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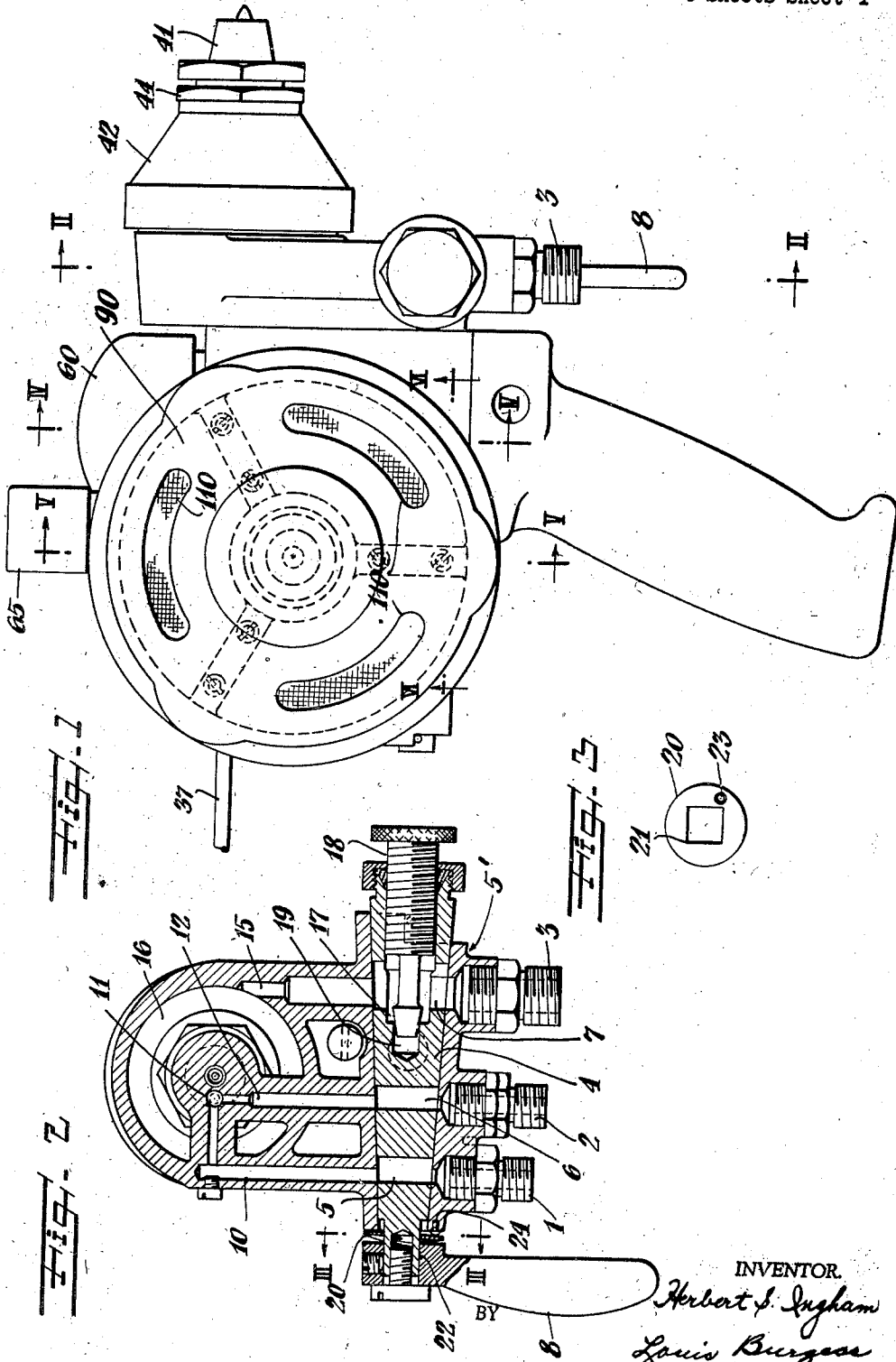
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2,227,752

METAL SPRAY GUN

Filed June 30, 1938

6 Sheets-Sheet 1



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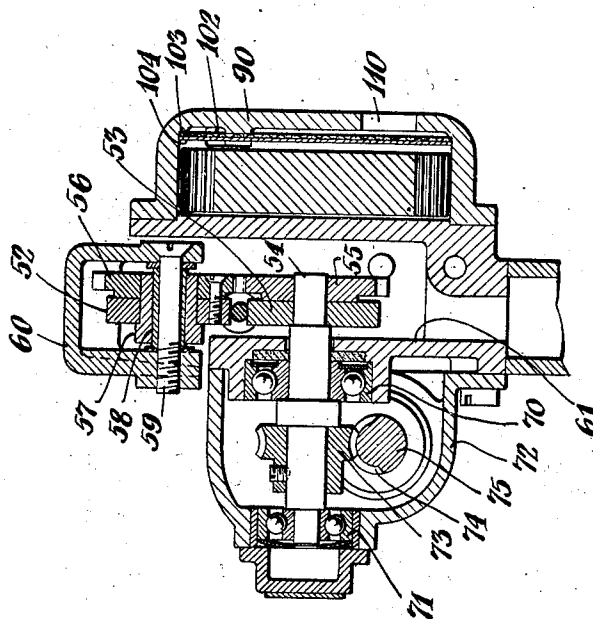
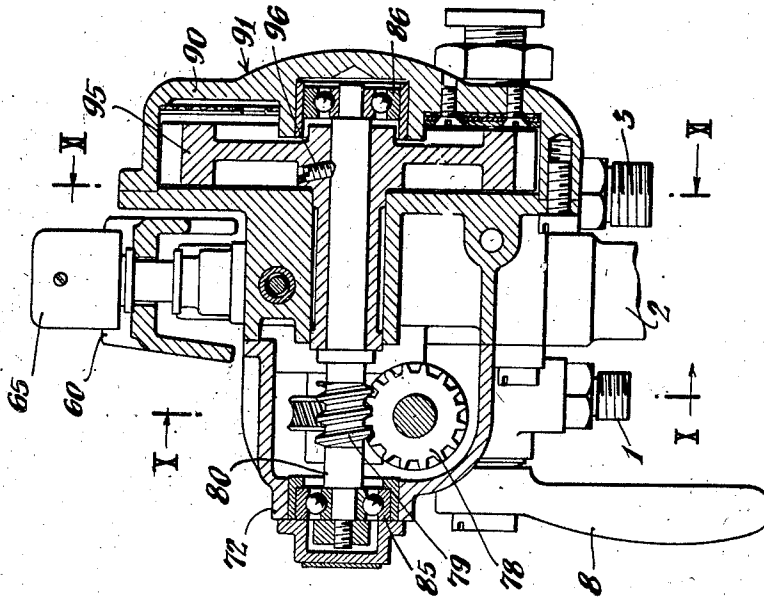
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METAL SPRAY GUN

