Feb. 17, 1953 R. O. WYLAND, JR 2,628,817

ROCK PIERCING BLOWPIPE

Filed Jan. 24, 1950 2 SHEETS—SHEET 1

Fig. 1.

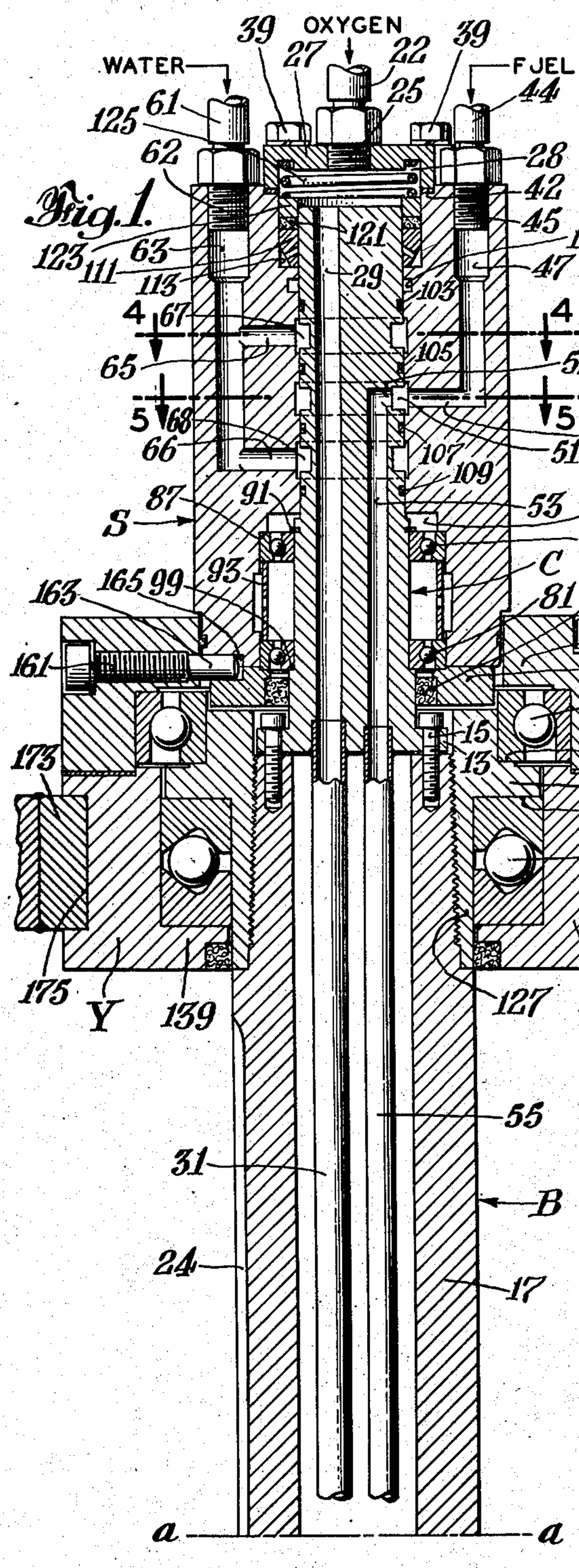
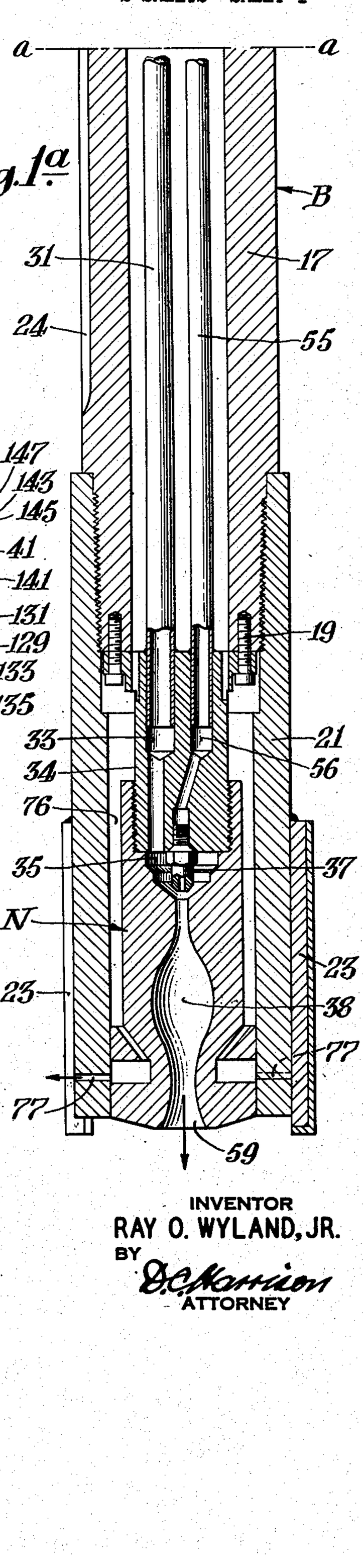


