Aug. 24, 1943. C. J. BURCH 2,327,499

PROCESS OF AND APPARATUS FOR WORKING MINERAL MATERIALS AND THE LIKE

Filed April 18, 1941 2 Sheets-Sheet 1

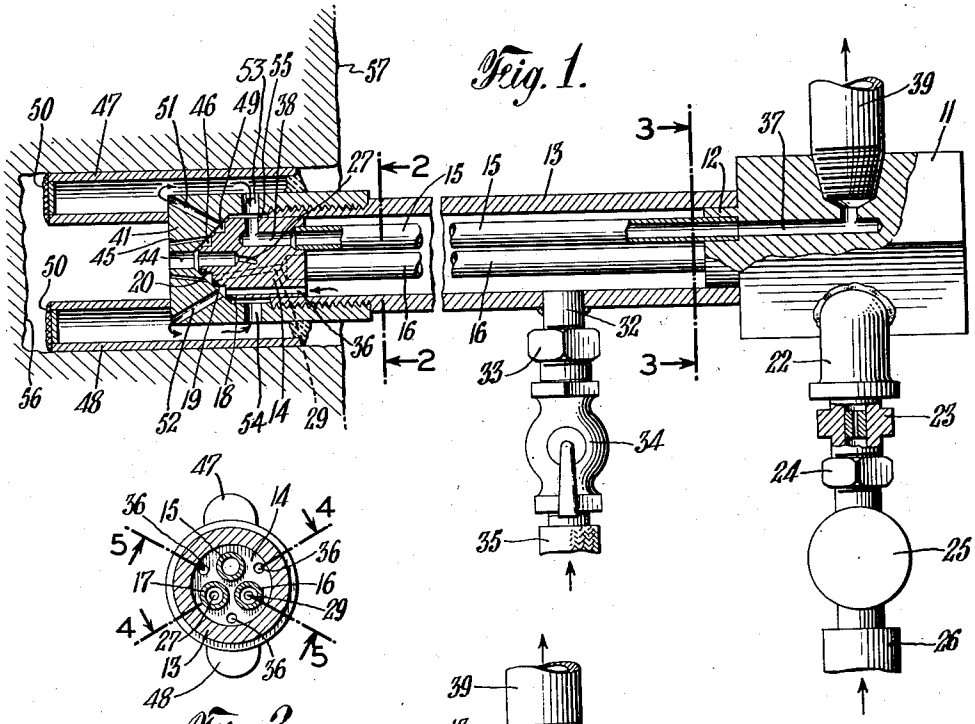


Fig. 1.

Fig. 2.

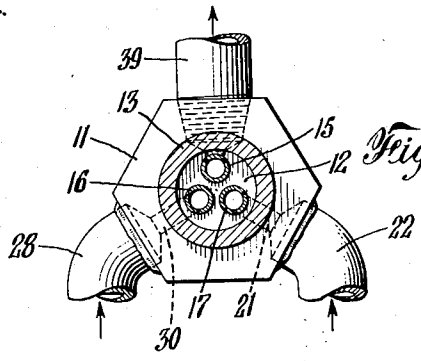


Fig. 3.

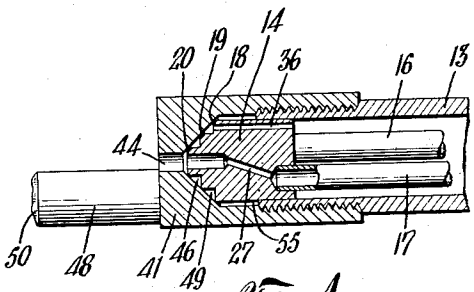


Fig. 4.

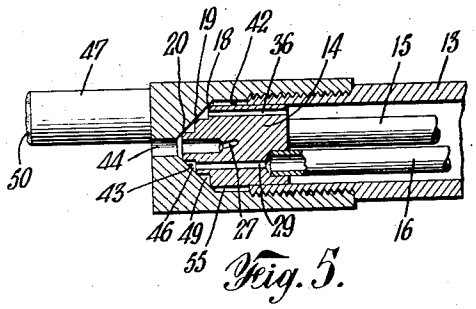


Fig. 5.