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6 Sheets-Sheet 2



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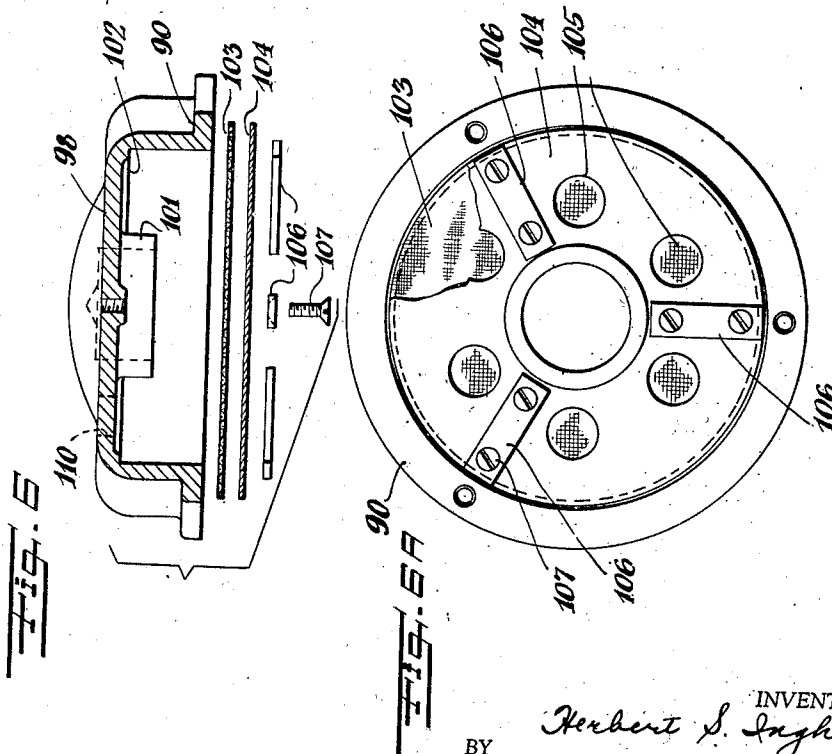
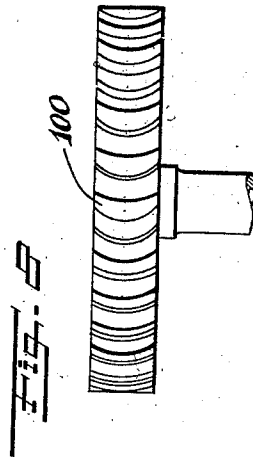
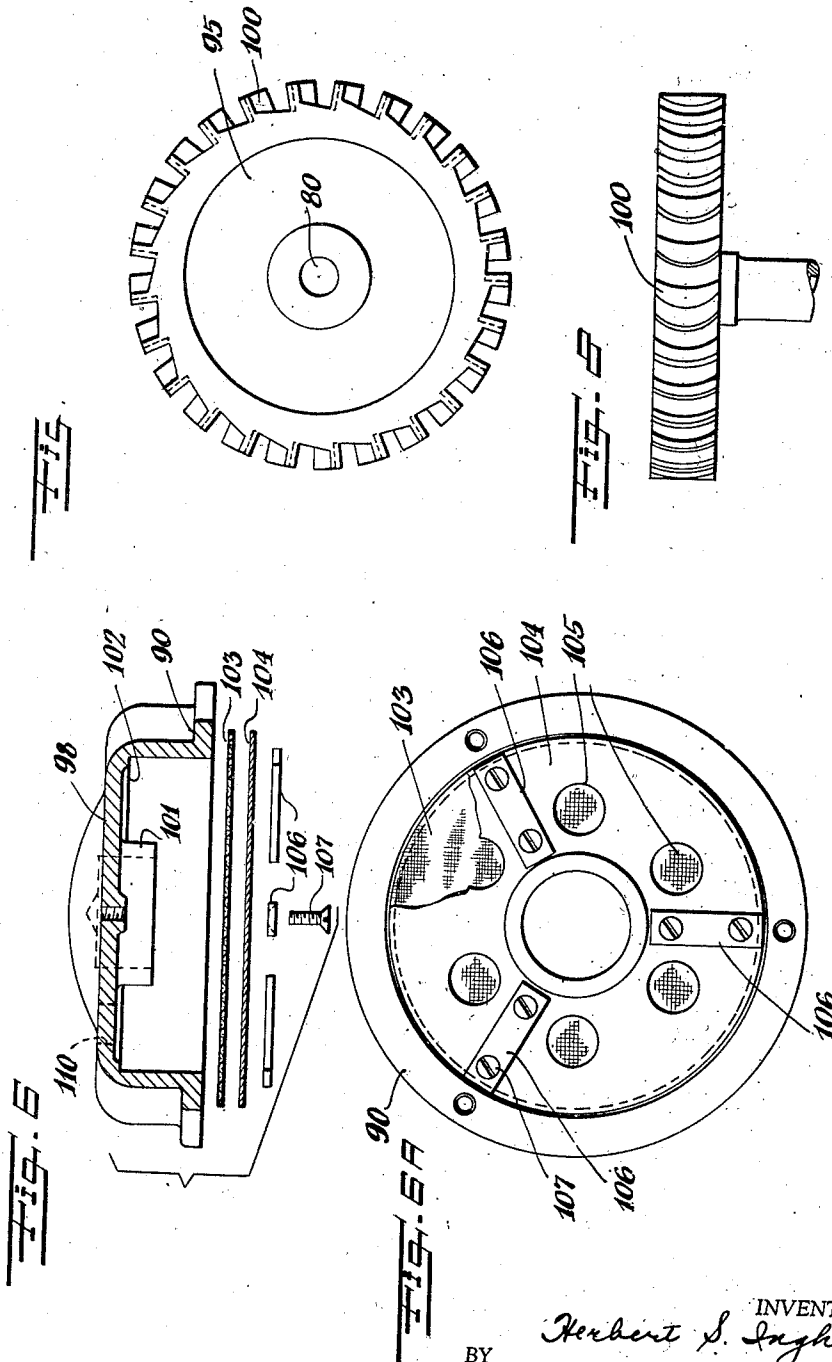
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6 Sheets-Sheet 3



