Feb. 13, 1962 A. E. PETERS 3,020,788

SHEAR CONTROL SYSTEM FOR MULTI-LINE CONTINUOUS ROD MILLS

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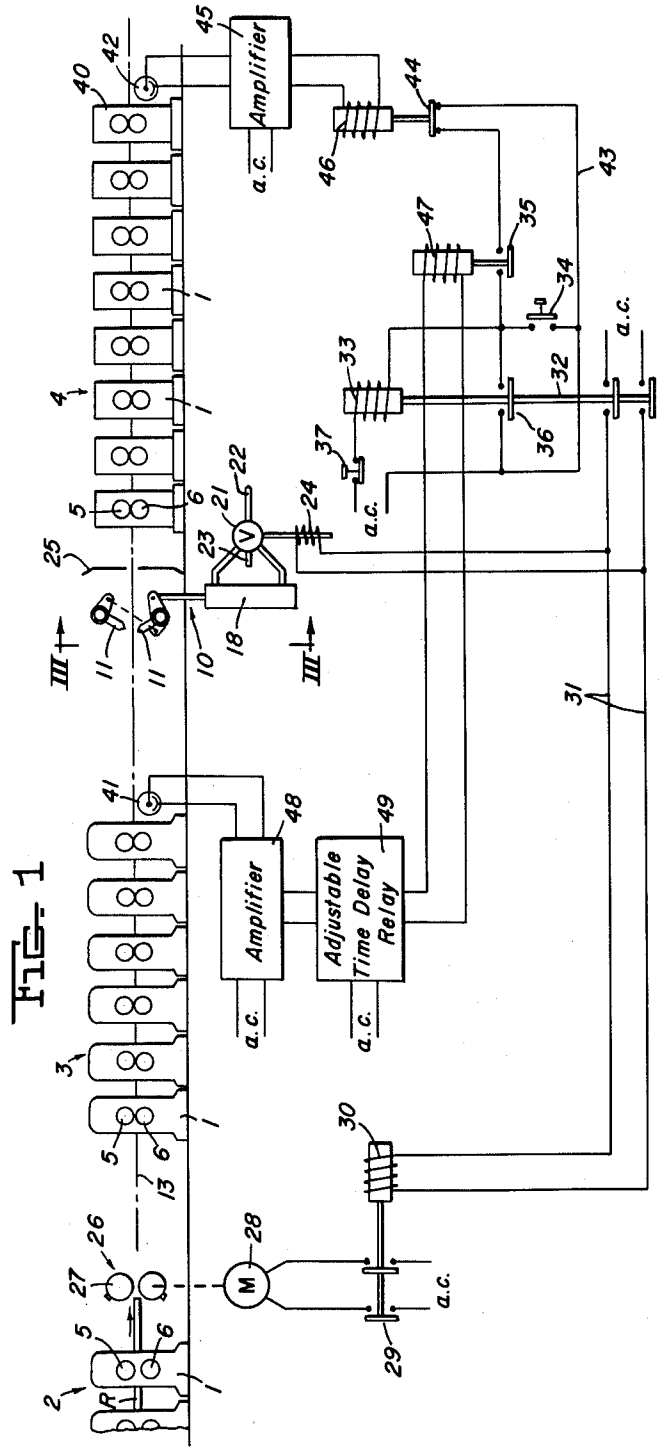


