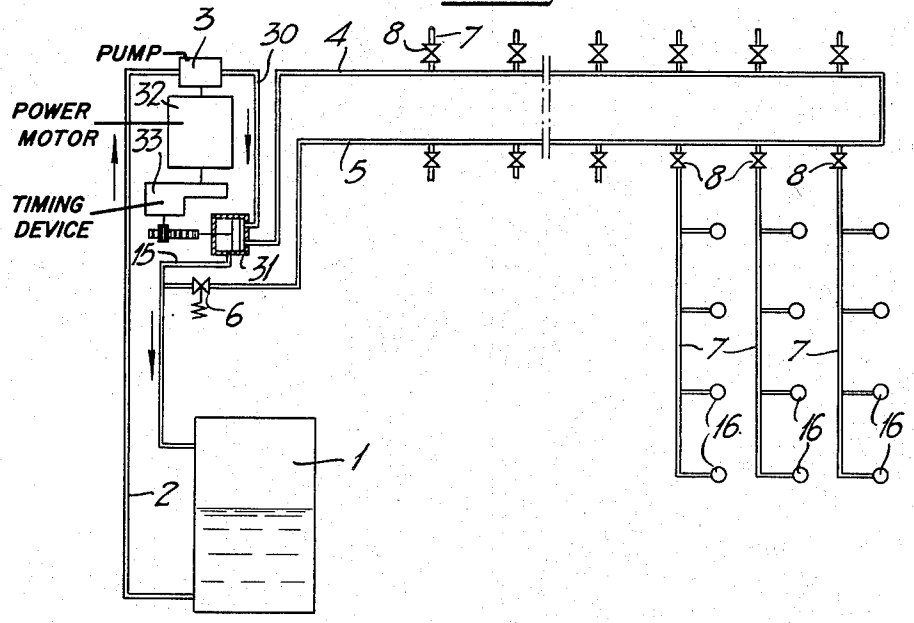
Nov. 30, 1954 B. C. W. HAGELIN ET AL 2,695,662

FUEL DISTRIBUTION TO PLURAL INJECTOR BURNERS

Filed May 13, 1949 4 Sheets-Sheet 1

FIG. 1.



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FUEL DISTRIBUTION TO PLURAL INJECTOR BURNERS

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FIG. 2

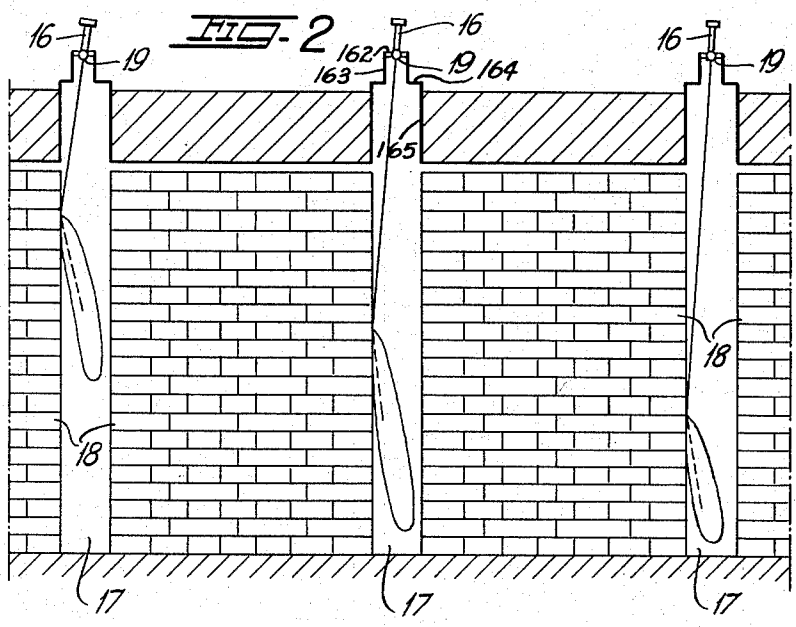


FIG. 3

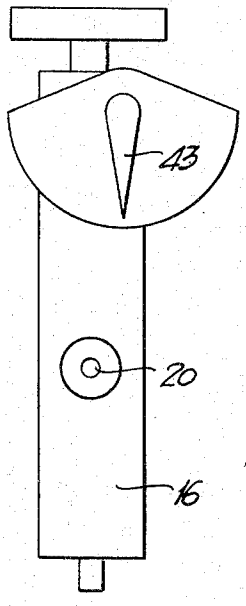


FIG. 4

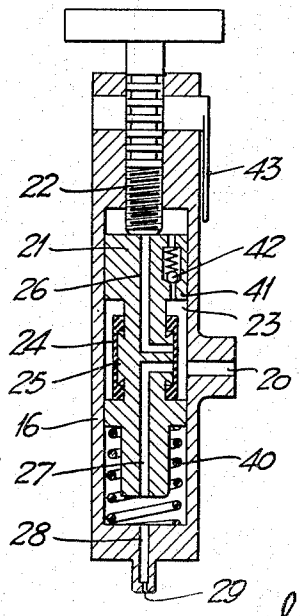
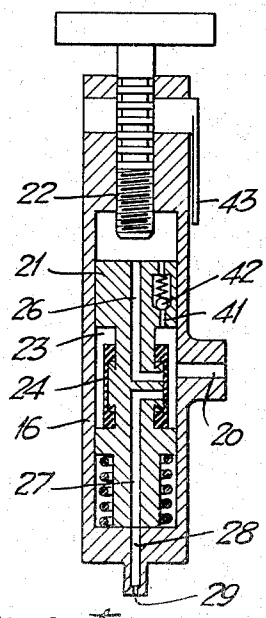


FIG. 5



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FUEL DISTRIBUTION TO PLURAL INJECTOR BURNERS

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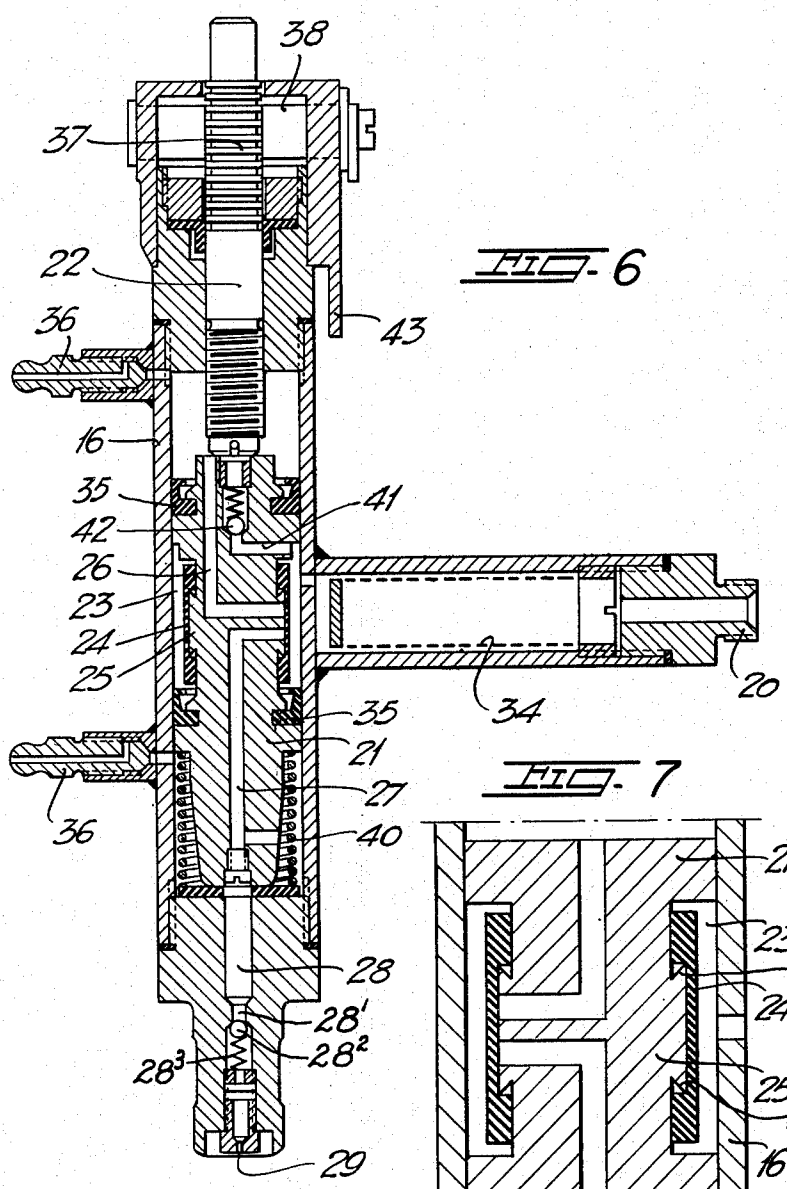


