

United States Patent

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269; 266/23, K, M

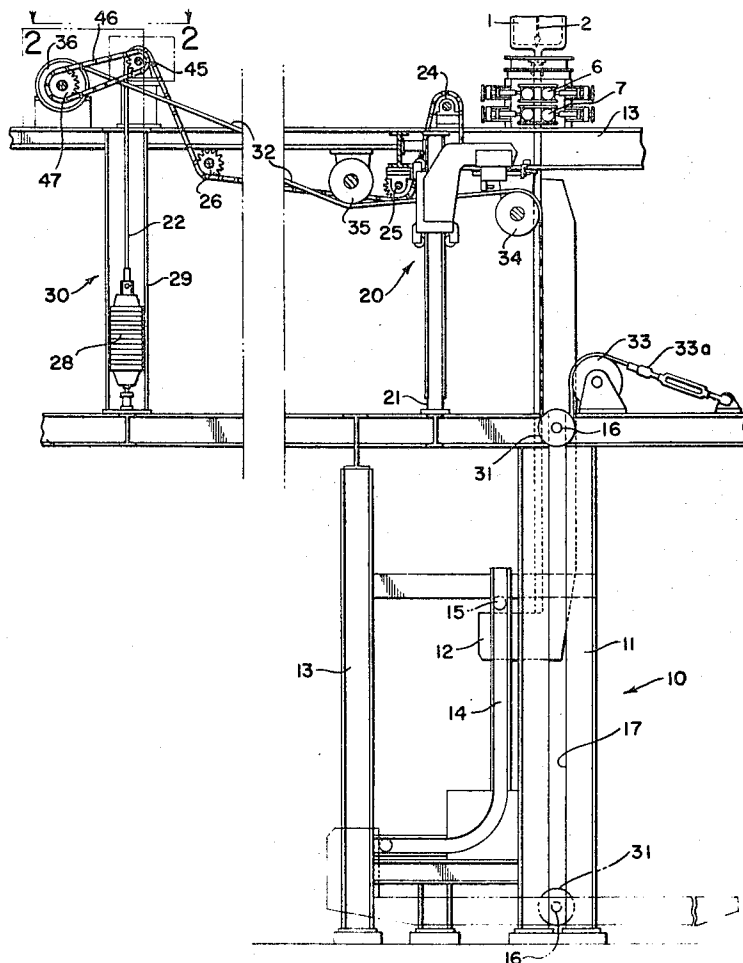
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[54] **SLAB CUT-OFF MECHANISM SUPPORTED FOR**
COOPERATING MOVEMENT WITH LOWERING
TROUGH
10 Claims, 9 Drawing Figs.

[52] U.S. Cl. **164/263,**
164/269; 266/23

ABSTRACT: A slab cutoff torch assembly is supported for synchronous movement with a lowering trough assembly during the cutting operation and is wholly unconnected to the casting being cut.



