Nov. 21, 1967 C. R. GINGERICH ET AL 3,354,002

THERMOCHEMICAL SCARFING METHOD

Filed March 10, 1966

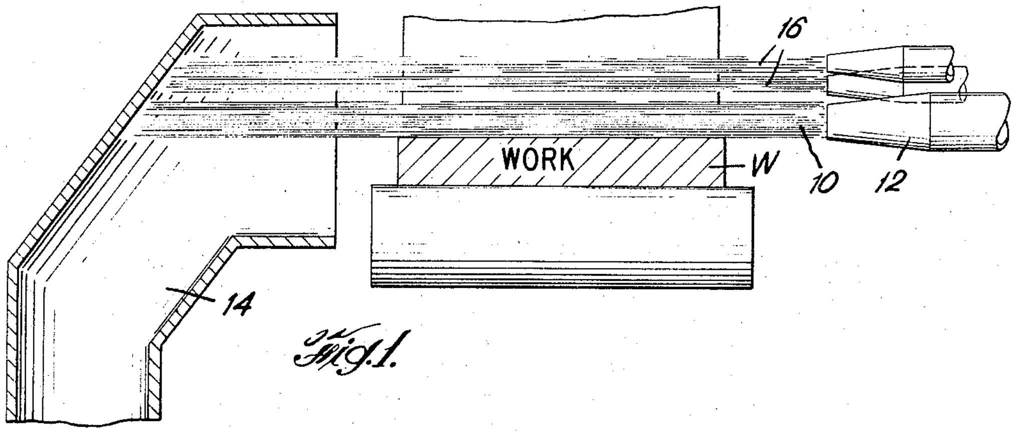

Fig. 1.

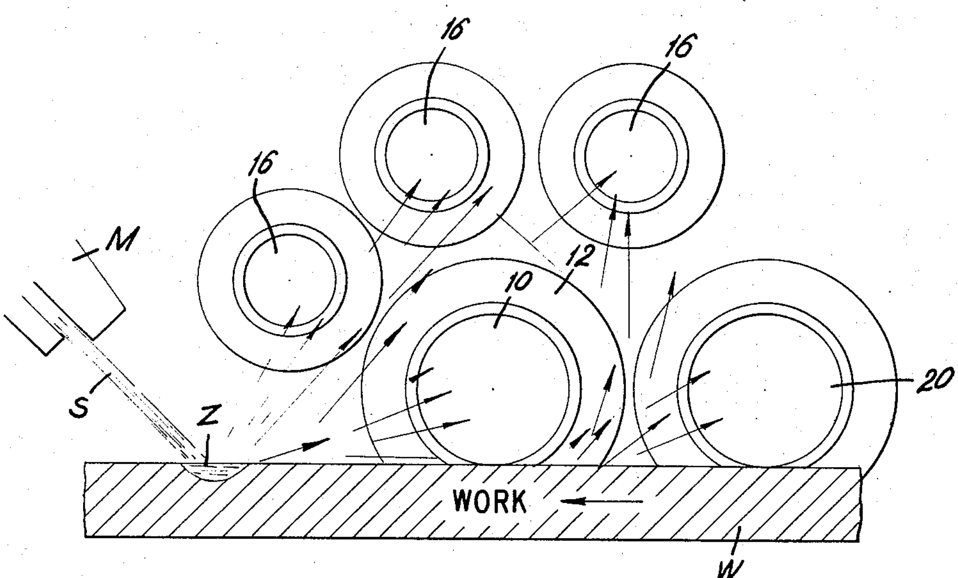

Fig. 2.

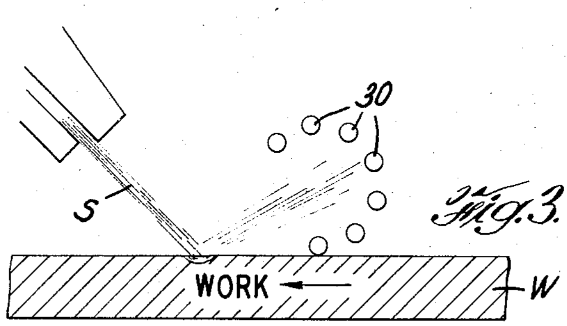

Fig. 3.

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1

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THERMOCHEMICAL SCARFING METHOD

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8 Claims. (Cl. 148—9.5)

This invention relates to thermochemical scarfing the surface of a metal body and particularly to improvements to the basic method of granulating, trapping and removing the molten slag produced during such process, by the utilization of a fluid stream, e.g. water, which is discharged to skim across the surface at high velocity. The basic method is disclosed by I. P. Thompson et al. in U.S. Patent 2,465,297.

As disclosed in the above-referenced patent, during the thermochemical scarfing process a stream of oxidizing gas is directed obliquely against a reaction zone of molten metal which has been previously formed upon the surface of the body. In so doing, a thermochemical reaction is produced, which continues along the surface of the body as relative movement is produced between such body and the stream of oxidizing gas. As a result of this thermochemical scarfing reaction, a molten slag is produced which must be removed from the surface of the body. This is accomplished according to the basic reference by directing a stream of fluid, e.g. water, at high velocity so as to skim across the surface of the body and thereby impinge against and completely deflect the slag off the surface thereof. The fluid stream also breaks the slag into small particles, chills it and directs the particles off the surface into a slag chute.