FIG. 6

FIG. 7

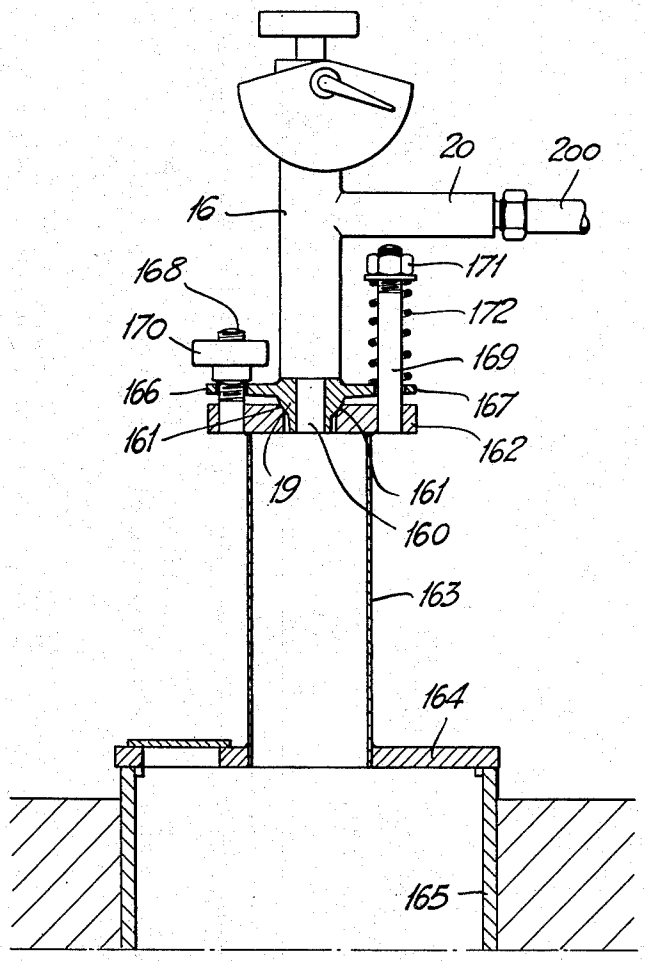
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FUEL DISTRIBUTION TO PLURAL INJECTOR BURNERS

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FIG. 8



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FUEL DISTRIBUTION TO PLURAL INJECTOR BURNERS

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1 Claim. (Cl. 158—36.4)

The present invention relates to a method of and means for distributing liquid matters from a main conduit to a plurality of consumption places in such a way as to satisfy certain predetermined requirements. The invention is especially applicable to the distribution of fuel oil to a furnace, having a plurality of oil injection points, such as for instance, a furnace for roasting of bricks, lime or the like. In the operation of such furnaces it may often be of advantage to abandon the hitherto commonly used firing with solid fuel and instead thereof use liquid fuel, as oil or tar. The use of liquid fuel permits an automatic control of the operation of the furnace, because of the fact that the feeding of the solid fuel, its placing into the furnace, and the removal of the ash may be dispensed with. In addition, the use of liquid fuel renders it easy to obtain a continuous control of the distribution of the fuel to the various portions of the furnace. This in its turn results in a better quality of the product and an economizing of the fuel. To these advantages are added such advantages as are inherent with the fact that a liquid fuel may be less expensive than a solid fuel as regards purchase and storing.

In case, for example, of annular furnaces for the roasting of building bricks there are two problems which above all must be taken into consideration in selecting the firing system. The first problem is to transmit the heat to the brick at a comparatively low temperature. This is due to the fact that building bricks, as a rule, are made from rather fusible clays having narrow sintering intervals. In order that with the use of such a comparatively low temperature the entire brick mass may be well roasted altogether, the fuel should be supplied at many points and in small quantities. The second problem has reference to appropriate distribution of the heat in the vertical direction of the furnace. The conditions of draught in a furnace of the type under consideration are usually such as to require the heat to be supplied to the upper, to the intermediate or to the lower portion of the furnace according to need.

Hitherto, various methods for firing annular brick roasting furnaces with liquid fuel have been tried. For instance, burners driven by compressed air have been used. Such burners are fit for this use because the intense atomizing of the fuel and the intimate mixing of the fuel with the combustion air allows the use of cheap oils. The compressed air burners, however, develop a rather high flame temperature which also provides a strong heating effect a rather great distance due to radiation. In order that the brick in a furnace fired with compressed air burners may not melt and bake, big wells must be provided for the flames in the piles of brick, which, of course, highly reduces the capacity of the furnace. Owing to the violent local heating within such firing wells the brick will, no doubt, have a tendency of melting adjacent to the walls of the wells, before the brick in the middle of the piles is roasted to a sufficient degree. The compressed air burner also does not allow a satisfactory distribution of the heat in the vertical direction. Furthermore, the use of such burners requires a complicated mechanical apparatus including, amongst other things, a compressor and a network of tubes for passing the air, in addition to the conduits and pumps required for supplying the fuel to the injection points.

According to another well-known method for firing with liquid fuel especially fuel oil, the oil is supplied by drops to a large number of apertures in which the oil drops are ignited by the heat radiating from the bricks.

This method may be carried out with the aid of comparatively simple mechanical means but, on the other hand, it suffers from several drawbacks. Due to the draught in the furnace the dropping oil will be moved against the wall at one side thereof and will be burnt up there owing to its contact with the hot brick mass. Such a combustion gives rise to the formation of coke, and the coke will absorb the dropping oil. Due to the draught the violently gasified oil will act as a smoking blowtorch resulting in a high local heating of parts of the brick mass. It has proved that under the action of such local heating the bricks may melt completely at one end while they are not roasted at all at the other end. Even in such case difficulties arise as regards the regulation of the combustion in the vertical direction. The heavy development of smoke renders it difficult to observe the bricks in order to estimate their temperature. It is also difficult to exactly adjust the quantity of oil to be supplied to each individual consumption place because of the highly viscous nature of the fuels and the small quantities to be passed to the various consumption places.

The object of the present invention is to provide a method and a plant which, when applied to brick roasting furnaces, permit firing such furnaces with liquid fuel while securing the advantages inherent to the use of liquid fuel but avoiding the drawbacks appearing of the hitherto known firing systems.

In applying the invention to the firing of brick roasting furnaces and for similar purposes, the fuel is introduced into the furnace at a large number of points as exactly controlled small quantities, so that the combustion temperature may be maintained sufficiently low. Besides, the supply of the oil is effected in such a way as to permit control of the position of the combustion zone in the vertical direction.

Let it be assumed, for instance, that a jet of furnace oil having, for instance, a diameter of 0.5–1 mm. is injected into a furnace heated to a temperature of 800–1000° C., then this jet cannot owing to its high speed be heated to ignition temperature until after it has covered a comparatively long distance. Such a jet will not be deflected in any substantial degree by the action of the draught in the furnace. If, on the contrary, the jet hits a red hot article, such as a brick, the jet will be divided up into small drops which are combusted more readily but owing to the size of drops not so hastily as in the so called atomization. It is thus possible, by varying the injection pressure and the diameter of the jet, to increase the length and intensity of the combustion zone. By increasing the speed of injection the subdivision of the fuel may be augmented by atomization, thereby giving rise to an intense local production of heat. Since the combustion takes place substantially only after the jet has been rebounded from a hot brick surface, it is possible by directing the jet towards a brick surface at a higher or lower level to locate the combustion zone on a correspondingly higher or lower level in the furnace.

At those pressures of injection which come into consideration in operation according to the invention, the large amounts of heat required would result in too large amounts of fuel injected if a continuous jet were used. According to the invention it is, therefore, suggested to use an intermittent injection method with the aid of injectors controlled by pressure impulses derived from the fuel passing through the supply conduit. By adjusting the length and/or the frequency of the strokes of the plungers, an exactly predetermined distribution of the fuel may be obtained independently of the pressure and viscosity thereof. By providing a scale for indicating the length of stroke of the injector plungers, the plungers may also act as exact meters for the amounts of fuel injected. With the use of this system it is possible to select the impulse frequency so low that any smoke which would otherwise render observations in the furnace difficult, may escape in the intervals between the impulses.

A plant for carrying out the method according to the invention may be principally arranged and operate as follows:

Inserted in each injector is a non-return valve and behind said valve a movable, sealing partition the one surface of which is acted on by the impulse pressure and

the other surface of which acts to force the fuel to an injection nozzle, while at the same time putting a retraction spring under tension. As the said movable partition reaches its extreme position as determined, for instance, by a stop member, the movement and thus also the injection ceases. It is thus seen that the amount injected depends on the length of stroke of the movable partition or plunger. As, thereafter, the feeding impulse pressure ceases, the movable partition is restored to its normal position under the action of the tensioned spring. Contrary to the condition during the impulse stroke, the pressure prevailing behind the non-return valve becomes higher than the pressure in front of said valve. According to the invention a valve controlled bypass is provided past said partition, the valve of said bypass being closed, when the pressure in front of the non-return valve is higher than the pressure behind the non-return valve, and is opened, as the pressure behind the non-return valve is higher than the pressure in front thereof. Said bypass valve may comprise, for instance, a plunger-like slide valve, the ends of which are under the influence of the pressure in front of and behind the non-return valve, respectively. The bypass valve, however, may also comprise an elastic sleeve tightly fitted around the movable partition, on the external surface of which the pressure prevailing in the fuel conduit in front of the non-return valve acts and the internal surface of which facing the movable partition cooperates with a bypass. When the movable partition comprises a plunger, the non-return valve may, preferably, be mounted within such plunger.

In the accompanying drawings a specific constructional form of the plant hereinbefore principally outlined is illustrated. Fig. 1 is a diagram of a fuel plant according to the invention. Fig. 2 is a vertical longitudinal section of a portion of a brick roasting furnace comprising a plurality of vertical combustion wells. Fig. 3 is an elevation of an injection device. Figs. 4 and 5 are longitudinal sections of such an injection device, shown in two different positions. Fig. 6 is a detail view of such an injection device in a longitudinal section. Fig. 7 is a longitudinal section on a larger scale of a portion of Fig. 6. Fig. 8 is a side view partly broken away and partly in section showing details of a pump mounting.

With reference to Fig. 1, the numeral **1** designates a fuel tank, **2** is a conduit leading from the tank to the intake of a pump **3**, the outlet of which is connected through a conduit **30** to a relief valve **31**. At **32** a power motor for driving the pump and controlling the relief valve is shown, and at **33** is shown a timing device for controlling the valve operation. The relief valve controls the connection between the pump conduit **30** and a main distribution conduit departing therefrom which takes the form of a conduit comprising an outgoing portion **4** and a return portion **5**, leading back to the tank **1** by way of a back pressure valve **6** and a return conduit **15** leading from valve **31** directly to the tank **1**, the valve **6** being located in said return portion close to said main distribution conduit's connection with said return conduit. Departing from the distribution conduit **4**, **5** are branch conduits **7**, each of which may be provided with a separate shut-off valve **8**. Only a few such conduits are completely shown in the drawings. To each branch conduit **7** a group of liquid injection devices **16** may be connected, said devices being suitably arranged, for instance, at the upper end of a vertical fuel space extending across the entire width of a brick roasting furnace.

The operation of the plant shown in Fig. 1 is substantially as follows:

During a short while, for instance 3 seconds, the valve **31** connects the pump conduit **30** to the distribution conduit **4** only, so as to allow fuel oil to enter those branch conduits **7** the valves **8** of which are open. The liquid fuel injecting devices **16** are by this time operating in the way hereinafter set forth in order to inject the fuel oil in a finely divided state into the combustion space. In case of a surplus of fuel, the fuel not injected passes through back pressure valve **6** back to the tank. After the elapse of said 3 seconds the valve **31** is again operated so as to bring both the pump conduit **30** and the distribution conduit **4** into connection with the tank **1** through conduit **15**. The distribution coil **4**, **5** now receives no fuel and the liquid injection devices **16** cease injecting. After the lapse of a somewhat longer while (for instance 7 seconds) valve **31** is again operated, so that only the distribution conduit **4** again receives fuel from the pump **3**. It is thus seen that in case under consideration the system is controlled by an impulse each tenth second. Another frequency may, of course, be selected according to the requirements in each individual case.

