July 6, 1948. E. MEINCKE ET AL 2,444,900

BLOWPIPE APPARATUS

Filed April 21, 1943

3 Sheets-Sheet 1

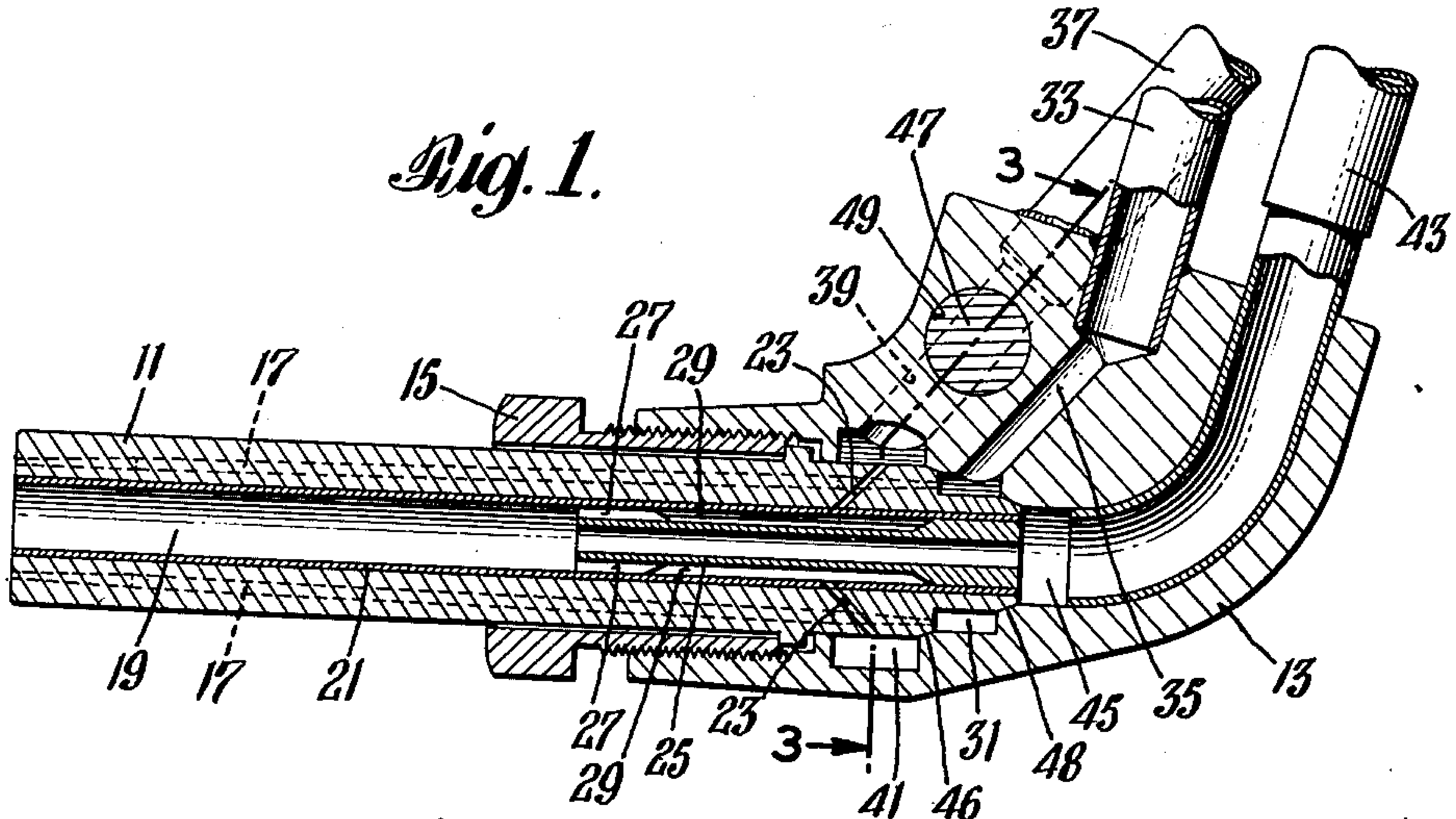

Fig. 1.

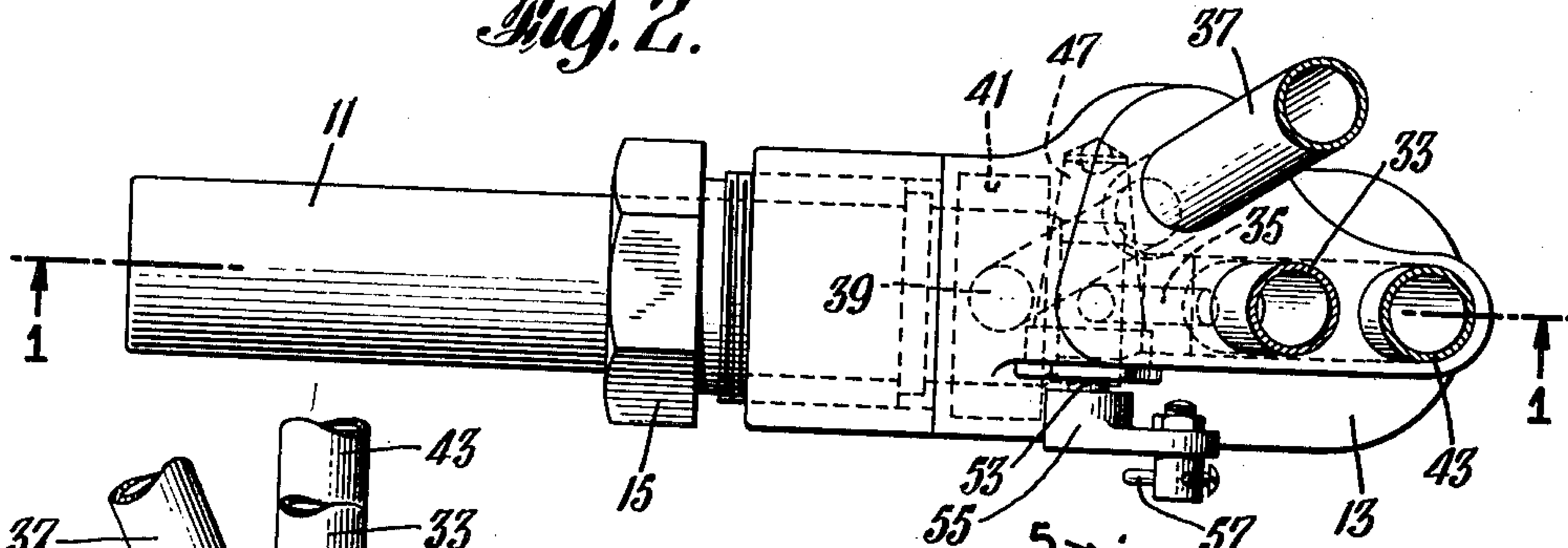

Fig. 2.