While the basic method has been successfully used for many years, it is not entirely effective in trapping the fine slag spray that is deflected from the main fluid stream as well as from the reaction itself. In addition, a considerable quantity of this slag spray is deflected in directions away from the slag chute. This has resulted in a substantial build-up and accumulation of slag upon the scarfing machine, slag target, roll table and smoke hood, which necessitates more frequent maintenance thereto.

The object of the invention is to provide an improved method of trapping and removing slag produced during a scarfing reaction, such that substantially all of the slag produced will be removed, with little if any being deflected against the surfaces of the scarfing machine, slag target, roll table and smoke hood, etc.

According to one embodiment of the present invention, at least one main fluid stream is discharged at high velocity and positioned so as to skim across the surface of the body in front of the reaction zone. The purpose of the main stream is to trap most of the slag and to wash it off the surface being scarfed, into a slag chute.

At least one additional fluid stream is then directed across the surface of the body in front of the reaction zone, from a position further above the surface than the main stream. The effect of this is that the molten slag and spatter which escapes from or is deflected by the main fluid stream is trapped by the additional stream or streams and deflected into the slag chute. Preferably, two or more additional streams are utilized. They are preferably positioned so as to partially surround the main stream. The volume flow rate of each additional stream may be substantially less than that of the main stream.

This embodiment is particularly well suited for the scarfing of wide metal bodies, i.e. slabs, where a relatively massive main stream is needed to traverse the entire surface thereof with sufficient force to trap and push the slag laterally off the surface into the slag chute. In this case, the smaller auxiliary streams act mainly to trap the fine slag spray which is not trapped by the main stream.

2

According to another embodiment of the invention, which has been found to be admirably effective when scarfing smaller sections, such as billets and blooms, a generally channel-shaped stream of fluid is directed across the surface of the body in front of the reaction zone, with the opening in the channel substantially facing the reaction zone. A fluid stream of this general configuration will act as a pocket to trap the slag and carry it laterally off the surface of the metal body. The channel-shaped stream may be formed from a single nozzle of appropriate shape or alternatively, it may be formed from a plurality of spaced individual streams arranged so as to form this pattern.

A particularly effective channel-shaped fluid stream has been formed from a plurality of individual streams arranged in a crescent type pattern, with the opening in the crescent facing the reaction zone.

In the drawings:

FIGURE 1 is an end view facing the reaction zone, of a metal body being scarfed, and illustrating the slag removal method of the invention;

FIGURE 2 is a side view of the body to be scarfed, and facing the fluid nozzles shown in FIGURE 1, and

FIGURE 3 is a side view similar to FIGURE 2 but illustrating another embodiment of the invention.

Referring to FIGURES 1 and 2, the metal body W to be scarfed is supported upon and moved by roll table R toward a scarfing unit M. A molten puddle of metal is formed upon the surface of the body at reaction zone Z, by preheat flames from the scarfing unit M. Thereafter a sheet-like stream of oxidizing gas S, e.g. oxygen, is directed obliquely against the molten puddle to cause a thermochemical reaction. Relative movement is then produced between the metal body W and the oxidizing gas stream S so as to continue the reaction along the surface length of the body.

As the scarfing reaction proceeds, molten slag is produced and projected forwardly and upwardly from the reaction zone Z.

A substantial portion of the molten slag comes into contact with a high velocity main stream **10** of fluid, e.g. water. The fluid stream is discharged from a nozzle **12** which is positioned so that the fluid will skim across the surface of the metal body at a point slightly downstream of the reaction zone. The fluid stream is discharged into a slag chute **14** adjacent the opposite side of the metal body. A significant portion of the molten slag is broken up and deflected by the main stream **10** and carried into the slag chute **14**.

To trap and remove slag which is deflected away from the slag chute by the main stream **10**, in addition to molten slag which does not come into contact with the main stream, we direct additional streams **16** of fluid across the metal body and into the slag chute **14**. The additional streams are positioned with their central axis above the central axis of the main stream **10**, and preferably such additional streams partially surround the main stream as illustrated in FIGURE 2. Preferably, at least one of the additional streams **16** is offset from the main stream **10** toward the reaction zone. In this manner, a significant portion of the slag which is deflected upwardly from the main stream **10** is trapped by the additional streams **16** and conveyed into the slag chute. In addition, a portion of the molten slag which does not come into contact with the main stream **10** impinges upon the additional stream or streams **16** whereupon it is broken up and carried to the slag chute **14**.

When scarfing wide slabs it becomes difficult to maintain the coherency of a single main stream due to the impinging thereagainst of molten slag. In such case it is advisable to back up the main stream with a second stream **20** which is skimmed across the surface of the body. When a second main stream is used, it is usually necessary to locate the additional shielding streams so as to partially surround only the main stream nearest the reaction zone, as shown in FIGURE 2.