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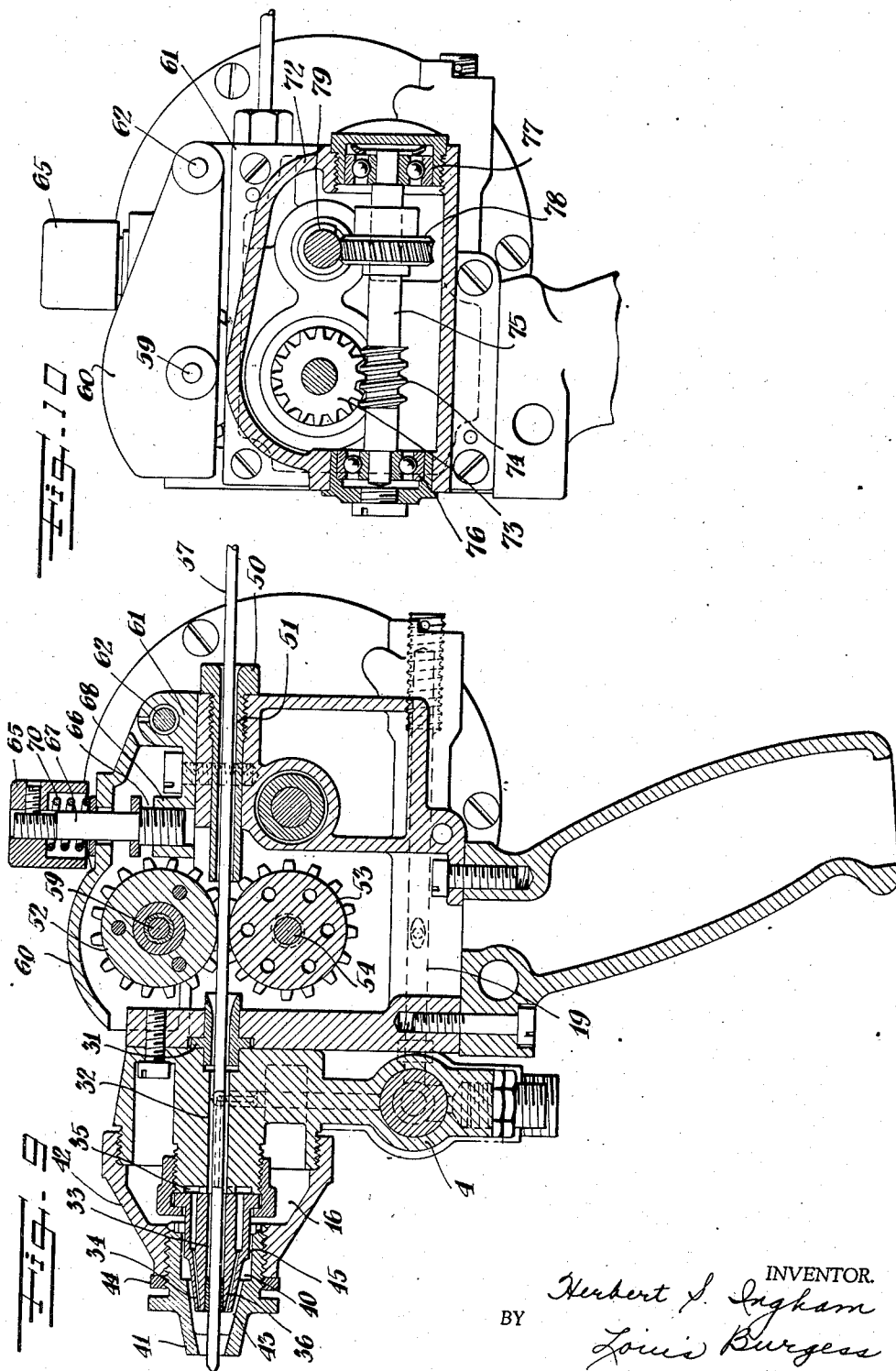
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METAL SPRAY GUN

Filed June 30, 1938.