FIG. 1

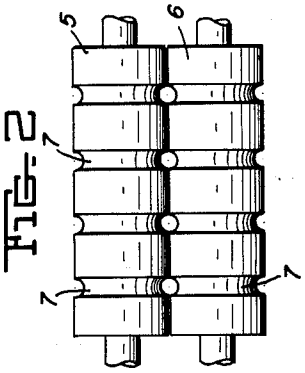

FIG. 2

INVENTOR
ANTHONY E. PETERS
By Donald G. Dalton
Attorney

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FIG. 3

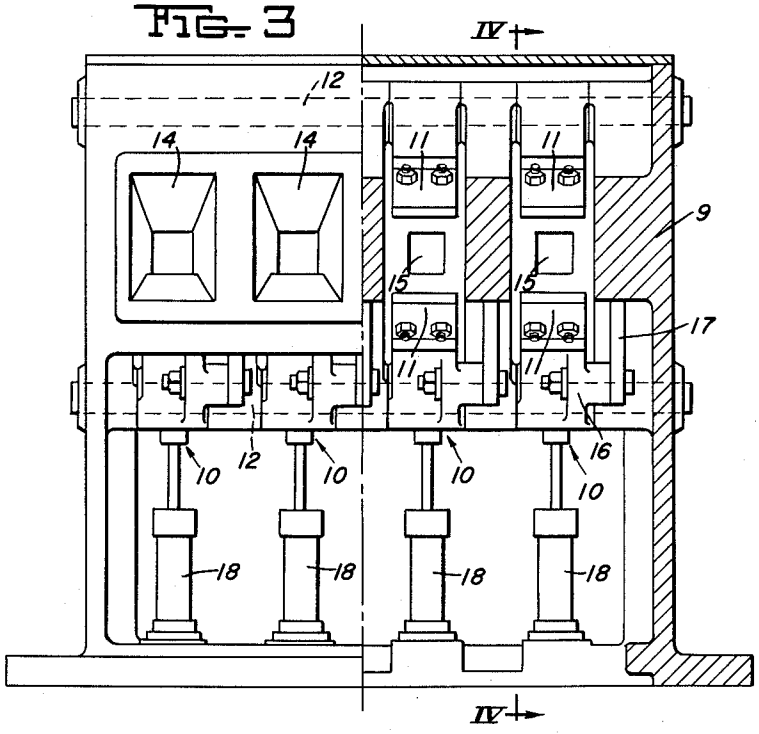
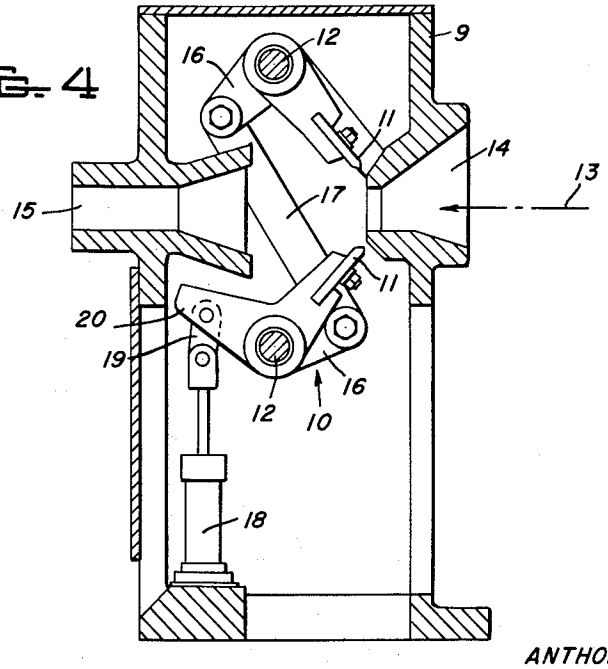



FIG. 4




INVENTOR
ANTHONY E. PETERS
By Donald G. Dalton
Attorney

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3,020,788

# SHEAR CONTROL SYSTEM FOR MULTI-LINE CONTINUOUS ROD MILLS

Anthony E. Peters, 4416 W. 60th St., Cleveland, Ohio

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12 Claims. (Cl. 80—35)

This invention relates to multi-line continuous rod mills and, more particularly, to shearing apparatus for stopping the feeding movement of rod to the roll-stands of a finishing mill. In a manner to be described, it contemplates improvements that function to operate the mill shears when the rod cobbles at any of the finishing mill roll-stands and thus does not complete its travel to the pouring and laying reels.