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PROCESS OF AND APPARATUS FOR WORKING MINERAL MATERIALS AND THE LIKE

Filed April 18, 1941 2 Sheets-Sheet 2

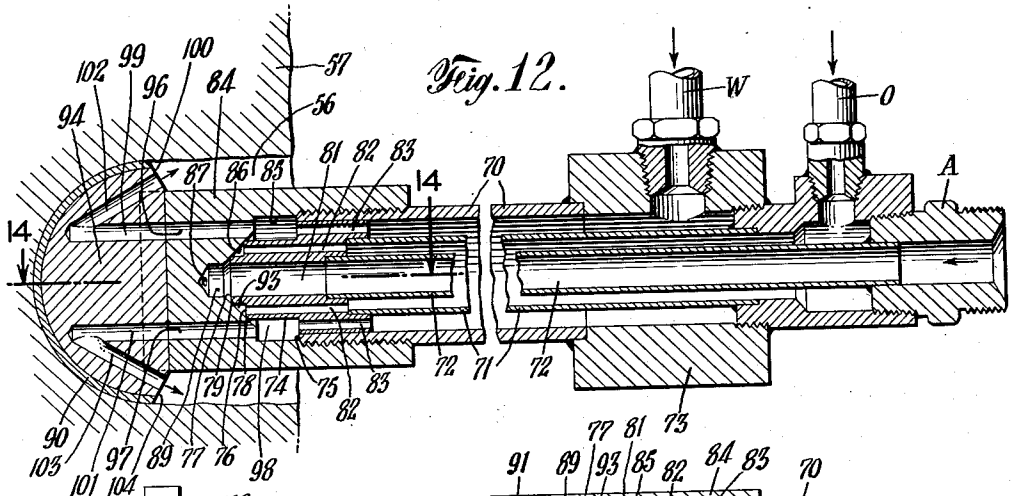


Fig. 12.

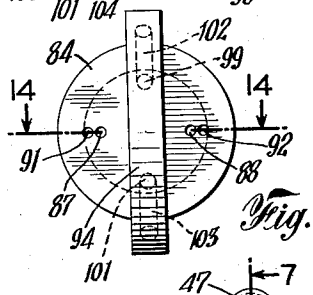


Fig. 13.

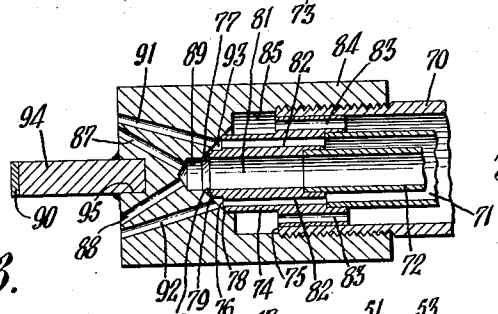


Fig. 14.

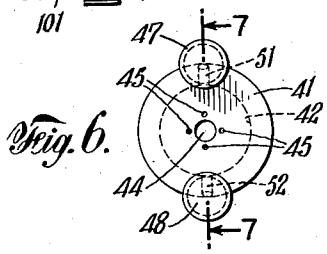


Fig. 6.

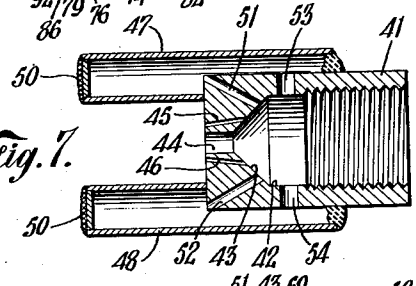


Fig. 7.

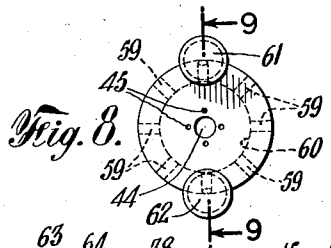


Fig. 8.

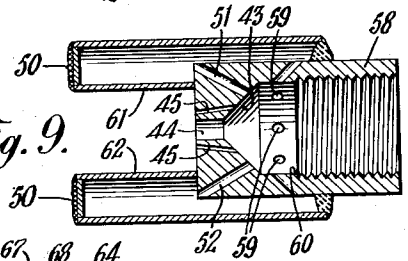


Fig. 9.

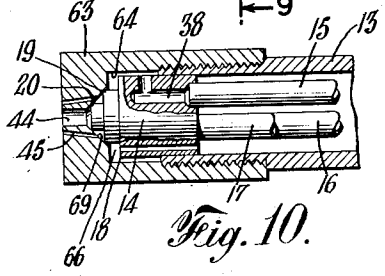


Fig. 10.

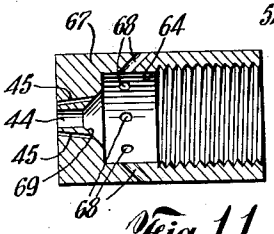


Fig. 11.