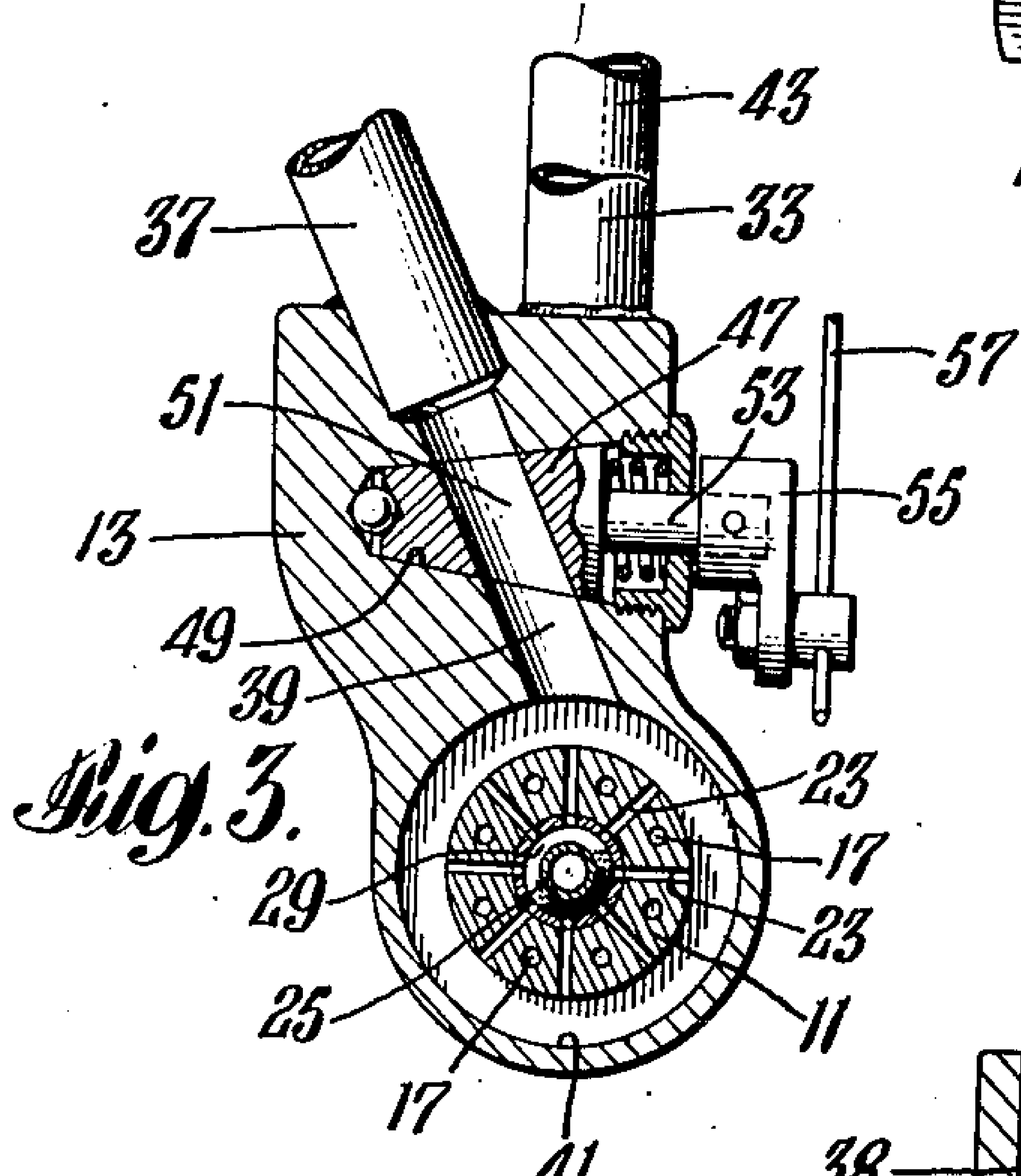

Fig. 3.

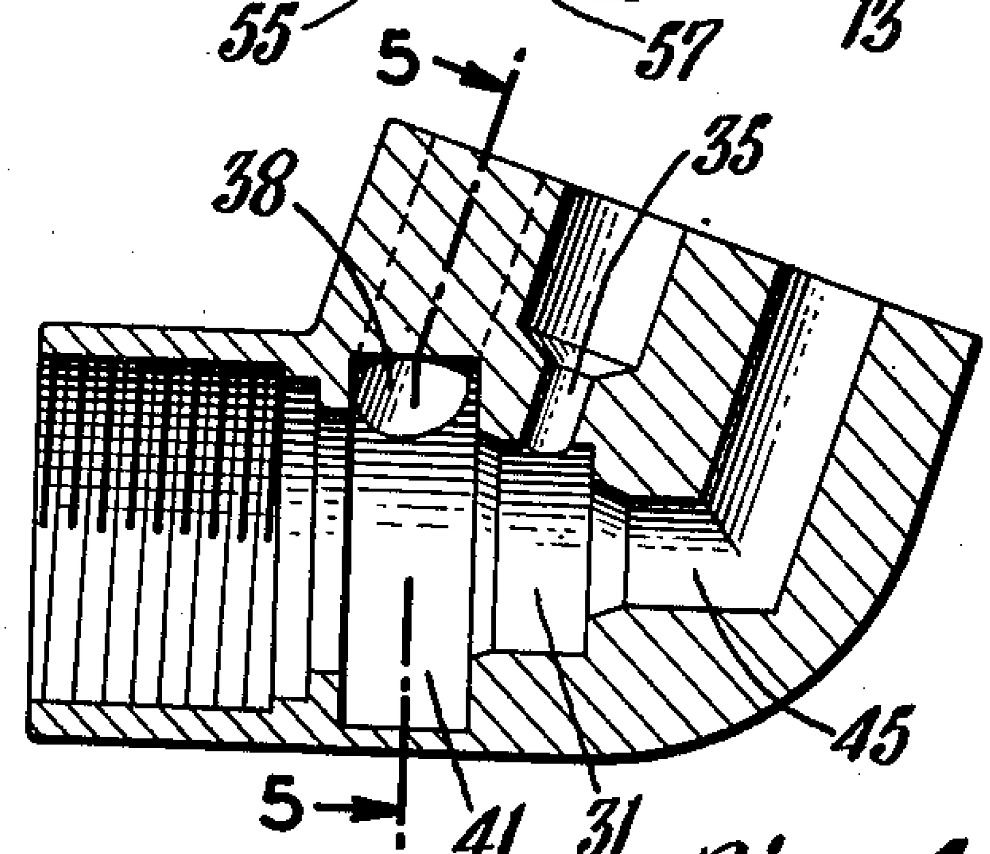

Fig. 4.

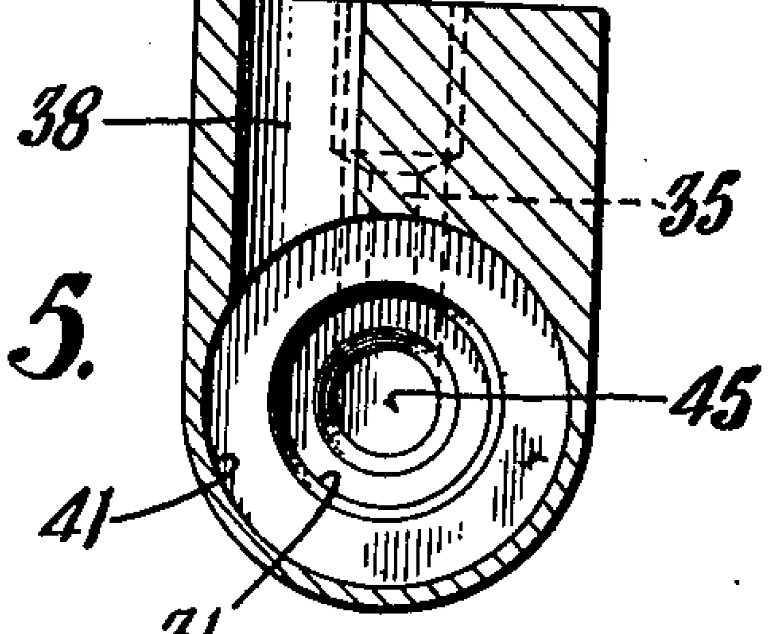

Fig. 5.

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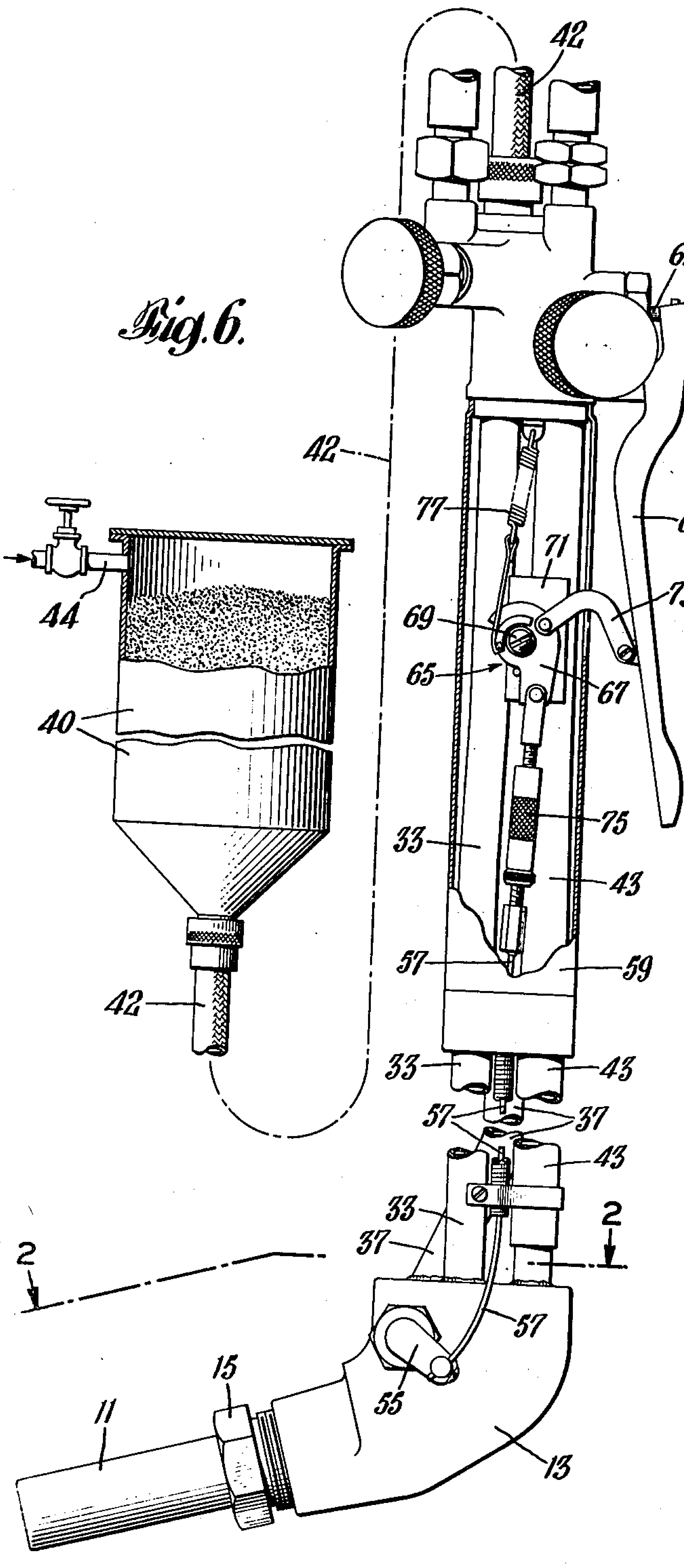