Fig. 1a.



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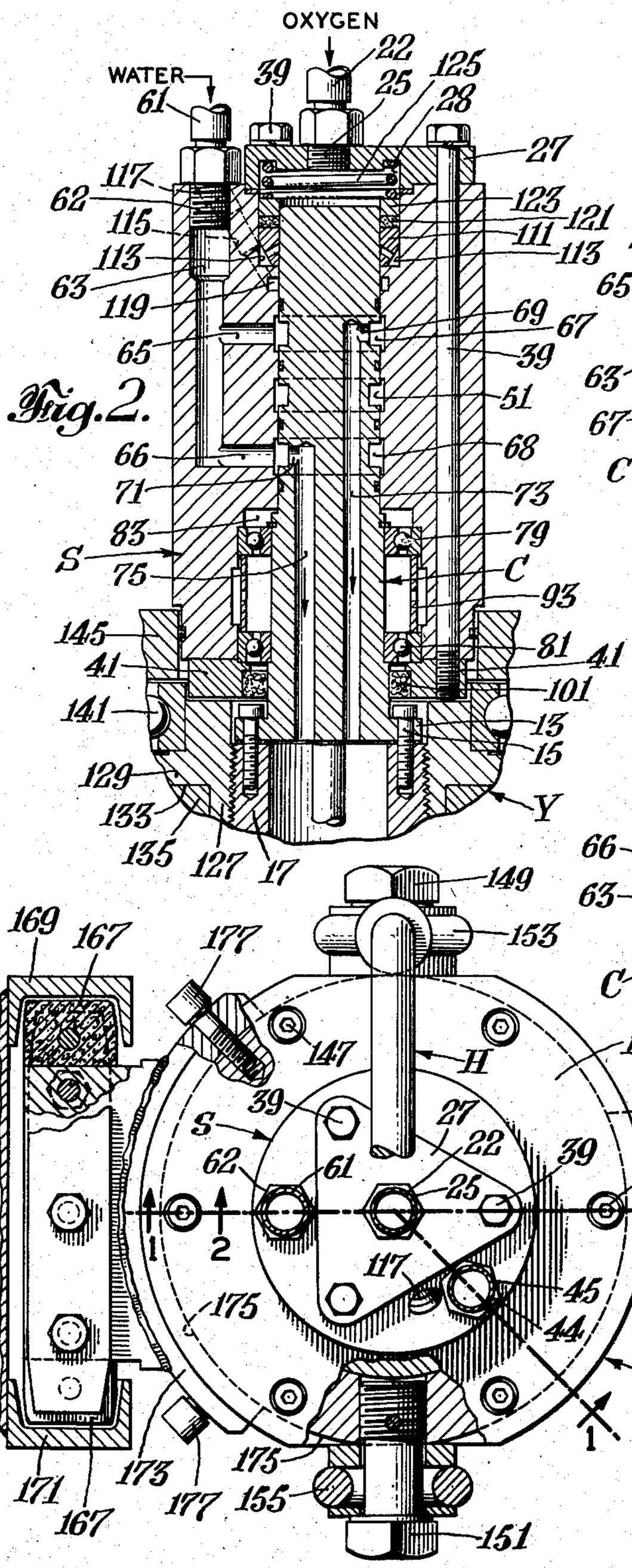

Fig. 2.