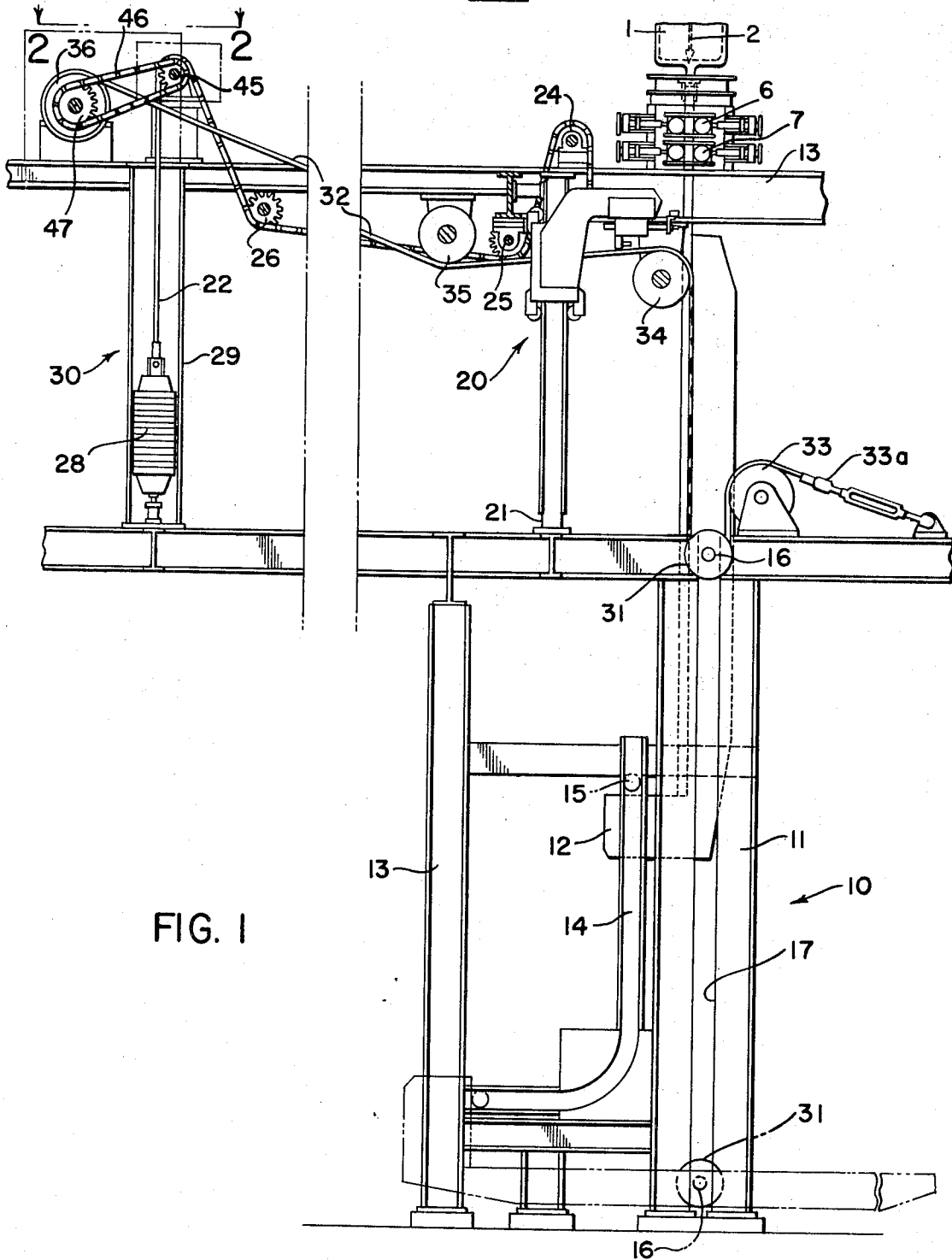


FIG. 1

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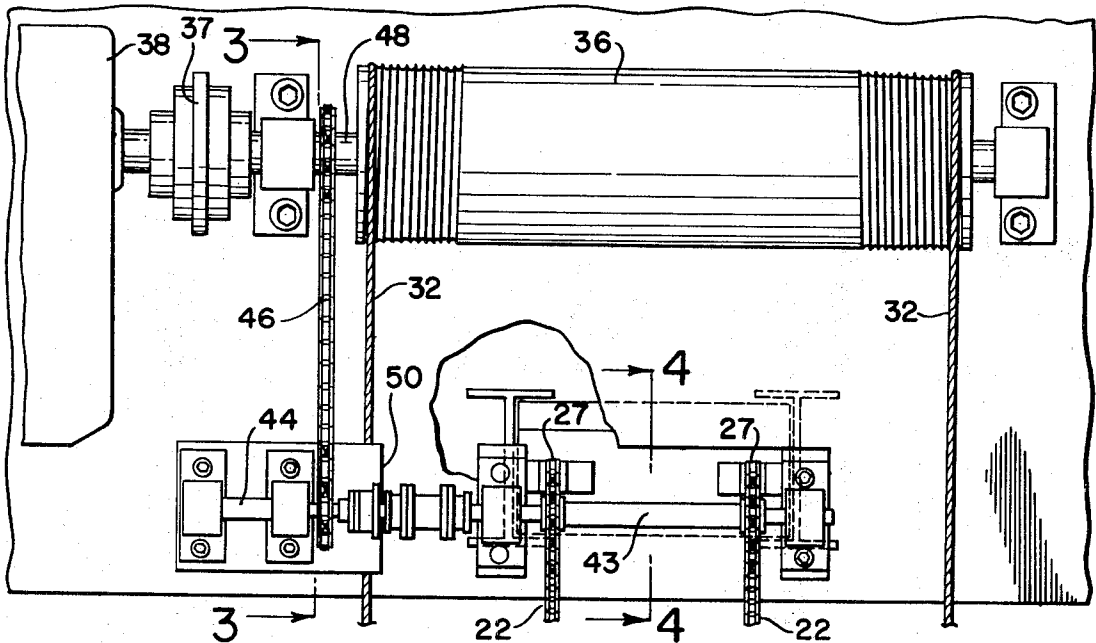


FIG. 2

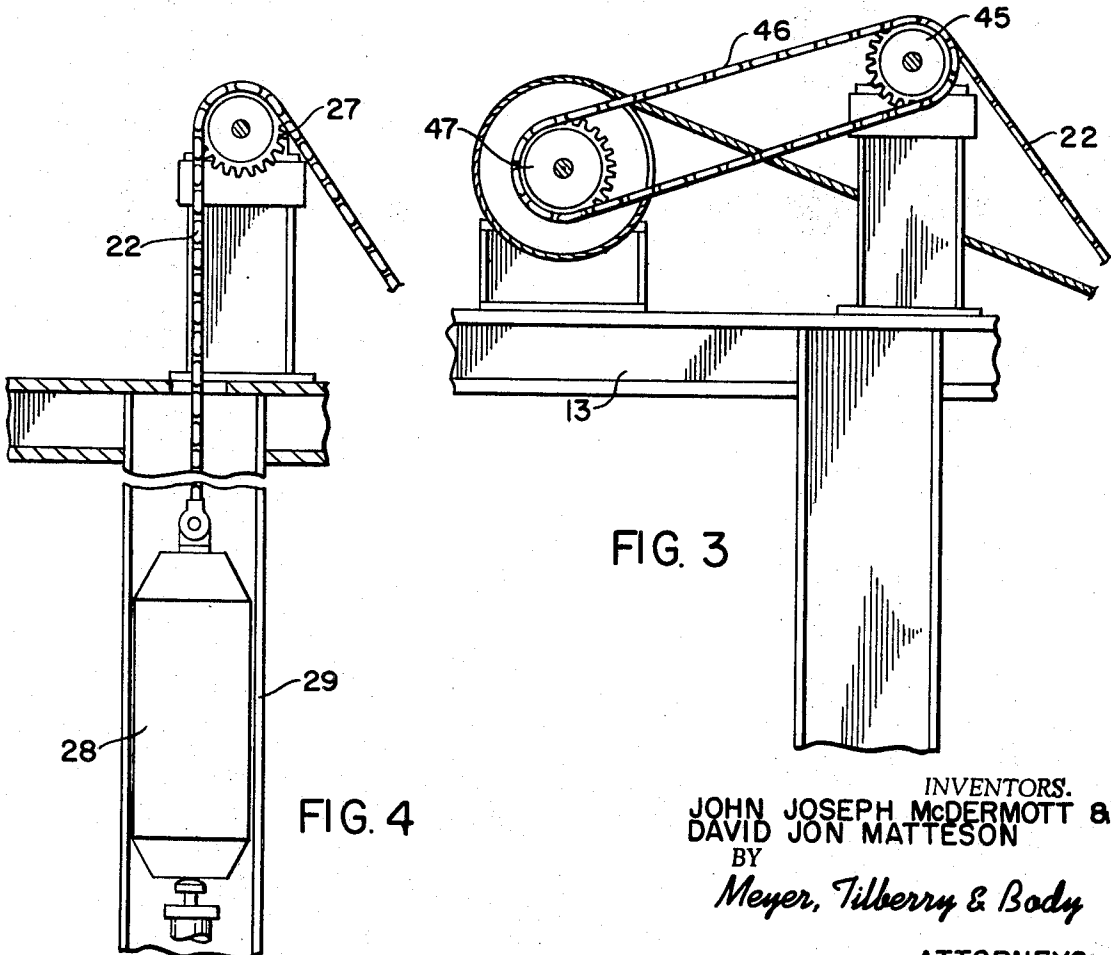


FIG. 3

FIG. 4

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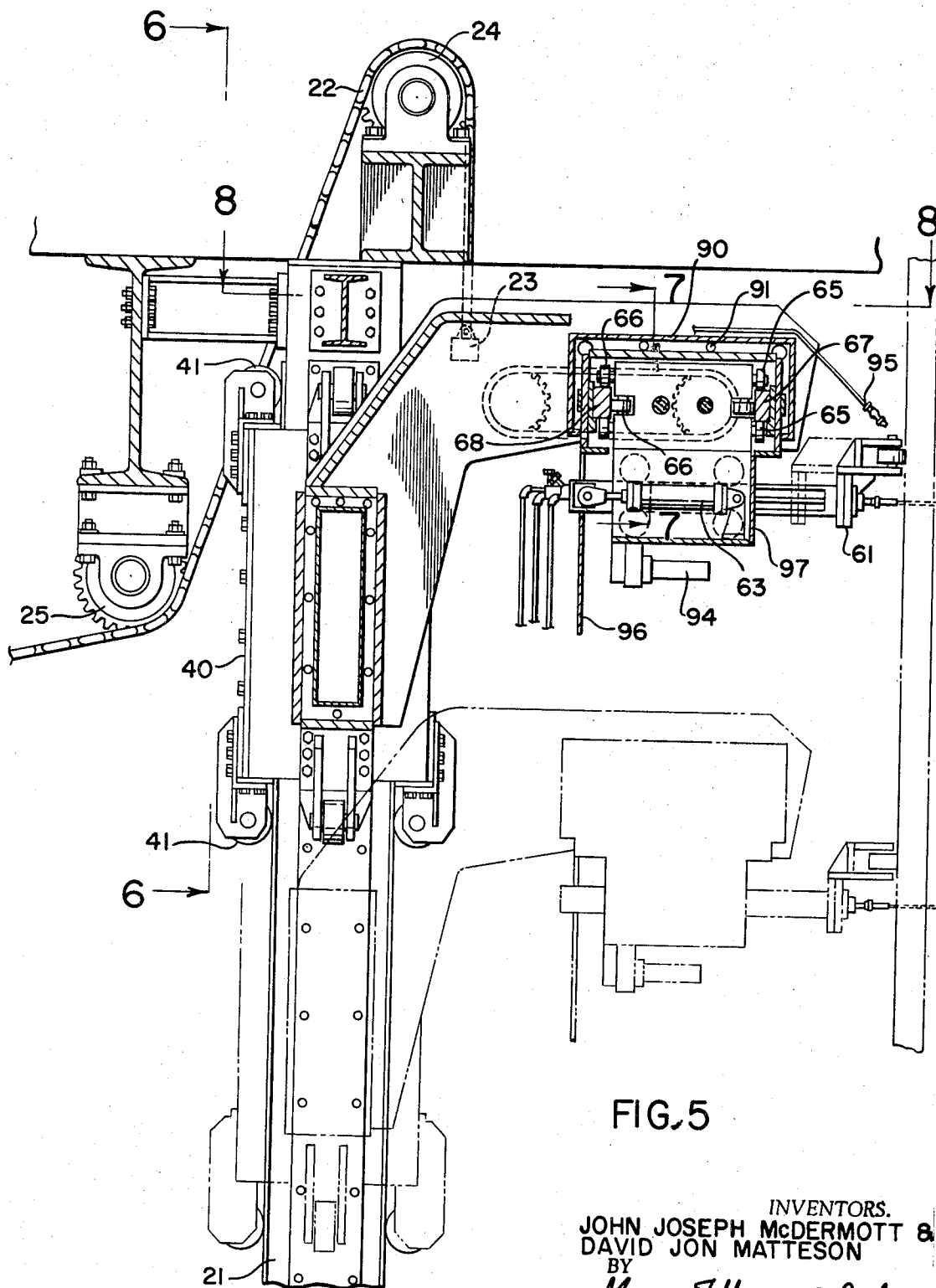


FIG. 5

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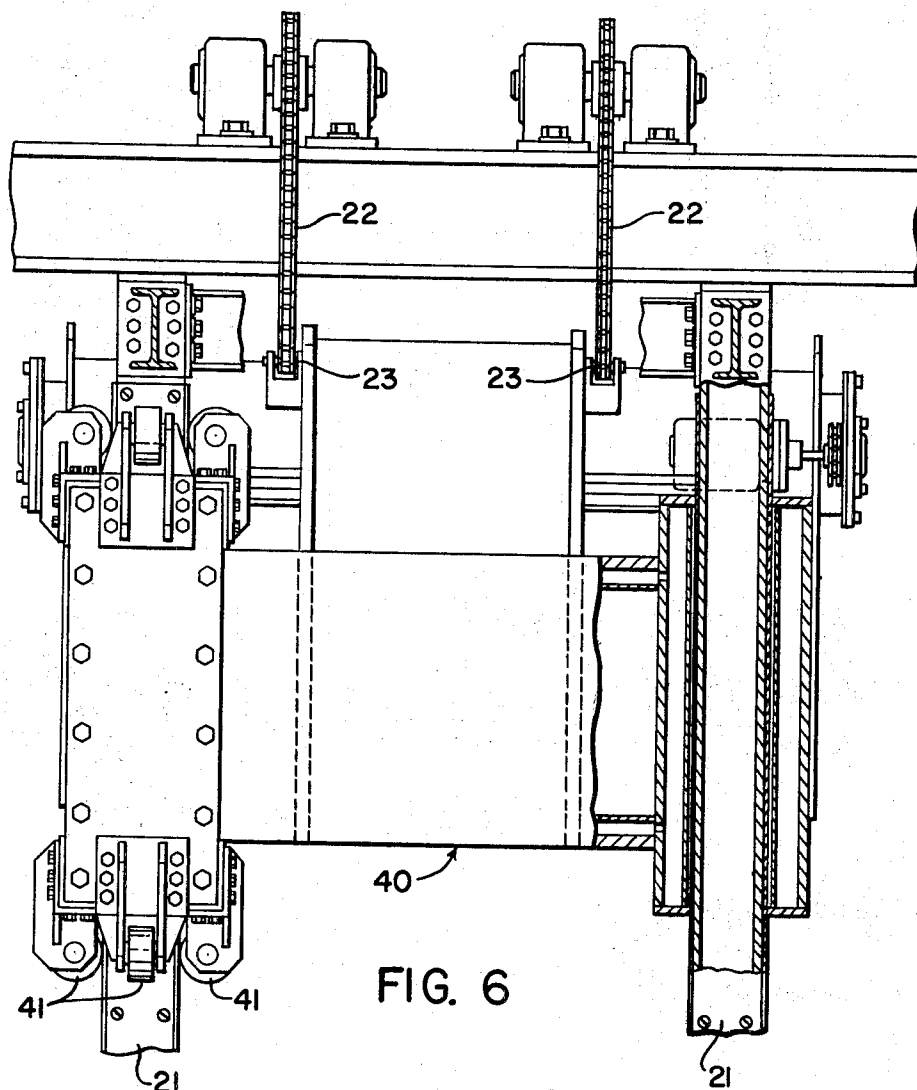


FIG. 6

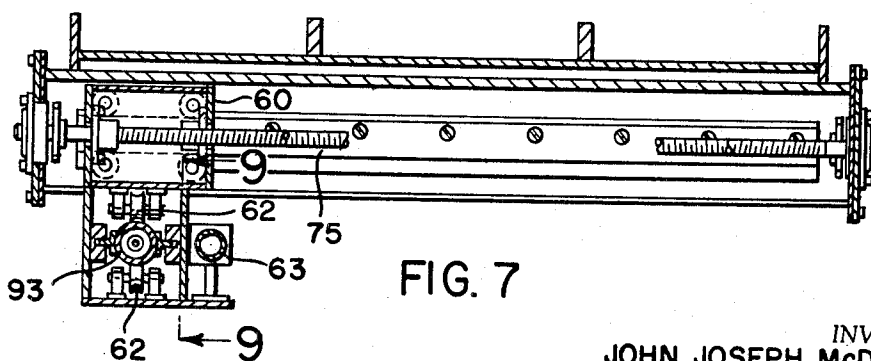


FIG. 7

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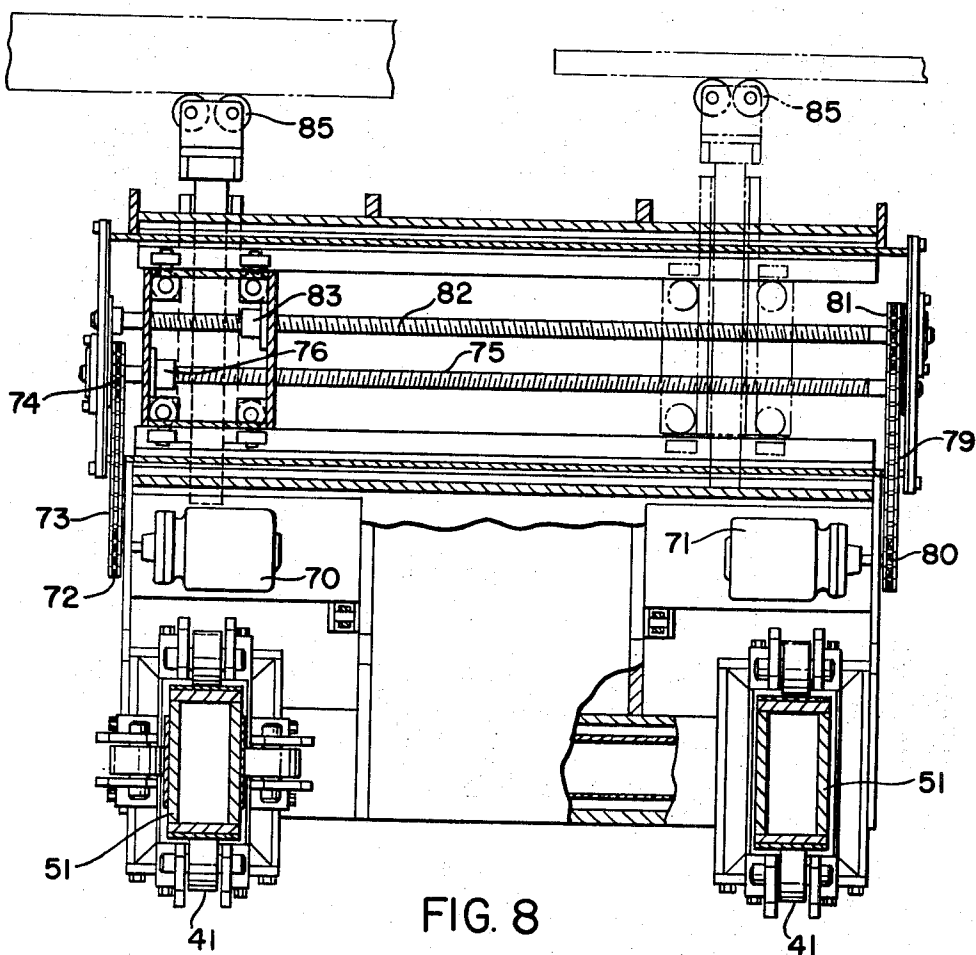


FIG. 8

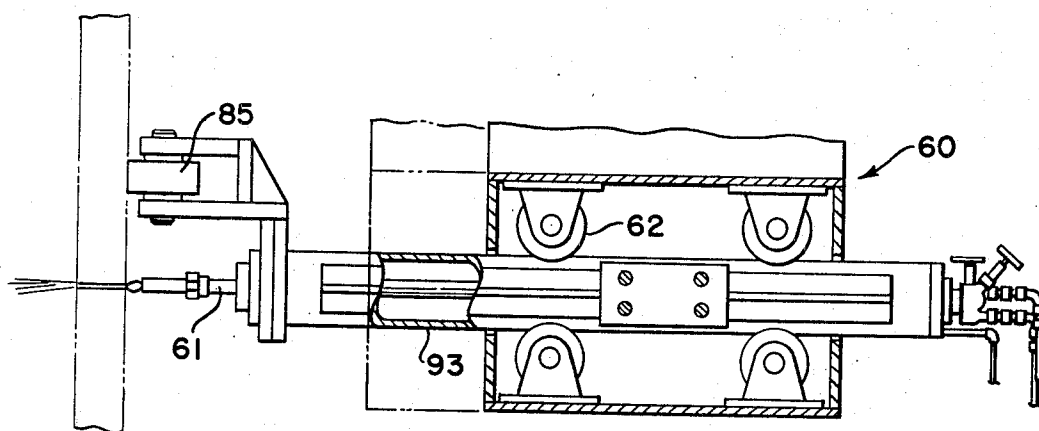


FIG. 9

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SLAB CUT-OFF MECHANISM SUPPORTED FOR COOPERATING MOVEMENT WITH LOWERING TROUGH

DISCLOSURE

This invention relates to the art of continuous casting and, more particularly, to an improved apparatus for severing the casting into slabs during the continuous casting operation.

In continuous casting apparatus of the type with which this invention is concerned, metal is delivered to the upper end of a mold and a vertically downward moving casting is continuously withdrawn from the open bottom end of a water cooled mold by withdrawal rolls. A cutoff torch assembly, the movement of which is coordinated with the movement of the casting, is provided to sever the vertically moving casting into billets or slabs of predetermined lengths governed by subsequent working or handling requirements. In order to receive the slab or billet and lower it from its original vertical position or a horizontal position, an apparatus commonly referred to as a lowering trough assembly is provided.

In general, the lowering trough assembly as employed in a continuous casting operation comprises a frame or cradle adapted to be moved from a vertical slab receiving position beneath the mold of the continuous casting machine to a horizontal slab discharge position. The frame or cradle is provided with a support platform or stop which is adapted to engage and support the lower end of a slab cut from the continuous casting. To permit the trough assembly to handle slabs of different lengths, the stop is adjustable longitudinally of the frame or cradle.

The lowering trough assembly normally moves vertically over a predetermined distance after the continuous cast slab has engaged the stop on the cradle with the assembly subsequently being tilted to a substantially horizontal position.

During the vertical movement of the lowering trough assembly, the prior art normally has employed a slab cutoff assembly to sever the slab from the remainder of the casting. Typically, the slab cutoff torch assembly has employed various types of clamping systems which have been used to clamp the torch carriage directly to the moving slab so that the torch carriage moves in unison with the slab while the torch moves transversely across the slab to complete the severing operation. Although this system has proven satisfactory from the standpoint of accomplishing the severing operation, several problems have been experienced. Chief among these problems is the extremely unfavorable operating conditions to which the clamp assemblies were subjected. Various types of water cooling systems and additional support structure have been necessitated as a means to combat the high temperatures of the slab; however, this additional equipment added both to the expense and the weight of the torch carriage.

It has also been suggested heretofore to employ a synchronized movement of the torch with a continuous casting by interconnecting the withdrawal rolls and the torch carriage. This arrangement has proved satisfactory where bars of relatively narrow width, for example six inches, are being severed by using a single torch. However, where slabs of significantly greater widths are being severed, such an arrangement is not feasible for several reasons. In severing relatively narrow bars, a certain amount of wear and nonsynchronized movement can be tolerated since only a single torch is moving over only a short distance. Contrasted with this is the severing of slabs wherein a pair of torches normally are employed with one torch being actuated to sever one-half the width of the slab followed by the other torch which completes the severing operation. It will be readily apparent that any nonsynchronous movement may result in the two torches operating along two longitudinally separated transverse paths with the net result being that the slab is not wholly severed from the casting. Thus, a bar severing mechanism is not a satisfactory solution to the severing of slabs.

