarily employed and the present invention has for its object to provide mechanism whereby they are attained and a very efficient operation of the mechanism is ensured.

The invention has the further advantages that the provision of valve mechanism to control delivery from the pump barrel or cylinder is dispensed with and the rotational adjustment of reciprocating plunger members is obviated.

Broadly the invention consists of pump feed mechanism particularly applicable for the injection of liquid fuel to the combustion chambers of internal combustion engines, or nozzles or atomizers in conjunction therewith, but which may also be applied in other connections where the same or like conditions of liquid feed may be called for, said pump feed mechanism being characterized by the provision therein, or in each element where a plurality of feed elements are employed as is the case where the mechanism is used in connection with multiple cylinder engines, of reciprocating plungers disposed in barrels or cylinders the discharge ends whereof are in communication with a common delivery passage or port, said barrels or cylinders having a port or ports communicating with a fuel supply which may be common thereto, and the combination therewith of mechanism whereby the plunger members may be reciprocated "out of phase", means being also preferably provided for

controlling the output and instant of the fuel injection.

The invention will be further and more particularly described with reference to the accompanying drawings, wherein:—

Figure 1 represents in vertical section a convenient embodiment of pump mechanism in accordance with the invention designed for effecting a pressure feed of liquid fuel to a single cylinder internal combustion engine of the Diesel type or for like purpose.

Figure 2 is a plan of the same showing one half in section on the plane indicated by the dotted line 2—2, Figure 1, and with portions broken away.

Figure 3 is a fragmentary view illustrating a modification hereinafter more particularly referred to.

Figure 4 represents partly in front elevation and partly in vertical section mechanism embodying four pump elements in accordance with the invention and designed for use with a four cylinder Diesel or like internal combustion engine.

Figure 5 is a transverse section on the plane indicated by the dotted line 5—5, Figure 4, certain parts being shown in elevation.

Figures 4 and 5 also illustrate a modification of the means whereby the control of the output and instant of the fuel injection can be effected.

The same numerals of reference indicate the same or corresponding parts in the several figures of the drawing.

Describing first the arrangement represented in Figures 1 and 2, the pump element comprises a body or casing 7 adapted for mounting adjacent the engine, said casing 7 being bored internally to provide two cylindrical guideways 8 in each of which a piston-like member or cross-head 9 is disposed and adapted to slide.

The axes of the said guideways 8 are preferably, but not necessarily, parallel, and located in the body or casing 7 and above and co-axial with each guideway 8 is a barrel or cylinder 10 wherein a rod 11 is adapted to fit and slide plunger-wise. The said barrels or cylinders 10 are provided with suction ports 12 adjacent their upper ends, the ported parts being located in a chamber 13, hereinafter referred to as the suction chamber, in the upper part of the body and which chamber is maintained filled with the liquid fuel to be supplied to the engine by a gravity or other feed of the fuel thereto.

The upper or discharge ends of the barrels or cylinders 10 are placed in communication with each other through end ports 14 entering a common passage 15 in the head 16 of the body, which head is preferably made separate from the main part 7 and bolted thereto, and the said common passage 15 is placed in communication with the atomizing nozzle or other connection with the combustion chamber of the engine by way of the passage 17 which is adapted to receive a suitable nipple or connection, not shown.

The plungers or piston rods 11 and the barrels or cylinders 10 wherein they are located constitute a pair of pumps which on reciprocation co-act to feed a predetermined volume of liquid fuel to the engine.

The plungers of the pumps are, or may be, maintained in their normal or bottom of stroke positions by the action of coiled springs 18 disposed around the lower part of the barrels 10 and the parts of the plungers 11 projecting therefrom, the said springs 18 taking a bearing at their upper ends against suitable shoulders provided in the body or casing 7, their lower ends being located in the recessed or tubular upper parts of the piston-like members or cross-heads 9 and taking a bearing against a flange or shoulder 19 at the lower ends of the plunger rods.

Preferably there is no positive connection between the plungers 11 and the pistons or cross-heads 9 and the lifting of the plungers against the action of the springs 18 may be effected through the medium of a cam 20 on which anti-friction roller devices 21 mounted in the recessed lower parts of the cross-head or piston-like members 9 are adapted to bear, the said cam 20 being carried by a shaft 22 appropriately geared with the engine shaft or otherwise driven and so designed and operating as to effect the "out of phase" reciprocation hereinbefore referred to of the pump plungers.

For the purpose of controlling the action of the pump and permitting great nicety of regulation of the predetermined quantity of fuel to be delivered per stroke of the plungers the ported upper end of one of the barrels may have combined therewith an adjustable liner or sleeve-like member which co-acts with the ports in the barrel to vary the point of cut-off by the plunger in the said barrel.