Rod cobbles in any of the roll-stands of a finishing mill constitute a troublesome problem in the operation of continuous rod mills. In such mills, billets are rolled to rod size in consecutively arranged roughing, intermediate and finishing mills that frequently provide in excess of twenty successive roll reducing passes. By reason of its elongation in each of the reducing passes, the rod is delivered to and moves through the finishing mill at high linear speeds that vary with the size of the rod being rolled. In some mills, the rod being delivered from the final rolling pass in the finishing mill to the pouring and laying reels, in the case of small diameter rod, for example, 7/32 inch rod, has an exit linear speed from the finishing mill in excess of 6000 feet per minute. Speeds of this character are conducive to the formation of cobbles that take place when the leading end of a rod does not enter or move through the entry pass at any of the reducing stands of the finishing mill. This not only stops the rolling operation, but results in an accumulation of several hundred feet of rod about the stand where the cobble occurred in a short period of time, and presents a serious removal problem that further contributes to the mill shut-down time.

In order to reduce the accumulation of cobbled rod, continuous rod mills are provided with shears in advance of the finishing and intermediate mills. In conventional arrangements such shears are manually controlled and are operated to cut the rod when it cobbles, and thereby interrupt its feeding movement to the finishing mill. However, considerable quantities of cobbled rod will usually accumulate in the time that elapses after a cobble is observed by the mill operator and before the shears are actuated. Moreover, in multi-line rod mills in which each line has separate shears for cutting the rod moving therethrough, the operator has to determine which line has cobbled and select the shear control therefor that is to be manually operated. Since these operations have to be performed quickly, wrong selections are common and a single cobble thus frequently results in stoppage of at least two, and at times, of all of the lines being rolled.

One of the objects of this invention is to provide an apparatus that will eliminate the delay caused by manual operation of the finishing mill shears in a multi-line rod mill when a cobble occurs, and that will eliminate the possibility of operating shears to stop the rolling operation in lines which have not cobbled.

Another object of the invention is to provide a shear control system for continuous rod finishing mills that will operate the shears when the rod fails to exit from the finishing mill within a predetermined time after its delivery thereto.

A further object is to provide in a finishing mill shear apparatus of this character a control system that will scan the movement of a rod through the finishing mill and that will operate the shears when the rod fails to emerge from its final rolling pass in a predetermined period of time after delivery to its initial rolling pass.



A still further object is to provide a shear control apparatus of this character in which the scanning means comprises a first photoelectric cell that operates when a rod is delivered to the finishing mill, a second photoelectric cell that operates when the rod exits from the final stand thereof, and circuit means under the control of both photoelectric cells, which includes a timed relay for actuating the shears upon failure of the second photoelectric cell to operate within a predetermined time after operation of the first photoelectric cell.

Other objects and advantages of the invention will become apparent from the following description.

In the drawings, there is shown a preferred embodiment of the invention. In this showing:

FIGURE 1 is a diagrammatic illustration of the relative arrangement of roll-stands and rod shears in a multi-line rod mill that is provided with a shear control system constructed in accordance with the principles of this invention;

FIGURE 2 is a diagrammatic side elevational view of a pair of rolls that provide plural reducing passes for use in a multi-line rod mill;

FIGURE 3 is an elevational view of the finishing mill shear shown diagrammatically in FIGURE 1 and which is taken looking in the direction of the line III—III of FIGURE 1 and in which a portion has been broken away and shown in vertical section; and

FIGURE 4 is a sectional view taken substantially along the line IV—IV of FIGURE 3.

