Nov. 6, 1962 I. P. THOMPSON ET AL 3,062,456

WATER NOZZLE

Filed Feb. 25, 1960

Fig. 1.

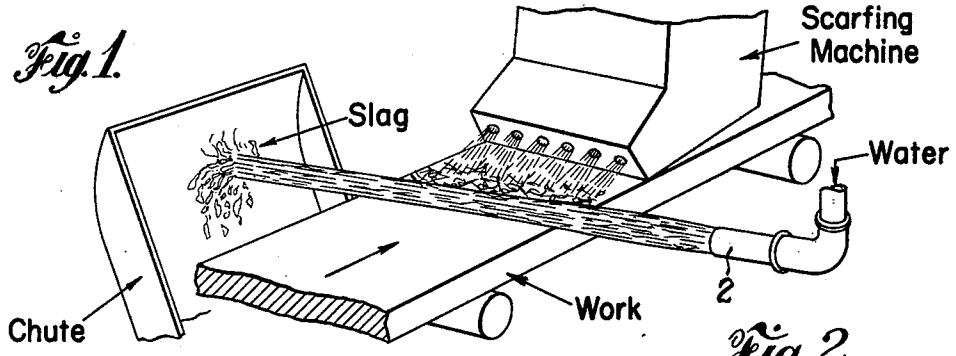
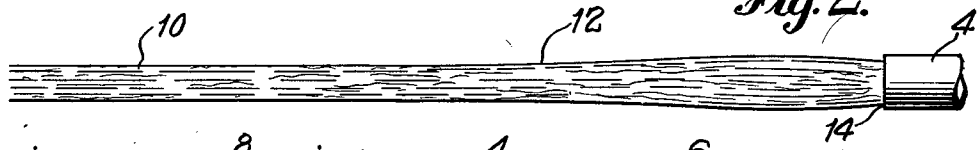


Fig. 2.



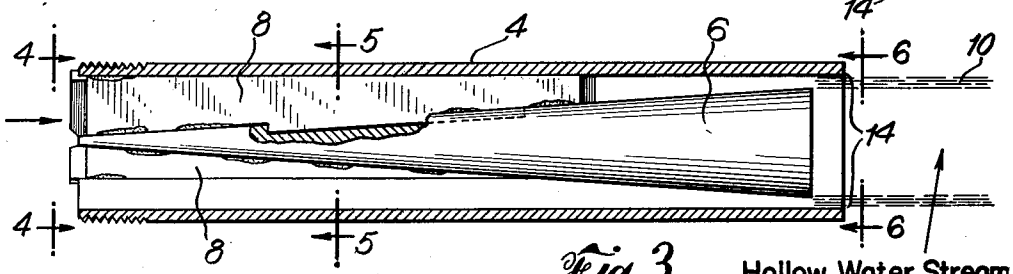


Fig. 3.

Hollow Water Stream

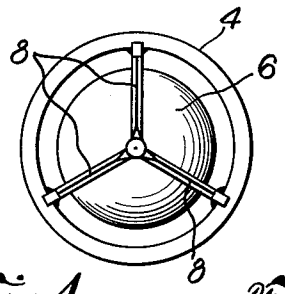


Fig. 4.

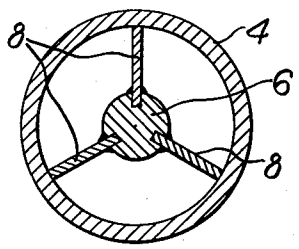


Fig. 5.

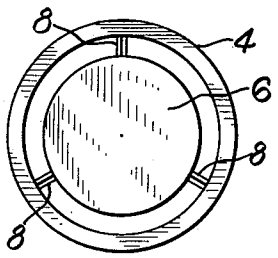


Fig. 6.

