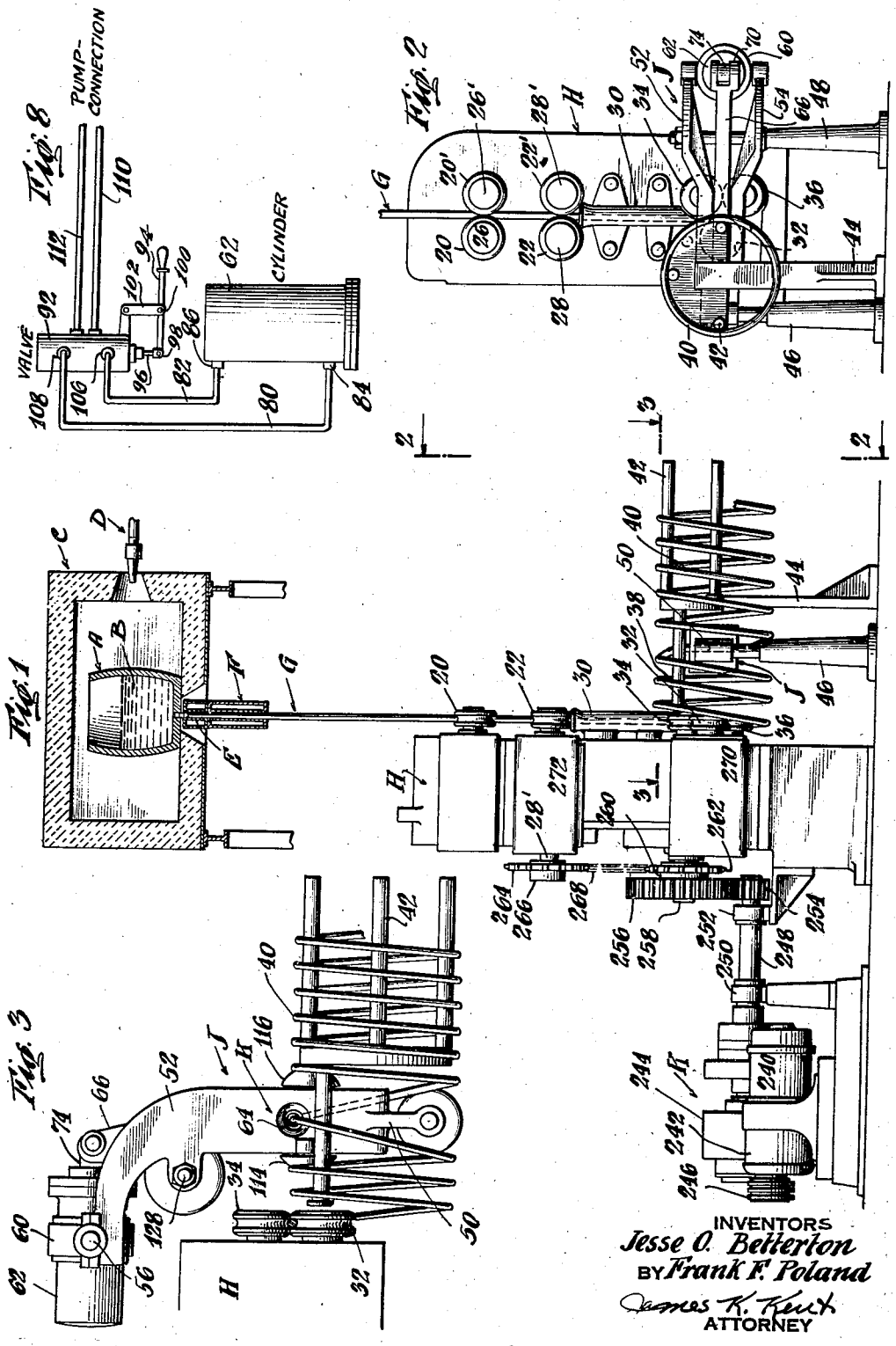
July 28, 1942. J. O. BETTERTON ET AL 2,291,204

APPARATUS FOR CASTING METAL

Filed Oct. 17, 1938 3 Sheets-Sheet 1



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Fig. 4

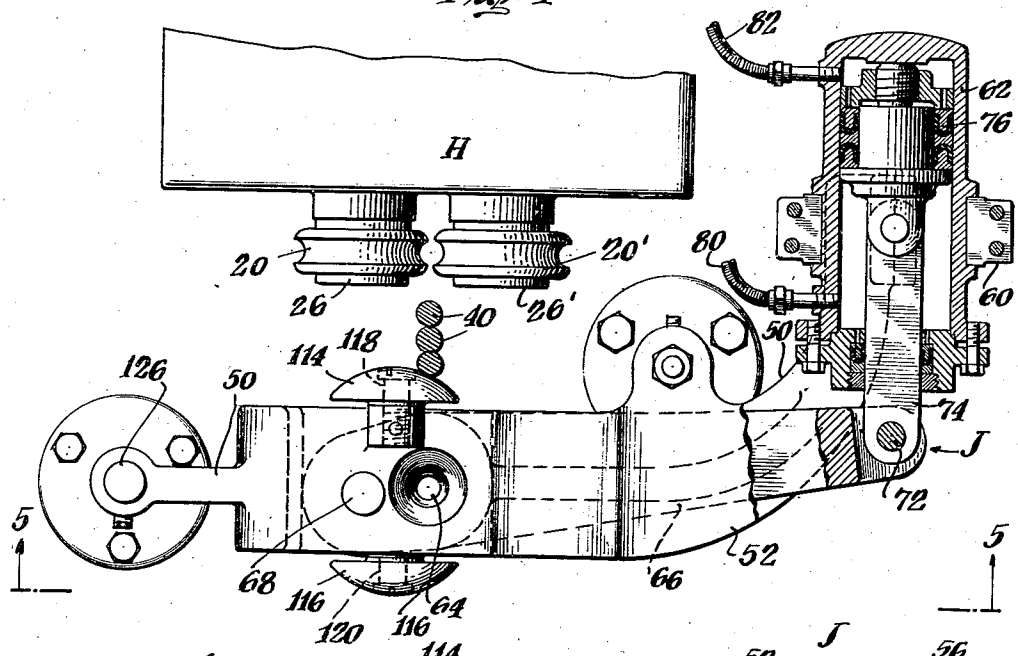
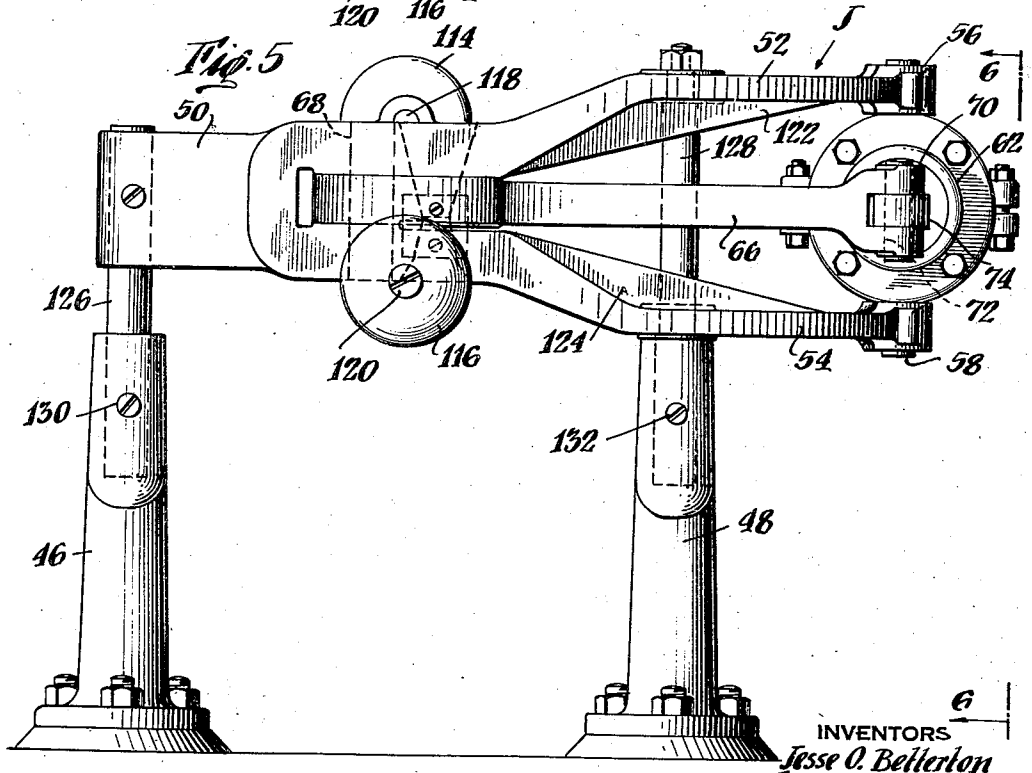


Fig. 5

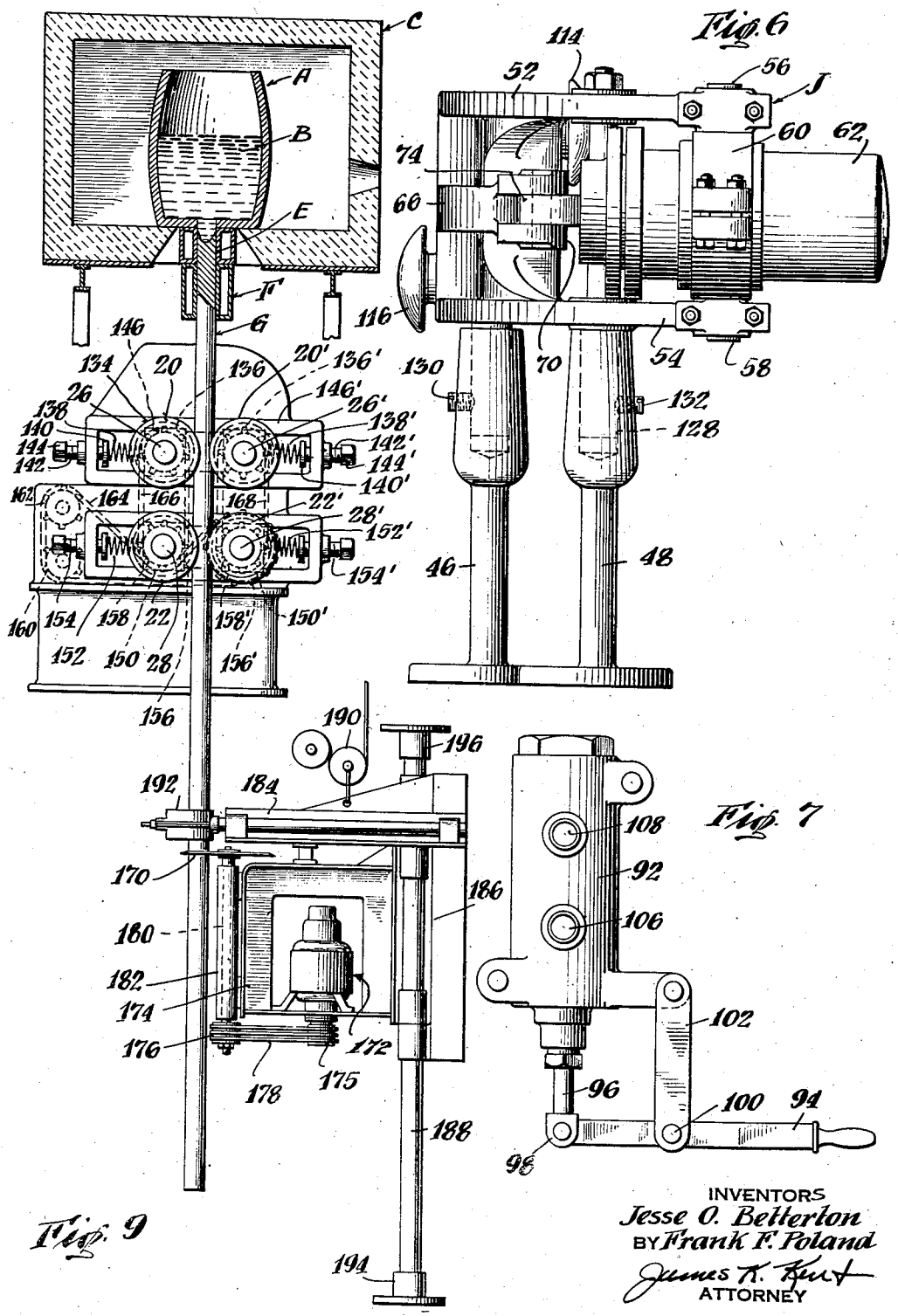


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APPARATUS FOR CASTING METAL

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12 Claims. (Cl. 22—57.2)

The present invention relates to a mechanism for facilitating the handling of indefinitely long cast shapes of metal, such as metal rod produced by continuous casting operations.

The production of metallic castings of indefinite length in a continuous manner is receiving a considerable amount of attention. In accordance with this process, molten metal is supplied from a reservoir or source thereof to one end of a die or mold having solid metal in the other end which serves as a plug and to which the molten metal welds as it solidifies, accompanied by withdrawal of the cast shape at a rate substantially equal to that of solidification of the metal.

Upon observing proper precautionary measures in the process, the metal may be withdrawn from the mold or die in a continuous manner and for indefinitely long periods of time without interruption to the casting process, the metal being withdrawn as a continuous rod of indefinite length and of desired predetermined diameter, depending upon the inside diameter of the die. Furthermore, since the cast rod is produced in a continuous manner and without interruption to the casting operation, it becomes necessary to provide means for handling the production of the cast metal in an expeditious manner.

It has been mentioned above that upon observing proper precautionary measures in the process, the metal may be withdrawn from the mold or die in a continuous manner and for indefinitely long periods of time without interruption to the casting process. These precautionary measures include certain factors in the manner of operation.

Among these factors there may be mentioned, specifically the following:

1. The provision of means for preventing slipping of the rod during casting. In order to avoid such contingency, the said means provide for a firm support against both lateral and longitudinal slippage, and accordingly it is preferred to provide a plurality of points of support for the rod in order to hold the rod rigid. Accordingly, the withdrawal of the rod from the die is controlled by providing preferably at least two sets of rollers which diametrically oppositely engage the rod, all of the rollers being power driven as further security against slippage of the rod. This is an important consideration especially in those instances where the rod being cast is of large diameter and it is necessary to saw it to make billets of predetermined length, and where the rod must be cool when it is sawed.

The avoidance of slipping is of importance also in that the steady withdrawal of the rod is an important consideration in maintaining a desired freezing zone in the die, for example in maintaining constant the casting conditions for the production of a copper casting with a definite radially crystalline structure.

2. The rollers should be adjustable as to tension, and means are provided for this purpose so that the rollers are maintained against the rod with constant pressure, while enabling the rollers to yield responsively to any variations in the rod diameter so as to be self-accommodating relatively thereto.

3. The provision of means for cutting the rod without checking the movement of the rod as it issues from the die. Such means may include coiling means for the rod and shearing mechanism, where the rod is a light rod, these means being positioned either adjacent to or remote from the casting furnace. When the rod is too inherently stiff for coiling, or where straight lengths of rod are to be cut, the cutting mechanism, either a saw or shear, is mounted so as to move with the rod during cutting operations, so as not to check the casting nor bind the cutting means.

4. The rollers described above are to be operated at constant speed, which means that the source of driving power for the rollers is to be adapted to maintain a constant speed under variable load, and to increase the speed of the rollers by smooth increments on starting.

5. The driving mechanism for the rollers should be enclosed in a suitable casing or housing for protection of the mechanism and to prevent contact of molten metal therewith in the event of run-outs or other accidental scattering of the metal being cast.

The above considerations indicate the principal objects of the present invention, the scope of which is intended to include any mechanical means which will perform in accordance with these indications and which will produce the results indicated by these considerations. Accordingly, the specific mechanical equipment employed or the specific arrangement of operating parts may be varied very widely, and the same which will be described herein are to be regarded only as illustrating one form of assembly which is suitable for producing these results.

In addition to the above, however, further objects of the invention include the provision of means for enabling the withdrawing mechanism for the cast metal to be adjusted with respect

to the die so that the cast metal may be withdrawn from the die in absolute alignment with the die opening; the provision of coiling apparatus for light rod for coiling the rod as it issues from the die without any check resulting on the movement of the rod; the provision of a shearing mechanism which may be either a part of the coiling assembly or separate therefrom, which mechanism severs the rod without impedance to the continuity of movement of the rod and which may be easily controlled and operated with the minimum of labor.

With respect to these additional objects of the invention, it may be mentioned, particularly, that it is important to withdraw the casting straight out from the die. In the case where copper and/or copper alloys are being cast, it has been found that attaining casting rates sufficiently high to produce commercial outputs of cast metal is accomplished by applying drastic cooling to the die walls so that heat from the metal being cast is withdrawn very rapidly radially from the metal and through the walls of the die, so that the die is made with walls as thin as possible in order to conduct the heat rapidly from the molten metal to the water jacket enclosing the die, while withstanding the mechanical strains to which the die is subjected. The material composing the die being graphite of low porosity the thin walls of the die render the die rather fragile under torsional strains. An angular withdrawal of cast metal from the die results in rapid destruction of the die through attrition of the thin walls thereof, and also tends to fracture the die because of the thin die walls.

In the accompanying drawings,

Fig. 1 is an elevation, largely diagrammatic in character, of an apparatus system constructed in accordance with the present invention, showing diagrammatically in section the continuous casting unit.

Fig. 2 is an elevation of the coiling mechanism of Fig. 1, the view being at right angles to Fig. 1 and taken on the line 2—2 of Fig. 1, looking in the direction of the arows.

Fig. 3 is a plan view of the shearing mechanism illustrated in Fig. 2, the view being taken on the line 3—3 of Fig. 1, looking in the direction of the arrows.

Fig. 4 is detailed plan view, partly in section, of the shearing mechanism of Fig. 3.

Fig. 5 is a front elevation of the mechanism of Fig. 4, the view being taken along the line 5—5, looking in the direction of the arrows.

Fig. 6 is a side elevation of the mechanism of Fig. 4, the view being taken along the line 6—6 of Fig. 4, looking in the direction of the arrows.

Fig. 7 is a view of a control valve for controlling the supply of hydraulic fluid to the pressure cylinder of the shearing mechanism.

Fig. 8 is a diagrammatic view of a piping system suitable for circulating hydraulic actuating fluid to the shearing mechanism.

Fig. 9 is a diagrammatic elevation of an assembly of apparatus somewhat similar to the showing of Fig. 1, but in which the coiling mechanism is eliminated and the shearing mechanism of the structure of Fig. 1 has been replaced by other cutting means, illustrated by means of a saw, the view showing further details of the driving mechanism for the supporting rollers for the rod and means for adjusting these rollers.

Referring more particularly to the drawings, it will be noted that the assembly of the apparatus comprises a reservoir A containing molten metal B to be cast, which is enclosed in a suitable furnace C, maintained above the melting point of the metal, e. g., copper or copper alloys to be cast, by means of a burner D.

The reservoir A is adapted to be supplied with additional quantities of metal to be cast as the supply thereof in the reservoir becomes depleted, and the reservoir is provided with a casting die or mold E enclosed in a divided water jacket F, the molten metal solidifying in the casting die, from which the solidified metal is withdrawn continuously as a rod G of indefinite length. For facilitating manipulation there is provided the system of mechanism of the present invention, which mechanism includes a coiling machine for coiling the rod, which is indicated generally at H together with shearing mechanism J with driving instrumentalities K for the coiling mechanism H.

This mechanism is to be regarded as being illustrative only, as the specific type of mechanism forms no part of the present invention except as an element in a system of assembled cooperating apparatus adapted to constitute a complete plant for continuously casting metal shapes.

In the illustrated form of the mechanism, however, it will be seen that it comprises a plurality of rollers which are driven by the driving mechanism indicated generally at K, through suitable power transmitting instrumentalities. As will be seen from the drawings, these rollers may be arranged suitably in pairs as indicated at 20, 20', 22, 22', which oppositely engage the rod G, the rollers being mounted on suitable shafts 26, 26', 28 and 28'.

These rollers control the withdrawal of the rod G from the die E, and direct the rod into a tubular guide 30, which guides the rod to the coiling instrumentalities, which includes three cooperating rollers 32, 34, 36, the roller 32 engaging the rod oppositely to the rollers 34 and 36 for imparting a convolution of desired radius to the rod, as is indicated at 38. These rollers 32, 34, 36, are also driven from the driving mechanism K.

This driving mechanism is to be regarded also as being only illustrative in its character, and it may be replaced by other suitable types, producing a constant driving speed regardless of variations in load. The illustrated form, however, has proven in practice to be very satisfactory in the control which it effects in the casting speed of the rod G, the actuation of the coiling means with the consequent interrelation between the casting speed and the rate of coiling, these obviously having to be synchronized properly for satisfactory operation.

As illustrated, however, the driving mechanism K for the coiling unit includes a motor 240 which operates a variable speed reducer 244 through a V-belt drive indicated at 246. The speed reducer 244 operates a driving shaft 248 which is mounted in bearings 250, 252, and carries a driving pinion 254 on the end of the shaft.

The driving pinion 254 meshes with a large gear 256 which in turn drives a shaft 258, the gear 256 having also a hub 260 to which is secured suitably a sprocket 262 for operating a second sprocket 264 on the shaft 28' through means of a chain drive 266, the sprocket 264 being provided with a hub 268 which keys the sprocket 264 to the shaft 28'.

Power is transmitted from the shaft 258 through suitable power-transmitting instrumentalities such as a chain drive arrangement, for

example, or a system of gears in housing 270 and also rollers 28, 28', 20, 20' are operated by suitable means, such as gearing or the like, not shown, in housings 270, 272, from the shaft 28'.

This internal power-transmitting mechanism is not illustrated, since it may vary in its details as will be apparent, and it specifically is not a part of the present invention.