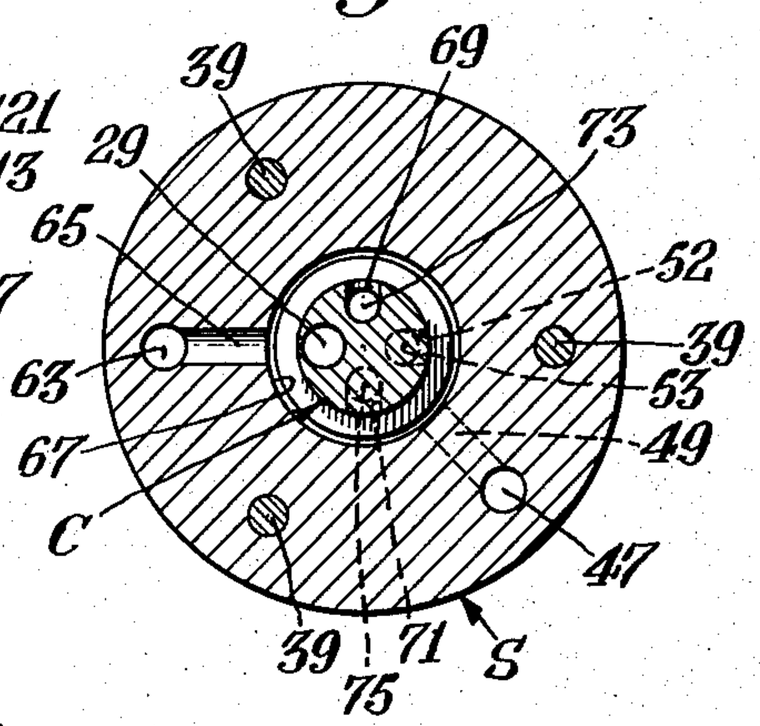

Fig. 4.

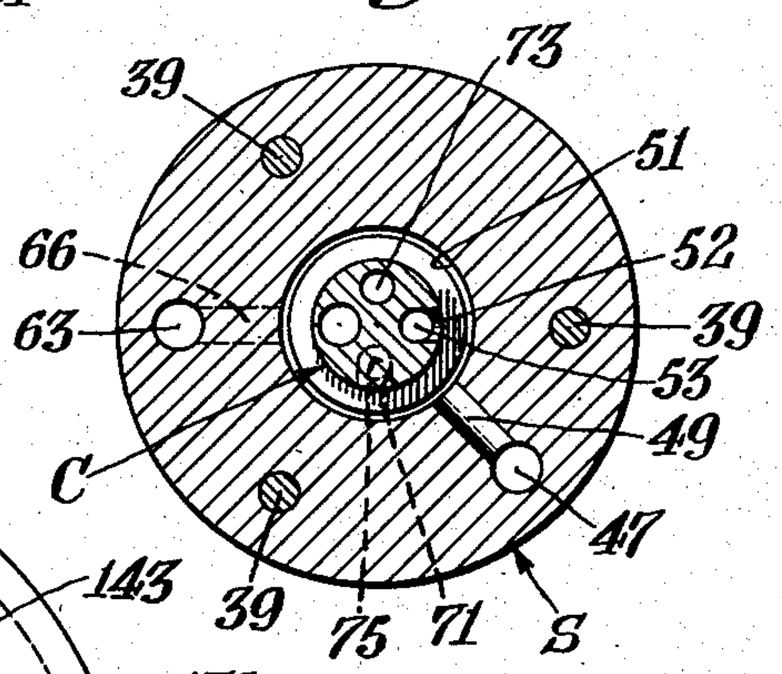

Fig. 5.

Fig. 3.

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ROCK PIERCING BLOWPIPE

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16 Claims. (Cl. 255—1.8)

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This invention relates to rock piercing blowpipes, and is especially concerned with such blowpipes wherein a burner nozzle rotates during the piercing of a hole.

In recent years there has been developed a novel process for thermally piercing deep blasting holes in mineral formations such as Taconite iron ore, trap rock, dolomite, quartzite, and others. Holes as deep as 30 feet and having a diameter of about 6 inches have been successfully pierced with the tremendous blowpipes which have been developed for performing the process. Many new problems in blowpipe design have arisen because of the great size of these blowpipes and the rough service they encounter. Problems have also been created by the need for rotating the flame during the piercing of a blasting hole.

Among the objects of the present invention are to provide a method for transmitting fuel and oxygen in a rock piercing blowpipe whereby premature mixing of the fuel with the oxygen is prevented; provide a novel blowpipe wherein the connections supplying fluids to the blowpipe are protected from damage; and provide a novel blowpipe wherein continuous adequate sealing of the various fluid passages from one another is accomplished. Still other objects are to provide a novel rock piercing blowpipe wherein parts can be rapidly and easily assembled and disassembled; and to provide such a blowpipe which is simple, compact, and sturdy in construction, and which is economical to service. Another object is to provide a rock piercing blowpipe including means for restraining parts of the blowpipe from rotation while the burner nozzle rotates.

The above and other objects, and the novel features of the invention, will become apparent from the following detailed description, having reference to the accompanying drawings, wherein:

Figs. 1 and 1*a* are vertical cross-sectional views taken along the line 1—1 in Fig. 3 of an upper portion and of a lower portion, respectively, of a rock piercing blowpipe in accordance with the invention, Fig. 1*a* depicting the part of the blowpipe extending down from the line *a*—*a* in Fig. 1;

Fig. 2 is a vertical sectional view of only the upper portion of a blowpipe taken along the line 2—2 in Fig. 3;

Fig. 3 is a plan view, partly broken away and in section, of a blowpipe in accordance with the invention;

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Fig. 4 is a cross-sectional view taken along the line 4—4 in Fig. 1; and

Fig. 5 is a cross-sectional view taken along the line 5—5 in Fig. 1.

In accordance with the present invention there is provided a novel rock piercing blowpipe comprising a non-rotating fluid-supplying sleeve S having open upper and lower ends, a long burner member B having a shaft C at its upper end journalled for rotation in the sleeve S, and a burner nozzle N at the lower end of burner member B for projecting a rotating flame against a mass of rock. For suspending the blowpipe in a vertical position there is provided a yoke Y below the sleeve S, which is so constructed as to permit rotation of the burner member B while holding the sleeve S against rotation. Suspension of the blowpipe vertically is accomplished by a handle or bail H (shown in Fig. 3) which is secured to a non-rotating part of the yoke Y, and which can be secured to a cable carried on a suitable mast.

More in detail in accordance with the invention, shaft C, which is journalled for rotation within the sleeve S, is provided with a flange 13 at its lower end carrying a plurality of bolts 15 which are threaded into the upper end of an elongated tube 17 extending downwardly to the burner nozzle N, which is secured to the lower end of tube 17 by bolts 19. A short reamer sleeve 21 carrying a plurality of longitudinally extending circumferentially spaced hole sizing teeth 23 fits over the burner nozzle N and is threaded over the outside of tube 17. In a typical rock piercing blowpipe tube 17 was about 34 feet long and 4½ inches in diameter for piercing holes about 30 feet deep and about 6 inches in diameter.

Tube 17 is similar to the conventional Kelly rod used in drilling oil wells, being provided with a plurality of external circumferentially spaced longitudinal grooves or keyways 24 for cooperation with suitable mechanism for rotating burner member B. Such a mechanism is disclosed in U. S. Patent 2,388,093.

A combustion supporting medium, such as gaseous oxygen, is supplied to the blowpipe by a flexible oxygen supply hose 22 secured to a metal conduit or nipple 25 which is threaded into and forms a unit with a connection plate 27 gastightly mounted on the top of sleeve S and covering the open upper end thereof in spaced relation to the upper end of shaft C to provide a chamber 23 therein. Oxygen then flows down through a longitudinal passage 29 in shaft C to a longitudinal oxygen pipe 31, which is secured within the

lower end of passage 29, and passes downwardly to a bore 33 in the header 34 of nozzle N within which the lower end of the pipe 31 is secured. From bore 33 the oxygen is discharged through an annular space 35 surrounding a fuel injector 37 and enters an internal combustion chamber 38.

Oxygen connection plate 27 is secured to the top of sleeve S by a plurality of long bolts 39 extending down through the plate and the main body of the sleeve, and threaded at their lower ends into an annular bearing retaining plate 41 forming part of the sleeve. A gas-tight connection is assured by a gasket 42 compressed between the connection plate 27 and the top of the sleeve S.

