METHOD AND APPARATUS FOR FLAME WORKING MINERAL BODIES


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ABSTRACT

Flame cutting mineral bodies with an improved form of flame jet to produce spalling is employed to carry out a channelling operation wherein a vertical channel is cut in an exposed vertical face of granite in a quarry. Emission of a stream of products of combustion from a burner at superatmospheric pressure is controlled by means of a specially formed exit orifice in a flame jet nozzle to provide a jet flame which is distorted out of the normally conical shaped configuration so as to provide a fan shaped flame operative over a relatively extended area of impingement on a vertical face of stone with more efficient utilization of flame energy being realized in spalling.

2 Claims, 18 Drawing Figures
METHOD AND APPARATUS FOR FLAME WORKING MINERAL BODIES

This is a division of application Ser. No. 818,203 filed Apr. 21, 1969 and now U.S. Pat. No. 3,608,967.

This invention relates to an improved method and apparatus for flame cutting mineral bodies such as granite and the like and more particularly the invention is concerned with an improved method of flame channeling wherein a vertical channel is cut in an exposed section of granite.

In an earlier invention disclosed by me in U.S. Pat. No. 3,019,004, there is described a method of flame channeling which improved utilization of flame jet energy is realized. In this method, a flame jet channeling operation is successfully carried out by directing a flame jet in an angularly controlled path against a vertical rock face, and by regulating the angularity within specific limits, namely, at angles lying between 15° and 30° to the normal to obtain a desired area of impingement.

As described in the Patent above-noted, the flame jet in the channeling operation referred to is not only required to be held within the range of angles referred to, but must also be moved upwardly and downwardly at a slow rate of travel in order for spalling of rock particles to take place at an efficient rate of removal to justify the cost of fuel and oxidants employed to form the flame jet.

It will be understood that to provide a flame jet of conventional form, it is customary to discharge products of combustion from the end of an elongated burner assembly of considerable length, and therefore correctly positioning the burner requires special equipment and handling techniques. It is also pointed out that the stream of jet flame emitted tends to be in the form of a cone and those portions of the flame which are visible appear as a somewhat bushy flame body at the points of impingement on a vertical rock face. With such a type of conventional conical cross section flame, the required angularity as disclosed in the patent is achieved by holding the burner at a suitable angle or by using a burner with a suitably angled tip and the area of impingement is limited.

It is, therefore, a chief object of the invention to provide an improved method and apparatus for producing a flame jet.

Another more specific object is to provide an improved method of controlled flame jet channeling in which the shape or configuration of the jet flame is controlled and applied to a vertical face of a mineral body to form a distorted flame which may provide a larger effective area of impingement against a stone surface.

Still another object is to devise a flame jet burner construction by means of which there may be produced an improved water cooled flame jet which may operate at lower velocities and which may be, for channeling purposes, through an increased range of angles of inclination to the normal with less loss of energy and consequently with greater spalling efficiency.

With these objectives in mind, I have conceived of a method of flame channeling in which discharge of a stream of products of combustion from a burner is selectively controlled to form a jet of controlled configuration. A flame channeling configuration characterized by such a configuration may in one preferred form be referred to as a “feather-type flame jet.” This novel flame jet configuration is characterized by an outer generally thin shaped portion capable of acting against a substantially increased area of impingement against a stone surface for spalling purposes.

I have further determined that I may selectively control flame configuration so as to have the characteristics described by providing a special form of burner having an exit orifice through which a flow of products of combustion from a burner is diverted and a distorted flame is emitted from the burner in directions both outwardly and downwardly. An immediate consequence of this, I find, is that there is produced a feather-type flame jet having outer fan shaped portions which provide a substantially larger area of impingement against a stone surface.

There may thus be accomplished, I find, an extended spalling effect wherein the fan shaped flame functions to carry out concentrated high-temperature, high-velocity heating and scouring over a larger area of impingement. As the fan shaped flame portion is moved upwardly or downwardly more efficiently, the spalling action is realized without being limited to a 15°-30° angle of inclination, and the actual effective area of flame impingement may occur in a range of sizes of from about 15° up to about 70°.

The nature of the invention and its other objects and novel features will be more fully understood and appreciated from the following description of a preferred embodiment of the invention selected for purposes of illustration and shown in the accompanying drawings, in which:

FIG. 1 is a diagrammatic view illustrating in perspective a typical flame channeling operation carried out in a granite quarry;

FIG. 2 is another diagrammatic view further illustrating a channeling operation with a portion of the rock body broken away to more clearly show the position of the burner of the invention in an operative position;

FIG. 3 is a detail elevational view of a desirable form of burner and further indicating diagrammatically the feather-type flame jet of the invention;

FIG. 4 is a cross section taken on the line 4—4 of FIG. 3;

FIG. 5 is a cross section taken on the line 5—5 of FIG. 3;

FIG. 6 is a cross section taken on the line 6—6 of FIG. 3.

FIG. 7 is an elevational view of another form of burner and feathered flame for carrying out the channeling method of the invention;

FIGS. 7a, 8 and 9 illustrate a preferred form of burner construction for producing a feathered flame jet;

FIGS. 10, 11, 12, 13, 14 and 15 illustrate modified forms of burner construction.

FIG. 16 is a diagrammatic plan view illustrating the feathered flame of the invention forming a vertical channel in a rock face;

FIG. 17 is another diagrammatic view showing the channeling operation as viewed from one side.

In the structure shown in FIG. 1, numeral 2 denotes a mineral body such as granite as it may occur in one typical quarrying operation. Reference may be had to U.S. Pat. No. 3,019,004, above noted, for details of a conventional flame channeling operation in forming cuts in a granite body.

As indicated in FIG. 1 the granite body 2 presents a vertical face 4 through which a vertical channel C is formed in accordance with the method of the invention. It will be understood that the granite body 2 may be of a height of from 20 to 30 feet or more and may be of a lateral extent such that a number of channels corresponding to channel C may be cut into the granite body 2 suitably spaced intervals extending over 50-100 feet or more. The sections or stands of granite defined by multiple channeling operations may thereafter be separated along vertical lines of wire sawing to facilitate splitting and other subsequent dimension stone processing operations.

It will, therefore, be readily apparent that flame cutting constitutes a very important part of dimension stone processing operations and the cuts are required to be extended horizontally along the quarry for substantial distances. Also the depth of the cuts may run from 10 feet all the way up to 20 to 40 feet or more. With these considerations in mind, it will be appreciated that relatively small improvements in efficiency of flame cutting as well as handling techniques become of considerable significance.

In accordance with the present invention, I have devised an improved method of flame channeling. In this method of flame channeling, flow of a stream of products of combustion through a burner is continuously controlled to form a feather-type jet which is characterized by outer fan-shaped flame portions.

In applying the feather-type flame jet to a rock face, the burner is not required to be held in critical range of 15° to 30° of angularity and may be disposed in a more nearly vertical position in which the fan-shaped flame portions provide for a
relatively greater area of impingement, whereby increased heating and scouring action may be realized. Greater utilization of the total flame energy may, therefore, be obtained and the increased area of flame impingement may be extended over a range of angles from about 15° up to about 70°.

The feather-type flame jet while held in an angled position such as described may be raised or lowered to carry out progressively concentrated heating of the rock face by the vanes or tongue of flame. Relative to efficient action may thus be produced by the fan-shaped flame portions acting along a greater area of flame impingement.

Considering these steps in greater detail, reference character B in FIGS. 1 and 2 refers to the specially constructed burner of the invention for producing a feather-type flame jet burning operation as described above. Burner B is suspended from a movable carriage 10 through an upright support 12 along which a hoisting cord 14 extends from a winding drum 16. The burner B is furnished in some convenient manner from a supply unit 18 with oxidant, fuel, and coolant water through conduits 20, 22 and 24 respectively. An operator A guides the burner B as suggested in FIG. 1 along a desired path of travel which may, for example, start with the lower end of burner B being located adjacent a bottom section of granite body 4 as is best shown in FIG. 2.

In FIG. 3, there is illustrated diagrammatically a burner B and the desirable form of feather-type flame jet as it appears in a typical channelling operation. In FIGS. 16 and 17 this feather-type flame jet is shown on a somewhat larger scale directed against a portion of body 2, and FIG. 17, in particular, illustrates the fan-shaped flame portions impinging against a granite surface to be spalled.

As best shown in FIG. 3, the feather-type flame jet is produced by controlling a flow of products of combustion resulting from burning fuel and oxidant at suprathermospheric pressures in the burner B. As earlier noted, the feather-type flame jet is characterized by an upper relatively thin feathered tongue of flame 30 which gradually increases in size to form a lower relatively spread-out bushy flame portion 32. The relatively thin feathered flame portion 30 may, I find, be produced by allowing a portion of the products of combustion moving through the burner B to be emitted laterally through a narrow elongated exit denoted by numeral 34 and indicated in dotted lines in FIG. 3. Simultaneously another larger portion of the stream of products of combustion is allowed to flow against a closed end portion 36 of burner B and is abruptly diverted through a relatively larger aperture 38 outwardly and downwardly to form the lower relatively spread-out bushy flame body 32.