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UNITED STATES PATENT OFFICE

2,327,499

PROCESS OF AND APPARATUS FOR WORKING MINERAL MATERIALS AND THE LIKE

Charles J. Burch, Kenmore, N. Y., assignor to The Linde Air Products Company, a corporation of Ohio

Application April 18, 1941, Serial No. 389,116

19 Claims. (Cl. 255—1.8)

This invention relates to a process of thermally working, as by piercing, cutting, or grooving, minerals and mineral-like substances. In addition, the invention also relates to apparatus for thermally working minerals and the like, and more particularly for the piercing of deep holes for blasting or other purposes.

In application Serial No. 268,634, filed April 18, 1939 by R. B. Aitchison, C. W. Swartout, and V. C. Williams, there are disclosed and claimed two methods of procedure for the thermal working of mineral materials and the like, namely, by a controlled spalling method wherein the mineral material, such as quartzite, is spontaneously disintegrated by the application of an oxy-fuel flame, and the disintegrated material is removed from the zone of heating in the unfused condition; and by a melting method wherein the mineral material, such as iron ore, is fused by the oxy-fuel flame before removal from the zone of heating. Choice of the proper method to follow depends primarily upon the type of mineral to be worked. Some minerals, such as quartzite, react readily to the spalling process, but minerals which do not spall, such as iron ore, must be melted. Wherever possible, it is most advantageous to employ the spalling process because of its simplicity and economy. It has now been found that a third class of mineral materials exists characterized by a predominant tendency to spall in response to heat, but having a minor proportion of constituents which are loosened only partially from the mass, thereafter melting and adhering to the mass being worked. Fused particles thus may accumulate in the hole or the like and eventually form a plug of slag preventing the advance of the mineral working operation. Examples of mineral materials of the third class are granite, dolomite, and some sand stones having a small proportion of iron impurities; and many other well known minerals may be found to exhibit the same properties. By the present invention, minerals of the third class may be thermally worked by a modification of the spalling method of procedure.

Ancillary problems solved by the invention are the production of blasting and like holes having uniform diameters; and the provision of blowtorches, readily adaptable for use in different types of mineral materials, which will permit any of a plurality of interchangeable flame-producing tips to be used according to the desired mode of operation, as well as permitting damaged tips to be replaced quickly and easily.

The principal object of the present invention, therefore, is the provision of a novel process of, and suitable novel apparatus for rapidly and economically thermally working minerals and the like of the third class discussed above. Another object is the provision of a process of, and apparatus for, thermally piercing holes in mineral materials and the like of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles, which are only partially loosened, tend to adhere to the mass and fuse. Other objects are the provision of a process and apparatus for thermally producing holes of uniform diameter in mineral materials and the like; and the provision of rock piercing blowtorches so constructed that flame-producing tips may be removed and replaced at will, either with identical tips or interchangeably with different types of tips.

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

Fig. 1 is a longitudinal sectional view, partly in elevation, showing one novel form of blowtorch, in position within a hole in a mineral mass, for performing the process of the invention;

Figs. 2 and 3 are cross-sectional views taken along the lines 2—2 and 3—3, respectively, in Fig. 1;

Figs. 4 and 5 are sectional views taken along the lines 4—4 and 5—5, in Fig. 2;

Fig. 6 is a front end elevational view of the blowtorch of Fig. 1;

Fig. 7 is a sectional view taken along the line 7—7 of Fig. 6, showing only the removable tip of the blowtorch of Fig. 1;

Fig. 8 is a front end view of another tip which may be used on the blowtorch of Fig. 1, interchangeably with the tip of Figs. 6 and 7;

Fig. 9 is a sectional view taken along the line 9—9 of Fig. 8;

Fig. 10 is a longitudinal sectional view of a front end of a blowtorch similar to that of Fig. 1, but employing still another form of interchangeable tip;

Fig. 11 is a longitudinal sectional view of still another form of tip;

Fig. 12 is a longitudinal sectional view of a modified form of rock piercing blowtorch, shown in position for piercing a hole in a mass of mineral material by the process of the invention;

Fig. 13 is a front end view of the blowtorch of Fig. 12; and

Fig. 14 is a sectional view taken along the lines 14—14 of Fig. 12 or Fig. 13.