6 Sheets-Sheet 4



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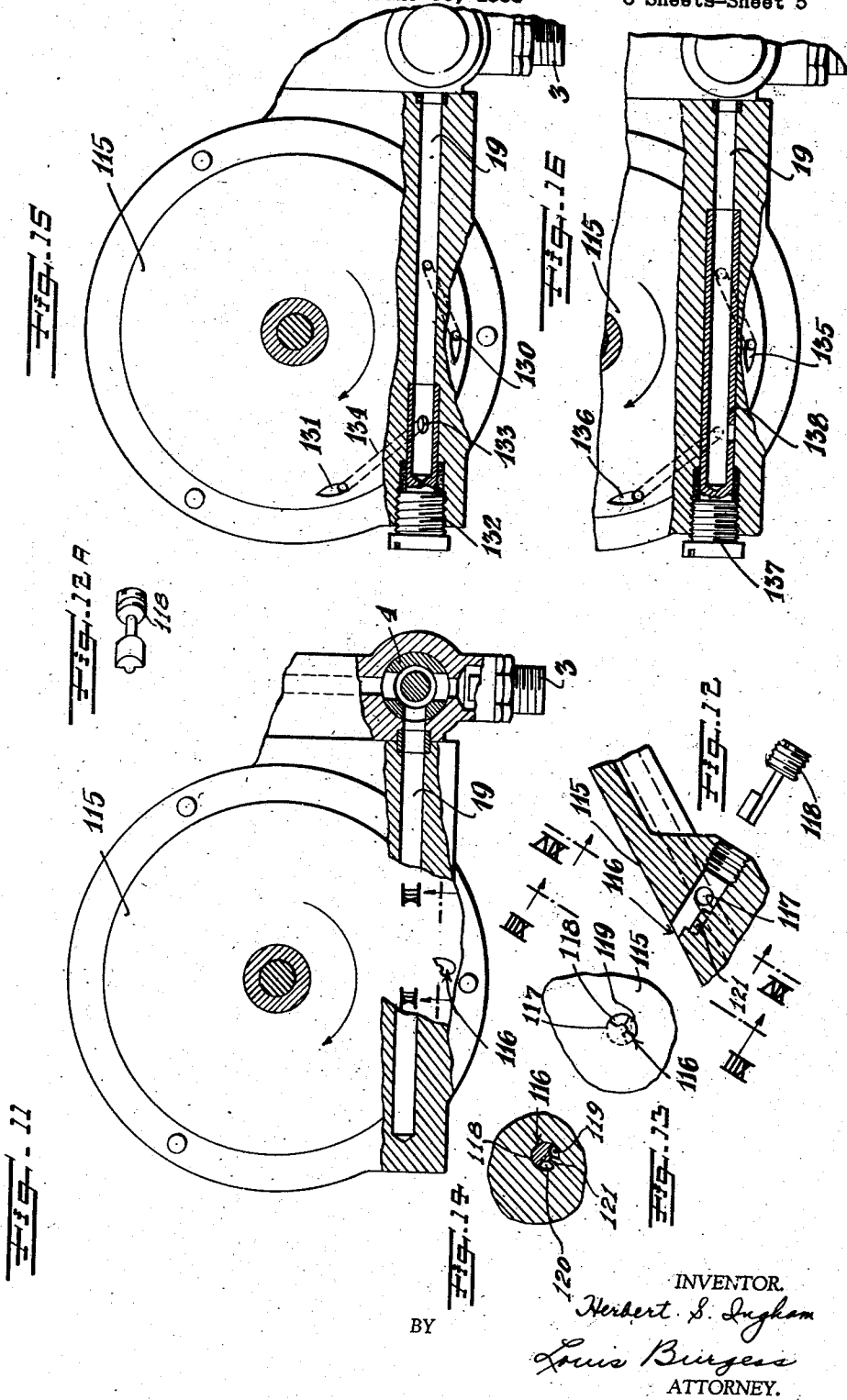
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METAL SPRAY GUN

2,227,752

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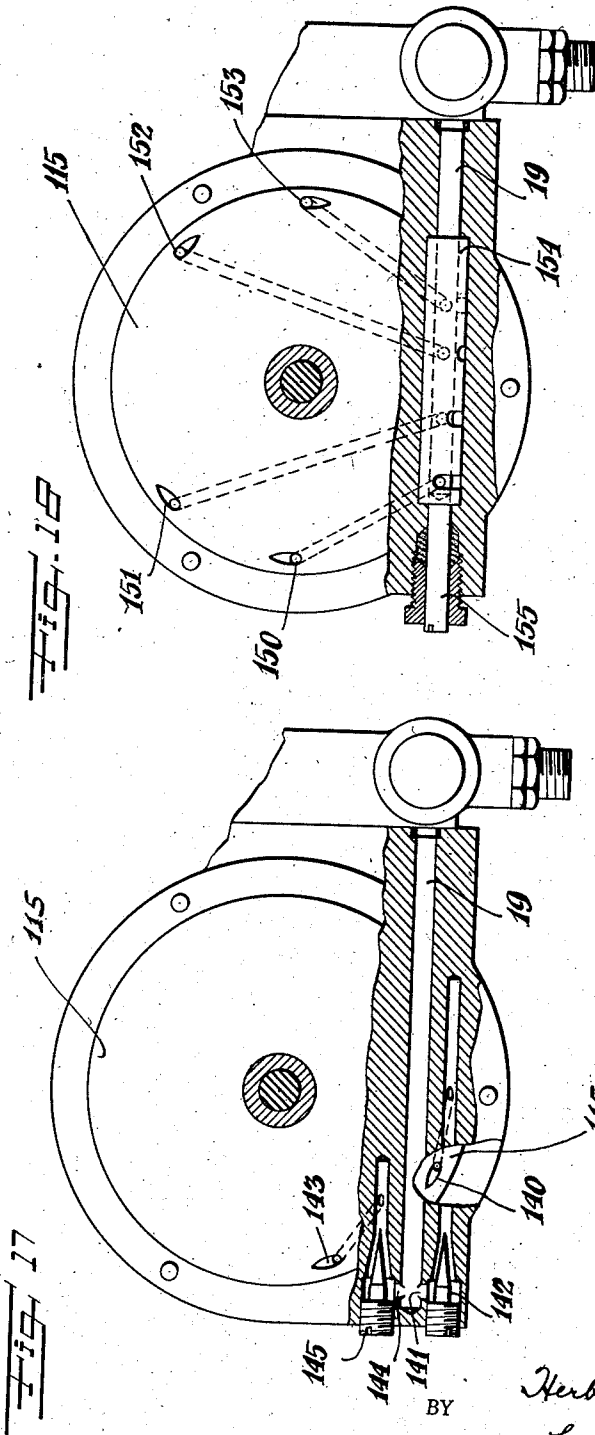
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METAL SPRAY GUN

Filed June 30, 1938

6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,227,752

METAL SPRAY GUN

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Application June 30, 1938, Serial No. 216,654

14 Claims. (Cl. 91—12.2)

My invention relates to metal spray guns and will be fully understood from the following description read in conjunction with the drawings in which:

5 Fig. 1 is a side view of a metal spray gun constructed in accordance with my invention.

Fig. 2 is a vertical section through the construction shown in Fig. 1 on the plane indicated by II—II.

10 Fig. 3 is a vertical section through the construction shown in Fig. 2 on the plane indicated by III—III.

Fig. 4 is a vertical section through the construction shown in Fig. 1 on the plane indicated by IV—IV.

15 Fig. 5 is a vertical section through the construction shown in Fig. 1 on the plane indicated by V—V.

Fig. 6 is an exploded section through the construction shown in Fig. 1 on the plane indicated by VI—VI.

Fig. 6a is a plan view of the interior of the construction shown in exploded form in Fig. 6.

Fig. 7 is a side view of one element of the gun constructed in accordance with my invention.

25 Fig. 8 is a view of the construction shown in Fig. 7 at a right angle to the showing in Fig. 7.

Fig. 9 is a central vertical section parallel to the construction shown in Fig. 1.

30 Fig. 10 is a vertical section through the construction shown in Fig. 5 on the plane indicated by X—X.

Fig. 11 is a section on the plane indicated by XI—XI in Fig. 5.

35 Fig. 12 is an exploded section through the construction shown in Fig. 11 on the plane indicated by XII—XII.

Fig. 12a is a perspective view of the plug of the nozzle shown in Fig. 12.

40 Fig. 13 is a fragmentary view of the face of the turbine casing at the point at which the nozzle discharges, taken on the line indicated by XIII—XIII in Fig. 12.

Fig. 14 is a section through the showing in Fig. 12 (with the parts in operating position, i. e., unexploded) on the plane indicated by XIV—XIV.

45 Fig. 15 is a section on the plane indicated by XI—XI in Fig. 5 showing an alternative embodiment of my invention.

50 Fig. 16 is a corresponding section showing a further alternative embodiment of my invention.

Fig. 17 is a corresponding section showing a further alternative embodiment of my invention.

55 Fig. 18 is a corresponding section showing a still further embodiment of my invention.

Metal spray guns of the type to which my invention relates are devices which operate by continuously feeding a metal rod or wire into a zone in which it is melted and from which this melted metal is sub-divided and propelled by a blast of air or other gas. The rod or wire is fed into the melting zone by knurled burs which press against opposite sides of the wire and are driven by a gas turbine operating through reduction gears. The load on the turbine varies from time to time due to changes in the position of the operator, kinks in the wire, etc., and since it is essential that the rate of feed of the wire be uniformly maintained, it is likewise essential that the turbine have a comparatively stable speed of operation, i. e., that its speed be affected as little as possible by variations in the load. This may be accomplished by appropriate turbine construction.

In the operation of metal spray guns, it is, however, necessary to maintain different rates of feed when spraying different metals; for example, metals, the heats of fusion of which are low, may be fed and sprayed more rapidly than metals with a high heat of fusion, and wires of larger diameter are fed and sprayed more slowly than wires of the same material of smaller diameter. In usual practice an effort is made to approximate proper conditions for the particular metal being sprayed by the provision of replaceable gearing designed to permit the gun to be operated at the desired rate of wire feed while permitting the turbine to operate within a range of stable operation. Changing the gearing involves a loss of time and the possibility that metal particles will be picked up by the gears in handling and interfere with the operation of the gun. If an effort is made to reduce the turbine speed by throttling the gas the turbine becomes unstable and a uniform wire feed is no longer maintained.

I have devised a new metal spray gun in which no change of gearing is necessary and by means of which it is nevertheless feasible to maintain two or, in fact, any number of rates of wire feed within limits practically desirable, shifting from one speed to another by simple adjustment and notwithstanding such changes in the rates of feed, maintaining the turbine at all times in a range of stable operation.

Broadly speaking, I accomplish this purpose by varying the total throat area of the turbine nozzle or nozzles and this may be done within the scope of my invention, either by means for continuously varying the throat area over a predetermined range or by means for varying the total throat area in steps. Starting with the jet ad-

justment of minimum area, a reduced stable operating speed of the turbine is obtained by increasing the total throat area of the turbine nozzle or nozzles. As the throat area is increased the pressure in the manifold which supplies gas to the nozzle or nozzles decreases so that the turbine speed actually decreases without becoming unstable. This reduction in manifold pressure may be the result of a restriction intermediate the air supply and the jets, but in the preferred construction the rate at which the manifold pressure decreases as the nozzle area is increased is determined by control means incorporated in the gun which may, for example, take the form either of a fixed orifice or a variable valve between the manifold and the air line. In the preferred practice this is controlled by the needle valve which governs the air flowing into the manifold. The operator selects that adjustment of the area of the nozzle or nozzles in use which will maintain the turbine in stable operation at approximately the desired speed, and then adjusts the needle valve to give the precise rate of wire feed required.

In accordance with the principle of my invention, where I provide a turbine nozzle or nozzles, the throat area of which may be continuously varied, any number of stable operating speeds may be obtained by corresponding adjustment of the total throat area in service. Alternatively, I may, in accordance with the principle of my invention, use a number of jets each of fixed throat area, and place in service a jet or combination of jets of progressively greater throat area.

For the purpose of illustrating the scope and character of my invention, I have hereinafter described a spray gun containing certain practical embodiments of the same. Referring to the drawings, 1 (Fig. 2) indicates the inlet for oxygen or other combustion supporting gas 2 the inlet for acetylene or other combustible gas, and 3 the inlet for air or other gas for use to project the metal spray and drive the turbine.

Each of the said inlets is connected by a suitable fitting and flexible tubing to a source of required gas. When plug 4 of valve 5' is in the position shown, each of the inlets registers with a corresponding hole in the plug, these holes being indicated by numerals 5, 6 and 7 respectively. When handle 8 and plug 4 are in the position shown, oxygen flows through duct 10 into duct 11. The combustible gas flows through duct 12 to mix with the oxygen in duct 11. The air flows through duct 15 into chamber 16 and also flows through the side connection 17 controlled by needle valve 18 into turbine manifold 19. Openings 5, 6, and 7 in plug 4 are so arranged that as handle 8 is turned from the off position which is at a right angle to the showing in Fig. 2 first some combustible gas passes into duct 11 and thence to the burner outlet to enable the burner to be lighted, some air passes simultaneously into manifold 19 to enable the turbine to come up to speed. Alternatively all the valve passages may be opened but at such rates of flow as to establish favorable lighting conditions which are different from the conditions obtaining when the gun is in operation. This position of the valve is called the lighting position. Under former practice a certain degree of experience was necessary to enable the operator to turn the handle 8 to the exact position at which the burner may be properly lighted, but with my construction this difficulty is eliminated, the washer 20 (Fig. 3) defines a hole 21

of rectangular cross-section which fits closely the shank 22 (of corresponding section) (Fig. 2) of the plug 4. The washer 20 is formed with the depression 23 (Fig. 3). This washer is spring pressed, and this depression slips onto the head of pin 24 when handle 8 is in the correct position for lighting the burner. This offers sufficient resistance to indicate to the operator the lighting position. After the burner has been lighted a slight pressure against handle 8 forces the depression 23 out of engagement with the head of the pin 24. A further movement of handle 8 causes oxygen to flow through duct 10 which establishes a melting flame with the ignited gas and the final movement of handle 8 to the position shown in Fig. 2 permits air to flow into duct 15 and thence into chamber 16 to project the sprayed metal upon the surface to be covered.

The construction of that part of the gun by which the rod or wire is melted and projected will be explained by reference to Fig. 9. The wire 37 moves forward to guide 31 and through duct 32 to the interior 33 of the burner tip 34. The mixture of air and oxygen move forward through the duct 11, which is immediately behind duct 32 (the arrangement is shown in Fig. 2) and into the annular space 35. From this annular space 35 the combustible mixture moves forward through a number of holes to be discharged through convergent orifices 36 against the wire. This forms a zone of gases undergoing combustion, whereby the wire 37 melts as rapidly as it is progressively advanced into the zone, for which reason this zone may be hereinafter referred to as a melting zone. The air from chamber 16 advances through the annular space 40 surrounding burner tip 34 and is projected by air nozzle 41 in such a way as to sub-divide and propel the molten metal. The air tip 41 is threaded to the outer shell 42 of the burner so that the orifice 43 defined by conical interior of air tip 41 and conical exterior of burner tip 34 may be adjusted with corresponding variations in the characteristics of the air blast. When a satisfactory adjustment has been made, the tip 41 is locked in position by the lock nut 44. It will be noted that the air in passing forward from the chamber 16 goes through the constricted annular space 45 which exerts a definite control over the volume of air passing. As a result of this constriction and the orifice effect thereby created, the adjustment of air tip 41 modifies the characteristics of the air blast without so great a modification of the volume of air passing thereto as would otherwise result, which is decidedly advantageous in the adjustment and operation of the gun.

The wire 37 (Fig. 9) enters the gun through the annular guide 50 of hardened material in which is the duct 51. The upper and lower surfaces of the wire are engaged respectively by the burs 52 and 53. Bur 53 is carried by shaft 54, which shaft is driven by an air turbine through suitable intermediate gearing which will be hereinafter described. Shaft 54 (Fig. 4) also drives the gear 55 in mesh with gear 56, which in turn drives the upper bur 52. Both gear 56 and bur 52 are secured to the tubular member 57 which rotates on the spool 58 carried by pin 59 (Fig. 4). The screw 59 is carried by the saddle 60 and this saddle is pivotally secured (Fig. 9) to frame 61 of the gun by the hinge 62. When cap 65 is turned the threaded end 66 of the screw 67 advances into the threaded member 68 which is a part of frame 61 and the spring 70 exerts pressure on the saddle 60, thereby forcing the upper bur 52 toward the

lower bur 53 and thereby causing the burs to engage and advance the wire 37. Conversely, when cap 65 is turned in the reverse direction, pressure of spring 70 on saddle 60 is released and the burs move freely without engaging and advancing the wire.

The shaft 54 (Fig. 4) which drives bur 53 is mounted in ball-bearings 70 and 71. Bearing 70 is held in frame 61 and bearing 71 is held in the housing 72 which is attached to frame 61. The shaft 54 is driven by the worm gear 73, which in turn is driven by the worm 74, carried by the shaft 75. Shaft 75 (Fig. 10) is carried by ball-bearings 76 and 77 mounted in the housing 72. Shaft 75 is in turn driven through the worm gear 78 by the worm 79. The worm 79 (Fig. 5) is integral with shaft 80 carried by bearings 85 and 86. Bearing 85 is mounted in housing 72 and bearing 86 is mounted in the cap or cover 90 of the turbine 91.

Turbine 91 (Fig. 5) includes the turbine rotor drum 95 secured to shaft 80 by the set screw 96. Details of the blading 100 are apparent from Figs. 7 and 8. As evident from the exploded view (Fig. 6) of the cover 90, this cover includes the mounting 101 for the ball-bearing 86 and three ridges 102 radially arranged about mounting 101 on the interior surface of the cover. The washer-shaped member 103 is made of fine wire mesh and rests directly upon ridges 102. The washer 104 rests directly on the washer 103 and is composed of fiber. The fiber washer 104 defines the perforations 105 (Fig. 6a). The washers 103 and 104 are held in contact with each other and with the ridges 102 by the strips 106, which in turn are secured to the ridges 102 by the screws 107. One result of this construction is that the exhaust from the turbine flows through perforations 105 in the fiber washer 104, thence through the openings in the fine screen of which washer 103 is composed, and thence through exhaust ports of the turbine 110, formed in the cover 90 (Fig. 6 and Fig. 1) thereby resulting in more quiet operation of the turbine. The strips 106 form ridges in the space in which the bladed drum of the turbine revolves. These ridges operate to broaden the range of stable operation for any given setting of the turbine nozzles by producing turbulent flow of gas within the turbine.

One nozzle arrangement falling within the purview of my invention is shown in Figs. 11, 12, 12a, 13, and 14. Fig. 11 shows the face 115 which (together with the housing 90) defines the space in which the turbine drum rotates; the drum is not shown to facilitate inspection of the nozzle structure. In this case one individual nozzle 116 is shown which is of variable area. This nozzle is composed of the bore 117 and the plug 118 which is turned within bore 117 to vary the effective area of the nozzle. The actual form of the delivery opening 119 from which the gas is discharged is shown in Fig. 13, which is a view of the face 115 at the point at which the nozzle discharges. It is evident from this that approximately half of the bore 117 is available for discharge. Fig. 14 is a section through Fig. 12 on the plane indicated by XIV—XIV (with the plug in operative position). By inspection of this figure, it is evident that gas in the space 120 between the plug 118 and the longitudinally extending barrier 121 cannot escape because this space is capped or covered by the extension of face 115, but that on the contrary, the only opening through which air may escape is that part of the opening 119 which

is not occupied by the plug 118 and for this reason the actual nozzle in use at any one time may be enlarged or decreased within the limits shown in Fig. 13 by turning the plug 118.

The preferred form of nozzle for practical applications is that shown in Fig. 15 in which the nozzle 130 is permanently connected to the manifold 19 while nozzle 131 may at any time desired be additionally connected by turning plug 132 so that hole 133 defined by the plug registers with inlet 134 of nozzle 131. In this case it is evident that when both jets are in operation, the effective nozzle area is greater than with either jet individually, and in this case two stable ranges of operation may be obtained by using either jet 130 alone or by the combined use of jets 130 and 131. As hereinbefore pointed out, a slower stable range of operating speeds is obtained by increasing the effective nozzle area.

A further alternative form of construction is that shown in Fig. 16 in which case I have shown two nozzles, 135 and 136, which may be alternatively brought into communication with the manifold 19 by turning the plug 137 so that holes in the tubular portion 138 of the plug register with either inlet to nozzle 135 or inlet to nozzle 136. In this case it will, of course, be understood that the nozzles are of different cross-sectional areas and are, therefore, of different effective discharge areas and that the lower stable range of operating speeds is obtained by the use of the jet of greater discharge area. The tubular section 138 may in addition carry another set of holes simultaneously registering with the inlets to nozzles 135 and 136 so that both nozzles may be simultaneously in use whereupon a third and still lower stable range of operating speeds will be obtained.

A further alternative embodiment of my invention is shown in Fig. 17. This also comprises two nozzles which may be alternatively used. Nozzle 140 is in communication with manifold 19 through side-arm 141 and is controlled by needle valve 142. Nozzle 143 is in communication with manifold 19 through side-arm 144 and is controlled by needle valve 145. In case the nozzles shown are of the same or substantially the same cross-sectional area, a lower stable range of operating speed of the turbine is obtained by placing both nozzles simultaneously in communication with the manifold. The nozzles may, however, be constructed with different cross-sectional areas, in which case a lower stable operating speed is obtained by the use of the nozzle of greater cross-sectional area and a still lower stable range of operating speeds is obtained by the simultaneous use of both nozzles. Since in this case the amount of gas discharged from each jet may be accurately determined by the needle valve controlling it, the use of a restriction or valve controlling the admission of air into the manifold 19 is not essential although in practical operation it is desirable.