According to Fig. 2 three fuel liquid injection devices **16** are used for injecting fuel at various levels into the vertical combustion space or well **17** between the piles of bricks **18**. The injection devices are rotatable on horizontal shafts **19** so that they may be adjusted to any inclined position desired. As an example, the left hand injection pump in shown as adjusted to inject fuel into an upper zone of the well, the intermediate injection device is adjusted to inject fuel into an intermediate zone, and the right hand injection device is adjusted to inject fuel into a lower zone. The injection pumps may, for instance, be mounted by means of universal joints, allowing injection of the jet in any desired direction also crosswise of the well, in order to permit a better distribution of the fuel over the cross section of the well. In Fig. 8 numeral **16** denotes an injection device with its supply pipe **20** connected to a flexible tube **200**. The reduced lower end portion of the device (indicated at **160**) is loosely inserted in a carrier **19** engaging by cylindrical contact surfaces **161** a correspondingly cylindrical recess formed in a horizontal disc **162** connected by means of a cylindrical tube **163** of small wall thickness with a base disc **164** rotatably mounted on the top of a cylindrical vertical wall **165**.

The member **19** is provided with two arms **166**, **167** extending along a diameter at right angles to the axis of the cylindrical contact surfaces **161**. Each arm is provided with an aperture through which extends a pin **168**, **169**, respectively. Both pins are rigidly attached to the disc **162**. Pin **168** is threaded and carries a nut **170** bearing directly on the respective arm **166**; pin **169** is also threaded and carries a nut **171**, said nut, however, presses on the respective arm **167** via a coil spring **172**. By means of the nuts **170** and **171** the body **19** may be turned around its axis, thereby causing the device to assume a more or less inclined position with a resulting more or less inclined direction of the oil jet. By rotating the base disc **164**, in which rotation the body **19** is caused to partake, the inclined oil jet may be caused to describe a conical surface, that is to say, it may be directed to any desired side of the pipe **165** and the associated well.

In Figs. 3–5 the principal construction of a fuel injection pump is shown. Here the numeral **16** indicates the injection pump cylinder. The cylinder has an inlet at **20**. Slidably mounted in the cylinder is a plunger **21** which may reciprocate between the bottom of the cylinder and an upper stop formed by a screw **22** which may be controlled from outside the cylinder. The plunger is formed with an annular recess **23** in its circumferential surface in the middle portion of which an annular projection **25** is made, the upper and lower edges of which are obliquely undercut so as to form sharp knife-edges as best shown at 25^1 and 25^2 in Fig. 8. Placed in said recess **23** is an elastic sleeve **24** having inwardly projecting flanges at its ends which embrace the projections **25**, preferably under a certain initial pressure. By this means a high sealing effect is obtained at the sharp edges of projection **25**. The middle thin portion of sleeve **24** covers the openings of two channels formed in the plunger, namely, an upwardly extending channel **26** opening into the top surface of the plunger and a downwardly extending channel **27** opening into the bottom surface of the plunger. Formed in the bottom of the cylinder in register with channel **27** is a boring **28** ending in a narrow aperture **29**, which may be suitably shaped to form a spraying or distributing nozzle. Approximately midway between its upper and lower ends the boring **28** is formed with a reduced area, as shown at 28^1 and the normally wide lower portion of boring **28** is a non-return valve 28^2 loaded by an upwardly acting spring 28^3. The lower end portion of the plunger is of a reduced diameter and is surrounded by a spring **40** resting on the bottom of the cylinder which tends to force the plunger upwardly. The annular recess **23** communicates with the space above the plunger through a channel **41** in which a non-return valve **42** is inserted for allowing a flow of liquid from recess **23** to the top surface of the plunger while preventing flow in the opposite direction. The screw **22** is geared to a pointer **43** for indicating the set position of the screw and thus the length of the stroke of piston. The injection device operates as follows:

Let it be assumed that fuel is contained in the space below the plunger **21** admitted thereto at the end of a previous operation, in the same way as described at the end of the next paragraph.

As soon as a pressure impulse is delivered from the fuel conduit through inlet **20** the pressure of said impulse is imparted through recess **23** and connection **41** past the non-return valve **42** up into the space above the plunger. In such case the pressure prevailing on the external surface of sleeve **24** will be equal to the pressure prevailing on that surface thereof which covers the opening of channel **26**, and since the operative pressure surface of the sleeve is much larger on the external surface of the sleeve than it is on the internal surface thereof, the bypass channel will remain closed as long as the pressure is acting. The pressure in the space above the plunger will consequently force the plunger downwards, thereby causing the fuel in the space below the plunger to open the non-return valve 28^1 and pass to the nozzle **29** to be ejected therethrough. Dribbling is precluded, first, by the action of the normally closed non-return valve 28^2 and, secondly, by the small (say capillary) area of the aperture of nozzle **29**, which does not allow oil to drip and air to enter at the same time. As soon as the plunger attains its lowermost position, Fig. 5, the movement and thus also the injection ceases. As soon as the pressure impulse ceases, the return spring **40** will raise the plunger. Since the non-return valve **42** prevents the fuel from returning to the fuel conduit, a pressure above atmospheric will be attained on the top surface of the plunger and since no external pressure acts on the elastic sleeve **24**, the pressure resulting from the fuel in the bypass channel **26** will force the middle portion of the sleeve outwards, so that during the upward stroke of the plunger fuel may pass from channel **26** to channel **27** and reach the cylinder chamber therebelow.

Fig. 6 illustrates the construction of an injection nozzle more in detail. The reference numerals are the same as those used in Figs. 2 and 5. In addition to the elements shown in said figures, Fig. 6 shows amongst other a filter **34** for the fuel entering through the inlet **20**, furthermore there are packings **35** and **35** provided in combination with the plunger on both sides of the annular recess **23**, and vents **36** leading from the spaces above and below the plunger in the injector casing **16**. The connection between the screw **22** and the pointer **43** comprises a rounded rack **37** formed integrally with the screw **22** and axially extending teeth, not shown, of a transverse shaft **38** which in its turn controls the pointer.

What we claim is:

A system for intermittently supplying liquid to a plurality of consumption points distributed over a wide range, comprising in combination, a liquid tank, a main supply conduit leading from said tank, a pump connected on its suction side to said conduit, a motor for continuously operating said pump, a relief valve, a conduit connecting the delivery side of pump to said valve, a timing device for operating said valve, a return conduit from said relief valve to said tank, a main distribution conduit communicating at its one end with said relief valve and at its other end with said return conduit, a back pressure valve in said main distribution conduit close to said main distribution conduit's connection with said return conduit, a plurality of feed conduits branched off in parallel from said main distribution conduits, and liquid injection devices connected with said feed conduits for delivering liquid to the individual consumption points, said timing device operating to connect said conduit leading from the delivery side of pump alternately only with the main distribution conduit, and then with the return conduit as well as with said distribution conduit for producing pressure impulses of predetermined intervals in the main distribution conduit, said pressure impulses having for their purpose to operate the injection devices in order to cause them to deliver liquid to the consumption points, said injection devices each having a casing provided with an outlet orifice and enclosing a reciprocable member operable by said pressure impulses for expelling at each impulse a quantity of liquid through its outlet orifice, a spring device in each of said injection device casings further operable in the reverse direction in said casings for moving the reciprocable member in a direction away from the outlet orifice during the intervals between each two succeeding pressure impulses for allowing a quantity of liquid to enter a space in said casings between the outlet orifice and the reciprocable member, while at the pressure impulse then following liquid is allowed to enter the side of said member remote from the outlet orifice, said last-mentioned liquid, on account of its higher pressure, acting to force the reciprocable member towards the outlet orifice, so that the quantity of liquid previously introduced between the reciprocable member and the outlet orifice, will be driven out towards the respective consumption point, any possible surplus of liquid as delivered to the main distribution conduit, through the relief valve, being allowed to pass to the return conduit by way of said safety valve.

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