In a suitable construction and arrangement for this purpose the upper end of the barrel is, as is seen in Figure 1, enlarged to provide a recess wherein a ported liner-like member 23 is fitted the bore of the said liner-like member being axially in alignment with the barrel and of the same diameter as the plunger in the said barrel a portion of the upper end of the plunger extending into the liner.

Means are provided for preventing the reciprocating plunger from rotating and its upper end is so shaped that by rotational adjustment of the liner-like member 23 relative to the plunger the point at which the reciprocating plunger will close or cut-off the ports in the liner can be regulated with great nicety.

The rotational adjustment of the liner 23 to the desired control position may be effected by the provision on its outer periphery of

a toothed quadrant 24, the teeth of the said quadrant meshing with a toothed rack on a rod or bar 26 mounted to slide in the upper part of the main casing 7 and operable by hand or by mechanical means which may be governor controlled.

Briefly the action of the pump mechanism described is as follows:—

In the normal positions of the parts, that is to say, when the plungers are at the bottom of their strokes the suction chamber, upper ends of the pump barrels and communicating ports and passages are filled with liquid fuel. On commencement of operation the cam first imparts motion to one only of the pump plungers the other or "lagging" plunger remaining temporarily at rest or if moving travelling with appreciably less speed than the leading piston.

No liquid however can be delivered to the feed pipe to the engine until both plungers have closed their respective ports for if one plunger only has closed its supply port, and would thereafter ordinarily commence its delivery of fuel to the engine cylinder, it will be prevented from so doing, since the suction port of the lagging plunger is still uncovered, and the delivery from the leading pump will take place through the suction passage of the lagging pump until the latter is closed by its plunger. By the time the lagging plunger closes its ports both the plungers are moving with considerable velocity, and the delivery to the cylinder will consequently commence with promptitude, and at a very uniform pressure. Thereafter both plungers proceed to deliver liquid to the cylinder at a rate proportionate to the sum of the individual plunger speeds.

When nearing the end of its delivery stroke, the speed of the leading plunger begins to diminish, while the speed of the lagging plunger is correspondingly increased, the relative plunger speeds being maintained at any desired appropriate figure.

When the leading plunger reaches the end of its delivery stroke, it comes momentarily to rest, and ceases to deliver fuel although the lagging plunger has not yet reached the end of its delivery stroke, and is consequently still delivering fuel at an appropriate pressure.

As soon as the leading plunger commences its suction or return stroke (its suction port being still covered) the fuel which remains to be delivered by the lagging pump is received into the barrel of the leading pump, thus causing an instantaneous cessation of supply of fuel to the engine cylinder. To assist in this, and also assist in the reduction of pressure in and withdrawal of liquid from the delivery piping, the plunger of the leading pump is or may be made of somewhat larger diameter than that of the lagging pump, and further, its rate of return is preferably made greater than the rate of motion of the lagging plunger for the remainder of its delivery stroke. Thus the delivery of fuel ceases suddenly, and the delivery piping is instantly relieved of fluid pressure.

The adjustable sleeve 23 operable by the sliding rod 26 and mounted as hereinbefore described within a recess in one of the pump barrels 10 is disposed in that barrel in which the "lagging" plunger operates, its adjustment serving to determine the point of cut-off in the said barrel and thereby regulating the amount of liquid ejected by the pump to the feed pipe to the engine.

I wish it to be understood that I do not limit myself to the precise details of construction and arrangement of the parts described as the same may be varied without departing from the nature of the invention.

For example, the means for controlling the point of cut-off of the "lagging" plunger may be constituted by a sleeve-like member disposed around the ported end of the barrel instead of being located therein said sleeve having a gap or port so shaped that on partial rotation of the sleeve it co-acts with a port in the barrel to effect the desired variation in the point of cut-off. Or a ported sleeve-like member adapted to be adjusted axially relative to the barrel may be employed for the same purpose, in which case the reciprocating plunger has a port therein which communicates with an axial bore in an extension of the upper end of the said plunger. The axial adjustment of the ported sleeve for setting its port in the desired position for determining the point of cut-off may conveniently be effected by providing a screw thread on the exterior thereof said thread working in a rotatable screw box or nut disposed in a suitable recess in the casing, the periphery of the said screw box or nut being toothed for engagement with a racked sliding control bar or a worm on a rotating control member, the sleeve being prevented from rotation so that on rotation of the nut or screw box in one or other direction its axial adjustment is effected.

Or instead of regulating the instant and output of the fuel injection by the provision of an adjustable sleeve member as above described the control of the instant of fuel injection and output may be effected by means adapted to vary the out-of-phase difference of reciprocation of the two plunger members.

Embodiments of this modification are illustrated in Figures 3, 4 and 5 of the drawings.

