United States Patent

Dennis

[15] 3,648,359

[45] Mar. 14, 1972

[54] WORKING OF CONTINUOUSLY CAST METAL STRAND

[72] Inventor: **William E. Dennis**, Pittsburgh, Pa.

[73] Assignee: **Jones & Laughlin Steel Corporation**, Pittsburgh, Pa.

[22] Filed: **Dec. 30, 1969**

[21] Appl. No.: **889,151**

[52] **U.S. Cl.** **29/527.7**, 164/70

[51] **Int. Cl.** **B23p 17/00**, B23p 25/00

[58] **Field of Search** 29/527.6, 527.5, 527.7; 164/70, 283

[56] **References Cited**

UNITED STATES PATENTS

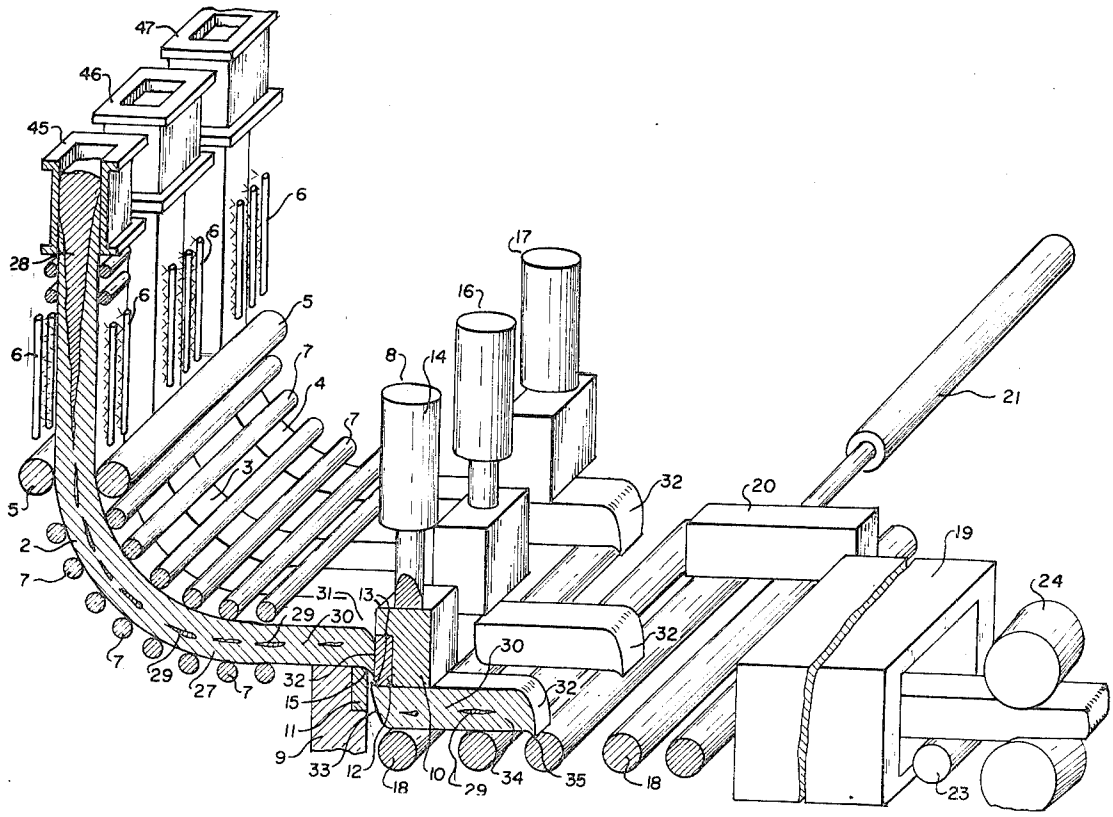
3,147,521	9/1964	Boehm	29/527.7
3,209,452	10/1965	Schneckenburger	164/283
3,292,217	12/1966	Boehm	29/527.7
3,365,791	1/1968	Olsson	29/527.7
3,483,915	12/1969	Schneckenburger	29/527.7