As an example of the water flows required in a typical situation, the top surface of a 95 inch wide metal body was scarfed with a flow rate of 325,000 c.f.h. of oxygen at a scarfing speed of the order of 120 feet per minute. A main stream of water having a diameter of approximately 2 inches and a flow rate of 310 gallons per minute was skimmed across the surface of the body. Three additional streams of water, positioned as shown in FIGS. 1 and 2 were used to trap and remove the slag deflected away from the slag chute by the main stream. Each of the additional streams had a diameter of approximately 1¼ inches, and each was discharged at a flow rate of about 200 gallons per minute.

The primary purpose of the additional streams is to act as a fluid shield for the main stream. When scarfing wide slabs it is often necessary to maintain more than one main fluid stream skimming across the surface of the body. In such case it is usually only necessary to shield the main stream nearest the reaction zone with the additional fluid streams.

Referring now to FIGURE 3, another embodiment of the invention is illustrated which is particularly effective in trapping slag during the scarfing of metal bodies having relatively narrow surface widths, i.e. billets and blooms. According to this embodiment a fluid pocket is formed by directing the fluid, e.g. water, in a channel shaped stream 30 across the surface of the metal body at a point adjacent the reaction zone. The channel-shaped stream is formed so that the opening in the channel substantially faces the reaction zone. This type of patterned water stream acts as a pocket to trap the slag and carry it off into the slag chute.

It will be noted that FIGURE 3 illustrates a crescent shaped channel pattern, having its opening facing the reaction zone. It should be understood, however, that numerous other channel-shaped configurations may also be used, according to this invention.

It should also be noted that the channel shaped stream may be formed from a plurality of individual streams arranged in a channel-shaped pattern as illustrated for example in FIGURE 3, or alternatively it may be formed into a continuous stream by an appropriately shaped nozzle, in either case the object being to form a type of fluid pocket so as to trap the slag and carry it laterally off the metal body.

As an illustration of this embodiment of the invention, the top surface of a 10 inch wide metal billet was scarfed with a flow rate of 45,000 c.f.h. of oxygen at a scarfing speed of the order of 120 feet per minute. Twelve individual streams of water having a diameter of about ¼ inch each and a total flow rate of about 250 gallons per minute were arranged in a crescent facing the reaction zone (see FIGURE 3). The ability of this method of slag removal was excellent, it being far superior to the methods heretofore used in the art.

What is claimed is:

1. In a thermochemical scarfing process wherein a stream of oxidizing gas is directed against a reaction zone of molten metal on the surface of a metal body to produce a thermochemical reaction thereon, and relative movement between such stream and the body is produced for continuing such reaction along the length of such surface, the improvement for granulating and trapping

molten slag produced during such reaction which comprises:

(1) directing at least one main fluid stream transversely of said surface in front of said reaction zone, while maintaining such fluid stream in immediate adjacency to such surface, to trap and granulate a substantial portion of such slag, and push it laterally off said surface, and

(2) directing at least one additional fluid stream transversely of said surface in front of said reaction zone, said additional fluid stream being positioned with its central axis further above the surface of the body than the central axis of said main fluid stream, whereby substantially all of the granulated slag deflected by said main stream in addition to substantially all ungranulated slag which does not come into contact with said main stream will be trapped by said additional fluid stream and pushed off laterally from the surface of the body.

2. In a thermochemical scarfing process as claimed in claim **1** wherein at least one of said additional fluid streams is positioned with its central axis offset from the central axis of said fluid stream, toward the reaction zone.

3. In a thermochemical scarfing process as claimed in claim **1** wherein each additional fluid stream is of smaller volume flow rate than said main fluid stream.

4. In a thermochemical scarfing process as claimed in claim **1** wherein said additional streams at least partially surround said main stream.

5. In a thermochemical scarfing process as claimed in claim **1** wherein two main streams of water are directed transversely of said surface in front of said reaction zone while maintaining said streams in immediate adjacency to such surface, and at least three additional streams of water are directed across such surface from positions partially surrounding the main water stream located nearest to the reaction zone.

6. In a thermochemical scarfing process wherein a stream of oxidizing gas is directed against a reaction zone of molten metal on the surface of a metal body to produce a thermochemical reaction thereon, and relative movement between such stream and the body is produced for continuing such reaction along the length of such surface, the improvement for granulating and trapping molten slag produced during such reaction which comprises directing a generally channel-shaped stream of fluid transversely of said surface in front of said reaction zone, with the opening in the channel substantially facing said reaction zone, whereby said stream will act as a pocket to trap the slag and carry it laterally off said surface.

7. In a thermochemical scarfing process as claimed in claim **6** wherein said channel-shaped stream of fluid is formed from a plurality of spaced individual streams.

8. In a thermochemical scarfing process as claimed in claim **6** wherein said channel-shaped stream is formed by a plurality of individual streams spaced apart from one another in a crescent formation, with the opening in the crescent facing the reaction zone.

References Cited

UNITED STATES PATENTS

2,465,297	3/1949	Thompson et al. -----	148—9.5
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W. W. STALLARD, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,354,002 November 21, 1967

Cecil R. Gingerich 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 4, line 23, for "said" read -- said main --.

Signed and sealed this 4th day of March 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents