July 2, 1963 K. LAMB 3,096,199

SURFACING TORCH WITH EXTERNAL POWDER FEED

Filed Dec. 2, 1959 2 Sheets-Sheet 1

Fig. 1

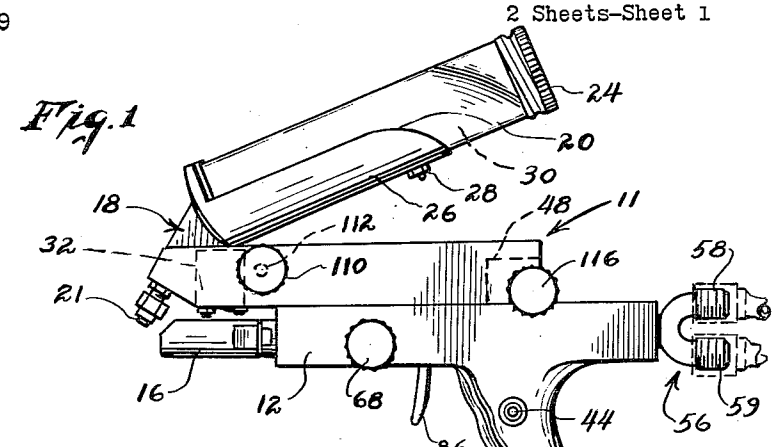
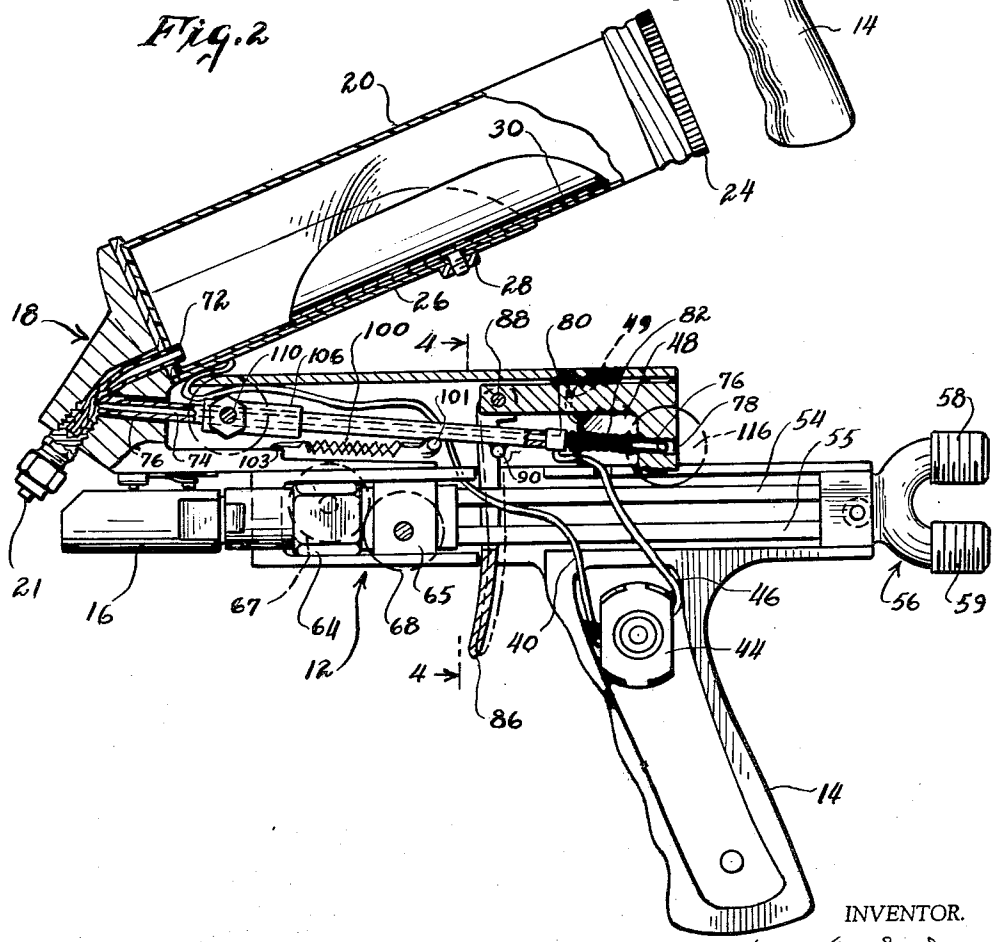


Fig. 2



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Fig. 3

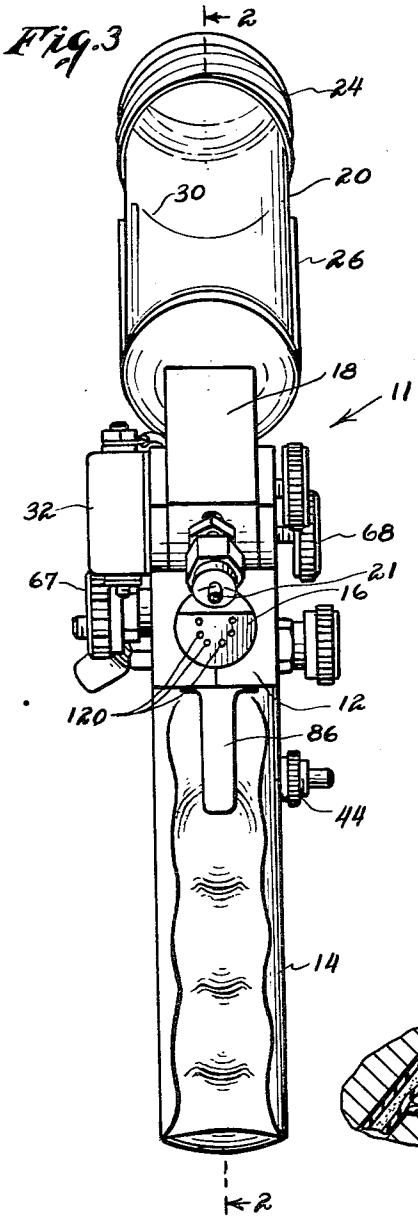


Fig. 4

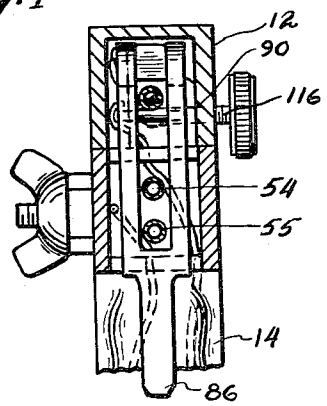


Fig. 5

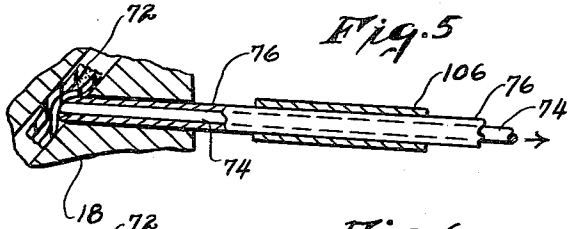


Fig. 6

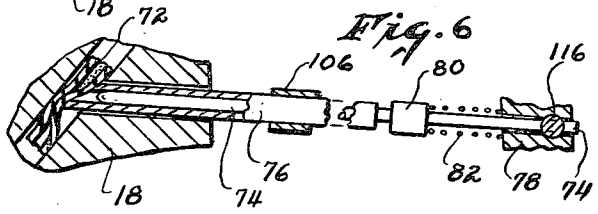


Fig. 7

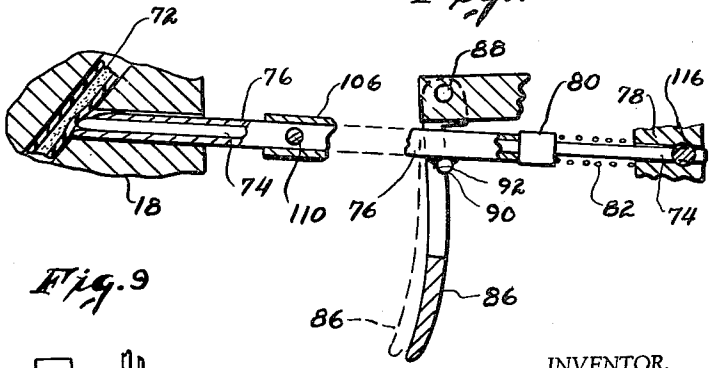


Fig. 8

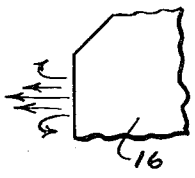
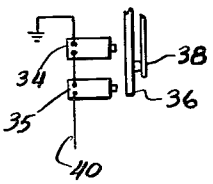


Fig. 9



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3,096,199

SURFACING TORCH WITH EXTERNAL POWDER FEED

Kenneth Lamb, Valencia, Pa., assignor to Coast Metals Inc., Little Ferry, N.J., a corporation of Delaware

Filed Dec. 2, 1959, Ser. No. 856,839
12 Claims. (Cl. 117—46)

This invention relates to torches having means for supplying powdered metal to a heated surface. The torch can be used for welding where metal is to be added to the weld, or it can be used for applying a metal surface, such as a surface of harder metal, to a work piece. The invention relates also to improved methods for applying surfacing metal to a work piece by means of a heating torch.

It is an object of this invention to provide an improved heating torch, preferably an oxyhydrocarbon fuel gas torch, with means for spraying powdered metal on the surface which is heated by the torch. The improvements are concerned principally with spraying large quantities of powdered metal while keeping to a minimum the amount of powder lost by bouncing from the work piece or by being blown away. There are two types of powder-feed torches. The first type has the powder supplied to the gas stream before the gas passes through the torch tip and the powder is, therefore, discharged through the tip to the flame jets. The second type feeds the powdered metal into the flame beyond the tip face and no powder passes through the tip. Torches of the second type can operate with greater powder flow and are more suitable for applying surfacing material to a work piece. This invention relates to the second type of torch, that is, to torches having external powder feed.

It is an object of the invention to provide an improved apparatus and method for applying the powdered metal by entraining it in the interior of the flame system. To accomplish this result, the flame system of the invention is formed with a U-shaped or channel-shaped cross section open at the top, and the powder feed is in position to supply powder through the open top of the channel-shaped cross section. This permits the powder to reach the center of the flame system and to be entrained within the flame in contrast to torches of the prior art where powder dropped on the periphery of a flame system and had many of its particles blown away by the flame envelope gases before the powder penetrated far enough into the flame system to be entrained thereby.

Other features of the invention relate to the control of the powder feed to the flame system. The powder nozzle is located far enough ahead of the torch and spaced from it to avoid damage to the nozzle by the heat of the flame; and the nozzle is far enough ahead of the tip face to prevent the powder from entering into eddy currents of the gas stream which turn back in the immediate vicinity of the tip face and which deposit metal on the tip face when powder falls into these eddy currents. The positioning of the nozzle in this invention is related to the channel-shaped cross section of the flame system because greater latitude in the location of the nozzle is made possible by the fact that there is an opening in the top of the flame system and into which the powder can drop.

The invention has valve means for controlling the powder flow and a manually-operated actuator for the valve means with locking elements for holding the valve means open when desired and with adjusting means for obtaining a minimum opening of the valve means and a greater opening as desired upon operation of the actuator.

Another object of the invention is to provide an improved powder holder on the torch. One feature of the powder holder construction is the low angle at which it is mounted so as to obtain a more compact torch and a

better balance of the torch. The powder holder is provided with means for facilitating feed of the powder in spite of the low angle, such means including a smooth slip plate on which the powder rests, and a vibrator which can be operated by a conveniently located switch on the handle of the torch.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views;

FIGURE 1 is a side elevation of a torch made in accordance with this invention;

FIGURE 2 is an enlarged view, mostly in section, of the torch shown in FIGURE 1;

FIGURE 3 is an enlarged front view of the torch shown in FIGURES 1 and 2;

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 2;

FIGURES 5, 6 and 7 are diagrammatic views showing the operation of the valve means;

FIGURE 8 is a greatly enlarged, fragmentary, diagrammatic view illustrating the eddy currents of the flame gases in the immediate vicinity of the tip face; and

FIGURE 9 is a detail view of the vibrator used on the torch shown in the other views.

FIGURE 1 shows a torch **11** having a body portion **12** and a pistol-grip handle **14**. There is a tip **16** at the forward end of the body portion **12**, and there is a bracket **18** connected to the top of the body portion **12** for supporting a powder holder **20** and a nozzle **21**.

In the construction illustrated, the holder **20** is a plastic jar with a screw cover **24** which is removed when the powder holder is to be refilled. The bracket **18** has a trough-like portion **26** into which the holder **20** fits and to which it is connected by a bolt **28**. This bolt is merely representative of fastening means for attaching the powder holder **20** to the trough-like portion **26** of the bracket **18**.

The torch is made more compact and its balance is improved by locating the powder holder **20** with its longitudinal axis at an acute angle to the length of the torch, that is, to the direction in which gas is discharged from the tip **16**. The nozzle **21** has its axis at a somewhat steeper angle for promoting gravity flow of the powder.

Within the powder holder **20** there is a slip plate **30** shaped to fit against the inside surface of the powder holder **20** and made of metal with a smooth surface over which the powder slides easily.

The slip plate **30** extends for most of the length of the powder holder in the preferred construction of the invention and the bolt **28** is bonded to the under side of the plate **30** so as not to leave any head which would be an obstruction to the powder flow. With this slip plate **30** it is practical to construct the powder holder **20** of light plastic material, and preferably transparent material so that the operator can observe the powder and know when the supply is getting low.

In order further to facilitate the feeding of the powder by gravity, the torch has a vibrator **32**, best shown in FIGURES 3 and 9. This vibrator has coils **34** and **35** which attract an armature **36** that carries one contact of a switch **38**. Power is supplied to the vibrator **32** through a wire **40**, the other side of the circuit being grounded on the torch body.

The vibrator **32** operates in accordance with the usual doorbell or buzzer construction and it is wound for low voltage power so that it can be connected with a battery. This makes the torch suitable for use in the field where electric power is not available except from a portable supply such as a battery.

The wire **40** leads to a switch **44** (FIGURE 2) located in the pistol-grip handle **14** with an operating button at

a convenient position to be pushed by the thumb or a finger of an operator's hand while gripping the handle 14. On the other side of the switch 44 there is a wire 46 leading to a receptacle 48 at the back of the torch body. One side of the receptacle is grounded on the torch body by another wire 49. The receptacle 48 has openings in the back of the torch for receiving prongs of a drop cord fitting which connects with a battery or other source of power.

Gas is supplied to the torch tip 16 through two tubes 54 and 55 extending through the body portion of the torch. An end fitting 56 has a branch 58 for connection with a hose to supply fuel gas to the tube 54. Another branch 59 of the fitting 56 is connected with a hose leading to an oxygen supply.

There are valves within the torch body for regulating the flow of gas through the tubes 54 and 55. These include a valve 64 commanding the flow of gas through the tube 54, and another valve 65 for controlling the flow of gas through the tube 55. The operating means for the valve 64 includes a knob 67 located on one side of the torch and the valve 65 is operated by a knob 68 on the other side of the torch.

Powder is supplied from the powder holder 20 to the nozzle 21 through a flexible tube 72 located in a passage in the bracket 18. This flexible tube 72 may be made of rubber or plastic, and the upper end of it extends through an opening in the bottom of the powder holder 20 and near the lowest portion of the powder holder. The other end of the tube 72 extends into the upper end of the nozzle 21. In order to cut off the powder feed from the holder 20 to the nozzle 21, the flexible tube 72 is pinched and flattened to close it at a location between the powder holder and the nozzle. There is a push rod 74 with a rounded end which contacts with the flexible tube 72 to pinch the tube without abrading it. This push rod 74 slides in a sleeve 76. The sleeve 76 has a diagonally-cut end the lower portion of which is rounded off to contact with the flexible tube 72 so that the tube can also be pinched by the sleeve 76. Thus, the open cross section of the flexible tube 72 may be closed by the push rod 74, as shown in FIGURE 5, or by the sleeve 76, as shown in FIGURE 6. Normally, the push rod 74 and sleeve 76 are both urged against the flexible tube 72 to pinch it closed.

The end of the push rod 74, remote from the flexible tube 72, slides in a bearing 78 which consists of a cylindrical opening through a back wall on the upper part of the torch body 12. There is a stop comprising a collar 80 rigidly connected to the push rod 74; and a spring 82 is compressed between the collar 80 and the back wall of the torch body. This spring 82 urges the push rod 74 toward the flexible tube 72 and keeps the flexible tube pinched to block powder flow except when the push rod is pulled back or held back by means which will be described.

The push rod 74 and the flexible tube 72 which is pinched by the rod to reduce the open cross section of the tube, or to close it altogether, constitutes a valve means controlling the flow of powder from the holder 20 to the nozzle 21, and for regulating the flow of powder by varying the extent to which the open cross section is closed by the push rod 74. The actuating mechanism for this powder feed valve means includes a trigger 86 extending below the torch body 12 in front of the pistol-grip handle 14. The trigger has a bifurcated upper end connected to the torch body by a pivot pin 88. A transverse bar 90 is brazed or otherwise secured to the lower side of the sleeve 76, and this bar 90 engages a recess 92 (FIGURE 7) in the back of the trigger 86. When the trigger 86 is pulled back (toward the right in FIGURE 7), the bar 90 and the sleeve 76 are also pulled back to release the flexible tube 72 from the pressure of the sleeve 76. During this movement of the sleeve 76, the bar 90 has a slight rotary movement in the recess 92 because of the change in the obliquity of the trigger 86. This movement of the sleeve 76 causes the sleeve to push the collar 80 back and thus to displace the push rod 74 toward the right with resulting compression of the spring 82. The trigger 86 thus retracts the push rod 74 and permits the flexible tube 72 to spring open as a result of its inherent elasticity. Powder is then free to flow through the tube 72 to the powder nozzle.

In the normal operation of the torch, releasing of the pressure of the operator's finger against the trigger 86 permits the spring 82 to push the collar 80 toward the left in FIGURE 7, and thus restore the push rod 74 to its original position in which it closes the cross section of the flexible tube 72, as shown in FIGURE 5.

The sleeve 76 is urged against the flexible tube 72 by a spring 100 (FIGURE 2) stretched between a bar 101 bonded to the sleeve 76 some distance ahead of the bar 90, and an anchor location 103 on the bracket 18.

The sleeve 76 extends through an outer sleeve 106 which is free on the sleeve 76; but a set screw 110 threads through the side wall of the outer sleeve 106 and extends through an opening 112 (FIGURE 1) in a side wall of the torch body. The head of the screw 110 is enlarged to provide a knob for manually rotating the screw.

Since the opening 112 is at a fixed location on the torch body, the screw 110 is free to rotate about its axis but cannot move lengthwise of the torch body. When the screw 110 is rotated to the right until it clamps against the sleeve 76 (FIGURE 7), the sleeve 76 is held against longitudinal movement. When the sleeve 76 is pulled back by the trigger 86 to open the tube 72, and the screw 110 is clamped against the sleeve 76, it becomes impossible for the sleeve 76 to return to its normal position in which it pinches the flexible tube 72. This maintains the push rod 74 in its retracted position because the collar 80 is against the end of the sleeve 76.

It will be apparent that the screw 110 can be clamped against the sleeve 76 with the sleeve 76 in any position. Thus, the set screw 110 can be used to hold the sleeve 76 and push rod 74 in positions which only partially open the tube 72.

The stop collar 80 can be held in various adjusted positions by a set screw 116 threaded through a side wall of the torch body in position to clamp the push rod 74. This set screw can be clamped against the push rod 74 when the push rod is fully retracted or when the push rod is at any intermediate position with the powder flow tube 72 open to any desired degree.

If the trigger 86 is pulled back to open the powder supply tube 72 for a desired rate of powder flow, and the set screw 116 is then clamped against the push rod 74, the trigger can not be moved back any farther to increase the powder flow. However, if the trigger is released, the sleeve 76 will move away from the collar 80 and return to its normal position where it pinches the tube 72 and shuts off the powder flow. As soon as the operator wishes to renew the powder flow, however, he pulls the trigger 86 back until the tube 72 contacts with the collar 80 and this results in the same opening as the last operation of the trigger since the collar 80 is held in its previous position by clamping of the set screw 116 against the push rod 74. Thus the collar 80 provides a stop with which a portion of the valve means, specifically the tube 74, comes into contact to limit the movement of the valve means toward open position.