The consecutive arrangement of roll-stands **1** in a roughing mill **2**, intermediate mill **3** and finishing mill **4** of a conventional continuous rod mill is shown diagrammatically in FIGURE 1 of the drawings. Each of the roll-stands **1** comprises a housing in which a pair of upper and lower work rolls **5** and **6** is rotatably supported for rolling movement. Each of the rolls **5** and **6**, as shown in FIGURE 2, has four sets of grooves **7** that cooperate to define four rolling passes so that four rods may be rolled simultaneously. The rolling passes in succeeding stands **1** are progressively smaller so that rod R, moving through the mill in the direction indicated by the arrow in FIGURE 1, is elongated as it moves through each pass with a corresponding increase in its linear speed. The linear speed of the rod, particularly in the finishing mill where it exits at speeds of (depending on the size of the rod being rolled) from 3700 to over 6000 feet per minute, contributes to the tendency of rod to cobble because of, for example, defective ends that stick in the entry guides to the rolling passes. When rod cobbles occur at any of the stands in the finishing mill, several hundred feet of cobbled rod will pour into the space about the cobbled stand in a short period of time. It must of course be removed before the line in which it occurred can be restored to operation. This is a difficult and time consuming operation that is also dangerous when the remaining lines in a multi-line mill continue to operate.

To reduce the accumulation of rod in the finishing mill **4** when a rod cobbles therein, shearing apparatus is provided at a point in advance of the movement of the rod to the initial pass thereof. As shown in FIGURES 3 and 4, the finishing mill shear comprises a housing **9** that is partitioned to provide four sets of shearing units designated, respectively as a whole by the numeral **10**, there being a shearing unit **10** for each line of the mill. Each of the units **10** comprises a pair of shears **11** that are supported on vertically spaced rock shafts **12** on opposite sides of each rod pass line **13** through the housing **9**. Each pass line **13** is defined by a pair of entry and exit guides **14** and **15** at opposite sides of the housing **9** that operate to guide the movement of rod therethrough and

to the finishing mill 4. The shears 11 in each pair are connected for simultaneous rocking movement in opposite pivotal directions to and from an operative position in which they engage each other at the pass line 13 by rock arms 16 connected by a common operating link 17. They are actuated by a double-acting air cylinder 18 that has an operating connection at 19 to an actuating arm 20 which forms a part of the rotatable support for the lower blade 11. As shown diagrammatically in FIGURE 1, a solenoid operated reversing valve 21 controls the connections of opposite ends of each air cylinder 18 with an air supply line 22 and an exhaust line 23 to the atmosphere. In its normal unoperated position, the valve 21 connects the lower end of the cylinder 18 to the air supply line 22 and the upper end thereof to the exhaust line 23, to thereby hold the blades 11 in the open position shown in FIGURE 4. As indicated, the valve 21 is solenoid operated and, when its operating coil 24 is energized, the connections of the cylinder 18 controlled thereby with the lines 22 and 23 are reversed to move the actuating arm 20 in a counter-clockwise direction as viewed in FIGURE 4, and thereby move the blades 11 into shearing engagement at the pass line 13. When the shears 11 are operated to cut the rod in this manner, they act additionally as a gate to prevent the movement of rod through the exit guide 15. Additional rod that is thereafter fed from the intermediate mill 3 will cobble at the shear housing 9 and will pile up against a shield 25 that prevents it from travelling with a looping movement into the finishing mill 4. The shearing units 10 and their arrangement in the housing 9 are conventional.

In a similar manner, each line of the mill has a shearing unit 26 in advance of the intermediate mill 3 for cutting the rod and interrupting its movement thereto. Since their construction is conventional, the unit 26 shown in FIGURE 1 has been illustrated diagrammatically as a pair of flying shears 27 that are rotated by a motor 28 to chop rod R moving from the roughing mill 2 into short pieces of scrap. Operation of the motor 28 is controlled by a relay 29 and is started upon energization of its solenoid operating coil 30. While only one shear unit 26 is shown in FIGURE 1, it will be understood that each line in the mill is provided with a similar unit, and that the operating coil 30 for each is connected in a common control circuit 31 in parallel with the reversing valve coil 24 for the finishing mill shear 10 of such line, and in such manner that the shears 10 and 26 in each line operate simultaneously when their control circuit 31 is energized.