A fuel, for example kerosene or other hydrocarbon fluid, is supplied to the blowpipe by a flexible hose 44 secured to a conduit or nipple 45 which is threaded into a longitudinal bore 47 in sleeve S. Fuel passes by way of a connecting radial duct 49 to an annular distributing chamber 51 formed between the internal wall of sleeve S and the external wall of shaft C. The fuel then enters a radial duct 52 in the shaft and flows down through a longitudinal passage 53 to a long fuel pipe 55 which is secured within the lower end of passage 53. Pipe 55 is secured at its lower end within a bore 56 in the nozzle N, through which the fuel flows to injector 37 for discharge into internal combustion chamber 38. The fuel and oxygen mix in chamber 38 and upon combustion therein an intensely hot high velocity flame leaves the nozzle through outlet 59.

It has been found that premature admixture of fuel and oxygen resulting from leakage can be eliminated when water is transferred from non-rotating sleeve S to the shaft C between the regions of transference of fuel and oxygen to shaft C.

This method of transferring fluids to prevent premature admixture is incorporated in the embodiment shown in the drawings wherein water is supplied to the interior of the tube 17 and then to nozzle N by a flexible water supply hose 61 secured to a metal conduit or nipple 62 which is threaded into a longitudinal bore 63 in the sleeve S. The water flows from bore 63 by way of two longitudinally spaced radial ducts 65 and 66 to a pair of longitudinally spaced annular water distributing chambers 67 and 68 formed between the external surface of shaft C and the internal surface of sleeve S, and respectively located above and below the annular fuel chamber 51 to provide barriers against the leakage of kerosene. Water from the annular chambers 67 and 68 enters radial ducts 69 and 71 in shaft C and flows down through longitudinal passages 73 and 75, respectively, to the lower end of the shaft where it is discharged to the interior of tube 17.

Water passes down through tube 17 around the pipes 31 and 55, enters the space 76 between nozzle N and hole sizing sleeve 21 to cool the nozzle, and is then discharged from the blowpipe through a plurality of circumferentially arranged radial ports 77 located between the several hole sizing teeth 23 for cooling the teeth and for quenching and moistening detritus which is separated from the rock by the flame.

During rotation of shaft C in sleeve S the annular chambers 51, 67, and 68 provide constant communication between the several fluid supply passages in the sleeve and the corresponding passages in the shaft. As shown, the annular chambers 51, 67, and 68 are each formed by a pair

of registering annular recesses in the internal wall of sleeve S and the external wall of shaft C. However, it is evident that equivalent results can be obtained by forming the annular chambers in either the shaft or the sleeve alone.

It should be noted that the three fluid supply conduits or nipples 25, 45, and 62 all project longitudinally from the top of sleeve S and are within the projected outline of the sleeve, to avoid damage and inconvenience.

During operation of the blowpipe for rock piercing, the burner member B is rotated relatively to the non-rotating sleeve S to sweep the flame from combustion chamber 38 over the bottom face of the hole, and to cause rotation of the teeth 23. A pair of ball bearings 79 and 81 is provided between shaft C and sleeve S to insure concentricity of the rotating shaft with the non-rotating sleeve, and to allow slight misalignment of tube 17 with respect to the shaft without damaging either sleeve or shaft. Bearings 79 and 81 are arranged in longitudinally spaced relation to one another within a counterbore 83 near the lower end of sleeve S. The upper bearing 79 is seated against an annular shoulder 87 on sleeve S, and against an annular spring ring 91 on shaft C. Upper bearing 79 is held firmly in position by a perforate cylindrical spacer plate 93 pressed upwardly by the lower bearing 81 which, in turn, is held by the bearing retaining plate 41 and a shoulder 99 on the outside of shaft C. Leakage of lubricating grease from the counterbore 83 is prevented by a packing ring 101 between shaft C and retaining plate 41.

Seals against the leakage of fluid from the several annular chambers 51, 67, and 68 are provided by rubber packing rings 103, 105, 107 and 109 which are carried in annular grooves in the surface of shaft C above and below each of the several annular chambers and which engage the internal wall of sleeve S. U. S. Patent 2,180,795, describes such a seal. Additional security against the leakage of fuel from the annular chamber 51 is provided by arranging the annular water chambers 67 and 68 on both sides of the annular fuel chamber 51. Thus, if any fuel tends to leak in either direction it will be picked up by a stream of water and carried through and out of the blowpipe. This is especially important for preventing leaking fuel from reaching the oxygen passages because oxygen and fuel form a hazardous combination which may burn or explode.

Lubrication adjacent the top of the shaft C is provided by introducing lubricant to the external surface of the shaft through a laterally perforated annular lubricating bushing 111 fitting within a counterbore 113 which extends downwardly from the top of sleeve S. A lubricant such as a silicone lubricating fluid, which has exceptionally good stability in the presence of oxygen, is supplied to the bottom of the counterbore 113 through a passage 115 extending diagonally to an opening in the top of the sleeve S, which is closed by a plug 117 (see Fig. 3). Lubricant is also supplied to an annular chamber 119 spaced below the counterbore 113, which is likewise tapped by lubricant passage 115 for the purpose of lubricating packing ring 103, which would otherwise run on a gas film and consequently have a very short life. Lubricant is forced from chamber 119 to packing ring 103 by the pressure of the oxygen entering chamber 38.

Lubricating bushing 111 is held securely in po-

sition by a coil spring 125 compressed between the underside of oxygen connection plate 27 and a metal washer 123, which in turn bears against a packing ring 121 of slippery resilient compressible oil-resistant material (such as mica-impregnated polytetrafluoroethylene) resting on bushing 111 in sealing engagement with the shaft C and sleeve S. The packing ring 121 also prevents seepage of fluid into the oxygen portion of the system when the blowpipe is in a horizontal position, as when it is being transported from one drilling location to another. Bushing 111 additionally assists the two bearings 79 and 81 in maintaining alignment.

The blowpipe described in detail above can be operated by rotating the burner member B while restraining the sleeve S from rotation in any desired way. However, it has been found advantageous to suspend the blowpipe from a winch-operated cable which lowers the blowpipe vertically into a hole being pierced. For this type of operation the blowpipe includes a yoke Y comprising an internal bearing mounting 127 threaded over, and rotatable with, the upper end of outer tube 17. Internal mounting 127 has an annular flange 129 between its ends which forms an upwardly facing shoulder 131 and a downwardly facing shoulder 133. An annular thrust bearing 135 fits over internal mounting 127 below flange 129 and is pulled up against the shoulder 133 by an external bearing mounting 137 fitting snugly over bearing 135 and having an inturned annular flange 139 which engages the bearing. An angular contact bearing 141 fits over the internal mounting 127 above flange 129 for the purpose of taking the weight of the yoke Y in the event that the blowpipe is allowed to rest on the bottom of the hole being pierced. Bearing 141 is held against shoulder 131 by an annular retaining plate 143 having an inturned flange 145 resting on the top of the outer race of the bearing. External bearing mounting 137 and annular retaining plate 143 are secured tightly together by a plurality of circumferentially arranged bolts 147 so that the two members act as a non-rotating unit while the internal bearing mounting 127 rotates with the burner member B.

As shown in Fig 3, a bail H for suspending the blowpipe is secured to yoke Y by a pair of radial bolts 149 and 151 passing through eyes 153 and 155 and threaded into the body of the external bearing mounting 137, so that the bail is free to swivel on the yoke.

The non-rotating sleeve S is secured to the non-rotating external bearing mounting 137 and annular retaining plate 143 and is restrained from rotating by a pair of oppositely disposed radial torque pins 161 (only one being shown for illustration) which are threaded into radial bores in the retaining plate 143 and are provided with unthreaded end portions 163 which extend into radial sockets 165 in sleeve S, each socket being half in the retaining plate 41 and half in the portion of sleeve S above the retaining plate. The radial sockets 165 fit the torque pins 161 loosely to allow the aforementioned slight misalignment of tube 17 with respect to the shaft C without damaging sleeve S or shaft C. The proper position of the bearing retaining plate 41 to receive bolts 39 can be readily obtained by matching up the two halves of the sockets 165 before inserting the bolts 39. When the sleeve S is to be separated from the rest of the blowpipe, torque pins 161 are retracted from the sockets

165 by rotating them in the appropriate direction and the sleeve is pulled off the shaft C allowing rapid replacement of the ring seals.

Sleeve S and the external non-rotating parts of yoke Y are restrained against rotation by a shoe 167 projecting laterally from one side of the yoke and riding in a pair of channel-shaped vertical tracks 169 and 171 forming a part of the mast for suspending the blowpipe. Shoe 167 includes an arcuate bracket 173 which fits within an arcuate groove 175 in the surface of external bearing mounting 137, and is secured to the latter by bolts 177.

The blowpipe described in detail above is simple, compact and rugged, which are particularly important factors in a device which must withstand rough handling in the quarrying and mining fields. Furthermore, it needs to be serviced only infrequently because the bearings and seals do not wear out rapidly. Adequate sealing of the various fluids against escape from their respective passageways also is provided once the several parts of the blowpipe have been assembled in the proper relation to one another, so that it is unnecessary to provide take-up adjustments.

What is claimed is:

1. A blowpipe comprising a sleeve having first and second open ends; an elongated burner member having a first end portion comprising a shaft rotatably mounted in said sleeve, said burner member projecting from said first end of said sleeve; said burner member having a burner nozzle at the end thereof opposite said first end portion; an oxygen conduit in said burner member having a first entrance through a surface of said shaft; a fuel conduit in said burner member having a second entrance through a side surface of said shaft spaced longitudinally from said first entrance; water conduit means in said burner member having third and fourth entrances through the side surface of said shaft longitudinally spaced from and on opposite sides of said second entrance, said third entrance being between said first and second entrances; means providing annular water chambers surrounding said shaft between the latter and said sleeve on opposite sides of said second entrance, said water chambers being in communication with said third and fourth entrances, respectively, for delivering water thereto; and means for supplying water to said annular water chambers, fuel to said second entrance, and oxygen to said first entrance during rotation of said shaft.

2. A blowpipe in accordance with claim 1 wherein said means for supplying water to said annular water chambers and said means for supplying fuel to said second entrance comprise passages extending longitudinally in said sleeve and opening through said second end of said sleeve.

3. A blowpipe in accordance with claim 2 wherein said first entrance of said oxygen conduit is through the end of said shaft opposite said burner nozzle, said blowpipe also comprising a longitudinally extending oxygen supply conduit gas-tightly secured to said second end of said sleeve in communication with the entrance of said oxygen conduit.

4. A blowpipe in accordance with claim 3, also comprising annular sealing and lubricating means between said shaft and said sleeve intermediate said first entrance of said oxygen conduit and said third entrance of said water conduit means.

5. A blowpipe in accordance with claim 4, also comprising a reservoir in communication with

said sealing and lubricating means for holding a supply of lubricant.

6. A blowpipe in accordance with claim 5, also comprising means providing an annular lubricant chamber surrounding said shaft and located between said annular sealing and lubricanting means and said third entrance, said lubricant chamber being in communication with said reservoir, and an annular packing ring surrounding said shaft between said annular chamber and said third entrance, said annular chamber being subject to oxygen pressure from said means for supplying oxygen to force lubricant to said packing ring.

7. A blowpipe in accordance with claim 2 wherein said first entrance of said oxygen conduit is through the end of said shaft opposite said burner nozzle; said blowpipe also having an annular recess surrounding said shaft adjacent said first entrance and within said sleeve; said blowpipe also comprising a perforated lubricating bushing in said recess, a ring of compressible sealing material on said bushing, a washer on said ring, an oxygen connection plate extending across said second open end of said sleeve and gas-tightly sealed to said sleeve in spaced relation to said shaft, a spring compressed between said plate and said washer and pressing said sealing ring into fluid-tight contact with both said shaft and said sleeve, and a longitudinal oxygen supply tube gas-tightly secured to said plate and opening into the space between said plate and said shaft.

8. A blowpipe comprising a sleeve having first and second open ends; an elongated burner member having a first end portion comprising a shaft rotatably mounted in said sleeve, said burner member projecting from said first end of said sleeve; said burner member having a conduit for fluid provided with an entrance through the end of said shaft opposite said burner nozzle; a connection plate for fluid extending across said second open end of said sleeve and gas-tightly secured to said sleeve in spaced relation to said shaft; and a fluid supply tube gas-tightly secured to said plate and opening into the space between said plate and said shaft to supply fluid to said conduit during rotation of said shaft.

9. A blowpipe in accordance with claim 8, also having an annular recess surrounding said shaft adjacent said entrance and within said sleeve; said blowpipe also comprising a perforated lubricating bushing in said recess, a ring of compressible sealing material on said bushing, a washer on said ring, and a spring compressed between said connection plate and said washer and pressing said sealing ring into fluid-tight contact with both said shaft and said sleeve.