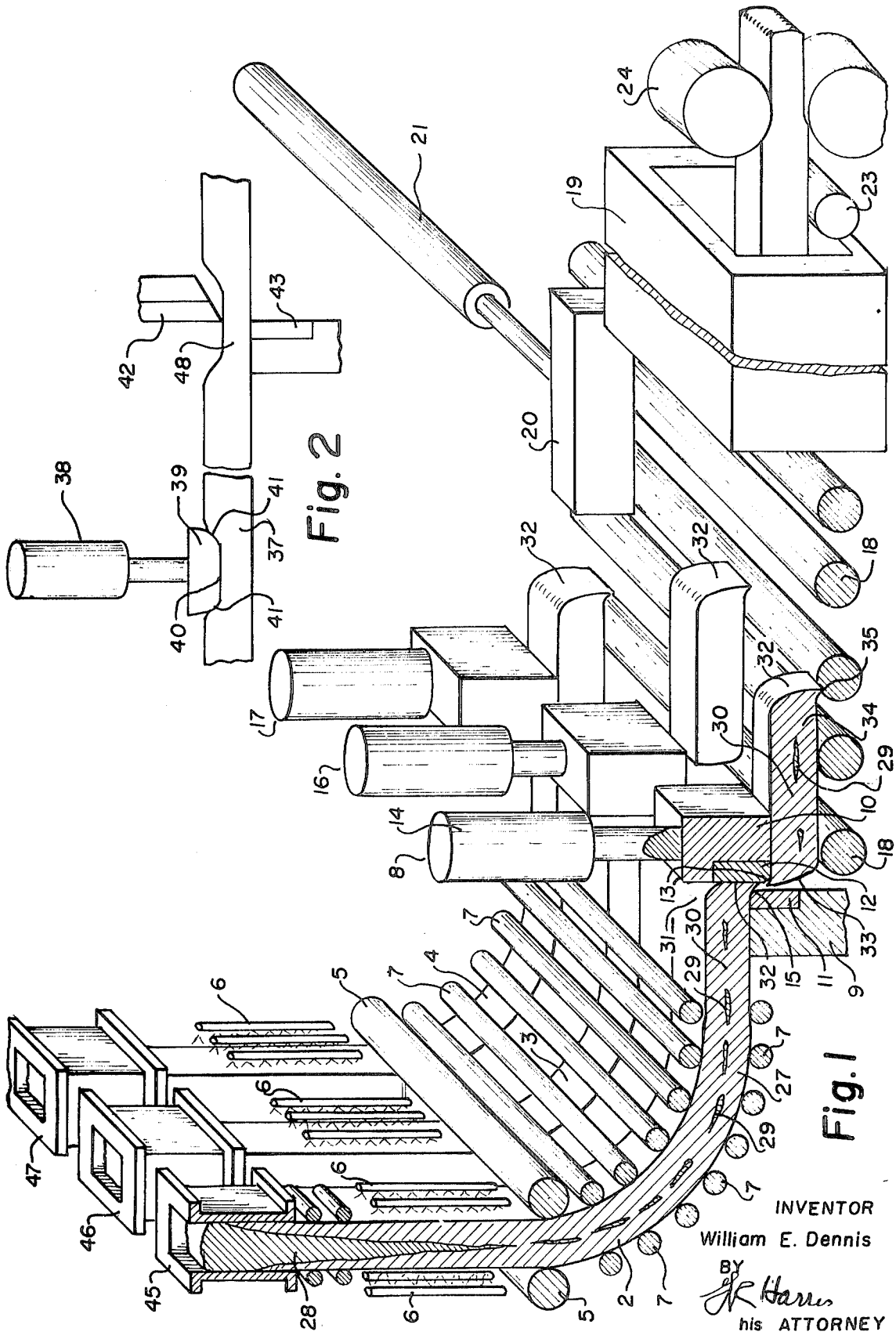
Primary Examiner—John F. Campbell
Assistant Examiner—Donald P. Rooney
Attorney—G. R. Harris and T. A. Zalenski

[57] **ABSTRACT**

Continuously cast metal strand with a porous center portion is sheared into lengths by working the solidified skin so as to form a solidified zone extending across the strand and severing it in this zone. Lengths so sheared from multiple strands are passed sequentially through a single reheating furnace and a single rolling mill.

9 Claims, 2 Drawing Figures




Fig. 2
Fig. 1
INVENTOR
William E. Dennis
BY
his ATTORNEY

WORKING OF CONTINUOUSLY CAST METAL STRAND

This invention relates to the process of continuously casting metal into strand of small cross section and rolling it to final form. It is more particularly concerned with such a process of multiple strand casting in which the strands are severed while hot into lengths so that the lengths can be rolled in a single rolling mill.

In the continuous casting of steel and other metals the ingot is withdrawn from the casting mold as a strand having a relatively thin skin of solidified metal surrounding a central portion of molten or unsolidified metal. If the strand is merely allowed to cool, this central portion solidifies into a relatively porous structure. It is therefore conventional to work the strand as by rolling to compact its center portion. For high casting speeds this requires that the strand be continuously rolled as it is withdrawn from the mold. It cannot be sheared into lengths prior to this rolling because the resulting exposure to air of the porous center portions at the sheared surfaces would result in their rapid oxidation. These oxidized areas never weld together in subsequent working but form laminations which persist into the finished metal product.