Energization of the circuit 31, and operation of the shears 10 and 26 may be effected manually as in conventional practice as well as by the control system of this invention. For this purpose, its energization is under the control of a relay 32 that picks up upon closure of an energizing circuit through its operating coil 33. An energizing circuit for the coil 33, and a shear starting operation of the relay 32, is completed upon closure of a manual push-button switch 34, or a relay contact 35 in a manner to be described. When the relay 32 is operated, a holding circuit for its coil 33 is established by closure of holding contact 36, to thereby maintain the common circuit 31 for the shear control coils 24 and 30 in an energized state, until opened by manual operation of a normally closed push-button switch 37. Operation of the switch 37 after each shear operation is required to condition the mill for a subsequent rolling operation.

The control system of this invention as shown in FIGURE 1 operates the shears 10 and 26 when a rod fails to exit from the final stand 40 of the finishing mill 4 in a predetermined period of time after it is fed thereto by the intermediate mill 3, as the result of its having cobbled in one of the stands of the finishing mill 4. For this purpose it includes a pair of photoelectric cells 41 and 42 that respectively scan the movement of rod into and out of the mill 4, and are operated at all times when rod is moving opposite their respective positions. The cell 41 is arranged between the intermediate mill 3 and the shears 10 and operates when the forward end of a rod being rolled moves by its respective position. Operation of the cell 41 thus indicates that a rod is being fed to the finishing mill 4. The cell 42 is arranged at a point beyond the last stand 40 of the mill, and its operation thus indicates that a rod has emerged from the mill 40. Since the time period required for the forward end of a rod to move from a point opposite the cell 41 to a point opposite the cell 42 is constant, operation of both cells within this time period indicates that the rod has moved through the mill 4 in a normal manner, while failure of the cell 42 to operate within this period of time indicates that it has cobbled in one of the stands of the mill 4, and that operation of the shears 10 and 26 is required. For this purpose the cells 41 and 42 control the energization of relay coil 33 through a branch energizing circuit 43 therefor that includes the normally open relay contact 35 referred to above, and a normally closed relay contact 44.

The photoelectric cell 42 controls the opening movement of the normally closed relay contact 44 and, for this purpose, is connected through an amplifier 45 to the operating coil 46 for the relay contact 44. When the cell 42 starts to conduct in response to movement of a rod out of the last stand 40 of the mill 4, the coil 46 is energized to open the relay contact 44 and thus prevent closing of the branch control circuit 43 for the relay coil 33. It thus operates under this condition to prevent energization of the relay coil 33 and a resulting shear operation upon subsequent closure of relay contact 35 in a manner to be described.

Closure of the relay contact 35 is effected upon energization of its operating coil 47, which takes place a predetermined time interval after the forward end of a rod passes the point at which the photoelectric cell 41 is located. For this purpose, the cell 41 controls the energization of the coil 47 through an amplifier 48 and an adjustable time delay relay 49 of conventional construction. When the cell 41 starts to conduct in response to movement of a rod thereby, the amplifier 48 operates the relay 49 which introduces a time delay between operation of the cell 41 and its energization of the coil 47. For this purpose the relay 49 is regulated to delay the energization of the coil 47 for a period of time after the cell 41 starts to conduct that is slightly greater than the time interval normally required for the forward end of a rod being rolled to travel from a point opposite the cell 41 to a point opposite the cell 42. In this manner, the cell 42 will operate to open the contact 44 just before closing of the contact 35 by operation of the relay 49. Under this condition, the circuit 43 is not closed and the shears 10 and 26 are not operated.

In the event that a rod cobbles in the finishing mill 4, the contact 44 will not be opened by the cell 42. In such case, energization of the coil 47 and closure of the contact 35 by the time delay relay 49 in response to a conducting operation of the photoelectric cell 41 will close the control circuit 43 to energize the coil 33 and pick up the relay 32. Operation of the relay 32 in this manner energizes the control circuit 31 for the shear control coils 24 and 30 in the line in which a cobble has occurred, and thus effects an operation of the shears 10 and 26.

The relay 49 must be one that provides an adjustable time delay interval between its operation by the photoelectric cell 41 and amplifier 48 and its energization of the coil 47, since the time required for rod to travel over the space between the cells 41 and 42 will vary with the size of the rod being rolled. By reason of their constant time operating characteristics, a relay 49 containing an electronic timer is preferred. In addition, the relay 49 must operate to maintain the coil 47 energized until the cell 41 ceases to conduct in response to movement of

the trailing end of a rod thereby, and be one that will then operate to reset itself for a subsequent timing cycle. Since there are a number of relays on the market that answer to these requirements, the specific structure of the relay **49** has not been shown in the drawings and it will be sufficient to indicate that one fom of relay suitable for the purposes of this invention may be obtained from the General Electric Company under the designation "Electronic Timer, CR7504–A142."

Under normal operating conditions, the photoelectric cell **41** stops conducting when the trailing end of a rod being rolled moves beyond the position at which it is located. This operates through the amplifier **48** and relay **49** to de-energize the coil **47** and open the contact **35** to prevent energization of the circuit **43** upon subsequent closure of the contact **44** when the photoelectric cell **42** stops conducting in response to movement of the trailing end of the rod to a position beyond the point at which it is located. Opening of the contact **35** in this manner thus operates to prevent actuation of the shears **10** and **26** at the end of each rod rolling operation.

The apparatus of this invention further operates to actuate the shears **10** and **26** when rod breakage takes place at any of the stands of the finishing mill **4** after the forward end of a rod has been rolled to a position beyond the cell **42** and the contact **44** has been opened as explained above. When a rod breaks in the finishing mill **4**, the portion of rod in advance of the point of breakage will move out of the final finishing stand **40** in a normal manner. Upon movement of this portion out of the mill, the cell **42** stops conducting and the coil **46** is de-energized so that the contact **44** drops to closed position. At this time, and by reason of the fact that the portion of the rod to the rear of the point of breakage is still moving to the mill **4**, the cell **41** is still conducting and the relay contact **35** is closed so that closure of the contact **44** energizes the circuit **43** and through relay **32** effects an operation of the shears **10** and **26** to prevent further feeding movement of rod into the finishing mill **4**.

While one embodiment of my invention has been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. In rod rolling apparatus comprising a finishing mill having a plurality of successively arranged reducing passes, means for feeding a rod to said finishing mill, and a rod cutting shear arranged between said feeding means and finishing mill, the combination therewith of a first scanning means operating in response to entry movement of a rod into said finishing mill, a second scanning means operating in response to exit movement of said rod from said finishing mill, and means controlled by both of said scanning means for actuating said shear.

2. In rod rolling apparatus comprising a finishing mill having a plurality of successively arranged reducing passes, means for feeding a rod to said finishing mill, and a rod cutting shear arranged between said feeding means and finishing mill, the combination therewith of a first scanning means operating in response to entry movement of a rod into said finishing mill, a second scanning means operating in response to exit movement of said rod from said finishing mill, and means for actuating said shear upon failure of said second scanning means to operate a predetermined time after a rod responsive operation of said first scanning means.

3. In rod rolling apparatus comprising a finishing mill having a plurality of successively arranged reducing passes, means for feeding a rod to said finishing mill, and a rod cutting shear arranged between said feeding means and finishing mill, the combination therewith of means controlling the operation of said shear and including a first relay effective when operated for preventing operation of said shear and a second relay effective when operated before operation of said first relay for actuating said shear, a scanning means for operating said first relay in response to exit movement of a rod from said mill, and a scanning means operating in response to the entry movement of a rod into said mill including a time delay means actuated thereby for operating said second relay a predetermined time thereafter, said second relay being operated under normal operating conditions after operation of said first relay by said rod exit movement scanning means.



4. An apparatus as defined in claim 3 characterized by each of said scanning means comprising a photoelectric cell operating in response to movement of a rod thereby.