It is the primary object of this invention to provide an improved slab cutoff torch assembly. In accordance with this pri-

mary object, the present invention contemplates a drive system connected between the torch carriage and the lowering trough assembly, whereby synchronism of movement between the torch carriage and the slab is achieved without the necessity of clamps, clamp actuation systems and clamp support structures. As a result of this arrangement, the torch cutoff system is not subjected to the high radiant heat of the slab except for the portion of the cutting torches which are performing the cutting operation.

In accordance with one aspect of the invention, an improved slab cutoff torch assembly is provided in which downward movement of the slab is transmitted to the torch carriage through a drive system actuated through limit switches actuated by the trough lowering assembly.

More particularly, it is contemplated that the improved apparatus for severing lengths of a continuous casting will include a trough lowering assembly, means supporting the assembly for movement vertically over a predetermined distance, drive means for imparting movement to the trough assembly and a torch assembly. The torch assembly is supported independently for movement vertically along a path substantially parallel to the path of movement of the trough assembly and means are provided for selectively interconnecting the torch assembly with the drive means for the trough assembly whereby the torch assembly may be interconnected to move in synchronism with the trough assembly.

These and other objects will become more apparent from the following description and attached drawings which are used to illustrate a preferred embodiment of the present invention.

In the drawings, wherein like reference numerals indicate like parts in the various views:

FIG. 1 is an elevational view of a slab handling mechanism which includes the slab cutoff mechanism of the present invention.

FIG. 2 is a view taken along line 2-2 of FIG. 1.

FIG. 3 is a view taken along sectional view taken along line 3-3 of FIG. 2.

FIG. 4 is a sectional view along line 4-4 of FIG. 2.

FIG. 5 is a side elevation view, partially in section, showing in expanded detail the slab cutoff torch assembly.

FIG. 6 is a sectional view along line 6-6 of FIG. 5.

FIG. 7 is a sectional view along line 7-7 of FIG. 5.

FIG. 8 is a sectional view along line 8-8 of FIG. 5.

FIG. 9 is a partial sectional view of the cutoff torch.

Referring now to the drawings which only illustrate a preferred embodiment and which are not intended to be limiting, FIG. 1 illustrates the environment in which the subject invention is adapted to be employed. Thus, a continuous casting enters the apparatus from a continuous casting device, the details of which are not shown and which form no portion of the invention. In general, the apparatus would be of the type in which an open-ended fluid cooled mold is arranged in an upright position with molten metal supplied from a delivery means 1 which may include a stopper means 2 to the upper end of the mold and a casting withdrawn by means of withdrawal rolls 6, 7 from the lower end of the mold. The casting is adapted to be received by a lowering trough assembly, indicated generally by the reference numeral 10. A slab cutoff torch assembly, indicated generally by the reference numeral 20, is positioned above the lowering trough assembly and serves to sever a slab or billet from the continuous casting at appropriate intervals. The third major component of this apparatus comprises the drive system, indicated generally by the reference numeral 30, which is employed for operating the lowering trough assembly and which, in accordance with the principals of this invention, is also employed to actuate the slab cutoff torch assembly 20.

Referring now to the lowering trough assembly 10, the details of which form no portion of the present invention, a guide frame 11 supports a trough or cradle assembly 12 which is movable from a lower horizontal position (shown in dotted lines) to any of a plurality of vertical positions (shown by solid

lines). In the vertical position, the cradle assembly functions to receive slabs severed by the cutoff torch assembly 20 from the continuous casting exiting from the continuous casting machine. While in the lower position, the cradle assembly functions to discharge the slab to a runout or conveyor.

As shown, the guide frame 11 is comprised of two pairs of vertically extending beams with the beams of each pair being spaced apart a short distance to define an open guide way 17. The beams are supported at their lower ends by being mounted in a suitable foundation and are supported at their upper ends in any convenient manner, such as being bolted or welded to the building frame work members 13.

A second pair of suitably spaced open guide ways 14 are formed by two pairs of beam members which also are supported from the building frame work members 13.

As shown, the frame work is positioned so that when the trough 12 is moved to its vertical position, it will be in the proper location to receive the continuous casting and the slab severed from such casting by the cutoff torch assembly 20. The lower end of the severed slab contacts a shelf or movable stop member which is carried by the cradle and which may be adjusted longitudinally of the cradle. The details of the stop form no position of this invention and have been omitted from the drawings. The trough assembly 12 further includes a pair of guide rollers 15, 16 which are positioned on opposite sides of the cradle for engagement with the guide way 14 and the guide way 17 on the guide frame 11. It will be appreciated that, as the trough assembly 12 moves downward, the guide roller 15 follows the arcuate path defined by the guide way 14 so that the entire trough assembly is pivoted horizontally and comes to rest in its lower most position in a horizontal orientation whereupon the severed slab may be discharged from the trough assembly to the rollout table or conveyor.

The drive system employed to move the trough assembly 12 between its lower horizontal position and its upper vertical position includes pulleys or sheaves 31 secured to the opposite sides of the trough assembly. A pair of wire ropes 32 which are secured at one end to a tension means 32a pass around a pulley 33, around the pulley 31, passing vertically upwards and around pulleys 34 and 35 to a trough drum 36. The drum is connected through appropriate coupling means 37 to a source of power such as an electric motor 38. It will be appreciated that as the motor is actuated, the drum will be rotated causing the rope to be wound around the drum thereby drawing the trough assembly from its horizontal position to a raised vertical position. Conversely, as the trough assembly descends, the rope 32 will be unwound from drum 36.

A similar drive system, and one which uses the same source of motive power, is employed to move the slab cutoff torch assembly 20 along a path parallel to the path of vertical movement of the lowering trough assembly 10. A pair of spaced, vertically extending columns 21 are supported on the frame work 13. The slab cutoff torch assembly includes an assembly frame, indicated generally by the reference numeral 40, with guide rollers 41 supported at the four corners of the frame assembly. A group of four rollers 41 is provided at each corner with the rollers being in engagement with the sides of the vertical columns 21. Normally, replaceable wear plates 22 will be attached to the columns and the rollers 41 will be engaged with these plates.

To control the movement of the assembly frame 40 vertically along the post 21, there is attached to the frame a pair of spaced roller chains 22. One end of each chain is secured to the frame at 23. The chains are passed over sprockets 24 secured on the frame work 13, around sprockets 25 and 26, over sprockets 27 and are connected to counterweights 28. The counterweights are normally enclosed in a column 29 for safety reasons as well as to guide their path of movement and prevent the counterweights swinging in pendulum fashion.

The sprockets 27 are secured to a shaft 43 which is coaxial with the shaft 44 on which a sprocket 45 is secured. A drive chain 46 interconnects sprocket 45 with a sprocket 47 secured to the shaft 48 on which the trough drum 36 is supported. It

will thus be apparent that as the drum 36 is driven by the motor 38, the sprocket 47 is likewise rotated causing the sprocket 45 to be driven by the chain 46. Normally, the shaft 44 is disconnected from the shaft 43 so that rotation of the former shaft does not cause any rotation of the latter shaft. However, to interconnect the two shafts, there is provided a clutch 50 which may be of any conventional construction and which is employed selectively to connect the two shafts 44, 43 for rotation.

It will be understood that the sprocket ratios selected must be such that synchronous movement is achieved. The selection of the sprocket ratios is best achieved by first selecting the outer diameter for the drum 36 and then proceeding to the sprocket ratios. It is important that the drum be as resistant to wear as possible so that the outer diameter remains essentially constant over a long period of time and is not reduced by the frictional engagement of the wire rope 32. Accordingly, the surface of the drum should be of a hardened material which has the necessary wear resistant characteristics.

The above described drive system for the slab cutoff torch assembly operates in the following manner. As the lowering trough assembly is moved vertically downward and the drum 36 is unwinding the rope, the clutch 50 is activated and the rotation of shaft 48 is transmitted through the roller chain 46 to shaft 43. Rotation of shaft 43 causes rotation of sprockets 27 which, through chain 22, lift counterweights 28 and permit the torch assembly frame 40 to move on rollers 41 vertically downward along the posts 21. Since the rate of descent of the slab cutoff torch assembly 20 is governed by the rate at which the counterweights 28 are lifted and, further, since the movements of the counterweights are dependent upon the speed of rotation of the shaft 43, it is apparent that the rate of descent of the lowering trough assembly is synchronized with that of the slab cutoff torch assembly and there is, for all practical purposes, no relative movement between the torch assembly and the trough assembly. Moreover, since the casting moves with the trough assembly, the movement of the casting is synchronized with the torch assembly.

Referring now to the detailed construction of the slab cutoff torch assembly, and particularly FIGS. 5, 8 and 9, there is provided on the assembly frame 40, a pair of torch housings 60 which normally carry a pair of cutoff torches 61, only one of which is illustrated. The torches 61 are supported for longitudinal movement relative to the housing between rollers 62 carried on the housing so that the torches may move toward or away from a casting to compensate for the varying thickness of such castings. The movement of the torches 61 longitudinally is controlled by air cylinders 63.

Each torch housing 60 is supported by rollers 65, 66 on a pair of spaced guide tracks 67, 68, respectively, supported on the assembly frame 40. The guide tracks extend between the two guide posts 21 and define a transverse path along which the torches travel when transversely severing a casting into slabs. Movement of the torches and the torch housings along the guide tracks 67, 68 is controlled by a pair of torch traverse drive motors 70, 71. The motor 70 has a sprocket 72 secured to the outer end of its drive shaft in engagement with a roller chain 73. The chain 73 passes around a sprocket 74 on the outer end of a threaded shaft 75. The shaft 75 is coextensive in length with tracks 67, 68 and is in threaded engagement with a threaded boss 76 on the housing 60. A similar arrangement is employed with the motor 71 wherein a chain 79 interconnects a sprocket 80 on the motor with a sprocket 81 on the end of a threaded shaft 82 which is in threaded engagement with a threaded boss 83 on the housing 60. It will be appreciated that as the motors 70, 71 are actuated, the threaded shafts 75, 82 are rotated causing the housings 60 to traverse the longitudinal length of the shafts along tracks 67, 68 whereby the torches carried by the housings 60 also pass transversely of the casting. A slab contact roller 85 is carried on the outer extremity of each of the torches 61 and is adapted to engage the surface of the casting to provide guidance for the torch as it passes transversely of the casting and also prevents engagement of the torch with the surface of the casting.

In view of the high level of heat which is always present adjacent such a casting, several means are employed to dissipate the heat and prevent overheating of the components in the torch cutoff assembly. Thus, the guide posts 21 are hollow and are adapted to have a cooling fluid such as water circulated therethrough. The torch housing 60 is also adapted to be received within a housing 90 on the frame 40 with a plurality of passages or ports 91 providing means for circulation of a cooling medium through the housing. The torch assembly itself is also enclosed within a housing 93 with a coolant within the housing serving to keep the torch cool. A heat detector 94 may also be employed and a water spray nozzle 95 may be used to cool the contact wheel 85. A radiation shield 96 may be used to protect the lines leading to the torch and similar shields may also be employed in other strategic locations such as at 97. In this manner, the operating mechanisms of the cutoff torch assembly are protected against the heat so that possible adverse affects of the heat on the operation of the assembly are minimized.

The operation of the overall device will now be described. As the continuous casting emerges from the withdrawal rolls of the continuous casting machine, the various parts of the device are in the condition illustrated in solid lines in FIG. 1. Thus the lowering trough assembly has the lowering trough 12 in its raised vertical position and the torch assembly is likewise in its raised vertical position. The continuous casting passes along the length of the trough 12 until it engages the stop at its inner end whereupon the trough 12 is moved downward in a vertical direction. Appropriate limit switches are provided whereby movement of the trough 12 trips these switches causing actuation of the clutch 50 so that continued movement of the trough 12 causes a synchronous vertical movement of the slab cutoff torch assembly 20. This occurs due to the actuation of the clutch 50 which interconnects the sprocket 27 through shaft 43, sprocket 45 chain 46 and sprocket 47 with the shaft 48 on which the trough drum 36 is supported. Thus, as the drum 36 is rotated to unwind the rope 32 and the trough 12 is lowered, the sprockets 27 are rotated to lift the counterweight 28 and permit the descent of the slab cutoff torch assembly along posts 21 in synchronism with the descent of the casting. Additional switches will also be employed to initiate, simultaneous with the actuation of clutch 50, the normal torch cutting cycle whereby the torch will travel to the edge of the casting, the air cylinder 63 will be activated to advance the torch into engagement with the casting, the torch will be ignited and the slab cutting operation will be initiated as the torch traverses the width of the casting. Throughout the torch cutting cycle, the torch carriage and trough assembly will continue to move downward at the same rate of speed as the casting since both mechanisms are effectively coupled to the same rotating shaft 48.

The speed with which the cutting operation is performed is adjusted to be accomplished prior to the lowering trough reaching the point in its descent at which it pivots to a horizontal position. At this point, a suitable switch is activated by the trough which disengages the clutch 50, whereby the torch assembly 20 is permitted to return to its original position under the force of the counterweights 28 while the lowering trough continues its descent and pivoting movement to a horizontal position. The return of the lowering trough to its raised vertical position may be accomplished by any appropriate means of actuating the motor 38 and trough drum 36 with the cutting torch assembly remaining stationary in its raised vertical position until it is actuated again through downward travel of the trough assembly actuating the limit switch controls.

It will be readily apparent that the particular element of the lowering trough assembly which is employed to actuate the limit switches to couple the torch cutoff assembly for synchronous movement is but a matter of choice. The important relationship to be observed is that sufficient time be provided during the vertical descent of the casting and the trough to permit the cutting operation to be performed.

While for ease of description, the principles of the invention have been set forth in connection with but a single illustrated embodiment, it is not our intention that the illustrated embodiment, nor the terminology employed in describing it, is to be limiting, but rather it is our desire to be restricted only by the scope of the appended claims.

We claim:

1. Continuous casting apparatus comprising an open-ended upright fluid cooled mold, means for delivering molten metal to the upper end of said mold, means for withdrawing a casting from the lower end of the mold, a handling trough mounted to receive the casting from said withdrawal means, means for supporting said handling trough for initial downward movement through a predetermined distance, cutoff carriage means positioned on guide means mounted between said withdrawal means and said trough, cutting torch means supported on said cutoff carriage means for movement thereon in a horizontal plane relative thereto, said carriage means including means adapted to move said cutting torch means in said horizontal plane a distance at least equal to the transverse dimension of said casting, support means for movement of said cutoff carriage means on said guide means parallel to the movement of said casting, the improvement wherein said support means for moving said carriage means includes means cooperating with said means for supporting said trough whereby said carriage means and said trough are adapted to move in concert with said casting through a selected distance with downward movement of said trough.

2. The improvement of claim 1 wherein said means for supporting said trough includes drive means therefor, said means cooperating with said means for supporting said trough includes means selectively interconnecting said cutoff carriage with said drive means whereby said cutoff carriage moves in synchronism with said trough assembly.

3. The improvement of claim 2 wherein said drive means for said trough includes a rotatable drum means, cable means interconnecting said drum means with said trough, and said interconnecting means including clutch means selectively interconnecting said cutoff carriage with said drum means.

4. The improvement of claim 3 wherein said cutoff carriage includes a torch supporting frame, said selective interconnecting means including chain and sprocket means with one end of said chain means connected to said frame, weight means connected to the other end of said chain means, said weight means being effective to exert a force on said chain means to move said frame in a first direction, and said clutch means being effective to interconnect said sprocket means with said drum means whereby the force of said weight means is overcome and said frame means is permitted to move in a second direction opposite to said first direction.

5. The improvement of claim 4 wherein said guide means for said cutoff carriage comprises elongated guide post means having a longitudinal axis parallel to the path of movement of said trough, and means on said frame supporting said frame for guided movement along the length of said guide posts means.

6. The improvement of claim 5 wherein said cutoff carriage further includes torch housing means, means supporting said torch housing means on said frame for movement transverse to the path of movement of said frame along said guide post means.

7. The improvement of claim 6 wherein said cutoff carriage further includes means supporting said cutting torch means on said torch housing for reciprocating movement toward and away from the continuous casting passing through the apparatus.

8. The improvement of claim 2 wherein said selective interconnecting means include chain and sprocket means connected to said cutoff carriage, and clutch means operable to interconnect said chain and sprocket means with said drive means.

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9. The improvement of claim 8 wherein said clutch means is actuated by movement of said trough assembly.

10. The improvement of claim 1 wherein said cutoff carriage includes a pair of torches, means supporting said torches

for movement transverse to said path of movement, toward and away from the continuous casting and toward and away from each other.

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