In accordance with the invention there is provided a novel process of thermally piercing, cutting, grooving, or otherwise working masses of mineral material and the like of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles tend to adhere to the mass and fuse, which process comprises continuously applying intense heat to such a mass to separate materials therefrom and form a hole, cut, groove, or the like; removing the separated material from the hole, cut, groove, or the like thus formed; and, concurrently with the heating operation, mechanically separating partially loosened adhering particles of material from the mass. Also in accordance with the invention, there are provided novel heating instrumentalities, such as blowtorches, for performing the process described generally above, comprising means for applying heat to a mass of the mineral to be worked, as by an oxy-fuel flame of sufficient intensity to loosen material from such mass, and means for mechanically scraping free and disintegrating any partially loosened material so that it may be readily removed from the zone of heating.

For the sake of simplicity, the process of the invention will be described hereinafter, by way of example only, as specifically applied to the piercing of holes of generally circular cross-section straight into masses of minerals and the like; and the various forms of heating instrumentalities specifically described, also by way of example, are particularly adapted for the piercing of such holes. It is to be understood, however, that the invention is not to be limited to the specific embodiments of the process and apparatus described, and that the invention is applicable not only to the production of holes extending straight into a mass of material, but also to the production of holes in the nature of cuts and grooves. For convenience, the terms acetylene and oxygen will be used hereinafter to indicate, respectively, any suitable fluid fuel, either alone or carrying in suspension a metallic or other powder, and any suitable combustion-supporting gas.

As shown in Figs. 1 to 7, inclusive, one form of blowtorch embodying the principles of the invention comprises a rear body 11 having a boss 12 on its forward end over which an elongated tube 13 is secured. The tube 13 may be of any desired length, in accordance with the depth of hole to be pierced, which in some instances may be as much as 20 feet deep. An adaptor body 14 is secured within the forward end of the tube 13 and is additionally connected to the rear body 11 by three conduits 15, 16, and 17 arranged side by side within the tube 13. The tube 13 and the conduits 15, 16, and 17 may be secured to both bodies 11 and 14 by silver soldering or other suitable means.

The adaptor body 14 is cylindrical in shape and is provided on its forward end with a series of concentric annular sharp-edged seats 18, 19, and 20 of progressively decreasing diameter toward the front of the blowtorch. Acetylene gas is supplied to the blowtorch through an inlet 22 and a metering orifice nipple 23 threaded into the inlet, to which is removably coupled, as by the coupling nut 24, a valve body 25 secured in the end of a supply hose 26. From the inlet 22, the acetylene passes through a passage 21 in the rear body 11 to the conduit 17 and is conducted to the adaptor body 14, from which it is discharged axially through a passage 27 having an opening in the front of the adaptor body concentric with the annular seats 18, 19, 20. Oxygen gas may be admitted through the inlet connection 28 to a passage 30 in the rear body 11, which conducts the gas to the conduit 16 leading to a passage 29 in the adaptor body 14, the passage 29 having an opening in the front of the body 14 on the annular shoulder between the annular seats 19 and 20.

A cooling medium such as water, which in some instances may also be used for ejecting detritus from a hole, is brought into heat-exchange relationship with the blowtorch through an inlet connection 32 in the side of the tube 13 connected, as by the coupling nut 33, to a removable valve body 34 carried in the end of a supply hose 35. Water thus circulates in the spaces formed between the inner wall of the tube 13 and the outer walls of the conduits 15, 16, and 17, and also is conducted to the front of the adaptor body 14 through three spaced ducts 36 extending through the adaptor body and having openings in its front face on the annular shoulder formed between the seats 18 and 19.

The third conduit 15 establishes communication between a passage 37 in the rear body 11 and a passage 38 in the adaptor body 14, which latter passage has a right angle bend within the adaptor body and opens to the side surface of the adaptor body in back of the seat 18. The conduit 15 may serve either to return cooling fluid from the front of the adaptor body 14 to the rear end of the blowtorch, from which it is then discharged through the nipple 39 threaded into the rear body 11, or it may serve as a fluid supply conduit, in which case fluid may be supplied to the nipple 39. The reasons for the alternative uses of the conduit 15 will be described more in detail hereinafter.

The constructions of the adaptor body 14 and the tube 13, described in detail above, are such that any one of a plurality of tips 41, removable and replaceable at will, may be secured over the adaptor body interchangeably in order to adapt the blowtorch for the most satisfactory and efficient performance of the particular operation contemplated. As shown in Figs. 1 to 7 inclusive, for example, a tip 41 having a cylindrical bore 42 terminating at its front end in a conical bore 43 is threaded over the outside of the forward end of the tube 13 with the surface of the conical bore 43 abutting against the annular seats 18, 19, and 20, thereby providing fluid-tight seals separating the several passages 27, 29, and 38 from one another and from the ducts 36. It is advantageous to construct the adaptor body 14 of a relatively hard metal, such as Monel metal, so that the seats 18, 19, and 20 will actually imbed themselves to a slight extent within the metal of the tip 41, which preferably is formed of a relatively soft metal such as copper.