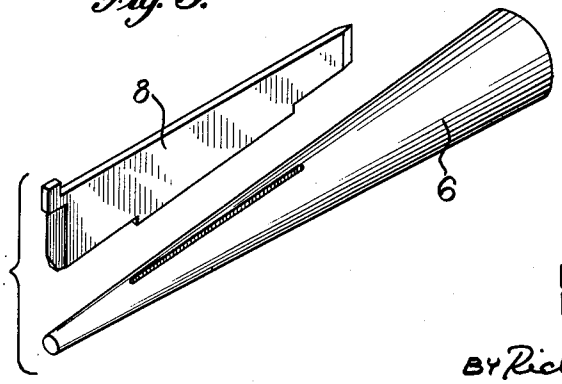


Fig. 7.

INVENTORS
IVAN P. THOMPSON
EDWARD H. MOUSTED

BY Richard S. Sheree
ATTORNEY

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WATER NOZZLE

Ivan P. Thompson, Elizabeth, and Edward H. Mousted, Garwood, N.J., assignors to Union Carbide Corporation, a corporation of New York

Filed Feb. 25, 1960, Ser. No. 11,947
1 Claim. (Cl. 239—590)

This invention relates to a process and apparatus for removing the slag and waste products from thermochemically desurfaced metal slabs.

The metal shapes produced by steel mills customarily have surface defects which it is desirable to remove. This removal is most commonly accomplished by a thermochemically desurfacing method known as "scarfing" which consists of projecting on such surfaces a voluminous oxygen stream accompanied by burning oxy-fuel-gas streams to convert the surface to a partially oxidized molten product or slag. The resultant slag must then be removed so that a clean surface will result. One common means for removing the resultant slag from the desurfaced slab is by high pressure water jets. When sufficiently high pressure jets are used, the slag is granulated and washed away leaving a cleaned billet, free of surface defects.

In recent years, scarfing machines have been developed which are capable of handling slabs of widely divergent sizes and shapes. It soon became apparent that conventional water nozzles were incapable of performing efficiently with all slab sizes. During desurfacing of the narrower slabs, for instance, the nozzle of the horizontal water jet may be over three feet from the near edge of the slab. Previously employed water nozzles produced streams which are incapable of effectively skimming the slab from such a distance. Further, divergence of the stream not only decreases the available force of the jet at the surface of the slab but causes some water to strike the edge of the slab with the possible development of an undesirable "black spot" due to uneven chilling. The diverging stream also causes both water and slag to spatter onto the desurfacing machine and onto the desurfacing reaction area, thus creating mechanical and electrical difficulties in the machine itself as well as interfering with the reaction of the desurfacing process. It has thus become apparent to those skilled in the art that a nozzle is needed capable of producing a jet of water with a diameter which will remain constant over a distance of at least eight feet.

The primary object of the present invention, therefore, is to provide a water nozzle capable of ejecting a stream of water having a substantially constant diameter over a distance of at least eight feet.

It is a further object of the present invention to provide more efficient means of disposing of the slag created by normal steel mill desurfacing procedures.

It is a further object of the present invention to provide water ejection means capable of more exact control of the point of impingement of the water jet on a surface.

It is a further object of the present invention to provide a water ejection nozzle which will substantially reduce uncontrollable spatter of solid particles and water in undesirable directions.

It is a further object of the present invention to provide a water jet capable of imparting a substantially constant impact pressure to a surface at various distances from the nozzle.

It is a further object of the present invention to provide a nozzle capable of impinging upon a hot, desurfaced steel slab a jet of water with sufficient precision that undesirable "black spots" will not be formed upon the edges thereof.

Other objects, features, and advantages of the present

invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an illustration in perspective of the nozzle of the invention in position to remove the slag produced by a scarfing machine;

FIG. 2 is a side view showing the jet produced by the nozzle of the invention;

FIG. 3 is a view of a longitudinal section through the nozzle of the invention indicating the internal construction of the nozzle and the manner in which the water jet is formed;

FIGS. 4–6 are end cross sectional views taken on lines 4—4, 5—5, and 6—6 as shown in FIG. 3; and

FIG. 7 is an exploded perspective view of the core and one fin, showing the manner of construction.