Thus, the set screw 116 provides a means for setting the torch for a selected maximum powder flow without interfering with the operation of the trigger for stopping and starting the powder flow.

FIGURE 3 is a front view of the tip 16. A plurality of flame jet orifices 120 open through the face of the tip and they are located along a curved line having the shape of a U. The flame jets which are formed by the gas streams from these orifices 120 from a continuous system of flame along the line of the U, but the flame system

is open at the top because of the absence of any top orifices. Thus, the flame system from the orifices **120** has a channel cross section with the channel open at the top.

The nozzle **21** is located above the open top of the flame system so that powder dropping by gravity falls through the open top of the flame system and into the interior or mid-portion of the flame system where it becomes entrained in the flame jets by which it is carried to the work piece, being strongly heated by the flames during its passage to the work piece. Although the direction of the powder flow is changed abruptly upon striking the flame jets, little or no powder is blown away because of the side flames which deflect powder back to the center of the stream in the event of any spreading of the powder stream when it strikes the bottom of the flame system. By the time the flames and powder strike the work piece, the powder is traveling at high velocity and is well distributed in the flames.

FIGURE 8 shows one of the flame jets adjacent the face of the tip **16** and the arrows representing the gas flow of the flame jet indicate the direction of the flow. Because of the friction of the gas against the sides of the jet passage, and the sudden decrease in gas pressure as it emerges from the tip, there is some turbulance at the boundary layer of the gas jet, as indicated by the curved arrows in FIGURE 8. Powder falling into a flame jet near the tip face, or powder particles deflected into these eddy currents indicated by the curved arrows, build up on the face of the torch and eventually interfere with the flow of gas through the jet orifices.

With this invention, the nozzle **21** is located far enough ahead of the tip **16** to drop the powder into the flame system beyond the region of eddy currents.

Ordinarily, such spacing of the nozzle from the flame system places the nozzle in a position where the envelope gases have begun to expand sufficiently to strongly heat the nozzle and at times, overheat it. To avoid overheating of the nozzle, this invention locates the nozzle high enough above the gas flames so as to be out of danger of over-heating and damage by the flame system. This is practical, even though it permits greater spreading of the falling powder stream, because of the feature of this invention which provides an open slot at the top of the flame system for receiving the powder into the flame system and thus avoiding loss of substantial quantities of powder which are deflected and blown away and lost when dropped on an ordinary flame system which does not have the channel cross section of the present invention.

The preferred embodiment of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. In a torch for applying a coating to a work piece surface, and in which the torch has a tip face through which a combustible gas mixture is discharged in a high-velocity jet system and is burned in a flame system beyond the tip face but with eddy currents that flow outward from the jet system and turn back toward the tip face immediately adjacent to said tip face, and there is a powder holder for powdered coating material located at a higher level than the tip and with a discharge passage through which powder from the holder flows by gravity into the flame system, at a location outside of the torch and in front of the tip, and there are bracket means connecting the nozzle and powder holder to the torch, the improvement which comprises means for preventing powder from being carried by said eddy currents into contact with the tip face with resulting build-up of coating material on the tip face, said means including a discharge nozzle at the end of the passage and facing in a direction to discharge the powder from the passage into the burning flame system transversely of the direction of flow of the gas of the flame system from the tip, and supporting means holding the discharge nozzle above the flame system and out in front of the tip face at a distance to discharge the powder into the flame system ahead of the eddy currents.

2. The torch described in claim 1, and in which there is a vibrator attached to the torch adjacent to the discharge end of the powder holder for facilitating flow of powder from the holder and through the nozzle.

3. The torch described in claim 1, and in which there is a smooth plate located inside the powder holder and on the inside bottom wall of the powder holder for reducing friction of the powder on the inside of the holder.

4. The torch described in claim 1, and in which the bracket means has a trough-shaped top surface, and the holder is a cylindrical jar with a removable cap at its upper end, a plate in the jar and shaped to fit the inside surface of the jar, and extending for most of the length of the jar, and a screw extending through the plate and through the side of the jar and into a threaded opening in the bracket for holding the jar against the trough-shaped top surface of the bracket.

5. The torch described in claim 4, and in which the cylindrical jar is made of transparent plastic and the plate in the jar is made of metal with a smooth top surface for facilitating the sliding of the powder toward the lower end of the jar.

6. A torch for applying surfacing material to a work piece including in combination a torch body through which gas flows, a tip at the discharge end of the torch body, the tip having an upwardly extending face with a plurality of orifices opening therethrough and in directions having substantially horizontal components for projecting of gas jets from the face of the tip to produce a flame system outside of and in front of the face of the tip, a discharge nozzle for powdered metal, the nozzle being located out in front of the face of the tip and high enough above the level of the orifices to be out of the flames, said flame jet orifices including some that produce a floor of flame on which the powder drops by gravity and including at least two other jet orifices located near the upper end of the tip face and higher than other jets between them and in position to project upper flame jets on opposite sides of a powder stream falling by gravity from the nozzle whereby said upper flame jets reduce transverse spreading of the powder stream.

7. The torch for applying surfacing material as described in claim 6, and in which there is at least one jet orifice in the lower part of the face of the tip in position to project a low flame jet under the powder stream, the low flame jet and the side flame jets providing a dynamic channel into which the powder falls and by which it is carried into contact with the surface of the work piece.

8. The torch for applying hard surfacing material as described in claim 7, and in which there are several jet orifices on each side of the powder stream and several jet orifices in the lower part of the tip providing a plurality of flame jets for each side and a plurality of flame jets for the bottom of the dynamic channel.

9. Apparatus for applying surfacing material to a work piece including a torch having a tip from which a flame jet system is projected against the work piece, means for adjusting the rate of flow of gas to the flame jet system, a powder holder at a higher level than the torch tip, a nozzle with a discharge end outside the tip face and adjacent to the flame system and extending in a direction having a substantial vertical component, a passage connecting the powder holder and the nozzle and through which powder flows by gravity from the holder to the nozzle, valve means movable into different positions to obstruct totally or partially the flow of powder through the passage, manually-actuated means on the torch operably connected to the valve means for operating said valve

means, a stop with which a portion of the valve means comes into contact to limit the movement of the valve means toward open position, said stop being adjustable to change the maximum opening of the valve means, and said stop including manually-operated means outside of the torch for adjusting the maximum opening of the valve means and the resulting powder flow in accordance with adjustment of the rate of flow of gas to keep the powder flow within the carrying capacity of the flame jet system.

10. The apparatus described in claim 9, and in which the valve means include two elements that pinch the tube, one of the elements being a sleeve movable axially to press the end of the sleeve against the side of the tube to pinch said tube, and the other element being a rod that slids in the sleeve to bring the end of the rod against the tube to pinch said tube, the stop including a rearward part of the rod, and the manually operated means being movable into position to lock the rod in any set position and a trigger operably connected to the sleeve and constituting the manually actuated means for operating the valve means.

11. The method of applying surfacing material to a work piece by means of a gas torch comprising projecting a plurality of jets of oxygen and fuel gas with the jets in contiguous relation to one another and in directions to form a channel of flaming gas ahead of the torch, burning the gases while flowing in said channel to produce walls of flame along the sides of the channel and a sheet of flame forming a bottom of the channel, directing the channel of flame against the surface to be coated, and discharging the surfacing material, in powdered form, from a location above the flaming gas and downwardly in a direction transverse of the direction of flow of the flaming gas and between the sides of the channel and onto

the bottom of said channel of flaming gas, the powder being introduced into the channel of gas at a location outside of and ahead of the torch for entrapment within said flame system and projection against the surface of the work piece.

12. The method of applying surfacing material to a work piece comprising projecting a plurality of jets of oxygen and fuel gas with the jets in contiguous relation to one another and in directions to form a channel of flaming gas, burning the gases while flowing in said channel to produce walls of flame along the sides of the channel and a sheet of flame forming a bottom of the channel, directing the channel of flame from a torch horizontally against a surface to be coated, and dropping powdered coating material into the flame system by gravity at a region spaced downstream from the torch face, powdered material being dropped from a region above the flame system and the spacing of the powder stream from the torch face being greater than any jet orifice tubulence around the flames where they issue from the torch face.

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