As the rod G passes through the guide 30, it enters between the rollers 32, 34, 36, and is bent into a spiral coil as designated at 40, the convolutions of which may be supported on a rack 42, carried on a suitable stand 44. The rod G is bent continuously as it feeds through the coiling rollers; and by adjusting the distance between the roller 32 and rollers 34 and 36, these may be adjusted correspondingly the radius of the convolutions 38 of the coil 40 so as to vary the diameter of the coil.

As the rod is produced and coiled, it passes a shearing mechanism which is indicated at J, and which may be of the construction illustrated in Figs. 3 to 6 inclusive, this mechanism being adapted to shear the rod as it comes from the coiling unit, without interruption to the continuous casting of the rod.

This shearing mechanism includes supporting standards, such as are indicated at 46 and 48, on which standards are mounted a fixed shear frame 50 which includes arms 52 and 54 which are fixedly connected to studs 56 and 58 of an annular collar 60 of a hydraulic cylinder 62. The frame 50 has a guide opening 64 therein, into which the rod G is inserted as the rod first reaches the opening, and within the frame 50 there operates the shearing lever 66 this lever moving across the opening 64, upon actuation of instrumentalities to be described hereinafter.

The shear 66 is pivotally mounted at one end on a pivot pin 68 which extends through the frame 50, the other end of the shear forming a yoke 70, which is pivotally connected by a pin 72 to a piston rod 74 having a hollow piston head 76 operating in the hydraulic cylinder 62. Fluid pressure is supplied to the piston head 76 through flexible hose lines 80, 82, the former being connected to the cylinder 62 in front of the piston head, while the latter is connected thereto behind the piston head, the connections being indicated, respectively, at 84, 86, flow of fluid through hose lines 80, 82 being controlled by the operation of a suitable valve in housing 92, which valve is operated by a lever 94 which is connected to the valve stem 96, as shown at 98, and which is fulcrumed at 100 to bracket 102 secured to housing 92. This valve, being of any suitable standard construction, is not shown in detail.

Hose lines 80, 82 are connected to the valve through connectors 106, 108, hydraulic pressure being supplied to the valve through either of lines 110, or 112, under pressure of a continuously circulating pump, there being an automatic bypass in the housing 92 connecting the lines 110 and 112, so that the pump, not shown, may be kept in continuous operation.

Actuation of the piston 74 moves the shearing lever 66 under hydraulic pressure against the portion of the coil of rod within the guide opening 64, so as to shear off the rod at the desired length without interrupting the operation. In order to prevent binding of the coil, friction rollers 114, 116 desirably are provided, which turn on their axes 118, 120 under frictional engagement of the rod with the rollers, thus keeping the rod continuously in free motion so as to maintain continuous the feeding of the rod from the die.

Stiffening members 122, 124 may be provided for the arms 52, 54 of the shear frame 50, these members being welded to the said arms for reinforcement purposes. The frame 50 is anchored to the supports 46, 48 by suitable anchor bolts or the like such as are illustrated, for instance at 126, 128.

The height of the shearing unit may be adjusted by providing set screws, 130, 132, release of which will release the anchor bolts 126, 128 in the respective supports.

In Fig. 9, there is shown diagrammatically a modified form of apparatus in which certain details of structure are illustrated, by which the principal objects of the present invention may be attained.

The view (Fig. 9) shows in greater detail than shown in the preceding views, means for mounting and driving the supporting rollers for the rod so as to enable the rollers to yieldably engage the rod with constant force, and also to enable the rollers to be centered accurately with respect to the die.

The rollers 20, 21' are shown in the view as being mounted in a yoke 134, the shafts 26, 26' passing through bearing blocks 136, 136' in the housing H, which blocks are slidably mounted in the yoke responsively to pressure exerted by springs 138, 138' which are compressed between the blocks and the abutment 140, 140' of the set screws 142, 142', the position of which screws may be adjusted by turning the heads 144, 144' by a suitable wrench, or other tool. The shafts 26, 26' are supported, of course, by at least two of these blocks and yokes with corresponding springs in order to assure rectilinear motion thereof without binding. The shafts 26 and 26' may be provided with suitable sprockets, such as designated diagrammatically at 146, 146' for receiving power-transmitting means as will be mentioned further hereinafter.

The mounting of the rollers 22, 22' in yoke 148 is similar to the mounting of rollers 20, 20' described above, the shafts 28, 28' being mounted in bearing blocks 150, 150' which are adjustable under the pressure of springs 152, 152' which pressure may be adjusted by suitable adjustment of screw 154, 154' as described above.

