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Grinshpun et al.

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[54] **FEED APPARATUS OF TUBE COLD ROLLING MILL**

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[51] **Int. Cl.** **B21b 21/04,** B21b 39/06

[58] **Field of Search** 72/252, 208, 214, 220, 72/249

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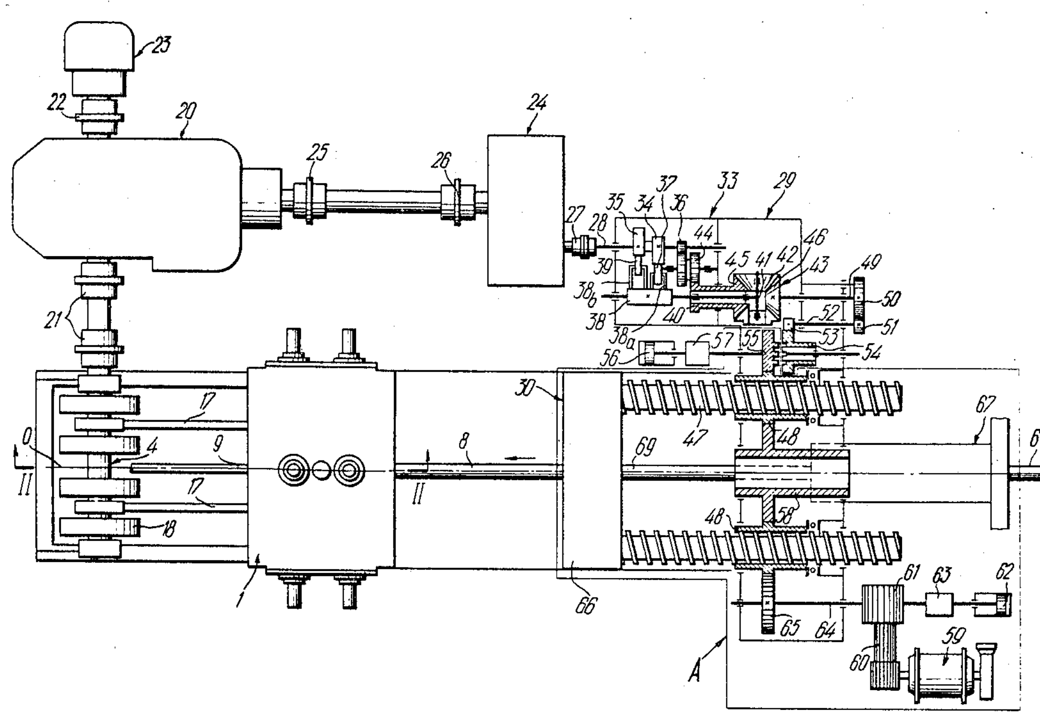
[57] **ABSTRACT**

A feed apparatus has means for conversion of a uniform rotational motion into an intermittent forward movement whose input shaft is imparted a uniform rotational motion by a drive kinematically connected to the drive of a roll stand, and a feed device being imparted an intermittent forward motion by said conversion means through the output member thereof and transmitting this motion to a tube being rolled. To decrease load on the parts of said conversion means at the moment of feed of the tube being rolled, the feed apparatus is provided with a hydraulic cylinder constantly transmitting, through the piston, fluid pressure onto the feed device in the direction of feed of the tube being rolled thereby making it possible to increase the number of the roll stand double strokes per minute and to roll large-diameter tubes.