10. A blowpipe in accordance with claim 9 wherein said sleeve is provided with a bore for lubricant extending diagronally between the bottom portion of said annular recess and the end surface of said sleeve.

11. A blowpipe comprising an elongated burner member including a shaft at one end thereof and a burner nozzle at the opposite end thereof, said shaft having passage for conducting fluids to said burner nozzle; a non-rotating sleeve fitting over said shaft and having fluid supply passages in communication with said passages in said shaft, said sleeve and said shaft being longitudinally separable from one another, said shaft being rotatable in said sleeve, and said sleeve having outwardly open radial sockets therein; a supporting yoke surrounding said burner member, said yoke including an inner rotating member engaging said burner member, and an outer non-rotating member; and radial retaining pins carried by said outer non-rotating member and extending into said sockets to secure said burner member to said sleeve, said retaining pins being retractable from said sockets to permit separation of said sleeve from said shaft.

12. A blowpipe comprising a non-rotating sleeve including a tubular body having fluid supply passages therein, said sleeve having open upper and lower ends; an elongated burner member including a shaft at the upper end thereof and a burner nozzle at the opposite end thereof, said shaft being journalled for rotation in said sleeve, said shaft having passages in communication with said fluid supply passages for conducting fluids to said burner nozzle; said shaft having another passage therein provided with an entrance in the upper end of said shaft for conducting fluid to said burner nozzle; bearing means between said shaft and said sleeve adjacent the lower end of said sleeve; said sleeve including a separate retaining plate on the lower end of said tubular body holding said bearing means in position; a fluid inlet connection on the upper end of said sleeve for supplying fluid to said entrance, said connection including a second plate covering said open upper end of said sleeve, and a fluid supply conduit opening through said second plate to supply fluid to said entrance; and bolts extending from said second plate through said sleeve to said retaining plate and holding said plates and said tubular body together as a unit.

13. A blowpipe in accordance with claim 12 wherein said sleeve is provided with outwardly open radial sockets therein located partly in said retaining plate and partly in said tubular body; said blowpipe also comprising a supporting yoke surrounding said burner member, said yoke including an inner rotating member engaging said burner member, and an outer non-rotating member; said blowpipe also comprising radial retaining pins carried by said outer non-rotating member and extending into said sockets to secure said burner member to said sleeve, said retaining pins being retractable from said sockets to permit separation of said sleeve from said shaft.

14. A blowpipe comprising a non-rotating sleeve having fluid supply passages therein; an elongated burner member including a shaft at the upper end thereof and a burner nozzle at the opposite end thereof, said shaft being journalled for rotation in said sleeve, said shaft having passages in communication with said fluid supply passages for conducting fluids to said burner nozzle; a pair of longitudinally spaced ball bearings between said shaft and said sleeve adjacent the lower end of said sleeve; a supporting yoke surrounding said burner member, said yoke including an inner rotating member engaging said burner member, an outer rotating member, and ball bearings between said inner and outer members; and coupling means connecting said outer member to said sleeve to restrain said sleeve from rotating, said coupling means being so constructed and arranged as to connect and disconnect said outer member and sleeve at will.

15. The method of preventing premature admixture of oxygen and fluid fuel in a blowpipe in which separate streams of oxygen and fluid fuel are transmitted between relatively rotating portions thereof to a combustion zone in advance of the blowpipe which comprises passing a stream of water through the blowpipe and across the interface between the relatively rotating portions

thereof at a point intermediate the stream of oxygen and fuel, thereby entraining in said stream of water any fuel and oxygen leaking from the respective streams thereof, and discharging any such entrained fuel and oxygen with the stream of water into the zone in advance of the blowpipe.

16. In a blowpipe having a rotating member and a non-rotating member provided with inlet means for supplying oxygen, fuel and water, wherein said oxygen, fuel and water are transferred from said non-rotating member to said rotating member across an interface between said members, the method of preventing premature admixture of said oxygen and said fuel at said interface which comprises transferring said oxygen and said fuel across said interface while transferring said water across said interface at a region between the region of transference of said oxygen and the region of transference of said fuel.

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