The screws 142, 142', and 154, 154' afford means for aligning the rollers 20, 20' and 22, 22' accurately with respect to the opening in the die. Also, the springs render the rollers self-accommodating to varying diameters of the rod while continuously urging the rollers against the rod under high pressure, depending upon the strength of the springs; and the pressure of the springs may be maintained constant by means of any requisite adjustment of the set screws.

It will be seen that the provision of multiple sets of rollers affords multiple points of support for the rod as a safeguard against the rod slipping. As further precautions, the rollers may have their rod-engaging surfaces knurled, and both rollers of each set are power driven in order to grip the rod more positively. This is necessary precaution where a heavy rod is being cast. As has been indicated previously, the specific character of the drive is unimportant, but for purposes of illustration, shafts 28 and 28' may each be provided with two sprockets, 156, 158 and 156', 158', respectively, idler and take-up sprockets 160 and 162 also being provided.

An endless chain drive 164 engages the idler sprockets 160, 162, passes beneath sprocket 156 and over sprocket 158, thereby driving both rollers, additional endless chain drives 166 and 168 passing around the sprockets 156' and 158' on shafts 28 and 28', and around the sprockets 146, 146' on the shafts 26, 26', thereby driving both rollers 20, 20'.

In Fig. 9, the coiling and shearing mechanism previously described has been replaced by a sawing arrangement. The saw itself is designated at 170, and it is mounted so as to travel with the rod during sawing operations.

This saw 170 is driven by a motor 172, the saw and motor being mounted on a frame, 174. Power is transmitted from the motor 172 to the saw 170 through pulleys 175, 176, and driving belts 178, the saw 170 being mounted on the end of a shaft 180 enclosed in a sleeve 182. The frame 174 is supported on a supporting frame comprising a horizontal arm 184 and vertical support 186 the latter being swivelly and slidably mounted on the post 188 so that the saw may be swung against the rod G for cutting the latter. The entire saw assembly is balanced by a counterweight 190. The end of the horizontal arm 184 is provided with a releasable clamp 192 which is adapted to clamp onto the rod above the saw so that the entire saw assembly is moved downwardly along the post 188 while the saw cuts the rod G to cut off a billet of desired length.

When the cutting operation is completed the saw assembly is lifted for the next operation by stopping the motor, releasing the clamp 192, swinging the saw out of alignment with the path of the rod by swiveling the saw frame 174 around the post 188 and lifting the frame along the support 188 until the frame reaches its high position. It will be understood, also, of course, that the cutting speed of the saw is such that the billet is severed before the frame reaches its lowermost possible position, a forcible drop to such position after the billet is severed being prevented by the clamp 192 on the rod G and the counterweight 190 which also maintains the saw-frame level with no binding tendency on the saw. The column 188 is supported at both ends, as indicated at 194 and 196 so as to be maintained entirely rigid.

What is claimed is:

1. Apparatus for continuously casting metal as a casting of indefinite length and severing the continuous casting at desired intervals without interrupting the continuity of the casting operation comprising severing mechanism, a continuous casting furnace and mold assembly in which the mold cavity is vertically disposed and from which the casting continuously passes downwardly to the severing mechanism positioned below, a plurality of pairs of rolls engaging the casting at a plurality of vertically-spaced stations intermediate the mold and severing mechanism to provide a multiplicity of points of support for the casting and maintain same in true vertical alignment with the casting mold at all times, and mechanism for positively driving all of the rolls simultaneously at the same speed and at a constant speed irrespective of load variations.

2. Apparatus for continuously casting metals comprising the combination with a casting furnace of apparatus for continuously withdrawing cast metal from the furnace at controlled casting speed and mechanism for cutting the cast metal into predetermined lengths as it is being withdrawn continuously from the furnace without interruption to the continuous movement of the cast metal from the casting furnace, the said mechanism comprising a fixedly mounted guide member for the continuously moving metal, and a shearing cutter operatively associated with the guide member for shearing the cast metal at selected intervals without interruption to the casting speed of the metal.

3. Shearing mechanism for cutting metal comprising the combination with supporting means, of a rigidly mounted member on the support having a guide opening therethrough for enabling metal to be sheared to be passed through the said member, a shearing blade pivotally connected to the said member and adapted to act on the said metal to shear the same, as it passes through the said member, and actuating mechanism for operating the shearing blade.

4. Apparatus for continuously casting metals comprising the combination with a casting furnace adapted to deliver continuously cast metal rod of indefinite length, of continuously operating pulling and supporting rollers for the rod arranged to provide a plurality of stations for supporting the rod to prevent slipping thereof, sawing means for cutting the rod into predetermined lengths as the rod passes downwardly from between the said rollers, clamping instrumentalities for the rod adapted to clamp upon the rod upon engagement of the sawing means therewith to prevent transmission of vibrations therethrough to the casting means during sawing of the rod, and a mount for the sawing means and the clamping instrumentalities adapted to move downwardly with the rod during sawing operations thereon responsive to clamping engagement of the clamping instrumentalities with the rod, and counterbalancing means for said mount.

5. Apparatus for continuously casting metals comprising the combination with a casting furnace adapted to deliver continuously cast metal rod of indefinite length descending vertically therefrom, of continuously operating pulling and supporting rollers arranged to engage the rod at a plurality of stations to prevent slipping thereof, means for sawing the rod as the rod passes from between the last of said rollers, mechanism for actuating the sawing means to saw the rod, instrumentalities for enabling the sawing means to be moved horizontally between operative and inoperative positions relative to the rod, vertically movable mounting means for the actuating mechanism and the sawing means, means substantially counterbalancing the mounting means, and means for gripping the rod during sawing thereof to cause the said mounting means to move with the rod during sawing thereof while preventing transmission of sawing vibrations to the pulling rollers and casting furnace during sawing.

6. Apparatus for continuously casting metals comprising the combination with a casting furnace adapted to deliver continuously cast metal rod of indefinite length downwardly therefrom, of continuously operating pulling and supporting rollers for the rod arranged to provide a plurality of stations for supporting the rod to prevent slipping thereof, sawing mechanism for cutting the moving rod transversely into a plurality of predetermined lengths without interfering with the continuous movement of the rod, the said sawing mechanism including a saw, a source of power for the saw, and power transmitting

means for transmitting power from the source to the saw, the said power transmitting means being yieldable responsively to any binding of the saw to prevent transmission of destructive shocks to the mechanism, mounting means for the saw mechanism adapted to be held normally in an upper position while being movable downwardly responsively to movement of the rod, and means for interconnecting the rod and mounting means for transmitting movement of the rod to the mounting means.

7. A machine for cutting a downwardly moving bar of metal into predetermined lengths comprising, in combination, clamping means for the bar, and sawing mechanism for cutting the bar, both clamping means and sawing mechanism being mounted on a common tool head, means for substantially counterbalancing the weight of the tool head during downward movement thereof, said sawing mechanism including a saw, a high-speed motor for driving the saw, and power transmission means between the motor and saw, the said motor driving the saw at sufficiently high speeds to prevent chattering of the saw.

8. A machine for cutting off successive longitudinal sections from a length of stock moving continuously in a downward direction, said machine having, in combination, a vertically movable tool head, a power actuated cutter thereon, means on said head for clamping the stock and head together during operation of said cutter on the stock, and means for substantially counterbalancing the weight of said head during downward movement thereof.

9. A machine for cutting off successive longitudinal sections from a length of stock moving continuously in a downward direction, said machine having, in combination, a vertically movable tool head, a power actuated cutter thereon, means on said tool head for clamping the stock and head together during operation of said cutter on the stock, and means for at least partially counterbalancing the weight of said head during downward movement thereof.

10. A machine for cutting off successive longitudinal sections from a length of stock moving continuously in a downward direction, said machine having, in combination, a tool head guide for vertical movement adjacent and parallel to the advancing stock and adapted to move downwardly therewith, a power actuated cutter carried by said head and movable horizontally across the path of the stock to cut off the leading end portion of the latter, means opposing downward gravitational movement of said head and overcoming the weight thereof to hold the head in an upper starting position, and means on said head for clamping the latter and said stock together for movement of the two in unison.

11. A machine for cutting off successive longitudinal sections from a length of stock moving continuously in a downward direction, said machine having, in combination, a vertically movable tool head, a power actuated cutter thereon, guide means for said tool head, means on said head for clamping the stock and head together during operation of said cutter on the stock, and means exerting a lifting force on said head to facilitate raising the head following cutting off of the stock.

12. A machine for cutting off successive longitudinal sections from a length of stock moving continuously in a downward direction, said machine having, in combination, a tool head for vertical movement adjacent and parallel to the advancing stock and moving downwardly with the stock, a power actuated cutter carried by said head and movable horizontally across the path of the stock to cut off the leading end portion of the stock, means on said head for clamping together the head and stock for movement thereof in unison, and means returning the head upwardly to starting position upon release of the clamping means.

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