With reference to FIG. 3, it will be seen that the nozzle 2 of the invention comprises essentially an outer tube or cylinder 4, an inner conical core 6 in axial alignment with the tube 4 and held in fixed position by a multiplicity of radial fins 8.

The cone 6 is positioned in such a manner that its small end is upstream. Fins 8 are tapered at both upstream and downstream ends to minimize disturbance of stream flow. The downstream end of aperture 14 of the outer tube or sleeve 4 projects slightly beyond the base of the cone 6 for the best results. This configuration results in a stream 10 which initially converges somewhat upon departure from the nozzle to form a vena contracta 12 and then expands to a uniform diameter substantially that of the nozzle. The distance between the aperture 15 and the vena contracta 12 varies in proportion to the distance the outer sleeve 4 projects beyond the inner cone 6. In one embodiment of the invention, the outer sleeve 4 is formed of two inch internal diameter tubing and has a length of 11 13/16 inches. The cone 6 is 11 5/16 inches long with a maximum diameter of 1 5/8 inches and is supported by three equi-angularly spaced supporting fins 8 to combine high maximum stability with minimum flow resistance and turbulence. The distance between the base of the cone 6 and the downstream end of sleeve 4 is ½ inch. When formed with these dimensions and operated with an inlet pressure of about 100 p.s.i., the vena contracta occurs two feet from the nozzle. This stream produces no appreciable "fan-out" over a distance of at least eight feet from the nozzle. Furthermore, this nozzle produces a stream of high velocity which effects excellent slag granulation and removal.

It is therefore apparent that the present water nozzle having the cone base disposed inwardly of the sleeve aperture provides a desirable improvement in any desurfacing operation. Not only does the nozzle help improve the quality of the slab being treated by eliminating "black spots" but the nozzle itself is protected less susceptible to damage should it be accidently struck by a misdirected moving slab or other object. It has been found, for instance, that if the conical portion is damaged at the peripheral section of the base, the resulting water stream will be substantially distorted from the desired constant diameter stream and tend to fan outwardly. With the base withdrawn as herein shown, there is little possibility of such damage and consequent stream distortion.

While the nozzle of the invention has been specifically described in connection with the scarfing of steel, it is to be understood that the invention is not so limited in application and may be advantageously employed wherever water jets of substantially constant diameter are desired.

What is claimed is:

In a nozzle for directing an annular cross-sectional, high pressure fluid stream having a substantially constant outer diameter and a hollow center portion, along a slag containing surface of a hot metal slab for removing said

slag and avoiding substantial contact of said stream with the slab surface, the improvement therewith which comprises; an elongated tubular sleeve of constant internal cross section having opposed ends, an upstream opening at one of said ends, a circular discharge aperture at the other of said ends and a smooth surfaced cylindrical wall connecting said opening and aperture, an elongated conical member having a base and an apex connected by a smooth surface therebetween, said conical member disposed in substantial coaxial relation with said sleeve, the apex positioned at the sleeve upstream end and the base positioned adjacent to but not forward of the aperture thereby defining a smooth walled annular passage having a gradually decreasing cross-sectional area and a constant outer diameter extending from the apex and terminating at the aperture, and a plurality of fins longitudinally positioned between and fixed to said sleeve and said

cone for supportably positioning said conical member in said sleeve, said fins terminating upstream of the base of the conical member to permit the stream of fluid to spread uniformly over the complete circumference of the cone before discharge from the nozzle.

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CERTIFICATE OF CORRECTION

Patent No. 3,062,456 November 6, 1962

Ivan P. Thompson et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 67, after "desired." insert the following paragraph:

> This is a continuation-in-part of Serial No. 695,846, filed November 12, 1957, now abandoned.

Signed and sealed this 28th day of May 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents