

- [54] APPARATUS FOR CUTTING BILLETS
FROM A CONTINUOUS CAST STRAND

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- [51] Int. Cl. B23k 7/00

- [58] **Field of Search**..... 266/23 E, 23 K; 164/263,
164/282

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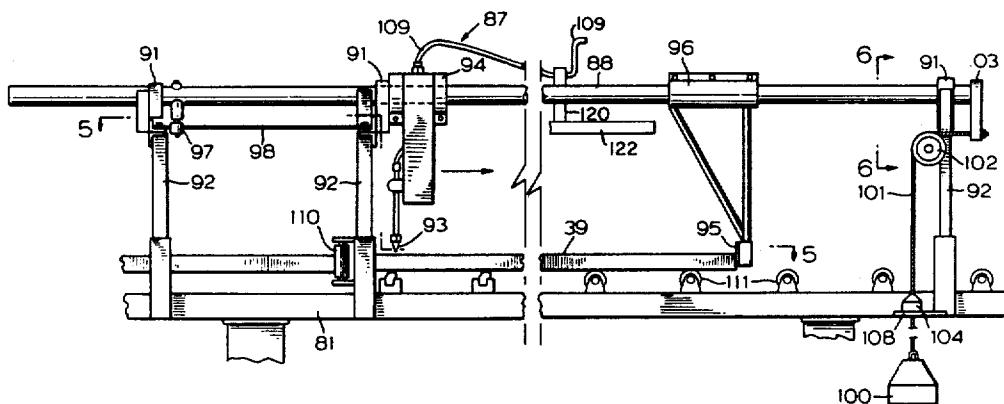
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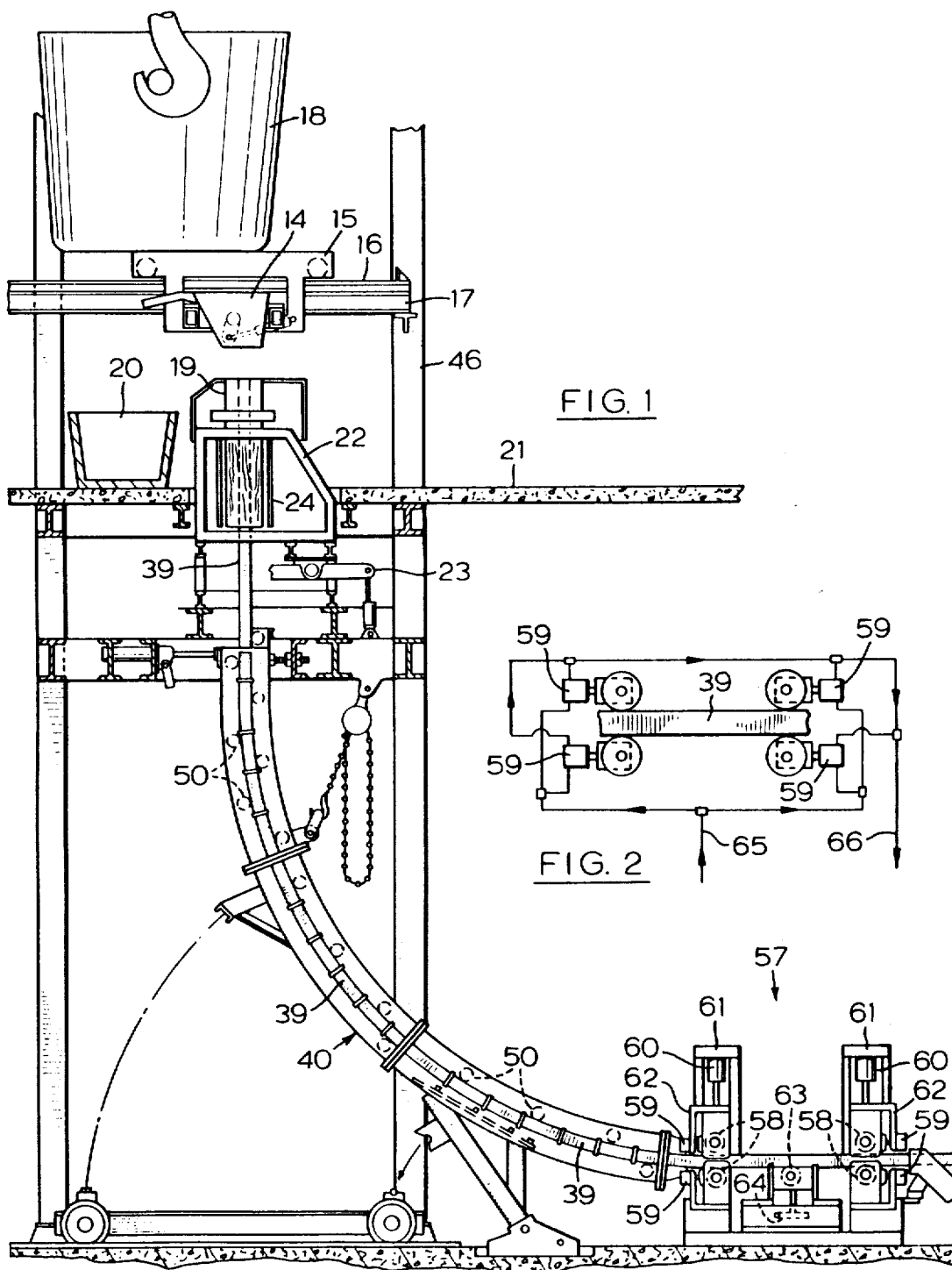
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ABSTRACT

A cast metal strand is withdrawn from a mold and through cooling means and a roller apron by a withdrawal mechanism having hydraulically activated drive rollers connected with their hydraulic fluid inputs in parallel. The drive rollers are synchronized by the strand itself, reducing pinch pressure to a minimum. The strand is then cut into billets by an automatic cutting mechanism motivated and synchronized by the moving strand.

4 Claims, 6 Drawing Figures





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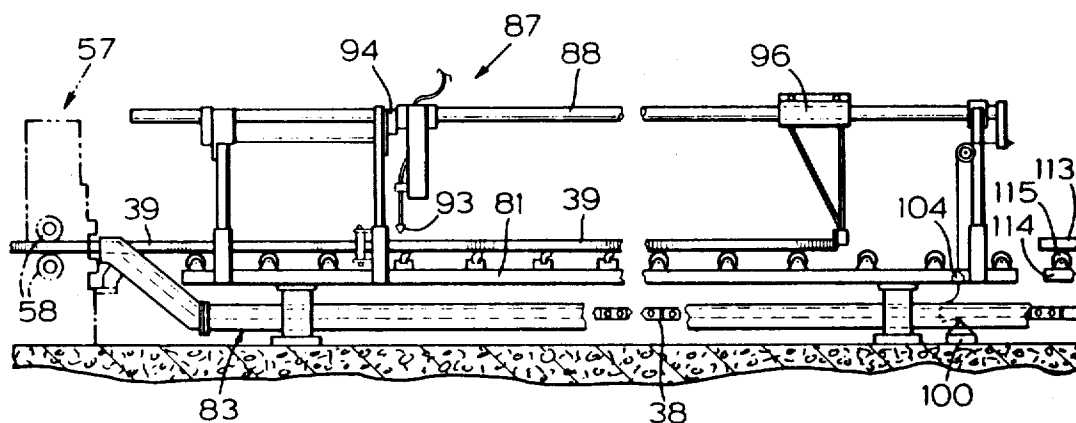
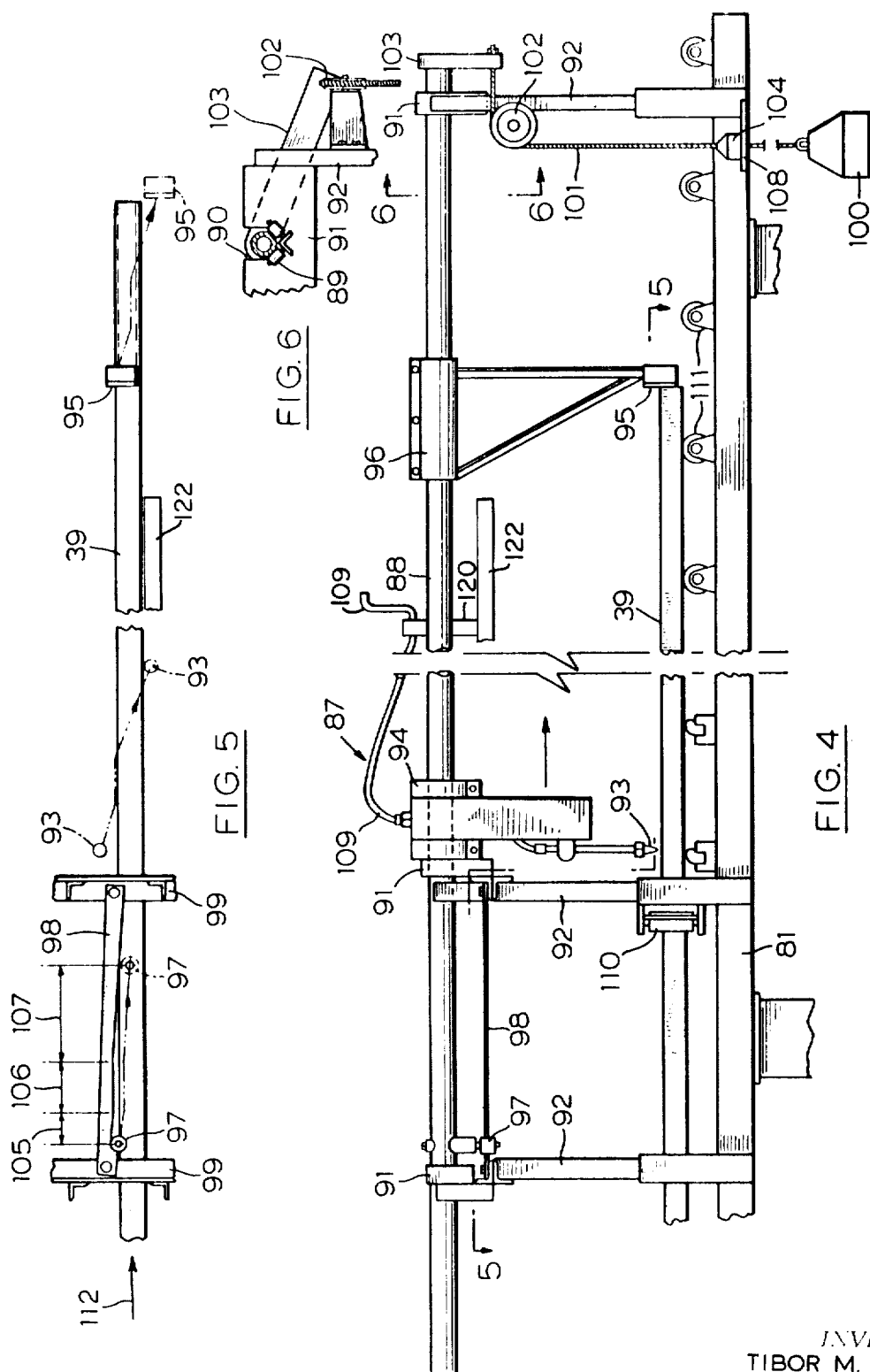


FIG. 3

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APPARATUS FOR CUTTING BILLETS FROM A CONTINUOUS CAST STRAND

The present invention relates to the casting of metal and more particularly to a method and apparatus for producing continuous metal strands.

Continuous strands of cast metal such as steel are produced by pouring the metal in a molten state through the top of a flow-through casting mold and withdrawing the metal continuously from an opening in the bottom of the mold as an elongated strand. In order to withdraw the metal in this manner the mold is placed in an elevated position and located above the mold is a ladle transporting the molten metal to the apparatus together with a tundish to receive the metal from the ladle and feed it continuously into the mold or a plurality of the molds.

To begin the continuous casting operation the bottom opening of the mold, from which the metal is to be continuously withdrawn, is initially plugged by a head attached to the end of a starting device moving along a guideway. The molten metal in the mold solidifies about the head which is then withdrawn from the bottom opening of the mold followed by a continuous strand of the metal which progressively solidifies as it emerges and recedes from the mold. Vibratory apparatus prevents the molten metal from adhering to the sides of the mold during its sojourn within the mold.

After the strand is withdrawn from the mold, it is typically cooled in a spray chamber, drawn through a curved roller apron to change its direction of travel from vertical to horizontal, and then travels through a withdrawal mechanism which provides the power to withdraw the strand from the mold and pull it through the roller apron. The withdrawal mechanism also typically straightens the strand, since the strand is bent into a curved configuration by the roller apron.

A typical withdrawal mechanism consists of independently driven drive rollers which pull the strand from the mold through the spray chamber and roller apron in synchronism with the rate at which liquid metal is poured into the mold, so that the level of liquid metal in the mold remains substantially constant. Since the drive rollers do not operate exactly in unison, i.e. with the same circumferential speed, even with additional controls, opposing forces will be set up between individual rollers and pairs of rollers acting on the strand. Because of this, the traction force required to withdraw the metal strand tends to be supplied by one roller and the resultant higher pressure may cause flattening of the metal strand.

It is therefore an object of the present invention to provide a method and means for synchronizing the operation of the drive rollers in the withdrawal mechanism by using the moving strand as a synchronizer.

After the solidified strand has passed through the withdrawal and straightening mechanism, it is cut into billets of desired length. It is an object of the present invention to provide a simple and purely mechanical mechanism for cutting a continuously moving metal strand into billets of desired length.

Further objects and advantages of the invention will appear from the following description, taken together with the accompanying drawings, in which:

FIG. 1 is a view in side elevation of a continuous metal casting apparatus with a strand passing there-through, and showing a mold, spray chamber, curved

roller apron, and a withdrawal and straightening mechanism;

FIG. 2 is a schematic hydraulic flow diagram for the drive rollers of the withdrawal and straightening mechanism shown in FIG. 1;

FIG. 3 is a view in side elevation continuing to the right of FIG. 1 and showing an automatic torch-cutting mechanism;

FIG. 4 is a view in side elevation of the automatic torch cutting mechanism to a larger scale than in FIG. 3;

FIG. 5 is a cross-sectional view of the torch cutting mechanism taken along line 5—5 of FIG. 4; and

FIG. 6 is a cross-sectional view of the torch cutting mechanism taken along line 6—6 of FIG. 4.

Referring first to FIG. 1 of the drawings, the casting apparatus consists of a tundish 14 which is supported by a carriage frame 15 movable along rails 16 which are mounted on and supporting structure 17. A ladle 18 containing molten metal is movable by a service crane (not shown) into a position above tundish 14 which takes molten metal poured from the ladle and in turn pours the molten metal into one or more continuous type straight flow-through molds 19 vertically positioned beneath the tundish. A spillover box 20 is placed on floor 21 and is located below tundish 14 adjacent mold 19 to receive overflow from the tundish. Mold 19 is fixed on a frame 22 which is connected to an oscillating mechanism 23.

A spray box 24 is fixed vertically on supporting mold table 22 immediately beneath mold 19, in a position axially aligned with the mold, and contains a through passage for a continuous metal strand 39 withdrawn from the mold. The spray box 24 contains nozzles to spray the strand 39 with water, to cool the strand.

After the strand 39 emerges from the spray box 24, it enters a curved roller apron 40 containing strand guide rollers 50. The apron 40 changes the direction of movement of strand 39 from vertical to horizontal, by bending the strand. The details of the roller apron do not form part of the present invention, and various types of roller aprons may be employed as desired.

After the strand 39 emerges from the roller apron 40, it enters a withdrawal and straightening mechanism 57, located at the lower outlet end of roller apron 40. Mechanism 57 consists of two pairs of pinch or drive rollers 58 each driven by a separate hydraulic motor 59. Each drive roller 58 is urged towards metal strand 39 by pressure from a hydraulic cylinder and piston assembly 60 mounted on a fixed frame 61 and acting against a floating frame 62 on which each drive roller is journaled. Located between the two pairs of rollers 58 is a roller 63, adjustable vertically by means of a worm and screw arrangement 64 which acts to straighten metal strand 39 emerging from apron 40 by bearing against its bottom. FIG. 2 shows schematically the hydraulic flow path for motor drives 59 in which a common input conduit 65 delivers hydraulic fluid from a pressure delivery means (not shown) directly and under equal pressure in parallel to all four motors, and a common output conduit 66 from the drive motors recirculates the hydraulic fluid back to the pressure delivery means. Connection of each drive motor 59 in parallel with input and output lines 65 and 66 enables strand 39 to synchronize the circumferential speed of drive rollers 58 as it is drawn by these rollers through mechanism 57, thus achieving an even distribution of traction

force applied to metal strand 39 and preventing flattening of the metal strand.

It may be noted that in the conventional operation of a withdrawal mechanism, as mentioned previously, the drive rollers are driven, usually electrically, by individual power feed lines and because of this the rollers act individually. Synchronizing mechanisms are employed but these cannot adjust for slight variations in the diameters of the drive rollers. Consequently the rollers in fact work against each other, and to achieve the required traction force a substantially increased load is impressed transversely through one effective roller onto the billet, which load often exceeds the permissible load limit, deforming the metal strand. This defeats the purpose of having a multiplicity of drive rollers to distribute the load and reduce pinch roll pressure applied by individual rollers to the strand.

By providing independently driven hydraulic motors 59 connected in parallel, each drive roller 58 takes its share in withdrawing the metal strand, which allows operation with minimum pinch roll pressure, thus reducing the likelihood of strand deformation.

After emerging from the withdrawal mechanism 57, strand 39 continues onto a cutting table 81 (FIG. 3), where it is cut into billets of suitable length. However, before strand 39 reaches the table 81, it must be disengaged from a starting device (not shown) used to start initial formation of the strand. Such a starting device usually consists of a plug (not shown) withdrawn from the bottom of mold 19 by a long chain assembly. The chain assembly is withdrawn through roller apron 40 by withdrawal mechanism 57, and as the plug moves through the apron, it draws the strand 39 with it. After the starting device completes its travel through roller apron 40, it is shunted out of the path of movement of strand 39 by any desired means (not shown) so that only the strand continues onto the cutting table. (In FIG. 3, the chain assembly of a starting device is indicated at 38 as being shunted into a storage track 83 beneath the cutting table 81.)

Positioned on the cutting table is an automatic torch cutoff mechanism generally indicated at 87 (FIGS. 3, 4 and 5). Cut-off mechanism 87 consists of a push rod 88 freely slidable axially on rollers 89 (FIG. 6) journaled in notches 90 of a series of cross-bars 91 (FIG. 4) which are supported by upstanding pairs of legs 92 mounted on cutting table 81. Push rod 88 is thus freely movable axially in a direction parallel to cutting table 81 and in the direction of a strand 39 moving on the cutting table. Push rod 88 is also rotatable about its axis. A cutting torch 93 is adjustably mounted on push rod 88 by a clamp 94 and extends downwardly towards cutting table 81. A stop 95 is also adjustably mounted on push rod 88 by a clamp 96 and is located on the rod forwardly of torch 93 in the direction of movement of metal strand 39 (to the right as seen in the drawings), extending downwardly into the path of the strand. A cam follower 97 is fixed to push rod 88 rearwardly of torch 93 and extends downwardly to engage a cam profile 98 which is fixed, parallel to rod 88, to a pair of spaced braces 99 each spanning a pair of legs 92. A weight 100 is connected to the forward end of push rod 88 by a cable 101 passing over a pulley 102 which is mounted on one of legs 92, the other end of the cable being fastened to an arm 103 fixed to the push rod. A second smaller weight 104 is fixed on cable 101 above weight 100. The profile of cam 98 consists of three sec-

tions, a first rear section 105 angled with respect to the axis of rod 88, a second intermediate section 106 parallel to the axis of rod 88, and a third forward section 107 again angled with respect to the rod axis. When torch mechanism 87 is in a position of rest, cam follower 97 bears against the rearward end of section 105 of cam 98 and torch 93 is directed laterally away from strand 39 with weight 100 resting on ground level as shown in FIG. 3 and weight 104 resting on an upper apertured support 108 fixed to one of legs 92. A shut-off valve 120 is connected through a conduit 109 with an oxygen supply which feeds torch 93. The shut-off valve 120 is triggered by a triggering mechanism 122 to supply oxygen to torch 93 at the beginning of the forward stroke of rod 88 and cut off the supply at the end of that stroke. Pairs of vertical side rollers 110 are journaled on pairs of legs 92 at each side of strand 39 to restrain the strand laterally as it moves forwardly on horizontal rollers 111 which are journaled on cutting table 81.

In the automatic operation of torch cutting mechanism 87 the position of rest of push rod 88 and its appurtenances is shown in FIG. 4 of the drawings with cutting torch 93, stop 95 and cam follower 97 assuming positions shown in solid lines in FIG. 5 which also shows metal strand 39 emerging from withdrawal mechanism 67 onto table 81 and meeting stop 95 located in its path. The force of strand 39 moving along table 81 and bearing against stop 95 will move push rod 88 forwardly on rollers 89 in the direction of arrows 112. Initial movement of push-rod 88 will rotate the valve 120 against the triggering mechanism 122 to open the oxygen supply valve to torch 93 while the torch is directed away from the strand. As push-rod 88 moves forward, the interaction of cam follower 97 bearing against section 105 of cam profile 98 will cause the push-rod, together with torch 93 and stop 95, initially to rotate about the axis of the rod and by this rotation the torch will be brought to point to the edge of strand 39. When cam follower 97 reaches section 106 of cam profile 98 which is parallel with the longitudinal axis of push rod 88, the push rod stops its rotational movement, thus allowing torch 93 to pre-heat the edge of strand 39 while the push rod and strand continue to move forward. When cam follower 97 reaches and moves along section 107 of cam 98, push rod 88 will again rotate about its axis as well as moving forward and strand 39 will be severed to form a billet 113 of a desired length (which has been determined by presetting the distance between torch 93 and stop 95). As cam follower 97 reaches the forward end of section 107 of cam profile 98, the oxygen supply valve 120 is automatically cut off by the triggering mechanism 122, and also stop 95 moves out of the path of strand 39 which allows weight 100 to return push rod 88 to its original position of rest. Weight 100 is brought to rest before the completion of return travel of push rod 88, and the rod is moved the remaining distance by the action of smaller weight 104 which decreases the momentum of the mechanism as it approaches the final rearward stop. In the rearward position of rest of push rod 88, clamp 94 of torch 93 bears against a pair of supporting legs 92 and stop 95 is again located in the path of strand 39. The paths of travel and final forward positions of cam follower 97, torch 93 and stop 95 are shown by dotted arrows and lines in FIG. 5 of the drawings.

Positioned forwardly of cutting table 81 is a discharge table 114, the two tables forming a continuous

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conveying surface. A plurality of rollers 115 journaledly mounted on table 114 are rotated at a circumferential speed faster than the travelling speed of metal strand 39 to clear each severed billet 113 from the strand and allow movement of stop 95 back into the path of the strand. A billet stop (not shown) is located adjacent the end of discharge table 114 remote from cutting table 81 to arrest further forward movement of the billet which is then removed laterally from the discharge table to a storage area.

We claim:

1. Apparatus for cutting billets from a strand produced by a continuous metal casting apparatus, comprising: a cutting table for receiving and passing a continuous metal strand; carrier means mounted above the table and freely movable from a position of rest forwardly in a direction parallel to the path of the strand over the table, said carrier means being also freely rotatable in a plane transverse to the direction of said path; a cutting torch adjustably mounted on the carrier means and being directed towards said path; a stop adjustably mounted on the carrier means forwardly of said torch and movable across said path; interacting

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cam means fixed to the table and to the carrier means, said cam means being adapted to rotate the carrier means whereby (1) the carrier means is moved forwardly from its position of rest by engagement of the stop with the free end of the strand (2) the cutting torch is moved across the strand to cut a billet of predetermined length therefrom, and (3) the stop is disengaged from the strand when the billet has been cut; and means to return the carrier means to its original position of rest when the stop is disengaged from the strand.

2. Apparatus as claimed in claim 1 in which the carrier means comprises an axially movable rod of uniform circular cross-section, the torch and the stop each being movable axially and circumferentially on the rod and being releasably clamped thereon.

3. Apparatus as claimed in claim 1 in which the carrier return means comprises a free weight suspended from said rod and acting against the force of the strand on the stop.

4. Apparatus as claimed in claim 1 including means operable to actuate the torch during forward movement of the carrier means.

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