ROCK PERCING BLOWPIPE

Ray O. Wyland, Jr., Somerville, N. J., assignor, by mesne assignments, to Union Carbide and Carbon Corporation, a corporation of New York

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This invention relates to an improved blowpipe of the internal combustion type, and more particularly to a long blowpipe which is advantageous for piercing holes in rock.

Among the objects of the invention are: to provide improved mixing of fuel and oxidant; to increase the life of a rock piercing blowpipe; to provide an internal combustion blowpipe which can be rapidly and easily taken apart and repaired; to improve the cooling of a blowpipe nozzle of the internal combustion type; to provide a rock piercing blowpipe including an improved shield; and to provide an improved rock piercing blowpipe which is simple, economical and rugged in construction, and sufficiently light in weight to be manipulated easily by an operator.

The above and other objects will become apparent from the following description, having reference to the annexed drawings wherein:

- Fig. 1 is a side elevational view showing a blowpipe in position for piercing a hole in a body of rock;
- Figs. 2a and 2b are longitudinal sectional views of the upper end portion and the lower end portion, respectively, of the same blowpipe embodying the principles of the invention;
- Fig. 3 is an enlarged longitudinal sectional view of the lower part of the same blowpipe, taken at 90 degrees from the view shown in Fig. 2b; and
- Figs. 4, 5 and 6 are cross-sectional views taken along the lines 4—4, 5—5, 6—6, and 6—6, respectively, in Fig. 3.

As shown in Fig. 1, a novel blowpipe B, in accordance with the present invention comprises a burner nozzle N which operates within a B being pierced in a body of rock R, an elongated fluid-conducting tubular member T extending rearwardly from the nozzle to a handle H, and a shield S through which the tubular member T slides so that the shield is held in contact with the face of the rock as the nozzle advances.

Referring to Figs. 2a to 6, the nozzle N comprises a head 11 over the front end of which is threaded a removable and replaceable unitary hollow internal combustion chamber member 13. Member 13 forms, with a conically concaue front face 15 of header 11, an internal combustion chamber 17 including a throat 19 of reduced cross section and a flaring or divergent discharge passage 21.

A fuel fluid such as kerosene or fuel oil is injected into chamber 17 through a longitudinal passage 23 in header 11 which terminates in a short duct 25 in inclined toward the nozzle axis and having its outlet arranged eccentrically in the front face 15. Fuel is supplied to passage 23 by a long tube 27 which extends rearwardly from header 11 to the handle H which is connected by way of a passage 29 with a fuel supply conduit 31 controlled by a valve 33.

Oxygen or other fluid oxidant is injected into the combustion chamber 17 by a longitudinal oxygen passage 35 in header 11 which terminates in a short duct 37 having its outlet arranged eccentrically in the face 15 on the side opposite the outlet of fuel duct 25. Duct 37 in inclined toward the axis of the nozzle and also inclined substantially normal to the fuel duct 25. Oxygen passage 35 is supplied with oxygen by a long tube 39 extending rearwardly to the handle and connecting with an oxygen passage 41 which receives oxygen from a supply conduit 43 controlled by a valve 45.

The oxygen from duct 37 atomizes the fuel from duct 25 by impinging against it forcibly and the two mix intimately together as they enter the combustion chamber 17. Thus no complicated and expensive special atomizer and injector is needed. In normal operation the burning mixture is discharged through throat 19 and flaring passage 21 to the outside of the nozzle at an extremely high velocity to form a flame which is exceptionally efficient for removing particles of rock and expelling them from a hole being pierced. Supersonic flame velocities between 5000 and 6000 feet per second have been realized.

Cooling of the chamber member 13 by water is necessary because of the high temperatures involved. The outside of the chamber member 13 comprises a helical water-swirling land 46 integral therewith and extending forwardly from the rear end of the member. Also formed integrally with the chamber member 13 is a water gallery 48 leading forwardly from the flaring passage 21. A rubber gasket 51 is carried in an annular groove 52 in flange 47 and presses against shell 53 to prevent leakage of water.

The front end of shell 53 is plugged by a removable and replaceable annular tip 56 having a flange 58 which is threaded into the end of the shell, and a counterebore 59 fitting snugly over the lower end of chamber member 13. Tip 56 projects below the lower end of chamber member 13 to protect the latter and has an outlet bore 60 aligned axially with chamber 17. To prevent water leakage an annular gasket 61 of heat-resistant material, such as a copper-asbestos composition, is compressed between tip 56 and a shoulder 60 formed integrally with chamber member 13.

Tip 56 is made of relatively soft metal such as copper but can be protected from excessive abrasive wear by a welded-on plate or layer 62 of hard and heat-resistant material such as a nickel-base alloy containing molybdenum. More than 300 linear feet of hole can be forced in diabase traprock before replacement of the tip becomes necessary.

Tip 56 also has a plurality of circumferentially arranged radial water discharge ports 63 extending radially through flange 47 from the inside to the outside surface thereof ahead of shell 53 and in communication with the annular water space 55.

Cooling water is supplied to the spiral passage 54, and thence to the radial ports 63, by a pair of longitudinal water passages 65 in the header 11 which open through a pair of radial outlets 67. Water passages 63, opposite end water tube 69 is secured to handle H and receives water from a supply conduit 71 controlled by a valve 73.

The outside of shell 53 carries a plurality of laterally projecting longitudinal teeth 77, such as four, which are made integral with the shell by silver-soldering or welding. The forward ends of teeth 77 are located just rearwardly of the radial water ducts 63 in position to be cooled by the water streams leaving the latter, which prevent burn-off of the teeth. Each of the teeth 77 advantageously is a generally cylindrical rod of a heat-resistant and abrasion-resistant metal, such as a cobalt-chromium-tungsten alloy which is secured to the shell by fillet welds 79.

When operating the blowpipe for piercing a hole in a body of rock, an intensely hot high velocity flame is discharged from the internal combustion chamber 17 for heating the rock to loosen material therefrom, predominantly by spalling without melting, although sometimes melting may also occur. The high velocity combustion gases force the removed material or detritus rearwardly and it is quenched by the water jets leaving ports 63. This cools and disintegrates the detritus so that...
it can be readily blown out of the hole by the gaseous products of combustion and the steam formed by the evaporation of water. During the piercing operation, the operator places the blowpipe into the deepening hole while agitating the nozzle in such a way that the teeth break up any large particles of detritus and rear the sides of the hole smooth and clean.

Small particles of detritus are ejected from a hole with great force and these, coupled with the intense heat radiated from the hole, may injure the operator unless he is protected, as by a shield S. This comprises a radially extending concave plate 81 having a central hole 83 through which tubular member T passes freely. Plate 81 is bolted by a plurality of longitudinal bolts 82 to an annular flange 85 carried on the forward end of longitudinal member 89 which is slingly mounted on the tubular member. Three spaced leaf springs 91 (only one being shown for illustration) are riveted to the inside surface of leaves 89 and are so curved as to bear against the blowpipe surface of tubular member T. Thus, the shield S can be moved to any desired position and will remain there due to the friction of the springs.

During the piercing of a hole the shield plate 81 must be spaced a short distance from the face of the rock R to permit detritus to drop to the ground. This is accomplished by moving the bolts 82 forward the proper distance to act as prongs 92 which are maintained in contact with the rock face around the hole H as the blowpipe B is passed through the shield.

The novel invention is operated in the field under such severe conditions that it is desirable to protect the valves 33, 43, and 73 from damage. This is done by a wide flat U-shaped metal bridge 93 which is secured to the front and rear ends of handle H and bridges the several valves. Bridge 93 has three apertures 95 therein through which pass the several supply conduits 31, 43, and 71.

Blowpipes as described, having a nozzle diameter of 1½ inches and a length of about 6 feet have been used successfully for piercing blasting holes 5 feet deep in granite at 25 feet per minute, in quartzite at 60 feet per minute, in dolomite at 36 feet per hour, and in diabase traprock at 20 feet per hour. They are particularly valuable for piercing secondary blasting holes in large boulders, and can be operated vertically, horizontally, or diagonally for this purpose.

