

March 25, 1952

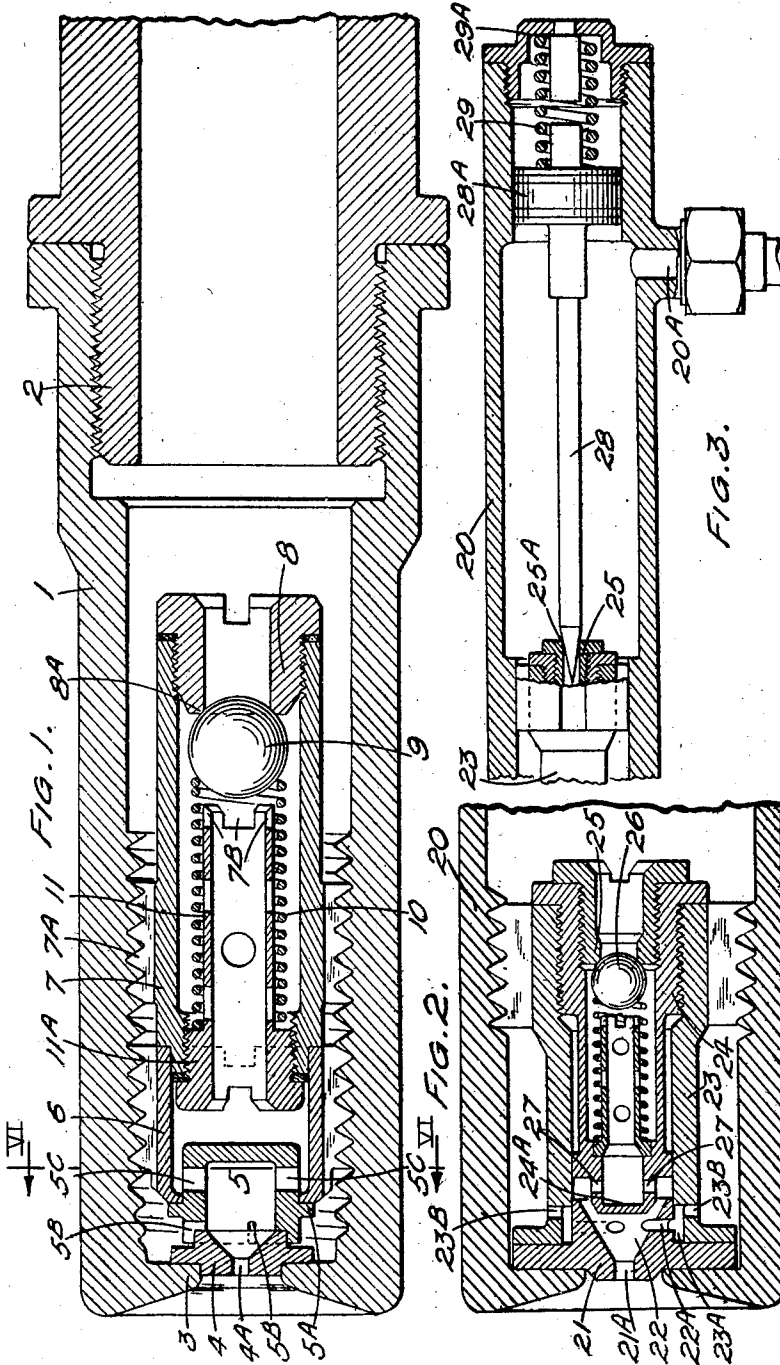
J. R. JOYCE

2,590,772

LIQUID FUEL BURNER AND THE LIKE

Filed Sept. 5, 1945

2 SHEETS—SHEET 1



Inventor  
John Rusk Joyce  
By Stevens and Davis  
His Attorney

March 25, 1952

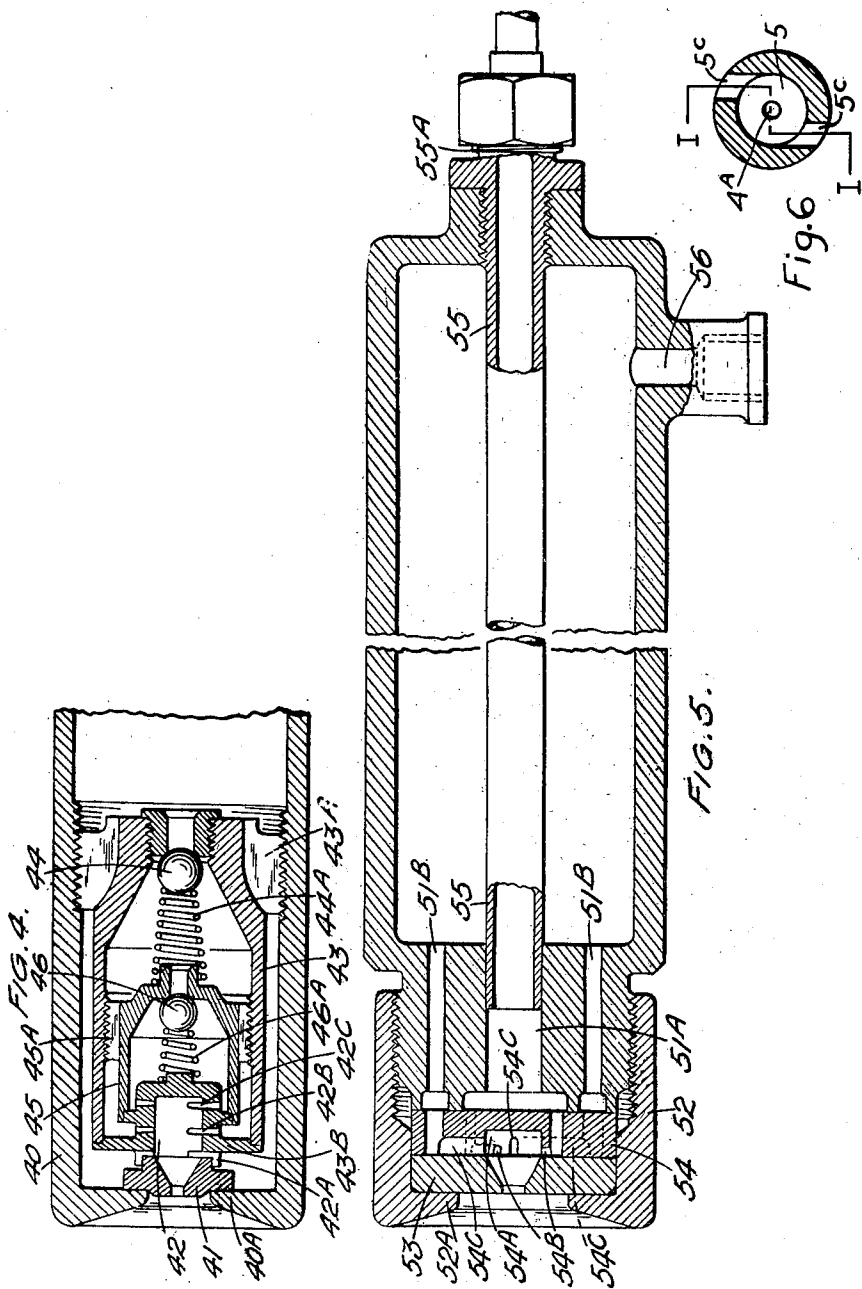
J. R. JOYCE

2,590,772

LIQUID FUEL BURNER AND THE LIKE

Filed Sept. 5, 1945

2 SHEETS—SHEET 2



Inventor:  
John Ruskin Joyce  
By Stevens and Davis  
His Attorneys

## UNITED STATES PATENT OFFICE

2,590,772

## LIQUID FUEL BURNER AND THE LIKE

John Ruskin Joyce, Wimbledon, London, England, assignor to Power Jets (Research & Development) Limited, London, England, a corporation of Great Britain

Application September 5, 1945, Serial No. 614,450  
In Great Britain June 11, 1943

Section 1, Public Law 690, August 8, 1946  
Patent expires June 11, 1963

5 Claims. (Cl. 299—118)

1

This invention relates to liquid fuel burners of the type in which fuel flows under pressure into a vortex chamber, whence it emerges through an orifice to form a finely divided or "atomised" spray.