An important feature of causing the flow of products of combustion to be diverted laterally through an exit aperture in the side of the burner is a novel distortion which takes place as suggested diagrammatically in FIG. 4, whereby outer fan-shaped flame portions are formed extending over a range of angles of roughly 70°, which may be seen from an inspection of FIG. 4. The result of this is to provide for an increased area of impingement when the flame is directed against a vertical face of a mineral body such as granite 2 as has been indicated in FIG. 17.

Details of the burner B are further illustrated in FIGS. 7a, 8 and 9, and in the later figure, numerals 40 and 42 denote passageways for conducting coolant water through the burner B.

Referring in greater detail to FIGS. 16 and 17, fashaped flame portions are shown directed against a vertical side of the rock body 2 and being raised gradually upwardly to carry out a progressive spalling operation. As will be observed, the upper portion of flame 30 may act to initiate heating of the stone along a transverse line of cutting 46 as shown in FIG. 16, and tends, therefore, to concentrate heating and scouring action in a relatively small section of the rock or granite as indicated diagrammatically in FIG. 16 by the dotted line 48. There is thus accomplished a desirable transfer of heat to the rock section at points denoted by arrows a1, a2, a3, and so forth.

At the same time heating and scouring with consequent spalling is also caused to take place by the bushy flame portion 32 at lower points along the rock face as indicated in FIG. 17 by arrows b1, b2, b3, b4 and b5 at the area included within the dotted line 52 of FIG. 16. Thus it will be apparent that the fashaped flame portion may act over a substantially larger area of impingement than a conventional flame covers.

It is pointed out that by controlling the stream of products of combustion through an exit aperture in the side of the burner with consequent distortion taking place, there may tend to occur a decrease in flame velocity. This may result in a more efficient spalling depending on the quantities of fuel and oxidant used and the type of rock which is being spalled. It will also be observed from an inspection of FIG. 17 that the feathered flame configuration will tend to provide a substantially increased area of overall flame impingement which, as I have found may extend through a range of angles of from substantially 15° up to about 70° and this may result in decreased energy loss and better spalling efficiency. The selective control of flow of products of combustion may also be modified to produce various other flame configurations from exit openings occurring with different spacings along the side of a burner.

It may also be desired when using the feathered flame jet to vary the rate at which fuel and oxidant is supplied, and in particular to regulate rates of supply in accordance with desired shapes and sizes of feather-type jet portions to further, the rate of travel of the burner upwardly or downwardly and the width and length of the exit apertures may be varied as desired. For example, I may desire to produce modified forms of flame jets by using several different types of burner construction such as has been illustrated in FIGS. 10–15.

In the burner constructions shown in FIGS. 7, 10 and 10 to 12, a burner B is formed with an elongated aperture 34 which extends all the way downwardly through the burner B and communicates with an axially disposed passageway 35 extending through the end of burner B as shown. In this arrangement, the flame may have a lower larger bushy portion which tends to be directed along the axis of the burner to give a somewhat different flame configuration 37 as suggested in FIG. 7. In this form of burner, coolant water passageways are denoted by the numeral 60.

In FIGS. 13, 14 and 15 still another modification is illustrated in which a burner B is provided with an elongated V-shaped slot 60 and is further formed with an angular shape.

From the foregoing description of the invention, it will be evident that we have disclosed an improved method of flame jet channelling in which a stream of products of combustion is emitted through an exit orifice in a controlled manner to distort the stream out of a normally conically shaped cross section and thus form a feather-type flame jet which is characterized by outer fan-shaped portions capable of acting over a greater area of impingement against a vertical stone surface.

I claim: combination. 1. A burner construct for channelling a mineral body comprising an elongated tubular burner for receiving and burning fuel and oxidants at suprathermospheric pressure to produce a stream of products of combustion, a nozzle member supported at one end of the burner through which the stream of products of combustion are conducted, and said burner being formed with a flame discharge aperture means for controlling the flow of said stream of products of combustion to produce a regulated flame configuration, said nozzle aperture means including a relatively narrow aperture formed through one side of an intermediate portion of the nozzle structure, and a relatively larger aperture formed through the side of the nozzle structure adjacent the outer end thereof.

2. A structure as defined in claim 1 in which the flame discharge aperture means includes a flame passageway which terminates along a coned flame diverting surface immediately adjacent the relatively larger aperture.