What is claimed is:

1. In a rock piercing blowpipe, a burner nozzle having a suction surface; an internal combustion chamber therein, said chamber having an inlet end, a wall at said inlet end, and an outlet end; a pair of supply passages for fluid fuel and oxidant opening into said chamber through said wall, each said supply passage being inclined toward one another for discharging intersecting streams of fuel and oxidant into said chamber to mix and burn therein; a divergent passage communicating between said outlet end and said outer surface of said nozzle; ducts arranged around said chamber in said nozzle for passing cooling fluid around said chamber and through said nozzle; and exit port means leading from said ducts to said outer surface of said nozzle in the region of the discharge end of said diverging passage for flashing said cooling fluid to vapor to provide for the ejection of detritus from the hole being pierced.

2. A nozzle in accordance with claim 1 wherein said wall is conically concave and said supply passages open through said wall at points on opposite sides of the longitudinal axis of said chamber.

3. A rock piercing blowpipe, a burner nozzle in accordance with claim 1 also having a tip comprising a wear-resistant metal ring secured over said nozzle and protruding beyond the said discharge end of said diverging passage in axial alignment therewith for protecting said nozzle from abrasion, said ring being removable and replaceable at will.

4. A rock piercing blowpipe nozzle comprising a header having a front end surface and a side surface, fuel and oxidant supply passages in said header opening through said front end surface, and at least one water supply passage in said header having a discharge opening through said side surface; a unitary internal combustion chamber member secured at one end to said header below said water supply passage means and having at the other end a divergent substantially axially positioned outlet passage, said combustion chamber member comprising a helical land on the outside thereof and an annular flange below the lower end of said chamber member, said flange having a plurality of circumferentially arranged longitudinal water ducts therethrough; a shell secured over said header and said combusor chamber member and having the internal surface thereof adjacent said land and said first flange to provide a path for cooling water around said chamber member; and an annular tip sleeve openings and protruding below the lower end of said chamber member, said tip having a portion thereof threaded to said shell and annularly spaced from said chamber member, said tip having a plurality of circumferentially arranged lateral water ducts, the lower end of said shell and in communication with the space around said chamber member and an outlet bore axially aligned and communicating with said divergent outlet passage of said chamber member.

5. A nozzle in accordance with claim 4 wherein said combustion chamber includes a constricted throat, and wherein said first annular flange is located adjacent said throat.

6. A nozzle in accordance with claim 4 wherein said chamber member has a second annular flange; said nozzle also comprising an annular gasket of heat-resistant material compressed between said tip and said second flange to prevent the leakage of water to the lower end of said combustion chamber member.

7. A nozzle in accordance with claim 4, also comprising a plurality of longitudinally extending teeth carried on the outside of said shell, each of said teeth having the front end thereof adjoining one of said water discharge ports in position to be cooled by water leaving said ports.

8. A nozzle in accordance with claim 7 wherein each of said teeth is a substantially cylindrical long rod of hard metal welded to said shell.

9. A nozzle in accordance with claim 4 wherein an annulus is positioned on the periphery of said annular flange of said chamber member and a rubber gasket is located in said annulus, said gasket being compressed between said chamber member and said shell to prevent the flow of cooling water other than through said longitudinal water ducts.

10. A rock piercing blowpipe comprising the burner nozzle of claim 1 at one end thereof; a handle at the other end thereof; a longitudinal tube connecting said handle; said burner nozzle; a sleeve carried on said tube and slidable therewith; friction means between said sleeve and said tube comprising at least one leaf spring carried by said sleeve and contacting said tube for holding said sleeve in position; said radial shield carried by said sleeve and movable therewith along said tube.

11. A rock piercing blowpipe in accordance with claim 10, also comprising at least one prong extending longitudinally forward from said radial shield for repulsion of said shield with reference to a rock face, the rear portion of said prong also serving to secure said shield to said tube.

12. A rock piercing blowpipe comprising a burner nozzle as claimed in claim 4 at one end thereof; a handle at the other end thereof; a longitudinal tube connecting said handle to said burner nozzle; a sleeve carried on said tube and slidable therewith; friction means between said sleeve and said tube comprising at least one leaf spring carried by said sleeve and contacting said tube for holding said sleeve in position; and a radial shield carried by said sleeve and slidable therewith along said tube.

13. A rock piercing blowpipe in accordance with claim 12, also comprising at least one prong extending longitudinally forward from said shield for repulsion of said shield with reference to a rock face, the rear portion of said prong also serving to secure said shield to said tube.

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