2 Claims, 4 Drawing Figures



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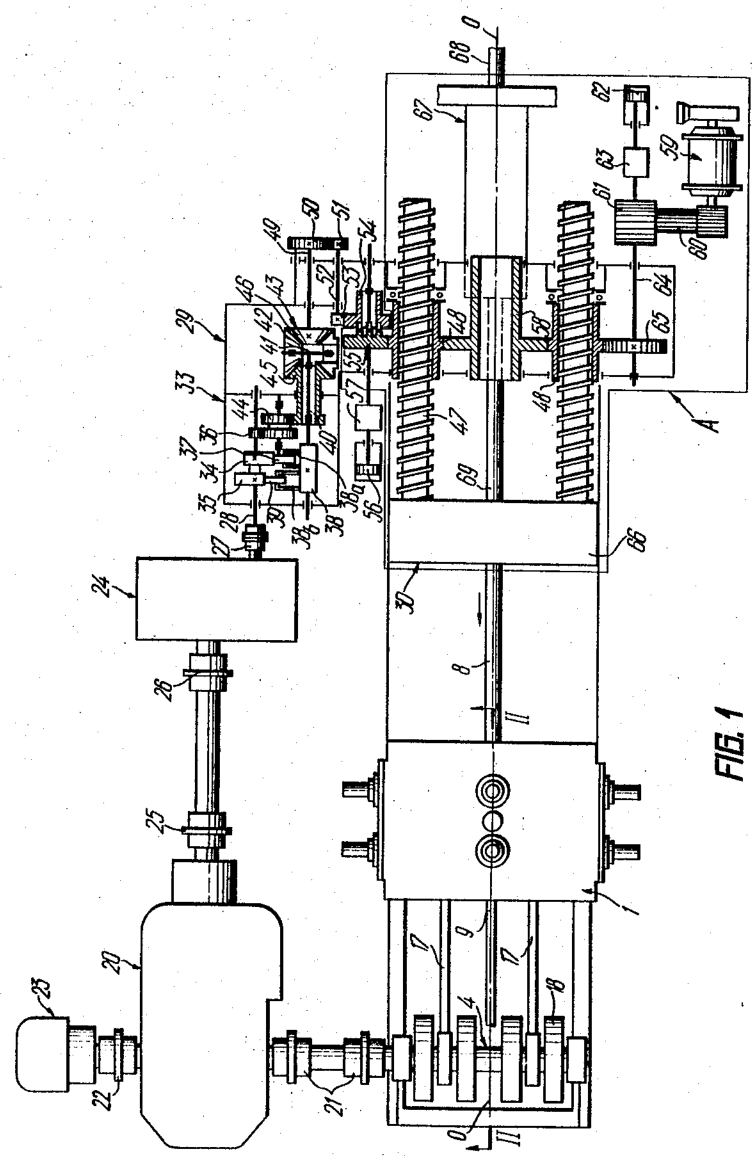

FIG. 1

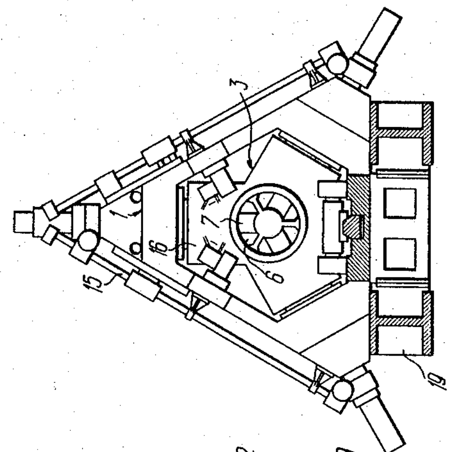
3
1
7
16
6
15
19

FIG. 3

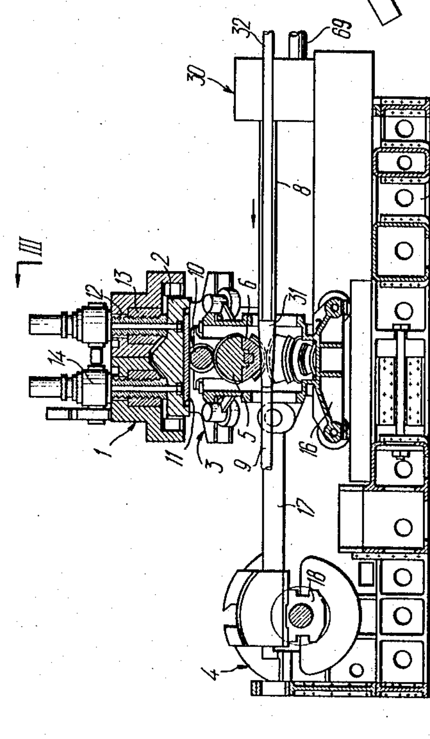
III
2
13
12
14
10
6
1
3
11
5
9
31
16
17
18
4
8
30
32
69
19
III

FIG. 2

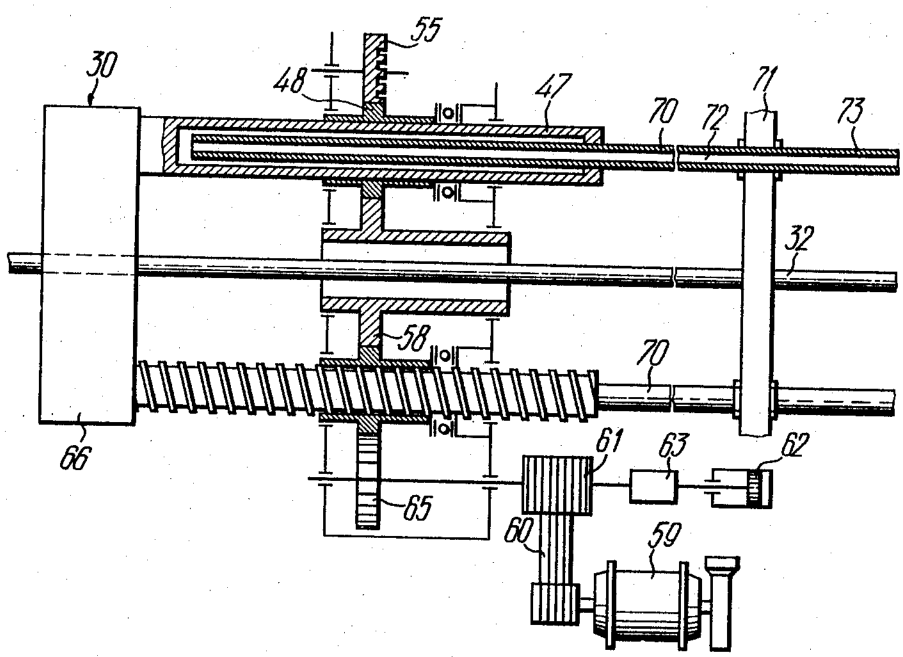

FIG. 4

FEED APPARATUS OF TUBE COLD ROLLING MILL

The present invention relates to mechanisms of tube cold rolling mills with a reciprocating roll stand and more particularly to mechanisms for feeding a tube being rolled into a deformation zone of a tube cold rolling mill.

An apparatus has previously been proposed for feeding the tube being rolled into the deformation zone of the tube cold rolling mill with a reciprocating roll stand set in motion by a drive, comprising a mechanism for conversion of a uniform rotational motion into an intermittent forward movement, whose input shaft is continuously rotated from a drive kinematically connected to the roll stand drive and whose output member has an intermittent forward movement strictly constant in magnitude and independent of a load applied thereon, and feed means engaging the tube being rolled, coupled with the output member of said conversion mechanism and being imparted an intermittent forward motion by the latter (See Author's Certificate No. 137,095, the USSR).

The conversion mechanism of the feed apparatus includes a cam shaft which is continuously rotated from a drive kinematically connected to the roll stand drive and a differential bevel gear onto which two motions are transmitted simultaneously: a reverse rotational motion from a cam and a uniform rotational motion imparted by a gear keyed to the cam shaft.

The cam profile is so designed that the cam transmits a rotational motion in one direction onto the differential bevel gear through a rocker arm, the differential gear output shaft turns through a definite angle whereas with the rotational motion transmitted in the other direction, this output shaft does not rotate.

Thus, the differential gear output shaft is imparted an intermittent rotational motion which is then converted into an intermittent forward movement by means of gear-nuts and screws which constitute an output member of the conversion mechanism and are threaded through said gear-nuts, the screw ends being connected on one side with the feed means enabling the screws to move progressively therewith.

The advantage of this apparatus consists in that, when the cam shaft is imparted a uniform rotational motion from the drive kinematically connected to the roll stand drive, feed of the tube being rolled is effected exactly at the movement required, with the roll stand in a definite position, the amount of feed being strictly determined independent of the roll stand double strokes per minute and the force applied which is most important for obtaining high quality tubing.