A still further embodiment of my invention is shown in Fig. 18 in which case the turbine is provided with four separate nozzles, numbered respectively 150, 151, 152 and 153. Communication of these nozzles with manifold 19 is controlled by tubular section 154 of the plug 155 in manifold 19. The sleeve is provided with slots so that nozzle 153 may be placed in service alone or nozzle 152 may be additionally placed in service or nozzle 151 may be placed in service in addition to nozzle 152 and 153 or if desired, all four nozzles may be placed in service. In this

way any one of four stable ranges of operating speed may be obtained, the speed being inversely related to the number of nozzles in operation and to the total cross-sectional area of the nozzles in operation. It will, of course, be understood that in this embodiment of my invention, the nozzles may be constructed with cross-sectional area different from one another so that a corresponding control would be obtained by their alternative use and if desired additional ports may be provided in the tubular section 154 so that these nozzles may also be combined with one another in various ways to produce additional ranges of operating speed.

The foregoing description is furnished by way of illustration and not of limitation and it is, therefore, my intention that the invention be limited only by the appended claims or their equivalents wherein I have attempted to claim broadly all inherent novelty.

I claim:

1. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and nozzle means positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising a manifold in communication with said nozzle means, means for varying the area of the nozzle means in use and pressure reduction means between said inlet and said manifold.

2. The improvement in a metal spray gun according to claim 1 in which said turbine comprises in addition at least one gas baffle within the same positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

3. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and a nozzle positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising a manifold in communication with said nozzle, means for varying the cross-sectional area of said nozzle and pressure reduction means between said inlet and said manifold.

4. The improvement in a metal spray gun according to claim 3 in which said turbine comprises in addition at least one gas baffle within the same positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

5. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and a plurality of nozzles positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising a manifold in communication with said nozzles, means for varying the average area of the nozzles in use and pressure reduction means between said inlet and said manifold.

6. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and nozzle means positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising a manifold in communication with said nozzles, means for varying the number of

nozzles in use and pressure reduction means between said inlet and said manifold.

7. The improvement in a metal spray gun according to claim 6 in which said turbine comprises in addition at least one gas baffle within the same positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

8. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and a number of nozzles of different cross-sectional areas positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising a manifold in communication with said nozzles, means for selectively placing a part of said nozzles in use, and pressure reduction means between said inlet and said manifold.

9. The improvement in a metal spray gun according to claim 8 in which said turbine comprises in addition at least one gas baffle within the same positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

10. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and nozzle means positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising means including at least one gas baffle in said turbine positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

11. In a metal spray gun of the molten metal gas blast type having an inlet for compressed gas and turbine actuated means for progressively advancing metal into a melting zone and including in said turbine a rotor drum and nozzle means positioned to direct a blast of gas against the blading of said rotor drum, the improvement comprising means including at least one stationary internal projection positioned to produce turbulent flow of gas therein in air frictional engagement with said rotor drum.

12. In a metal spray gun of the type including means for maintaining a melting zone, means for directing a blast of gas against metal which has been melted in said zone adapted to subdivide and convey such melted metal, a control cock for gases required in the operation of said gun, said control cock including a housing defining multiple inlets and corresponding outlets, and including a handle operated plug defining at least three passages, each of said passages controlling flow through one of said inlets and the corresponding outlets, at least one of said passages defining a port for combustible gas, at least one other a port for oxygen and at least one-third a port for a compressed non-combustible gas, the improvement comprising gas bleeding means within said housing positioned to bring into communication said combustible gas inlet and outlet in advance of the registry of said port for combustible gas with its inlet and outlet in substantially lighting position, and a detent positioned to arrest the motion of said plug when said bleeding means are in said lighting position.

13. In a metal spray gun of the type including means for maintaining a melting zone, means for directing a blast of gas against metal which has been melted in said zone adapted to subdivide

and convey such melted metal, a control cock for gases required in the operation of said gun, said control cock including a housing defining multiple inlets and corresponding outlets, and including a handle operated plug defining at least three passages, each of said passages controlling flow through one of said inlets and the corresponding outlet, at least one of said passages defining a port for combustible gas, at least one other a port for oxygen and at least one-third a port for a compressed non-combustible gas, the improvement comprising first gas bleeding means within said housing positioned to bring into communication said combustible gas inlet and outlet in advance of the registry of said port for combustible gas with its inlet and outlet in substantially lighting position, second gas bleeding means within said housing positioned to bring into communication said compressed non-combustible gas inlet and outlet in advance of the registry of said port for compressed non-combustible gas with its inlet and outlet in substantially lighting position and a detent positioned to arrest the motion of said plug when said first and said second bleeding means are in said lighting position.

14. In a metal spray gun of the type including means for maintaining a melting zone, means for directing a blast of gas against metal which has been melted in said zone adapted to sub-divide and convey such melted metal, a control cock for

gases required in the operation of said gun, said control cock including a housing defining multiple inlets and corresponding outlets, and including a handle operated plug defining at least three passages, each of said passages controlling flow through one of said inlets and the corresponding outlet, at least one of said passages defining a port for combustible gas, at least one other a port for oxygen and at least one-third a port for a compressed non-combustible gas, the improvement comprising first gas bleeding means within said housing positioned to bring into communication said combustible gas inlet and outlet in advance of the registry of said port for combustible gas with its inlet and outlet in substantially lighting position, second gas bleeding means within said housing positioned to bring into communication said compressed non-combustible gas inlet and outlet in advance of the registry of said port for compressed non-combustible gas with its inlet and outlet in substantially lighting position, third bleeding means within said housing positioned to bring into communication said oxygen gas inlet and outlet in advance of the registry of said port for oxygen with its inlet and outlet in substantially lighting position and a detent positioned to arrest the motion of said plug when all of said bleeding means are in said lighting position.

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