According to the arrangement represented in Figure 3 I combine with each of the piston-like or cross-head members 9 which serve to raise the plunger rods 11 into the operative or injecting positions a swivelling link 27, the said links depending from the guideways 8 in which the pistons or cross-heads 9

are located and carrying at their free ends the rollers or anti-friction members 21 which rest on the periphery of the actuating cam 20.

One or other, or both, of the swivelling link members 27 carrying the contacting rollers 21 has an eccentric or crank and link connection with a rotatable shaft and this control mechanism is adapted to be actuated manually and/or mechanically or governor controlled.

In the said arrangement, Figure 3, eccentric mechanism for effecting this control is shown in connection with one of the swivelling link members 27, the said member having pivotal connection with the arm or link 28 mounted on the eccentric sheave 29 on a rotatable shaft or spindle 30.

The said control mechanism operates to adjust the relative positions between the cam rollers 21 and it will be appreciated that by adjustment of the said rollers relative to each other and to the periphery of the cam 20 whereon they bear the out-of-phase operation of the plunger members 11 and consequently the output of fuel and instant of the injection thereof can be very efficiently varied and regulated.

Where provision is made for the control or adjustment of one only of the roller carrying links, the said control means are preferably combined with the leading plunger and I may in this case combine with the roller carrying link 27 in connection with the other or trailing plunger means whereby an initial adjustment of the said roller may be effected and the adjusting means then locked or secured in their adjusted position.

For example, as shown in Figure 3 the roller carrying link 27 in connection with the lagging plunger has connection with an arm 31 which is mounted on an eccentric part of the bearing shaft or spindle 32 and may be adjusted thereon to permit the initial setting of the plunger to compensate for any inaccuracies of workmanship, or the re-setting of the plunger from time to time to compensate for wear.

Further modifications in the construction and arrangement or combinations of certain of the parts hereinbefore described are illustrated in Figures 4 and 5 which represent a suitable embodiment of the invention for use in connection with a four cylinder engine.

In the said arrangement the main casing 7 is not provided with a separate head, the head being formed integral with the said main casing which is constructed to receive the requisite number of pump elements each pump element comprising two plunger members 11 and reciprocating means in connection therewith.

As will be seen from an examination of these Figures the plungers 11 reciprocate in barrels or cylinders 10 to which the fuel admission takes place through independent admission or suction ports 33, 34 opening thereinto and the barrels or cylinders are in communication only through the common delivery passage 15 in the upper part of the main casting. Two outlet passages from the head are provided conveniently constituted by the tubular nipples or pipe connections 35, 36. One of these outlets only namely the passage through the nipple 35 is utilized for the ejection of the fuel from the pump, the other passage being merely an air release passage.

It will be appreciated that instead of barrels or cylinders 10 made separate from the main casting the cylinders for the plungers 11 may be constituted by borings made in the main casting.

The said Figures 4 and 5 further illustrate a modified construction of the link mechanism by adjustment of which variation in the degree of out-of-phase reciprocation of the plunger members can be effected, the said modification consisting in so shaping the members 28 which are mounted on the eccentric sheaves 29 on the spindles 30 and carry the cam contacting rollers or anti-friction devices 21, that the links 27 whereby the said members 28 are connected with the piston-like members 9 have a connection with the said members 28 on joint pins 37 independent of the pins or pivots 38 on which the rollers 21 are mounted. This construction has the advantage that the pivot 38 can be of considerably reduced length as compared with the similar pin in the arrangement shown in Figure 3 which has to have a length sufficient to accommodate the forked ends both of the link 27 and the member 28 as well as the roller 21.

What I claim is:—

1. Pump mechanism for effecting an intermittent pressure feed of liquids in which the pump or each pump element incorporates as a combination a liquid supply, a pair of cylinder barrels, ports in said barrels intermediate the ends thereof which place the barrels in communication with one another and with the liquid supply, outlet means from the said barrels, to a common feeding passage, plunger members reciprocably mounted within said barrels and adapted to control the ports in the respective barrels and means for reciprocating the plunger members out-of-phase, the means for reciprocating the said plungers being such that no delivery can be effected until the inlet ports in both barrels have been closed by their respective plungers and the said plungers have each attained relatively high velocity for the purpose of minimizing dribble in the feeding operation.

2. Mechanism for effecting an intermittent pressure feed of liquids, according to claim 1, in which each pair of plunger members is actuated by a single cam so that when

the initial movement is imparted to the leading plunger the lagging plunger is momentarily at rest and so that the suction stroke of the leading plunger commences before that of the lagging plunger.

3. In mechanism for effecting an intermittent pressure feed of liquids, according to claim 1, means for varying the degree of out-of-phase of the plunger members in order to vary the output and instant of liquid feeding with respect to the pump cycle.

In testimony whereof, I have signed my name to this specification.

WILLIAM PATRICK SILLINCE.