Fig. 6.

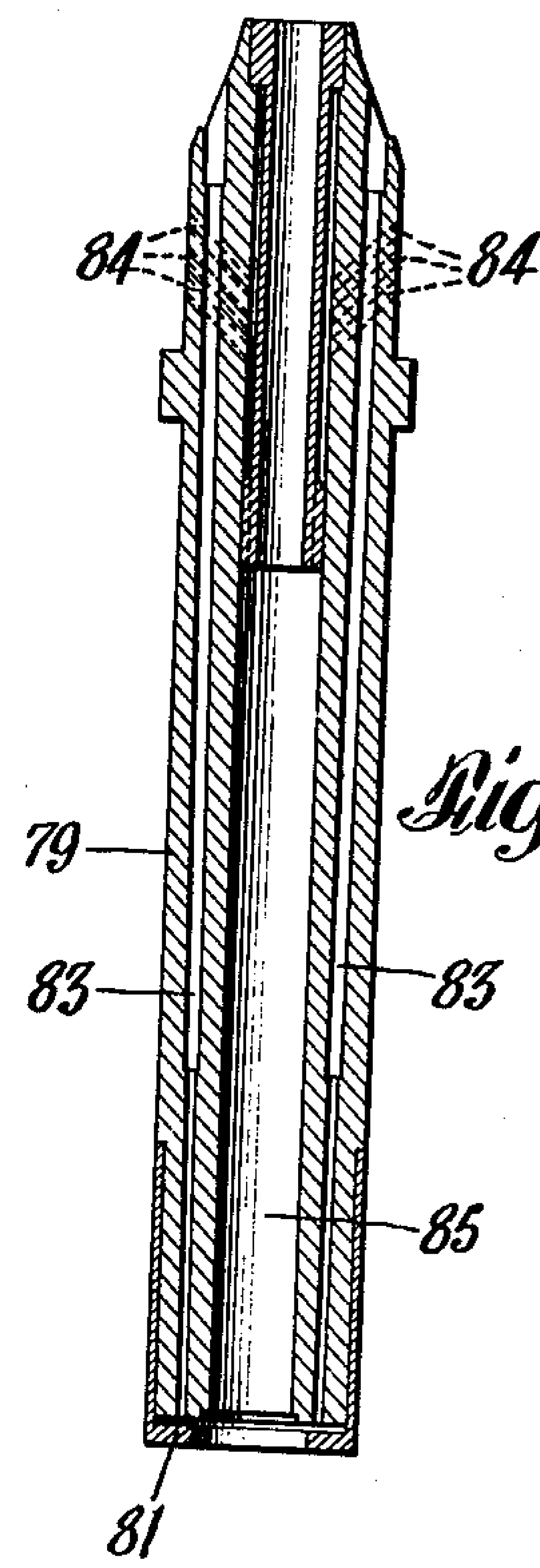

Fig. 7.

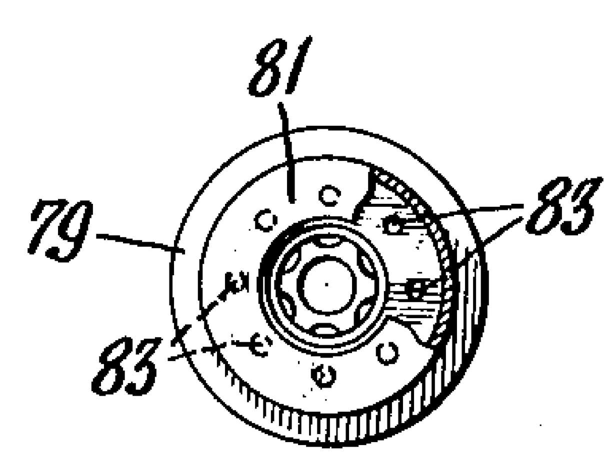

Fig. 8.

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BLOWPIPE APPARATUS

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3 Sheets-Sheet 3

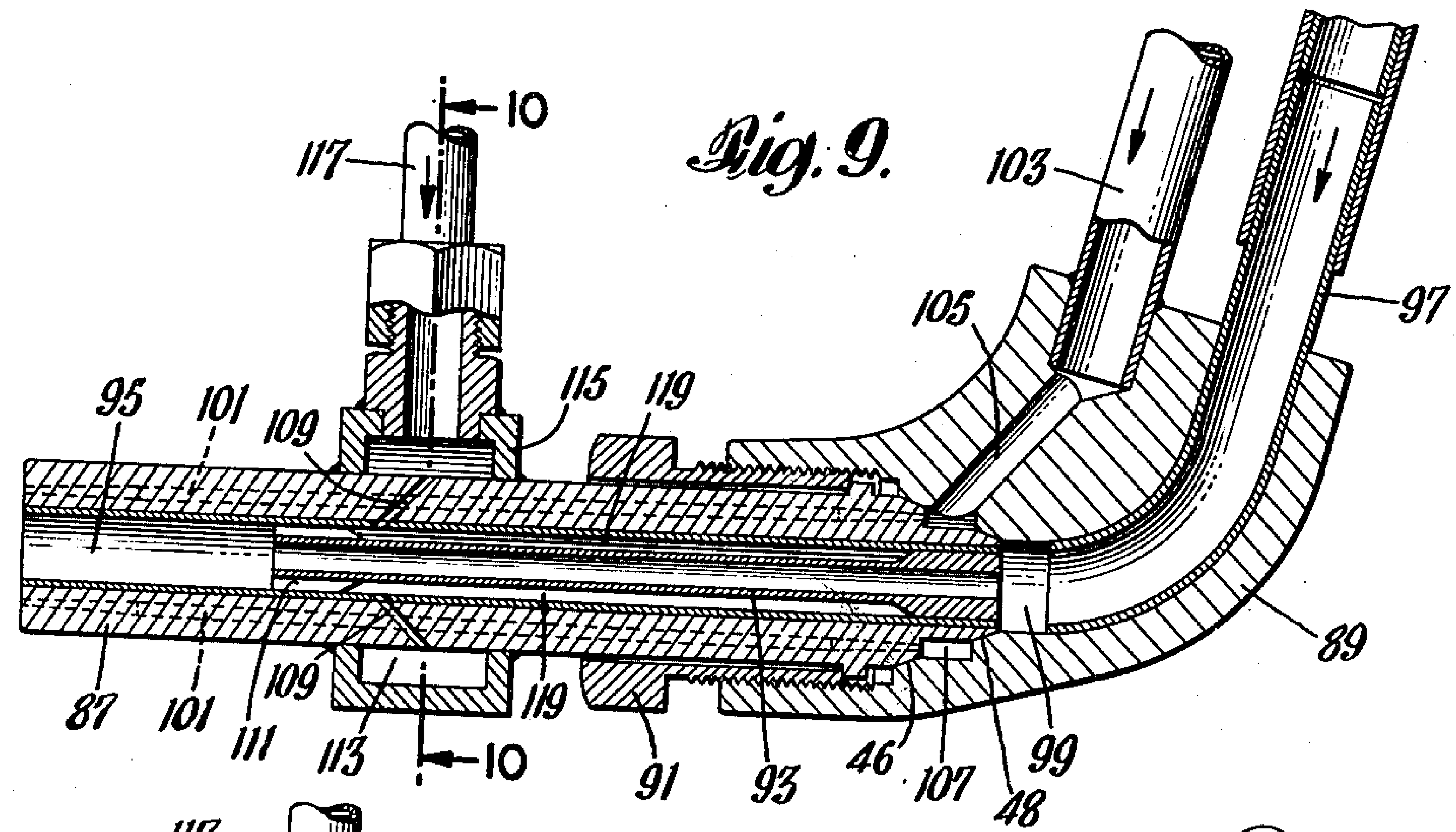

Fig. 9.