The production rate of metal continuously cast in small cross sections is low in any event and it is therefore commercially desirable to cast steel or other metal of billet cross section in multiple strands. Each strand requires a separate rolling train and, preferably, a separate reheating furnace to equalize the center and surface temperatures of the strand before rolling. The speed of the travel of the strand through the rolling train is limited by the rate that the strand cools after leaving the casting mold and is much less than the speed at which the billets can be reheated and rolled. Thus, the reheating furnaces and rolling trains of conventional multiple strand billet mills are not used to capacity.

In the steel industry, billets are rolled steel articles the cross sections of which are round cornered squares ranging from about 2X2 to about 5X5 inches in size. Billet lengths are always many times their cross-sectional dimensions, ranging up to 25 feet or so. Billets are commonly rolled down to bars of various cross sections and wire rod, and the heating furnaces for bar and rod mills are designed to accept billets of a range of cross sections and a specified length. For maximum utilization of those furnaces and the mills they supply, the billets should closely approximate the maximum specified length.

The invention described hereinafter is concerned with the continuous casting of metals, particularly steel, into strands of billet cross section. Such steel both before and after being cut into lengths is sometimes referred to hereinafter as billets, to distinguish it from relatively wide continuously cast slab strand intended to be rolled into strip, sheets or plate.

A method of rapidly producing lengths of continuously cast metal of billet cross section has been proposed in Olsson U.S. Pat. No. 3,365,791. Olsson discloses a process of continuously casting a strand of slab cross section and shearing the strand transversely into billets of length equal to the slab width. These billets are then rolled in the direction of their long axis, that is, transversely of the slab. Olsson's process, however, is of limited usefulness. The widest slab now being continuously cast is believed to be 80 inches by 12 inches thick, which width is far short of the length of billet for which bar and rod mill furnaces are designed. Furthermore, a shear which can handle a slab of the size above mentioned is an expensive and necessarily slow acting piece of machinery. It is, of course, possible to roll a sheared slab section or a continuously cast strand of large cross section to the desired size by conventional means, but to that extent the advantages of continuous casting are foregone.

It is therefore an object of my invention to provide a process for high speed production of billets from continuously cast strand of billet cross section. It is another object to provide such process in which billets from multiple strands are rolled in a single mill. It is another object to provide such a process in which continuously cast strand having a porous center portion is sheared into billets prior to rolling without detriment to the metal. Other objects will appear in the description of my invention which follows.

I have found that continuously cast metal of billet cross section having a solidified skin portion and a porous center portion can be sheared into lengths of the same cross section by working the solidified skin portion so as to close up the center portion and shearing the billet in the zone so worked. In this way the porous center portion is not exposed to the air and does not oxidize. In my process, billet lengths so sheared from multiple continuously cast strands are passed sequentially through a single reheating furnace and then through a rolling mill which reduces them sufficiently to close up the porous center portion.

Apparatus suitable for an embodiment of my invention presently preferred by me is illustrated schematically in the attached figures, to which reference is now made.

FIG. 1 is a conventionalized view of a multiple strand continuous casting plant and associated apparatus.

FIG. 2 is a detail view of a two-stage working and shearing apparatus.

In FIG. 1, molten metal from a suitable source not shown is teemed into multiple molds 45, 46 and 47 which conventionally are water cooled by means not shown. From the bottom of those molds, cast strands 2, 3 and 4 respectively are continuously withdrawn vertically at a controlled rate by the rotation of pinch rolls 5—5. Spray nozzle headers 6—6 are disposed around strands 2, 3 and 4 immediately below molds 45, 46 and 47 respectively so as to spray cooling water on the hot surface of each strand. Strands 2, 3 and 4 pass between a plurality of rolls 7—7 which are disposed in a curved path and the strands emerge therefrom traveling horizontally.

In the horizontal path of travel of strand 2 is disposed a shear 8 which comprises an anvil 9 over which the strand passes, a movable head 10, and a hydraulic cylinder 14 which raises and lowers head 10. Anvil 9 is provided with a knife blade insert 11 in its upper surface and head 10 with a knife blade insert 12 in its lower surface which coacts with blade 11 to shear strand 2. The mating edges 15 of blade 11 and 13 of blade 12 are not ground sharp however, but are ground to a small radius for a purpose to be described.

Shears 16 and 17, which are duplicates of shear 8, are positioned in the paths of travel of strands 3 and 4, respectively.