A primary object of the invention is to provide a burner which will be operative with a good quality of spray over a wide range of rates of flow. It is of considerable importance in certain applications of burners, that the spray should be as uniform as possible in particle size and distribution, and of wide cone angle, even at low rates of delivery, and it is also desirable to provide for control in design or manufacture of the "characteristic" of a burner, that is to say the relationship between applied fuel pressure and rate of delivery. In this connection, it may be mentioned that a burner has been previously suggested in which there were six swirl ports leading fuel into a single vortex chamber and with each one of these was associated a spring-loaded ball valve acting as a check valve the idea being that the valves or pairs of valves should open at different pressures, so that with rise of pressure the swirl ports should come into successive operation. A construction of this kind would be difficult in manufacture. It is believed that to match several of such burners when supplied in parallel from a single source—and it is to such purposes that the present invention is primarily intended to be applied—would be extremely difficult, and in any case the previously proposed construction involved a comparatively large number of component parts and design complications, with considerable delicacy of adjustment of the operation of the valves if symmetrical action were to be achieved.

The present invention seeks to provide constructions of burner which are simple both in manufacture and operation, are reliable and not unduly prone to clogging or to carbon deposit, or to damage by heat and which can with reasonable care be matched in sets for plural use in parallel with characteristics sufficiently nearly identical. In some cases burners may be provided by the invention with a smooth characteristic curve (pressure plotted against rate of delivery) or if required the characteristic may show "steps." In one application of the invention specifically intended for plural use, no moving parts exist in the burners themselves, the wide operative range being afforded by valve means common to the whole set of several burners, and for that reason being easily accessible for adjustment if required.

2

In United States Patent No. 1,873,781 there is to be found a description of a liquid fuel burner in which one or both of separated channels of flow terminating in tangential swirl ports are brought into use by the action of a spring-loaded pressure-opened valve. The construction shown and described has only one tangential swirl port for low pressure operation. This is believed to be a defect and to be liable to produce comparatively poor results. Moreover, the structure involving this single swirl port is somewhat complicated and involves the use of three dissimilar disc members which (and especially in view of the difficulty of obtaining symmetrically flow conditions with the single port) would require great care and accuracy in manufacture.

In other earlier publications there are shown burners with two sets of swirl ports, but in these the control of flow is in general described as manual though in one case there is reference to automatic control which in the absence of further description might have been intended to be thermostatic, mechanical, or by some operational factor not divulged. The present invention is concerned with automatic control by the pressure of the fuel itself.

According to the invention there is provided a liquid fuel burner of the type stated having at least two sets of swirl ports (each set comprising ports symmetrically disposed about the axis of the vortex chamber) to lead fuel into a common vortex chamber, a first set of ports being supplied by a channel leading from the fuel source, and each further set being supplied by a channel fed from the source through valve means which control the supply through the further set or sets, according to the required characteristic of the burner, such valve means being actuated by the supply pressure of the fuel. The first set may therefore be regarded as a set corresponding to the first or lower pressure stage of operation, each further set corresponding to a further stage operating at a higher pressure. Further, such a burner is associated with valve means which open for the supply of the further set or sets of ports by the pressure of the fuel supply against resilient resistance, which preferably takes the form of a simple helical spring, and such valve means may comprise a simple ball valve, or a valve of needle or corresponding type, operated by fuel pressure acting on an associated piston against a spring; this form of valve being a pressure-actuated valve affording a graduated characteristic, according to the effective area of opening corresponding to given fluid

## 3

pressures. According to a further feature of the invention, the burner body is of substantially cylindrical form and hollow, and the disposition of the internal parts, including passages, ports and valve means, is symmetrical about the axis of the vortex chamber. An illustration of the invention, several adaptations are described hereinafter with the aid of the accompanying drawings.

The invention will now be described in several forms with the aid of the accompanying drawings:

Fig. 1 is a sectional view of a two stage embodiment of the invention.

Fig. 2 is a similar view of an alternative two stage embodiment showing the internal assembly only.

Fig. 3 is a fragmentary view illustrating an alternative mode of valve control.

Fig. 4 is a similar view illustrating a three stage application.

Fig. 5 shows a variant with no internal valve.

Figure 6 is a view in cross section taken on the line VI—VI of Figure 1.

The burner of Fig. 1 comprises an outer body 1 which is of generally cylindrical form and which at its rear end has a fuel pipe union 2 screwed into it. At its forward end the body has an inward flange 3 with a flat machined internal face forming a seating against which bears a complementary face of a circular orifice plate 4 which has a shallow spigot to locate it within the flange 3 and a final orifice 4A. Behind the orifice plate which is rearwardly spigoted to receive it is a vortex chamber 5 in the form of a small cylindrical body with closed rear end. The vortex chamber has an external flange 5A against which abuts and seats a cylindrical element 6 which at its rear end again abuts and seats against a step formed towards the forward end of an inner cylinder 7. The cylinder 7 has at its rear end an axially bored screw ferrule 8 comprising an annular seating at 8A for a ball valve 9 which is pressed towards the seating by a compression spring 10 located by a hollow and perforated sleeve 11, which forms part of a threaded hollow plug 11A which is screwed into the forward end of the cylinder 7, the upstream side of the ball valve is open to the interior bore of the body 1. The cylinder 7 is held axially in the body 1 by being screwed into a thread within the body towards the forward end thereof, the external thread of the cylinder 7, as at 7A, being interrupted by axially disposed grooves or flutes permitting the axial flow of fuel. The element 6 is likewise externally threaded for screwing into the body 1 and similarly provided with longitudinal passages. The rear end of the sleeve 11 is castellated at 7B to form an abutment stop for forward movement of the ball 9. The wall of the vortex chamber 5 has two sets of swirl ports, i. e. ports which perforate the wall and enter the interior of the chamber in a substantially tangential direction. The forward set 5B is somewhat smaller in effective cross sectional area than the rear set 5C.

Assuming fuel to be entering by the union 2 at comparatively low pressure with the valve 9 closed, the flow is between the internal sub-assembly and the body 1 and this fuel passes to the forward end of the body through the ports 5B into the vortex chamber 5 and is expelled through the final orifice 4A. When the applied pressure is sufficiently raised it acts on the valve 9 to open it and further fuel passes through the

## 4

valve into the interior of the inner cylinder 7 through the perforations in the wall thereof to the interior of the element 6 and thence through the ports 5C into the vortex chamber. It will be observed that in the first stage of operation the first set of ports 5B which are symmetrically disposed about the axis of the vortex chamber are supplied direct from the source whilst at elevated pressures the additional channel through the valve 9 supplements the supply into the vortex chamber through the ports 5C. The manner of assembly of the burner is practically self-evident; there is first inserted into the body 1 the orifice plate 4, then the vortex chamber 5 (if not previously fitted on the orifice plate), then the element 6 is screwed into place and finally the sub-assembly comprising cylinders 7 is screwed in to bear firmly on the end of the element 6.

Turning to Fig. 2 a construction is illustrated which is functionally similar to that of Fig. 1 only in this case an outer burner body indicated at 20 has secured within its bore by any convenient means as assembly made up as follows: An orifice plate 21 with final orifice 21A has an axial conical chamber 22 formed in its rear surface through the wall of which is formed a set of first stage symmetrically disposed swirl ports 22A. The rear of the orifice plate is formed with a cylindrical boss or spigot standing from it which fits into a cylindrical element 23 which at its forward end has a somewhat enlarged bore forming a cavity 23A from which the ports 22A lead. Through the wall of the element 23 and into the cavity are perforations 23B for the passage of fuel. In a thread within the rear end of the element 23 is screwed a valve mounting body 24 in which is the screwed ferrule 25 forming a seat for a ball valve 26. The forward end of the body 24 forms the rear face (at 24A) of the vortex chamber, being of projecting or spigot like form and a second set of swirl ports 27 connecting the interior of the body 24 to the interior of the vortex chamber 22. The ports 27 emerge substantially tangentially into the vortex chamber. The arrangement of the valve is so nearly the same as that of Fig. 1 as to require no description. In operation the interior of the burner body 20 being supplied with fuel under pressure at comparatively low pressures, the fuel passes via 23B and 23A into the first stage ports 22A and thence into the vortex chamber 22 emerging from the orifice 21A. Upon sufficient application of supply pressure, the valve 26 opens and fuel takes the channel through the interior of the body 24 outwards through the 2nd stage set of ports 27 to supplement the flow in the vortex chamber.

Fig. 3 illustrates a variant of valve by which a gradual effect in the changeover from the operative condition of one stage to that of two stages may be achieved. This variant is drawn as an alternative to the construction of Fig. 2 and consequently some of the same references are employed. The rear end of the body 23 can be seen within the body 20, but in this case there is no ball valve within the body 23, the ferrule 25 being modified to have an external facing seat at 25A to cooperate with a needle type valve 28 operated by a piston 28A sliding in a cylindrical bore in the rear end of the body 20 (behind a fuel supply union 20A) the piston 28A being urged forward by a spring 29, which reacts against an end cap 29A screwed into the body 20. It is evident in this case that the fuel supply

5

6

pressure will urge the piston 28A rearwardly when the pressure is sufficiently high to overcome the spring 29, and the valve 28 is thereupon opened, the degree of opening being controlled by the fuel pressure and the rating of the spring 29. Means (not shown) may be provided to guide the stem of the valve 28 and keep it coaxial with the valve seat 25A.

Turning now to Fig. 4 there is here represented the elements of a 3 stage burner. The outer body 40 has an inturned inwardly faced flange 40A at its forward end against which seats an orifice plate 41 behind which is fitted a vortex chamber 42 all substantially in the same manner as in Fig. 1.

The vortex chamber has in this case 3 sets of swirl ports each set comprising tangential ports disposed symmetrically about the axis of the chamber. The first stage set shown at 42A is supplied directly from the source by flow along the interior of the body 40 past an interrupted thread 43A formed on an intermediate cylinder 43 which is provided internally with a ball valve 44 loaded by the spring 44A. The forward end of cylinder 43 bears against a rigid diaphragm 43B which forms a closure between the wall of cylinder 43 and the wall of the vortex chamber 42 immediately behind the ports 42A. The interior space of the intermediate cylinder 43 forms a channel for the supply of fuel to the 2nd stage swirl ports 42B. Again within the cylinder 43 is an inside cylinder 45 with an interrupted thread 45A screwing into the cylinder 43 and having internally a 3rd stage valve 46 with its spring 46A which reacts against the rear end of the vortex chamber 42. Exposed within the cylinder 45 is a 3rd set of swirl ports 42C isolated from the channel for the ports 42B, by an end closure between the wall of the cylinder 45 and that of the chamber 42. It will be seen that the two valves 44 and 46 are virtually in series; at relatively low fuel pressures flow is through the body 40, ports 42A and out from the chamber 42. At medium pressures the valve 44 opens and the delivery is augmented by supply through the ports 42B; at still more elevated pressures the valve 46 is opened and the supply into the chamber 42 is further augmented through the ports 42C. The spring loading and effective areas of the valves is clearly to be determined by the required burner characteristics, the example illustrated being an indication of the fact that a plurality of stages of operation may quite conveniently be afforded by the invention. It will be observed that the arrangement as a whole is symmetrical about the axis of the burner so that inequalities of flow which may result in lob-sided delivery or bad spray are avoided. Each set of ports and its corresponding channel of supply are symmetrically distributed around the axis.

Figure 5 illustrates an application of the invention in which no internal moving parts are provided within a burner. Whilst this form of the invention is applicable to single burners, it is more specifically intended to be applied where a plurality of burners are to be used in parallel and are required to have as nearly as possible matched performance.

The burner proposed comprises a body 52 which is of generally cylindrical hollow form and which at the forward end has a comparatively large axial bore 51A and a pair of parallel smaller bores 51B spaced from the axis. The outside of the forward end of the body 51 is threaded to receive a retaining cap 52 which has an inturned inward-

ly faced flange 52A against which seats an annular orifice plate 53. Behind the orifice plate there is provided a second disc-like element 54 which is recessed centrally at 54A to form a vortex chamber in its forward face. Also formed in the forward face are two sets of swirl ports which are tangential slots milled in the face of the disc 54. One pair of ports is formed by comparatively short and shallow slots 54B and the other by deeper and longer slots 54C. The ports 54B opening into the vortex chamber 54A are supplied by two bores passing through the disc 54 and thus opening to the bore 51A which is somewhat widened at the front end of the body 51. The slots 54C communicate with the bores 51B in corresponding manner. Into the bore 51A there extends from the rear end of the body 51 a tube 55 coming from a fuel union 55A. The bores 51B are supplied from the hollow interior of the body 51, there being for this purpose a second fuel supply connection 56. It is supposed in this case that the first stage source of supply is via the union 55A and the 2nd stage via 56.

It is to be appreciated that the illustration Fig. 5 is intended to be mainly diagrammatic, various details having been omitted for clarity. For example, means should be provided for locating the disc 54 to ensure registration of the passages and means should also be provided for sealing the tube 55 in the bore 51A.

I claim:

1. A liquid fuel burner comprising means defining a vortex chamber having a central frustoconical portion leading to a cylindrical discharge orifice at its apex end and leading from a cylindrical portion at its base end, two sets of swirl ports discharging into said chamber, each set comprising a plurality of ports symmetrically disposed about the axis of the vortex chamber a first set of said ports being located in a plane immediately adjacent the plane of the base of the frustoconical central portion of the vortex chamber and a second set of said ports being located in the cylindrical portion of said vortex chamber in a plane more remote from said discharge orifice than said first set, a common fuel supply chamber, separate conduits leading from said common supply chamber to each of said sets of ports and a normally closed valve in the conduit leading to said second set of ports, said valve being exposed to the pressure of said supply chamber and opening in response to the attainment of a predetermined pressure therein.

2. A liquid fuel burner as claimed in claim 1 wherein the ports of both of said sets discharge tangentially inwardly into said vortex chamber.

3. A liquid fuel burner as claimed in claim 1 wherein the ports of said first set discharge tangentially inwardly into said vortex chamber and the ports of said second set discharge tangentially outwardly into said vortex chamber.

4. A liquid fuel burner comprising means defining a vortex chamber having a central frustoconical portion leading to a cylindrical discharge orifice at its apex end and leading from a cylindrical portion at its base end, two sets of symmetrically arranged swirl ports discharging into said chamber, a first set being located in a plane immediately adjacent the plane of the base of the frustoconical central portion of the vortex chamber and a second set being located in the cylindrical portion of said vortex chamber in a plane more remote from said discharge orifice than said first set, a common fuel supply chamber, separate conduits leading from said common

7

supply chamber to each set of ports, a throttle valve controlling flow in the conduit leading to said second set of ports, a piston for operating said throttle valve and a spring normally biasing said throttle valve to the closed position, said piston being exposed to the pressure of said supply chamber whereby to open said valve to an extent correlated with the pressure prevailing in the supply chamber.

5. A liquid fuel burner comprising an outer hollow body, a vortex chamber closing one end of said body, said vortex chamber being internally frustoconical to define a discharge orifice for the burner, a plurality of symmetrically arranged tangential swirl ports establishing communication between the interior of said hollow body and the interior of said chamber, an inner hollow body concentrically located within said outer body and defining therewith a space communicating with said ports, said vortex chamber also closing one end of said inner body, a plurality of symmetrically arranged tangential swirl ports establishing communication between the interior of said inner hollow body and the in-

8

terior of said vortex chamber, a normally closed pressure responsive valve controlling flow from said outer body to said inner body and means to deliver fuel to said outer body.

JOHN RUSKIN JOYCE.

## REFERENCES CITED

The following references are of record in the file of this patent:

## UNITED STATES PATENTS

| Number    | Name                 | Date          |
|-----------|----------------------|---------------|
| 1,568,427 | Strachan et al. .... | Jan. 5, 1926  |
| 1,822,047 | Leask .....          | Sept. 8, 1931 |
| 1,873,781 | Nightingale .....    | Aug. 23, 1932 |
| 2,044,720 | Fletcher .....       | June 16, 1936 |
| 2,127,172 | Hermitte .....       | Aug. 16, 1938 |
| 2,254,123 | Soaper .....         | Aug. 26, 1941 |
| 2,313,298 | Martin et al. ....   | Mar. 9, 1943  |

## FOREIGN PATENTS

| Number  | Country             | Date          |
|---------|---------------------|---------------|
| 367,510 | Italy .....         | Jan. 25, 1939 |
| 409,211 | Great Britain ..... | Apr. 26, 1934 |