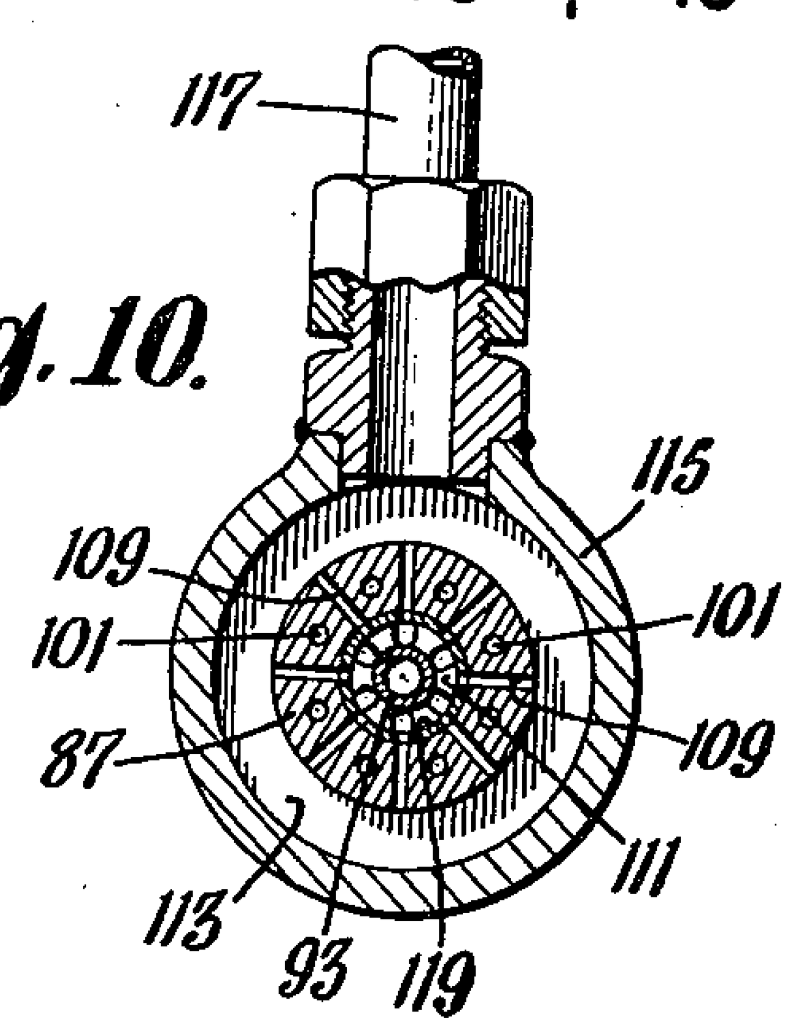

Fig. 10.

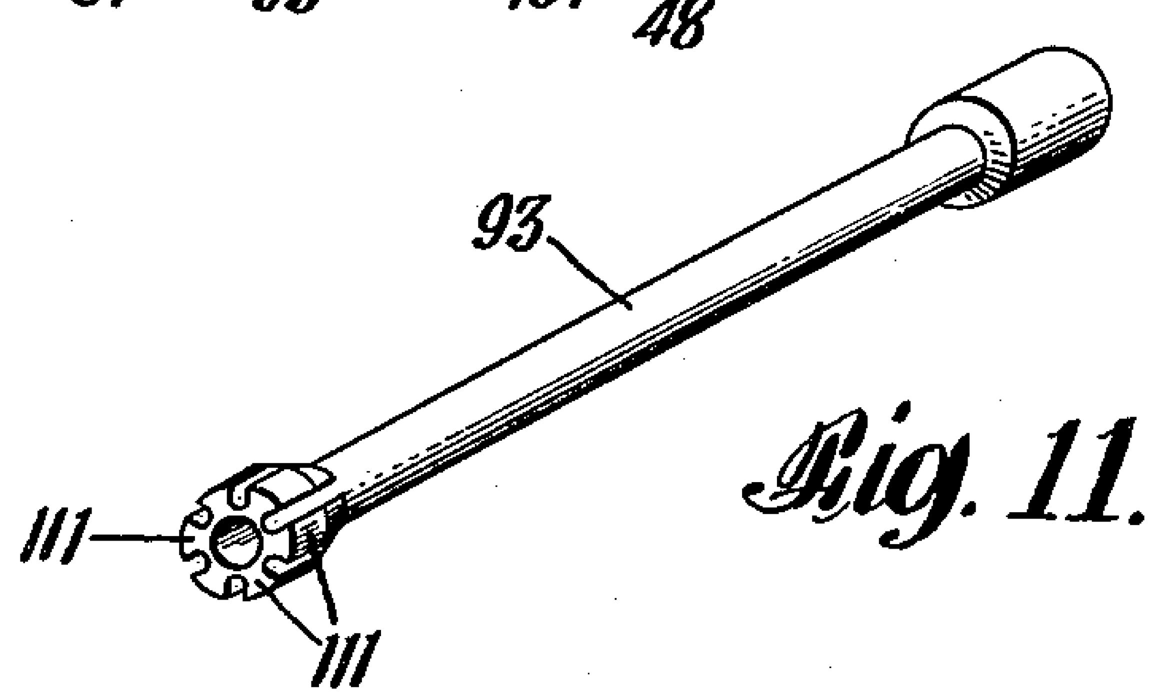

Fig. 11.