5. In rod rolling apparatus comprising a finishing mill having a plurality of successively arranged reducing passes, means for feeding a rod to said finishing mill, and a rod cutting shear arranged between said feeding means and finishing mill, the combination therewith of means including a control circuit effective when energized for actuating said shear, a normally closed relay contact in said circuit and a relay for operating it to open position to prevent energization of said circuit, a first photoelectric cell means operating in response to exit movement of a rod from said mill for operating said relay, a normally open contact in said circuit and a second relay for operating it to closed position to energize said circuit when such operation is effected prior to opening of said normally closed contact, a second photoelectric cell means operating in response to entry movement of a rod into said mill, and a time delay means actuated by said second photoelectric cell means for operating said second relay a predetermined time interval after said entry movement of a rod into said mill, said predetermined time interval being slightly greater than the time normally required for operation of said first photoelectric cell means after operation of said second photoelectric cell means, whereby said shear is operated when the forward end of a rod does not move through the final stand of said finishing mill in a normal manner.

6. In rod rolling apparatus comprising a finishing mill having a plurality of successively arranged reducing passes, means for feeding a rod to said finishing mill, and a rod cutting shear arranged between said feeding means and finishing mill, the combination therewith of a first scanning means for detecting the movement of rod into said finishing mill, a second scanning means for detecting the movement of rod out of said finishing mill, and means controlled by both of said scanning means for actuating said shear when a rod breaks at any of said reducing passes and its movement out of the mill terminates before its movement into the mill has been completed.

7. An apparatus as defined in claim 6 characterized by said controlled means including a time delay relay means for effecting actuation of said shear in response to failure of a rod to exit from the final one of said reducing passes in a predetermined time after it is fed to the initial one of said passes.

8. In rod rolling apparatus comprising a mill having a plurality of successively arranged reducing passes, means for feeding a rod to said mill, and a rod cutting shear arranged between said feeding means and said mill, the combination therewith of a shear control means actuated in response to delivery of a rod by said feeding means to said mill for operating said shear after a predetermined time interval, and means actuated in response to exit movement of said rod from said mill in a period of time less than said predetermined time interval for rendering said control means ineffective to actuate said shear.

9. An apparatus as defined in claim 8 characterized by said last-named means operating through said control means to actuate said shear when a rod breaks at any of said reducing passes and its movement out of the mill terminates before its movement into the mill has been completed.

10. In rod rolling apparatus comprising a mill having a

plurality of successively arranged reducing passes, means for feeding a rod to said mill, and a rod cutting shear arranged between said feeding means and said mill, the combination therewith of a control means actuated in response to delivery of a rod by said feeding means to said mill, means including an adjustable timer operated by said control means for operating said shear a predetermined time interval after actuation of said control means, and means actuated in response to exit movement of rod from said mill for rendering said shear operating means ineffective.

11. In rod rolling apparatus comprising a mill having a plurality of successively arranged reducing passes, means for feeding a rod to said mill, and a rod cutting shear arranged between said feeding means and said mill, the combination therewith, a first photoelectric cell means operated in response to entry movement of a rod by said feeding means into the initial pass of said mill, a second photoelectric cell means operated in response to exit movement of a rod from the final pass of said mill, control means including an adjustable time delay means for actuating said shear a predetermined time interval after operation of said first photoelectric cell means, and means responsive to operation of said second photoelectric cell means for preventing actuation of said shear by said control means.

12. In a rod mill having a plurality of rolling lines respectively comprising a plurality of successively arranged reducing passes, means for feeding rod to the initial one of said passes, and a shear effective when operated for cutting the rod being fed by said feeding means, the combination therewith of a separate apparatus in each of said lines comprising a relay controlling the rod cutting operation of the said shear therein, a control circuit for energizing said relay, a normally open contact and a normally closed contact in said circuit, means responsive to exit movement of a rod from the final one of said reducing passes for opening said normally closed contact, an adjustable time delay relay, means responsive to feeding movement of a rod to the initial one of said passes for operating said time delay relay, means operated by said time delay relay for closing said normally open contact a predetermined time interval after operation of said rod feeding responsive means, said predetermined time interval being sufficient to provide for opening of said normally closed contact prior to closing of said normally open contact by said exit responsive means, and a holding circuit for maintaining said shear control relay energized after energization by said control circuit.



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