The billets or sheared lengths of strands 2, 3 and 4 are moved in the direction of their long axis over a table comprising horizontal rolls 18—18 toward a reheating furnace 19. A manipulator bar 20 which is elongated in the direction of billet travel is arranged for movement transverse of that path of travel by hydraulic cylinder 21.

Furnace 19 which is heated by conventional means not shown is provided in its floor with conveyor rolls not shown and is dimensioned to receive a sheared billet and heat that billet as it passes through the furnace from one end to the other. The heated billet leaving the furnace passes over conveyor roll 23 and into rolling mill 24 where it is rolled between profiled rolls to reduce its cross section and compact its porous interior.

As may be seen the cast strand leaving the mold has a solidified skin 27 and a molten central portion 28. By the time strand 2 reaches shear 8, for example, central portion 28 has solidified and may no longer be continuous but may be broken into individual pockets 29 of porous metal separated along the strand axis by solidified metal 30. If the strand were sheared so as to break open a pocket 29 the hot inner surfaces of the porous metal would oxidize rapidly, as I have mentioned. To avoid this undesirable result, I shear the strand so as to form a zone of solidified metal through its cross section and sever it in this zone. This is most easily accomplished by using shear knives with profiled edges 15 and 13 which I have described. These edges coact so as to drag the solidified metal from the top surface 31 of the strand over the sheared end to form a solid face 32 thereon. A solid face 33 of worked solid metal is formed on the adjacent end of sheared billet 34. This operation may leave a projecting drag edge 35 on the ends of the billet which, if objectionable, is removed by grinding or flame cutting.

Alternatively, I shear the strand into billets in a two-step operation shown schematically in FIG. 2. The strand 37 is positioned beneath a hydraulic cylinder 38 which raises and lowers a die element 39. Element 39 has a flat bottom surface 40 with upwardly rounded edges 41—41. Die 39 is forced into the hot strand 37 deforming it so that its upper surface assumes the shape of the die and the metal therebelow is worked and solidified in a localized zone 48 of lesser thickness. The metal is then sheared in zone 48 by conventional upper and lower sharp edge shear knife blades 42 and 43, respectively.

From the foregoing description the operation of the apparatus adapted for practice of my process may be understood. The continuously cast multiple strands 2, 3 and 4 containing porous center portions 29 are sheared into billets, such as billet 34, by shears 8, 16 and 17, respectively. The sheared billets have the same cross section as the cast strand and are many times longer than either dimension of that cross section. The shearing is accomplished as has been described so that the solidified skin from at least one side of the strand is worked to form a solidified zone 32 extending across the strand at its sheared end and a like zone 33 at the contiguous end of the sheared billet. These zones close off the porous central portion 29 still remaining in the billet or strand center and prevent oxidation of any internal cavities. The sheared billets from all three strands are aligned one after another by manipulator 20 so as to pass sequentially through heating furnace 19 and rolling mill 24. The rolling of the billets in mill 24 compacts them and closes up all porous zones 29.

I claim:

1. In the process of continuously casting a metal billet strand which is withdrawn from the casting mold with a solidified skin portion and a porous center portion and is thereafter rolled, the improvement comprising working its solidified skin portion in a localized area from at least one side while its center portion is still porous so as to close up its porous center portion therebeneath and form a solidified zone extending throughout the strand cross section, severing the strand in that zone into billets each having the same cross section as the strand and lengths many times either cross section dimension, and rolling those billets in the direction of the strand axis.

2. The process of claim 1 in which the rolling of the billets is carried out while they retain their casting heat.

3. The process of claim 1 in which the strand is successively worked in localized areas spaced from each other along its length and is severed therein into successive billets.

4. The process of claim 1 in which the skin portion is worked from opposite sides of the strand.

5. The process of claim 1 in which the solidified skin is worked by indenting it on one side until it is brought into contact with the solidified skin on the opposite side and seals off the porous center portion.

6. The process of claim 1 in which the severed billet has a porous center portion extending over the greater part of its length.

7. The process of claim 1 in which the strand is continuously cast so that porous center portions persist in the severed billets and the rolling of the billets is adjusted to close up those portions.

8. The process of claim 1 including the step of supplying supplemental heat to the billets before rolling them.

9. In the process of continuously casting multiple parallel separate strands of metal billets each of which is withdrawn from the casting mold with a solidified skin portion and a porous center portion and is thereafter rolled, the improvement comprising working the solidified skin portion of each strand in a localized area from at least one side while its center portion is still porous so as to close up its porous portion therebeneath and form a solidified zone extending throughout the strand cross section, severing each strand in that zone into billets each having the same cross section as the strand and lengths many times either cross section dimension, and rolling the billets from the multiple strands successively through the same rolling mill in the direction of the axes of the strands.

* * * * *