A central passage 44 in the tip 41 is adapted to discharge acetylene in a centrally flowing stream from the front end of the blowtorch. Thereafter, the acetylene mixes with four small streams of gaseous oxygen discharged from the tip 41, around and converging toward the acetylene stream, through four ducts 45 converging forwardly toward the axis of the blowtorch and one another, and communicating at their inner ends with the annular passage 46 between the seats 19 and 20 and the wall of the conical bore 43. When the combustible gas mixture thus

produced outside of the blowpipe is ignited, an intense flame of the so-called diffusion type is produced which is suitable for piercing holes in minerals and mineral-like materials without the occurrence of flashbacks within the blowpipe.

Two longitudinally extending tubular prongs or scraper 47 and 48, having closed ends, are secured, as by welding or brazing, to opposite sides of the tip 41 and overlie the front face of the tip. The prongs 47 and 48 project forwardly and laterally of the tip 41 for scraping from the bottom and side walls of a hole being pierced any partially loosened material which may fuse and form plugs unless disintegrated, and also for the purpose of breaking up any plugs which may be formed during a piercing operation. For resisting the abrasive action of mineral materials, the leading surfaces or ends of the tubular prongs 47 and 48 are protected by layers 50 of a hard facing material, for example, a cobalt-chromium-tungsten alloy known commercially as Haynes "Stellite" alloy.

Cooling of the tip 41, and of the prongs 47 and 48, is accomplished by water discharged into the annular space 49, between the annular seats 18 and 19 and the wall of the conical bore 43, which passes through forwardly and outwardly inclined ducts 51 and 52 into the prongs 47 and 48, respectively. Water leaves the respective prongs through the two radial ducts 53 and 54 in the tip 41, and enters an annular space 55, in back of the annular seat 18 between the cylindrical wall of the adaptor body 14 and the wall of the cylindrical bore 42 in the tip 41. Thence, the water is discharged from the blowtorch through the passage 38, the conduit 15, the passage 37 in the rear body 11, and the nipple 39.

From the foregoing description it is evident that there has been provided a blowtorch comprising an elongated straight tubular member having front and rear ends, which is adapted to provide a flame adjacent to its front end. This tubular member which, in the specific embodiment shown, includes the rear body 11, the front adaptor body 14, the tube 13, the conduits 15, 16, and 17, and the tip 41, carries tooth means projecting therefrom adjacent to its front end constructed and arranged for disintegrating material loosened by the flame.

When piercing a hole 56 in a mass of material 57, such as granite, the intense diffusion type heating flame projected from the tip 41 causes material to spall off continuously as the blowtorch is advanced; and the gaseous products of combustion exert a force upon the spalled particles to eject them from the hole. As the blowtorch is advanced into the mass, it is rotated by the operator with a reciprocating motion to cause each of the prongs 47 and 48 to describe a half circle and scrape off any partially loosened fragments of material from the walls of the hole, particularly from its forward face. In the event that the mass of material being pierced is of a fully spallable nature, for example quartzite, the prongs 47 and 48 ordinarily may be dispensed with. However, some quartzite deposits embody thin strata of clay or like material, which may fuse under the action of the blowtorch flame. When such strata are encountered, the fused plugs may be broken up by the prongs 47 and 48 for ready removal from the hole.

Inasmuch as the tip 41 is removably threaded upon the elongated tube 13, a fluid-tight seal being maintained by applying lead to the threads of the tubular member before the tip is threaded thereon, the tip 41 may be readily removed and replaced by another tip. For example, the tip shown in Figs. 6 and 7, as described particularly in connection with Figs. 1 to 5 inclusive, may be removed and replaced by the tip shown in Figs. 8 and 9, which is particularly adapted for piercing under circumstances requiring auxiliary fluid streams to assist the ejection of detritus from a hole, or for piercing holes in a material wherein the detritus is so fine and dust-like that it must be moistened before removal from a hole in order to prevent contamination of the atmosphere with dust. The tip 58 shown in Figs. 8 and 9 is substantially identical with that shown in Figs. 6 and 7 except for the provision of a plurality of circumferentially arranged rearwardly and outwardly inclined lateral ports 59 establishing communication between the cylindrical bore 60 and the external surface of the tip. These ports 59 are adapted to discharge streams of a debris-ejection and/or wetting fluid toward the mouth of the hole being pierced. When the tip 58 is used on the blowtorch shown in Fig. 1, the debris-ejection and blowtorch-cooling fluid, which may be either compressed air or water, for example, is supplied to the blowtorch through both the inlet 32 and the nipple 39 concurrently. Adequate circulation of cooling fluid within the prongs 61 and 62 is maintained because the fluid pressure in the annular space 55 (see Fig. 1) is reduced by the discharge of fluid from the blowtorch through the ports 59.

Still another form of tip which may be used is shown in Fig. 10. There, the tip 63 is useful when no scraping action is necessary, and when no auxiliary debris-ejection fluid is required, the pressure of the gaseous products of combustion being sufficient to eject all debris from a hole. In this modification, the tip 63 is provided with a cylindrical bore 64 of such a depth that the wall of the conical bore 69 at its inner end only engages the two seats 19 and 20 of the adaptor body 14, the third and outer seat 18 being bridged to provide an L-shaped annular chamber 66 within which the water or other coolant may circulate before being discharged through the passage 38.

The tip 67 of Fig. 11 is identical with the tip 63 of Fig. 10, except that the tip 67 is provided with a plurality of circumferentially arranged rearwardly and outwardly inclined ports 68 opening to the side surface of the tip and adapted to communicate with the chamber 66 (see Fig. 10) for the discharge of rearwardly directed debris-ejection and/or wetting fluid streams from the blowtorch. As in the modification of Figs. 8 and 9, the fluid, such as water or compressed air, may be supplied to the blowtorch through both the inlet 32 and the nipple 39.

In a preferred form of blowtorch embodying the principles of the invention, as shown in Figs. 12, 13, and 14, three concentrically arranged conduits 70, 71, and 72, one surrounding the other in the order named, are connected at their rear ends to a rear body 73 having inlet connections W, O, and A, respectively, for supplying a cooling and debris-ejection fluid, gaseous oxygen, and acetylene gas to the respective conduits. An adaptor body 74 is secured within the front end of the conduit 70 and is connected to the rear body 73 by the conduits 71 and 72 which are secured within bores in the adaptor body. The adaptor body 74 is formed with three annular shoulders 75, 76, and 77, of progressively smaller diameter toward the front, which provide two

annular sharp-edged seats 78 and 79 for cooperation with a tip to provide seals.

A central passage 81 through the adaptor body 74, and four eccentrically arranged passages 82 having openings on the annular shoulder 76, are adapted to supply acetylene and oxygen, respectively, to a tip from the conduits 72 and 71. A second set of eccentrically arranged passages 83 having openings on the annular shoulder 75 are adapted to supply cooling and debris-ejection fluid from the outer conduit 70 to a tip.

A tip 84, having a cylindrical cavity 85 and a conical bore 86 at the bottom of the cylindrical cavity, is removably threaded over the outside of the outer conduit 70 with the wall of the conical bore 86 engaging the seats 78 and 79 to provide fluid-tight seals between the several passages 81, 82, and 83. The tip 84 is provided with two diametrically opposite acetylene discharge ducts 87 and 88 extending from a small central bore 89 to the front face of the tip in forwardly divergent relation to the longitudinal axis of the blowtorch. Two separate streams of gaseous oxygen are discharged from the tip 84, in converging relationship to the streams of acetylene from the ducts 87 and 88, through two diametrically opposite oxygen ducts 91 and 92 extending to the front face of the tip from the annular space 93, between the two seats 78 and 79 and the conical counter bore 86. The ducts 91 and 92 diverge forwardly from the axis of the blowtorch at a smaller angle than do the acetylene ducts 87 and 88 and have their openings in the front face of the tip spaced at a greater distance from the center of the tip than are the openings of the ducts 87 and 88, respectively. The two gases mix outside of the blowpipe to form a combustible gas mixture which may be ignited to produce two intensely hot flames which will not flash back into the blowtorch.

A substantially semi-circular plate-shaped scraper tooth 94 is welded or otherwise secured edgewise within a diametrical slot 95 in the forward end of the tip 84 between the openings of the two sets of gas discharge passages 87, 91, and 88, 92. The scraper 94 thus projects forwardly from the tip 84, and also is of such size that it projects laterally from the tip to provide for scraping the sides of a hole as well as the bottom face. The arcuate leading edge or surface of the scraper 94 is protected against abrasion by a layer 90 of a hard-facing alloy of the cobalt-chromium-tungsten type, such as Haynes "Stellite" alloy.

Two diametrically opposite ducts 96 and 97 in the tip 84 establish communication between an annular fluid distributing passage 98, between the adaptor body 74 and the tip 84, and two generally V-shaped discharge passages 99 and 101, respectively, in the scraper 94. The legs 102 and 103, respectively, of the V-shaped passages 99 and 101, are inclined outwardly and rearwardly toward the rear end of the blowtorch with respect to its forward end, and have openings in the external surface of the scraper on two beveled surfaces 100 and 104, respectively, so that fluid may be discharged into a hole adjacent to its bottom and directed toward the mouth thereof for the ejection and/or the moistening of debris.

The operation of the blowtorch shown in Figs. 12, 13, and 14 is generally the same as that of the blowtorch shown in Fig. 1. The principal advantage of the blowtorch of Fig. 12, however, is that, inasmuch as when a hole is being thermally pierced its forward face is usually approximately hemispherical in shape, the semi-circular scraper 94 insures that the entire area of the face of the hole will be scraped free of clinging fusible particles of material. In operation, during the piercing of a hole, the blowtorch is positioned with the scraper 94 approximately on a diameter of the hole and in contact with a narrow zone of material extending across substantially the entire bottom face thereof, the two heating flames are applied to the bottom face on opposite sides of the scraper to separate material from the mass, and the blowtorch is rotated or oscillated back and forth by the operator. Thus, the operator rotates the flames over the forward face about the longitudinal axis of the hole and drives the scraper over the bottom face and a small portion of the side wall of the hole while progressively advancing the blowtorch into the mineral mass. In this way adhering particles of material are scraped from the forward face of the hole over a constantly shifting narrow zone between the flames extending across the whole width of the forward face. The separated material, including both spontaneously spalled particles and mechanically separated particles, then is discharged from the hole by the action of the gaseous products of combustion and the debris-ejection fluid discharged from the passages 99 and 101. It is evident, therefore, that clinging particles of material are scraped free from the mass as rapidly as they are produced because the scraper 94 follows immediately behind the heating flames as the blowpipe is rotated through a half-circle in each direction.

It is to be understood that the foregoing description is by way of example only, and changes in the construction and mode of operation shown and described may be made within the scope of the invention as defined by the claims appended hereto.

What is claimed is:

1. A blowtorch comprising a front body; said body having gas-passage means therethrough; said body having coolant-passage means therethrough; conduits communicating with said gas-passage means and said coolant-passage means; a tip removably engaged over said front body; said tip having passage means communicating with the gas-passage means in said body and adapted to discharge gas to provide a flame; at least one scraper member carried by said tip, said member having a passage therein; and said tip having passage means establishing communication between the passage in said scraper member and the coolant-passage means in said body.

2. A blowtorch comprising a front body; an elongated tube extending rearwardly from said front body; said body having gas-passage means therethrough; said body having first coolant-passage means therethrough communicating with the interior of said tube; said body having a second coolant-passage therethrough; conduits connected into said gas-passage means and said second coolant-passage and extending rearwardly from said body within said tube; a tip removably engaged over said front body; said tip having passage means communicating with said gas-passage means in said body and adapted to discharge gas to provide a flame; at least one member carried by said tip and projecting forwardly therefrom for mechanically operating on mineral materials and the like, said member having a passage therein; said tip having coolant-passages establishing communication between the

passage in said last-named member and the respective coolant-passages in said body; and means providing fluid-tight seals between said body and said tip to prevent leakage between passages.

3. A blowtorch comprising a front body; an elongated tube extending rearwardly from said body; said body having gas-passage means therethrough; said body having first passage means therethrough for a cooling and debris-ejection fluid communicating with the interior of said tube; said body having a second passage therethrough for a cooling and debris-ejection fluid; conduits communicating with said gas-passage means and said second fluid passage and extending rearwardly from said body within said tube; a tip removably engaged over said front body; said tip having passage means communicating with said gas-passage means in said body and adapted to discharge gas to provide a flame; at least one member carried by said tip and projecting forwardly therefrom for mechanically operating upon mineral materials and the like, said member having a passage; said tip having passages establishing communication between the passage in said last named member and the respective cooling and debris-ejection fluid passages in said body; means providing fluid-tight seals between said body and said tip to prevent leakage between passages; and said tip having ports communicating with said first and second cooling and debris-ejection fluid passages in said body, said ports being adapted to discharge fluid from said tip.

4. A blowtorch comprising a front body; said body having passages therethrough; conduits communicating with said passages; said front body having a series of concentric annular sharp-edged seats of progressively decreasing diameter toward the front of such blowtorch, each seat being disposed between two passages; and a removable tip cooperating with said front body, said tip having a recess provided with a conical wall engaging said seats to provide seals, and said tip having passages therein communicating with the passages in said body.

5. In a blowtorch, a front body having a series of concentric annular sharp-edged seats of progressively decreasing diameter toward the front of said front body; said body having gas-passage means and two cooling-fluid passages therethrough; each of said annular seats being between two of said passages; and separate conduits communicating with said passages; said body being adapted to cooperate with a tip having passages therein adapted to communicate with passages in said body, said sharp-edged seats being adapted to engage such tip to provide seals.

6. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end; and means adjacent to said front end and projecting forwardly and laterally from said tubular member for disintegrating mineral material loosened by the flame.

7. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end; a pair of hollow prongs carried on the front of said tubular member; and means for bringing a cooling medium into heat-transfer relation with said prongs.

8. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end; and a plate-shaped disintegrating device projecting edgewise from the front end of said tubular member.

9. A blowtorch as claimed in claim 8 wherein said disintegrating device is approximately semicircular in shape and is arranged approximately on a diameter of said tubular member with its arcuate edge to the front; and wherein said tubular member is adapted to provide heating flames on opposite sides of said disintegrating device.

10. A blowtorch as claimed in claim 8, wherein said disintegrating device has passages therein arranged to discharge fluid toward the rear of the blowtorch, and wherein said tubular member includes means for supplying fluid to said passages.

11. A blowtorch comprising an elongated tubular member having front and rear ends, said tubular member including a tip at such front end; a plate-shaped disintegrating device projecting edgewise from the front end of said tip and approximately bisecting the same; said tip having passages for discharging streams of a fuel gas on opposite sides of said plate-shaped device; and said tip having separate passages for discharging streams of a combustion-supporting gas on opposite sides of said plate-shaped device adjacent to and converging toward said fuel-gas streams.

12. A process for piercing a hole of generally circular cross section in a mass of mineral material and the like of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles tend to adhere to the mass and fuse, which process comprises progressively and concurrently spalling off material from such a mass and leaving a hole having a mouth and a forward face applying a heating flame to such mass of sufficient intensity to separate material therefrom by spalling, scraping adhering particles of material from the forward face of said hole, advancing said flame straight into said mass along the longitudinal axis of the desired hole thereby deepening said hole, and removing the separated material from the hole thus formed.

13. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end; and a scraper projecting ahead of said front end for scraping the forward face of such hole, the leading surface of said scraper comprising a layer of a hard abrasion resistant material.

14. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member having passages for separately discharging therefrom fuel gas and combustion supporting gas to mix together outside of said tubular member and provide on ignition a flame of the diffusion type; and scraper means carried by said tubular member and extending ahead of said front end for scraping the forward face of a hole being pierced.

15. A process for thermally working a mass of mineral material or the like of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles tend to adhere to the mass and fuse, comprising spalling off particles from such a mass solely by applying intense heat thereto

of sufficient intensity to separate material therefrom by spalling, and, concurrently with the heating operation, mechanically separating adhering particles of material from the mass.

16. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end; and means adjacent to said front end and projecting forwardly from said tubular member for disintegrating mineral material loosened by the flame.

17. A blowtorch for thermally piercing holes in minerals and the like comprising an elongated tubular member having front and rear ends, said tubular member being adapted to provide a flame adjacent to said front end, said tubular member including a tip removable and replaceable at will, said tip having tooth means projecting therefrom constructed and arranged for disintegrating mineral material loosened by such flame.

18. A process of thermally producing holes in masses of mineral materials and the like of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles tend to adhere to the mass and fuse, comprising spalling off material from such a mass and leaving a hole by applying intense heat thereto of sufficient intensity to separate material therefrom by spalling; concurrently with the heating operation mechanically separating adhering particles of material from the mass; and removing the separated material from the hole thus formed.

19. A process of piercing a hole in a mass of mineral material and the like, of the type wherein intense heat causes separation of particles of material from the mass by spalling, but wherein some particles tend to adhere to the mass and fuse, comprising applying to the forward face of such hole two flames of sufficient intensity to separate material from the mass; rotating such flames over such forward face about the longitudinal axis of such hole; concurrently scraping adhering particles of material from such face over a constantly shifting narrow zone between such flames extending across the whole width of such forward face; and removing the separated material from the hole.

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