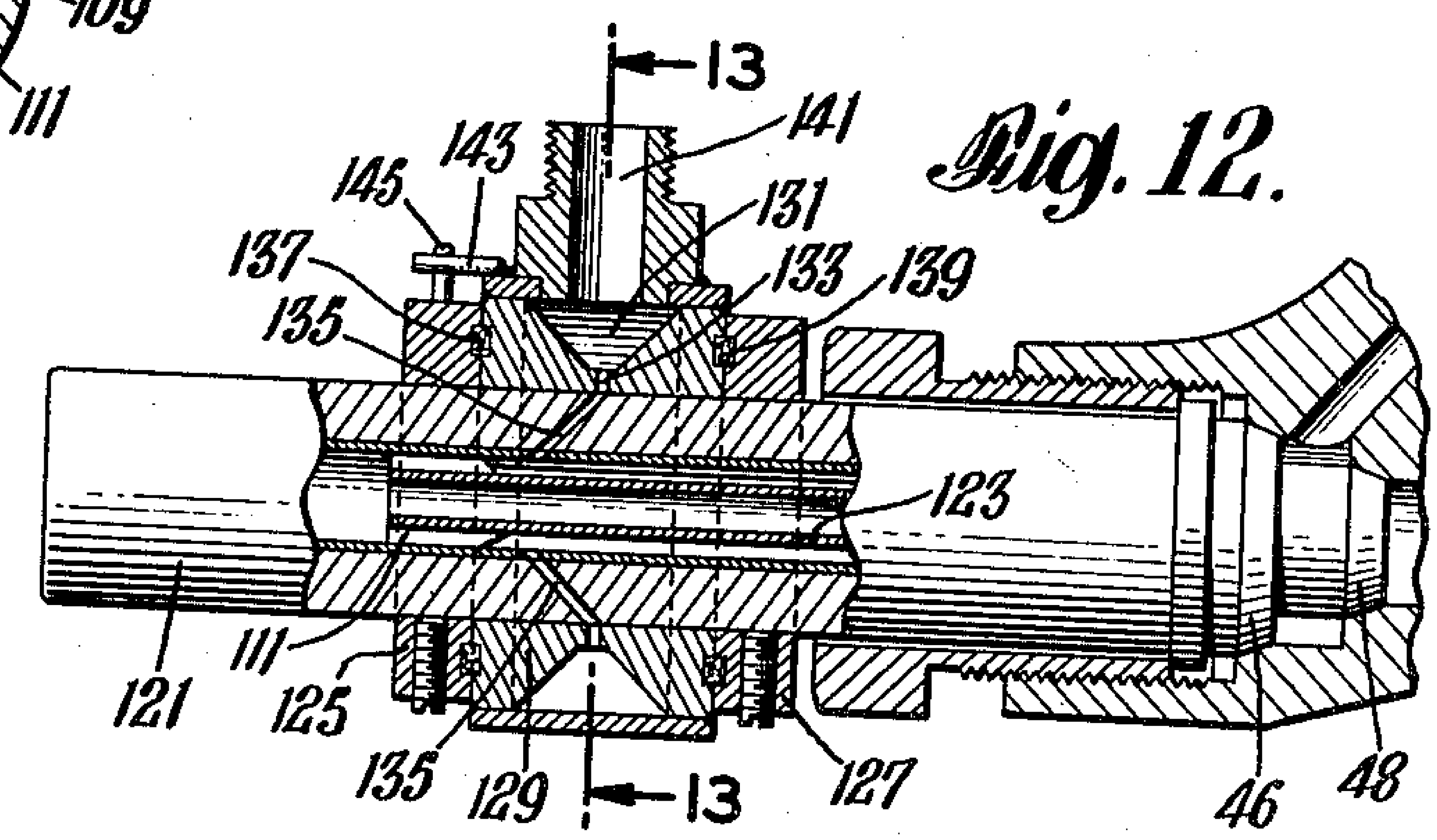

Fig. 12.

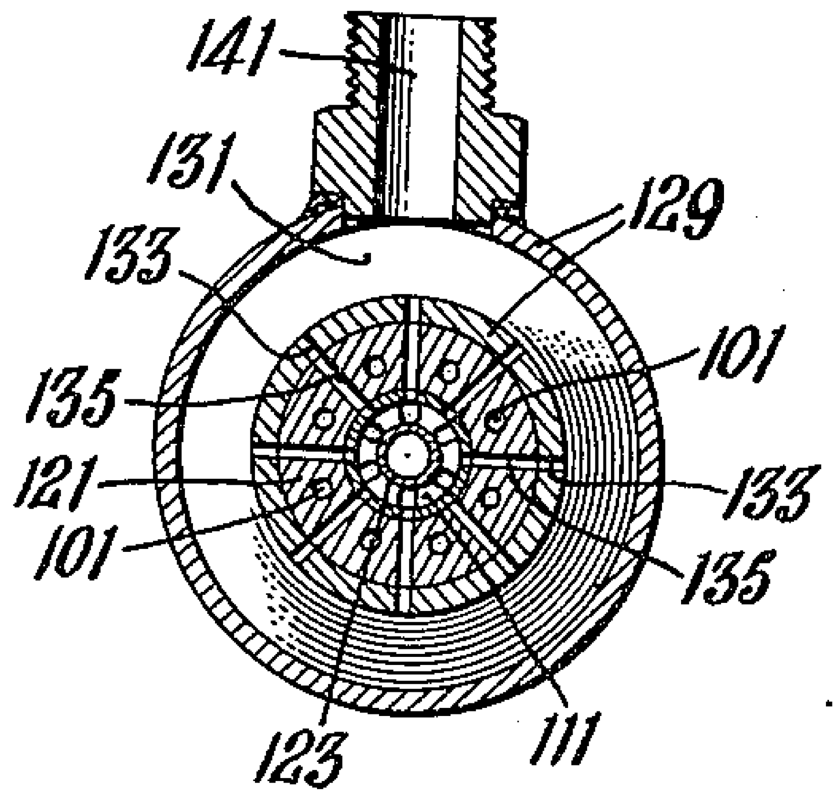

Fig. 13.

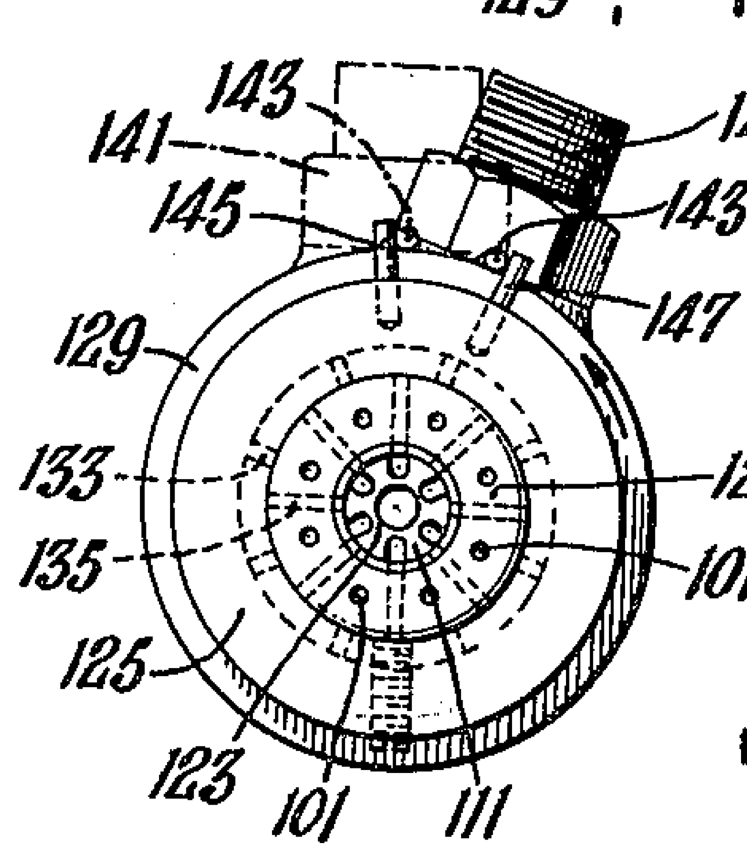

Fig. 14.

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UNITED STATES PATENT OFFICE

2,444,900

BLOWPIPE APPARATUS

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Application April 21, 1943, Serial No. 483,874

19 Claims. (Cl. 110—22)

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This invention relates to blowpipe apparatus for thermochemically removing metal by a stream or jet of oxygen from metal bodies having a composition which resists the normal thermochemical action of a stream or jet of oxygen, such resistance being sufficient to hinder or substantially prevent such normal removal of metal. Examples of such metal bodies are ferrous metals, such as stainless steels, cast iron, and the like, and non-ferrous metals, such as copper, aluminum, nickel and various alloys. Such metal bodies are difficult or impossible to cut, deseam, desurface or the like by the normal impingement of a stream of oxygen upon successive portions heated to their ignition temperature, or by heating flames which would provide sufficient heat for the removal of metal from plain carbon steel by melting.

Previous attempts to thermochemically remove a surface layer of metal from a body of stainless steel, for instance, have met with little or no success. However, stainless steel plates have been cut or severed by placing a mild steel plate over the stainless steel plate, and cutting through the mild steel plate so that the molten slag from the mild steel kerf flows into the kerf of the stainless steel. In such cutting operation, large amounts of mild steel are wasted, the cutting operation is relatively slow, and cuts of poor quality are produced.

The present invention is particularly applicable to the thermochemical cutting, deseaming or desurfacing of metals and alloys which have heretofore resisted such thermochemical operations. Metal is thermochemically removed from a metal body, heretofore resisting such action, by introducing a finely-divided oxidizable adjuvant material such as iron powder into the zone of action of the oxygen stream or jet in order to produce reaction products sufficiently fluid that successive portions of the metal body may be thermochemically removed when a relative movement is effected between the body and the oxygen stream or jet. Preferably, the powdered adjuvant material is carried directly into the reaction zone by the stream or jet of metal-removing oxygen.

It is an object of the present invention to provide an improved apparatus for introducing the adjuvant material into the stream of metal-removing oxygen, which stream of oxygen carries the adjuvant material into the reaction zone. Among other objects of this invention are to provide apparatus for introducing finely-divided adjuvant material into a stream of metal-removing oxygen in such manner that the material will

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be substantially uniformly distributed in the stream of oxygen, and the metal-removing effectiveness of the oxygen stream or jet will be rendered uniform across the width thereof; to provide such apparatus wherein the finely-divided material is introduced into the oxygen stream in the oxygen blowpipe passage of a blowpipe nozzle; to provide such apparatus whereby the material is introduced at the most effective point in the oxygen discharge passage; to provide such apparatus which follows, as far as is practicable, the design of cutting and deseaming nozzles and blowpipes in current usage; and to provide other features which will be apparent as the following description proceeds.

In accordance with this invention, oxygen is introduced into the oxygen discharge passage of a blowpipe nozzle through a tube extending into the passage from the rear toward the front thereof in spaced relation to the wall thereof, and terminating at a point spaced from the forward end thereof. Finely-divided adjuvant material is supplied to the space surrounding the tube by a plurality of small ports or ducts extending through the wall of the nozzle from an annular chamber surrounding the nozzle. The ducts are positioned in the nozzle wall in such a manner that they pass between but do not communicate with the usual longitudinal preheat passages in the nozzle wall. As the oxygen stream passes out of the tube and into the discharge passage of the nozzle, it expands, creating an aspiration effect which draws the adjuvant material into the oxygen stream from the space around the tube. A plurality of small orifices advantageously are provided in the space surrounding the oxygen discharge tube for distributing powder uniformly around the periphery of the oxygen stream and for arresting powder back flashes. The mixture of oxygen and finely-divided adjuvant material, opon passing out of the discharge passage of the nozzle, may be brought into contact with a heated portion of a metal body to effect thermochemical removal of metal therefrom.

Apparatus constructed in accordance with this invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of the head end of a blowpipe constructed in accordance with this invention, taken along the line 1—1 in Fig. 2;

Fig. 2 is a cross-sectional view taken along the line 2—2 of Fig. 6;

Fig. 3 is a cross-sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a longitudinal sectional view of a part of a modified form of blowpipe;

Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 4;

Fig. 6 is a side elevational view, partly broken away and in section, of the apparatus of the invention;

Fig. 7 is a longitudinal sectional view of a modified form of blowpipe nozzle;

Fig. 8 is a bottom end view of the nozzle of Fig. 7;

Fig. 9 is a longitudinal sectional view of the front end of a modified form of blowpipe;

Fig. 10 is a cross-sectional view taken along the line 10—10 of Fig. 9;

Fig. 11 is a perspective view of a part of the blowpipe of Fig. 9;

Fig. 12 is a side elevational view, partly broken away and in section, of a modified form of blowpipe nozzle;

Fig. 13 is a cross-sectional view taken along the line 13—13 of Fig. 12; and

Fig. 14 is an end view of the nozzle as seen from the left in Fig. 12.

In the embodiment of this invention illustrated in Figs. 1, 2, and 3, a blowpipe nozzle unit including a tubular barrel or nozzle 11 having a wall and front and rear ends is detachably secured in a head 13 by an annular nut 15, in a well-known manner. The nozzle 11 is provided with a plurality of annularly arranged longitudinal preheat passages 17 in its wall for a combustible preheating medium having inlets arranged in a ring or circumferential row near the rear end of the nozzle, and with a central longitudinal bore or oxygen passage 19 around which the preheat passages 17 are arranged. Near the rear end of the nozzle a plurality of circumferentially spaced ports 23 for powder are drilled transversely through the wall of the nozzle from the outside thereof to the oxygen passage 19 with their axes lying in planes between combustible gas passages 17. The ports 23 are located between the preheat passages 17 in non-communicative relation therewith, as shown clearly in Fig. 3, have entrances arranged in a ring or circumferential row on the outside of the nozzle spaced forwardly from the ring or row of preheat passage inlets, and are inclined or converge forwardly and inwardly toward the axis of the nozzle. An oxygen gas discharge tube or injector tube 25, which has an annular flange adjacent to its rear end fitting snugly in the rear end of the passage 19, is carried by the nozzle 11 and extends forwardly in spaced relation to the wall of the passage 19. Tube 25 terminates at a point well ahead of the ducts 23 and spaced from the forward or outlet end of the passage 19. The front portion of the tube 25 carries a plurality of laterally extending circumferentially spaced fins 27 fitting snugly in the passage 19 and dividing the discharge end of the annular space around the tube 25 into a plurality of small ducts.

A combustible preheating medium, such as an oxyacetylene gas mixture, may be distributed to the passages 17 by an annular distributing chamber 31 supplied by a communicating supply duct comprising a conduit 33 secured in a connecting bore 35 in the head 13.

Finely-divided adjuvant material may be supplied to the ports 23, and thence to the annular space 29, by a tube 37 secured in a connecting bore 39 leading into an annular powder distributing chamber or header 41 surrounding a rear portion of the nozzle barrel 11 and communicating with the entrances of all the ports. As shown in Figs. 2 and 3, the bore 39 opens into the annular chamber 41 above the longitudinal axis thereof. However, a good distribution of powder in the distributing chamber is also obtainable if the bore opens into the chamber at a locality to one side of the axis, as does the bore 39 shown in Figs. 4 and 5. A suitable source of powder, as shown in Fig. 6, may comprise a closed hopper 40 connected to the tube 37 by a flexible hose 42, and having an inlet pipe 44 through which gas under pressure may enter above the powder level.

Oxygen enters the discharge tube 25 through a communicating supply duct comprising a conduit 43 secured in a bore 45 in head 13, and is then discharged into the relatively large passage 19, aspirating into the passage a plurality of small streams of powder flowing smoothly in substantially a straight line from the annular space 29. The powder and oxygen mix intimately together while passing along the passage 19, and may be discharged against a body of metal preheated by the flames from the passages 17, thereby removing metal from the body thermochemically.

Adequate gas-tight seals preventing leakage between the oxygen, fuel gas, and powder passage and ducts are provided by two annular conical seats 46 and 48 near the rear end of the nozzle 11, which seat tightly on corresponding seating surfaces in the body 13. Seating surface 46 is arranged between the ring of preheat passage inlets and the ring of powder port entrances.

It is desirable that powder from the passage 39 be controlled so as to enter the nozzle 11 only when metal-removing oxygen is flowing through the tube 25. This is accomplished by placing a suitable shut-off valve 47 in the bore 39 of the head 13. The valve 47 illustrated, by way of example only, is an ordinary rotatable plug valve secured in a cross bore 49 of the head 13 and having a through passage 51 which may be rotated into and out of register with the bore 39. The valve 47 includes a stem 53 projecting from the side of the body 13 and engaging a crank 55 to which an operating rod or wire 57 is attached by a set screw. With this arrangement, the operator of the blowpipe can start or stop the flow of powder to the nozzle 11 by manipulating the wire 57.

In Fig. 6 there is shown an arrangement whereby the operator may control in unison the flows of powder and metal-removing oxygen to the nozzle 11. The blowpipe handle 59 has the usual long lever 61, fulcrumed between its ends, and engaging at its rear end the stem 63 of a spring-closed valve controlling the flow of metal-removing oxygen to the nozzle 11. The lever 61 is connected through a suitable linkage 65 to the connecting rod 57, the construction and arrangement being such that when the operator actuates the lever 61 to start or stop the flow of oxygen, the powder control valve 47 is rotated to start or stop the flow of powder. The linkage may be such that the flows of oxygen and powder start and stop simultaneously, or any other predetermined relation may be maintained, such that the flow of powder may be started and stopped either before or after the oxygen.

The particular linkage 65 shown in Fig. 6, by way of illustration only, comprises a rotatable element 67 pivoted at 69 to a stationary support 71 within the handle 59. An L-shaped connecting link 73 is pivotally secured at one end to the element 67 on one side of the pivot 69, and at its other end to the valve-operating lever 61, whereby movement of the lever 61 causes the element 67 to turn through part of a revolution. A turnbuckle 75 is pivotally secured at one end to the element 67 on the opposite side of the pivot 69, and at its other end grips the connecting rod or wire 57, whereby rotation of the element 67 opens or closes the valve 47. A return spring 77 is secured at one end to the handle 59, and at its other end engages the pivoted element 67, for assisting the return of the lever 61 to its raised position when released by the operator, thereby closing the oxygen control valve 63 and the powder control valve 47.

Figs. 7 and 8 show a modified form of nozzle which is designed to provide a preheating flame of the externally-mixed type, wherein the combustible fluid and the oxygen are not mixed together until after discharge from the nozzle. The nozzle 79 is generally similar to that shown in Fig. 1, and may be mounted in an identical head. However, it differs from the nozzle of Fig. 1 mainly by the provision of an inturned annular deflector lip or flange 81 on the front of the nozzle, extending across the outlets of the preheat passages 83 in slightly spaced relation thereto; and by the provision of a greater number of powder inlet ports 84. In the operation of this nozzle, a constant flow of oxygen at a relatively low rate (without powder) is maintained from the outlet of the passage 85, and combustible fluid such as acetylene gas from the separate adjacent outlets of passages 83 is deflected by the annular lip 81 into the central stream of oxygen leaving the nozzle. The two gases thus mix together intimately only outside the nozzle and, on ignition, burn with a hot flame which will not flash back within the nozzle.

When the flame has brought the metal body to the proper temperature, the rate of flow of oxygen through the passage 85 is increased by the operator, and the flow of adjuvant powder into the oxygen is begun. The preheating flame continues to burn, and the excess oxygen and the adjuvant powder from the passage 85 will react with a metal body to remove metal therefrom.

In another embodiment of the invention, shown in Figs. 9, 10, and 11, a nozzle 87, quite similar in many respects to that of Fig. 1, is secured to a blowpipe head 89 by a hollow nut 91. Oxygen is supplied to a discharge tube 93, carried in the passage 95 of the nozzle, by a conduit 97 secured in a connecting bore 99 in the head 89. A combustible preheating fluid, such as an oxy-acetylene mixture, is supplied to the preheat passages 101 in the nozzle by an annular distributing chamber 107 receiving gas from a conduit 103 secured in a connecting bore 105 in the head 89.

The main distinctions of the nozzle 87 over that shown in Fig. 1 lie in the location of the forwardly and inwardly inclined powder ports 109 outside of the head 89 and just in back of the fins 111 on the tube 93; and the provision of a separate annular powder distributing chamber or header 113 formed within a hollow collar 115 fitting snugly over and welded to the outside of the nozzle 87 in spaced relation to head 89. Collar 115 has an inwardly open channel closed by the outside surface of the nozzle. Finely-divided adjuvant material is supplied to the chamber 113 by a conduit 117 conected to a suitable source of supply, such as a powder hopper of the type shown in Fig. 6, and thence passes through the connecting ports 109 to the annular space 119 around tube 93.

Fig. 11 shows in detail the construction of the oxygen discharge tube 93, which is similar to the discharge tubes of Figs. 1 and 12.

In another embodiment of the invention, shown in Figs. 12, 13, and 14, the nozzle 121 and oxygen discharge tube 123 are identical with the corresponding parts of Fig. 9. However, the powder is fed into the nozzle by a device which may be actuated to start or stop the powder feed at will, if desired. Two narrow guide collars 125 and 127 are secured on the nozzle 121, on opposite sides of powder inlet ports 135 in spaced relation to one another, in any suitable manner, as by clamping screws. Between the guide collars a powder distributing header ring 129 is mounted on the nozzle 121 for rotational sliding movement thereon. The ring 129 has an annular powder distributing chamber 131 of generally triangular cross section, and a plurality of short ducts 133 leading from the chamber corresponding to and arranged to register with the outer ends of the powder inlet ports 135 of the nozzle. Rings 137 and 139 of suitable packing material are disposed in mating grooves between the ring 129 and the collars 125 and 127. Powder is supplied to the annular chamber 131 by a conduit 141 welded to the ring 129 and connected to a suitable source of supply (not shown).

When operating a blowpipe embodying the structure of Fig. 12, the operator so adjusts the ring 129 that the ducts 133 register with the ports 135, as shown in Fig. 13, thereby permitting powdered adjuvant material to flow into the nozzle. When the operator wishes to stop the powder flow, he simply turns the ring 129 an amount sufficient to take the ducts 133 and ports 135 out of registry with one another, as shown in Fig. 14. Adjustment is facilitated by a pin 143 projecting from the ring 129, which may abut against a movement-limiting stop pin 145 when the ring is adjusted for powder flow, and may abut against a second movement-limiting stop pin 147, when the ring is adjusted to stop the powder flow.

Although several different embodiments of this invention have been described, it will be understood that various changes in the apparatus can be made and that the principles of this invention are applicable to the removal of metal from metal bodies other than those described and to the use of adjuvant materials other than iron powder. In addition, other changes may be made without departing from the spirit and scope of the invention as defined in the appended claims.

This invention constitutes an improvement on the apparatus disclosed and claimed in application Serial No. 584,715, which was filed March 24, 1945, as a continuation-in-part of abandoned application Serial No. 456,667, filed August 29, 1942, both of which applications are assigned to The Linde Air Products Company.

What is claimed is:

1. A blowpipe having a head; a nozzle carried by said head, said nozzle having a longitudinal oxygen passage therethrough and a plurality of longitudinal preheating gas passages arranged around said oxygen passage; a gas discharge tube extending into said oxygen passage from the rear toward the front thereof in spaced relation to the

wall thereof, and terminating at a point spaced from the forward end of said oxygen passage; said head having oxygen and preheating gas supply ducts in communication respectively with said tube and said preheating gas passages; an annular powder distributing header surrounding said nozzle in spaced relation to said head; and said nozzle being provided with a plurality of ports passing transversely of said nozzle between said preheating gas passages in non-communicative relation therewith and connecting said header with the space suronding said gas discharge tube.

2. A blowpipe according to claim 1, wherein said header comprises a collar fitting snugly over said nozzle, said collar having an inwardly open channel closed by the outside surface of said nozzle.

3. A blowpipe nozzle having a longitudinal oxygen passage therethrough and a plurality of longitudinal preheating gas passages arranged around said oxygen passage; said nozzle being provided with a plurality of ports passing transversely between the inside and the outside thereof between said preheating gas passages in non-communicative relation therewith; and a header slidably mounted on said nozzle, said header having a distributing chamber therein, and said header having a plurality of ducts corresponding to said ports leading from said chamber, said header being slidable on said nozzle to bring said ducts into and out of register with said ports at will.

4. A blowpipe, said nozzle having a longitudinal oxygen passage therethrough and a plurality of longitudinal preheating gas passages surrounding said oxygen passage; said nozzle being provided with a plurality of ports passing transversely between the inside and the outside thereof between said preheating gas passages in non-communicative relation therewith; a pair of guide collars secured over said nozzle on opposite sides of said ports; a powder distributing header mounted on said nozzle, between said guide collars, for rotational sliding movement thereon, said header having an annular chamber therein and a plurality of ducts leading from said chamber, the construction and arrangement being such that said ducts may be brought into and out of register with said ports by turning said header; and a pair of stops cooperating with said header limiting the movement thereof, the arrangement being such that when said header abuts against one of said stops, said ducts and said ports are out of register, and when said header abuts against the other of said stops, said ducts and said ports are in register.

5. A blowpipe nozzle provided with an oxygen passage, and a plurality of fuel gas passages adjacent to said oxygen passage, all of said passages having outlets adjacent to one another in the forward end of said nozzle; an oxygen discharge tube extending into said oxygen passage in spaced relation to the wall thereof and terminating at a point spaced from the forward end of said nozzle; said nozzle being provided with passage means for supplying powder to the space surrounding said tube; and deflector means on said nozzle extending across the outlets of said fuel gas passages in spaced relation to the forward end of said nozzle for deflecting fuel gas toward the stream of oxygen leaving said oxygen passage, whereby said fuel gas and at least a part of said oxygen mix together intimately only outside of the nozzle to form a combustible gas mixture.

6. A blowipe nozzle according to claim 5 wherein said passage means for supplying powder includes a plurality of ports provided in said nozzle extending transversely between the inside and the outside thereof, said ports being located between but in non-communicative relation with said fuel gas passages; in combination with a header for distributing powder to all of said ports.

7. A blowpipe device comprising a nozzle having a central longitudinal passage therethrough; said nozzle being provided with a plurality of longitudinal passages around said central passage; an annular powder distributing header secured to said nozzle and having a chamber therein; and said nozzle being provided with a plurality of ports passing transversely of said nozzle between the inside and the outside thereof, said ports passing between said second-named passages in non-communicative relation therewith, and said ports establishing communication between said chamber and said central passage.

8. A blowpipe device comprising a nozzle having a central longitudinal passage therethrough; said nozzle being provided with a plurality of longitudinal passages around said central passage, and a plurality of ports passing transversely of said nozzle between the inside and the outside thereof and passing between said second-named passages in non-communicative relation therewith; a pair of guide collars mounted over said nozzle on opposite sides of said ports; and a powder distributing header mounted on said nozzle, between said guide collars, for rotational sliding movement thereon, said header having an annular chamber therein and a plurality of ducts leading from said chamber, the construction and arrangement being such that said ducts may be brought into and out of register with said ports by turning said header.

9. A blowpipe nozzle having a first longitudinal passage therethrough; said nozzle being provided with a plurality of longitudinal passages arranged around said first passage; all of said passages having outlets adjacent to but separate from one another; said nozzles having a plurality of ports extending transversely of said nozzle between said first-mentioned passage and the outside of the nozzle, said ports passing between said second-named passages in non-communicative relation therewith; and deflector means on said nozzle extending across the outlets of said second-named passages in spaced relation to the forward end of said nozzle for deflecting gas toward the stream of gas leaving said first passage to mix therewith only outside of said nozzle.

10. A blowpipe comprising a nozzle having a first longitudinal passage for metal-removing oxygen and a plurality of longitudinal preheating gas passages arranged around said first passage; an oxygen injector tube extending forwardly into said first passage in spaced relation to the wall thereof but terminating at a position within said first passage spaced from the discharge end thereof; and means providing a powder distributing chamber outside of and extending around said nozzle; said nozzle having a plurality of ports extending transversely between said preheating gas passages in non-communicative relation therewith and connecting said powder distributing chamber with the space in said first passage around said oxygen injector tube.

11. A blowpipe comprising a nozzle having a first longitudinal passage for metal-removing oxygen and a plurality of longitudinal preheating gas passages arranged around said first passage; an oxygen injector tube extending forwardly into said first passage in spaced relation to the wall thereof but terminating at a position

within said first passage spaced from the discharge end thereof; and means providing a powder distributing chamber outside of and extending around said nozzle; said nozzle having a plurality of ports extending transversely between said preheating gas passages in non-communicative relation therewith and connecting said powder distributing chamber with the space in said first passage around said oxygen injector tube, said ports being inclined inwardly and forwardly.

12. A blowpipe comprising a nozzle having a first longitudinal passage for metal-removing oxygen and a plurality of longitudinal preheating gas passages arranged around said first passage; an oxygen injector tube extending forwardly into said first passage in annularly spaced relation to the wall thereof but terminating at a position within said first passage spaced from the discharge end thereof; means providing a powder distributing chamber outside of and extending around said nozzle; said nozzle having a plurality of powder ports extending transversely between said preheating gas passages in non-communicative relation therewith and connecting said powder distributing chamber with the space in said first passage around said oxygen discharge tube; and a plurality of laterally extending circumferentially spaced fins on the outside of said tube adjacent the forward end thereof dividing a part of the annular space around said tube into a plurality of small ducts near the front of said tube for conducting a plurality of streams of powder from said annular space into said first passage ahead of said tube.

13. A blowpipe comprising a nozzle having a first longitudinal passage for metal-removing oxygen and a plurality of longitudinal preheating gas passages around said first passage; an oxygen injector tube carried by said nozzle as a unit therewith within said first passage, said tube having a rear portion engaging the wall of said first passage and a front portion spaced from said wall and terminating within said first passage at a position spaced from the discharge end thereof; and means providing a powder distributing chamber outside of and extending around said nozzle; said nozzle having a plurality of ports extending transversely between said preheating gas passages in non-communicative relation therewith and connecting said powder distributing chamber with the space in said first passage around said oxygen injector tube.

14. A blowpipe comprising a head; a nozzle detachably carried by said head, said nozzle having a first longitudinal passage for metal-removing oxygen and a plurality of longitudinal preheating gas passages arranged around said first passage; an oxygen injector tube extending forwardly into said first passage in spaced relation to the wall thereof but terminating at a position within said first passage spaced from the discharge end thereof; said nozzle having a plurality of ports extending transversely between said preheating gas passages in non-communicative relation therewith from the space around said injector tube to the outside of said nozzle; said head having an oxygen duct for supplying oxygen to said injector tube, a preheating gas duct for supplying preheating gas to said preheating gas passages, and a powder distributing chamber extending around said nozzle for supplying powder to said powder ports; and means providing seals between said nozzle and said head in positions for preventing leakage between said oxygen duct, said preheating gas duct, and said chamber.

15. A blowpipe nozzle comprising a tubular barrel having a wall and front and rear ends, said barrel being provided with a longitudinal oxygen passage, said wall being provided with a plurality of longitudinal combustible gas passages arranged around said oxygen passage, said combustible gas passages having inlets arranged in a ring near said rear end, and said barrel being provided with a plurality of powder ports extending transversely through said wall between said combustible gas passages in non-communicative relation therewith from said oxygen passage to the outside of said barrel, said ports having entrances arranged in a ring on the outside of said barrel spaced forwardly from said first-named ring; and an annular seating surface between said rings adapted to abut against a corresponding annular seat in a blowpipe to provide a tight seal between said rings.

16. A blowpipe nozzle comprising a tubular barrel having a wall and front and rear ends, said barrel being provided with a longitudinal oxygen passage, said wall being provided with a plurality of longitudinal combustible gas passages arranged around said oxygen passage, said combustible gas passages having inlets arranged in a ring near said rear end, and said wall being provided with a plurality of powder ports extending transversely through said wall between said combustible gas passages in non-communicative relation therewith from said oxygen passage to the outside of said barrel, said ports being inclined inwardly toward the front end of said oxygen passage, said ports having entrances arranged in a ring on the outside of said barrel spaced forwardly from said first-named ring; and an annular seating surface between said rings adapted to abut against a corresponding annular seat in a blowpipe to provide a tight seal between said rings.

17. A blowpipe nozzle unit comprising a tubular barrel having a wall and front and rear ends, said barrel being provided with a longitudinal oxygen passage, said wall being provided with a plurality of longitudinal combustible gas passages arranged around said oxygen passage, said combustible gas passages having inlets arranged in a ring near said rear end, and said wall being provided with a plurality of circumferentially spaced powder ports extending transversely through said wall between said combustible gas passages in non-communicative relation therewith from said oxygen passage to the outside of said barrel, said ports having entrances arranged in a ring on the outside of said barrel spaced forwardly from said first-named ring; and an annular seating surface between said rings adapted to abut against a corresponding seat in a blowpipe to provide a tight seal between said rings; said nozzle also comprising an oxygen injector tube within said oxygen passage having a rear portion engaging said wall behind said powder ports, said tube extending forwardly in spaced relation to said wall and terminating at a position between said ports and said front end of said barrel.

18. A metal-removing blowpipe apparatus comprising, in combination, a blowpipe nozzle having a central longitudinal bore extending therethrough, a plurality of combustible gas passages extending longitudinally of and spaced apart around said bore, and adjuvant powder passage means constructed and arranged to deliver adjuvant powder into an oxygen stream passed through said bore, such powder passage means including a plurality of powder passages formed in said nozzle and spaced apart around said bore

and converging forwardly toward the axis of said bore but in non-communicative relation with said combustible gas passages; means secured to said nozzle and providing a powder distributing chamber extending around said nozzle and communicating with the entrances of said converging powder passages but not communicating with said combustible gas passages; and a plurality of conduits for separately supplying oxygen to said bore, combustible gas to said combustible gas passages and adjuvant powder to said powder distributing chamber.

19. A metal-removing blowpipe apparatus in accordance with claim 18, wherein said plurality of powder passages pass transversely between said combustible gas passages in non-communicative relation therewith.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
Re. 16,307	McGutcheon	Mar. 30, 1926
135,895	Delouest	Feb. 18, 1873
346,611	Root	Aug. 3, 1886
351,854	Delhaye	Nov. 2, 1886
675,840	Phillips	June 4, 1901
694,002	Davis	Feb. 25, 1902
914,105	Bowland	Mar. 2, 1909
968,350	Harrison	Aug. 23, 1910
1,013,379	Dunn	Jan. 2, 1912
1,305,726	Leonard et al.	June 3, 1919
1,341,010	Cartwright	May 25, 1920
1,412,656	Jenkins	Apr. 11, 1922
1,480,310	Smith	Jan. 8, 1924
1,541,712	Horn	June 9, 1925
1,606,013	Wulff	Nov. 9, 1926
1,713,102	Stedwell	May 14, 1929
1,775,159	Donaldson et al.	Sept. 9, 1930
1,856,134	McLaughlin	May 3, 1932
1,888,385	Jenkins	Nov. 22, 1932
1,908,578	Vawter	May 9, 1933
2,181,095	Ness	Nov. 21, 1939
2,227,161	Shelburne	Dec. 31, 1940

FOREIGN PATENTS

Number	Country	Date
192,600	Germany	Nov. 29, 1907
198,627	Great Britain	May 28, 1923
494,888	Germany	Mar. 29, 1930