However, in rolling large-dimater tubes the demand for which is consistently growing, the force of stripping the tube off a mandrel at the moment of feed increased due to which it is necessary to enlarge the size of the apparatus parts operating under acceleration or deceleration modes.

Therefore, in case of tube cold rolling mills with an increased number of the roll stand double strokes per minute it is impossible to create a reliably operating feed apparatus for rolling large-diameter tubes since there are quite great inertia forces arising in parts of such an apparatus during their acceleration or deceleration which results in causing excessive stresses in the apparatus parts and thereby in their failure.

The principle object of the present invention is to provide such a feed apparatus for a tube cold rolling mill which will reliably operate in mills with an increased number of the roll stand double strokes per minute and also in rolling large-diameter tubes.

A feed apparatus is proposed for feeding a tube being rolled into the deformation zone of a tube cold rolling mill with a reciprocating roll stand operated by a drive, comprising means for conversion of a uniform rotational motion into an intermittent forward movement whose input shaft is imparted a uniform rotational motion from a drive kinematically connected to the roll stand drive and whose output member has an intermittent forward motion strictly constant in magnitude and independent of a load applied thereon, and a feed device engaging the tube being rolled and connected to the output member of said conversion mechanism, said member transmitting intermittent forward motion thereto. According to the invention, the apparatus has a hydraulic cylinder continuously transmitting fluid pressure through its movable member onto the feed device in the direction of feed of the tube being rolled, thereby decreasing load on parts of the means for conversion of a uniform rotational motion into an intermittent forward movement at the moment of feed of the tube being rolled.

It is preferable, in the feed apparatus, wherein the output member of the means for conversion of a uniform rotational motion into an intermittent forward movement is provided in the form of screws with their ends on one side coupled with the feed device and threaded through rotating nuts located from axial displacement, to make said screws hollow and to place pistons in the screw inner chambers, with their ends being fixedly secured on one side thus forming hydraulic cylinders, the pistons being provided with through passages along their entire length for supplying fluid into the inner chambers of the screws, the fluid pressure being continuously transmitted via the screws onto the feed device thereby decreasing load on the nuts and hence on other parts of the means for conversion of a uniform rotational motion into an intermittent forward movement at the moment of feed of the tube being rolled.

Such design of the feed apparatus simplifies its construction.

As a result, there has been developed a feed apparatus of a tube cold rolling mill reliably operating with a greatly increased number of double strokes per minute and also in rolling large-diameter tubes.

The invention will be hereinafter described taking by way of example an embodiment thereof and with reference to the accompanying drawings in which:

FIG. 1 illustrates a feed apparatus of a tube cold rolling mill made in accordance with the invention with a drive and a stationary frame;

FIG. 2 is a sectional view on the line II—II of FIG. 1;

FIG. 3 is a sectional view on the line III—III of FIG. 2;

FIG. 4 is a version of the A assembly of the FIG. 1.

A stationary frame **1** (FIGS. **1**, **2**, **3**) has the form of a closed triangle wherein on support rails **2** (FIG. **2**) moves a roll stand **3** (FIGS. **2** and **3**) reciprocated by a slider-crank mechanism **4** (FIGS. **2** and **1**).

In the roll stand **3**, three work rolls **5** (FIG. **2**) are arranged, each roll having on one portion of its circumference inserted dies **6** (FIGS. **2**, **3**) with grooves **7**

(FIG. 3) of varying cross-section along the roll circumference which grooves, with the roll stand in a working position approaching the extreme rear one in the rolling direction, form a closed circle corresponding to the diameter of a tube **8** being rolled (FIGS. **1, 2**) whereas with the roll stand position approaching the extreme front one they form a closed circle corresponding to the diameter of a finished tube **9.** In order that upon reduction of the tube being rolled the dies can release it with the roll stand in its extreme rear position, the grooves **7** in the dies **6** form a circle of a greater diameter than that of the tube being rolled. With the stand in this extreme rear position, the tube feed is effected in the direction of rolling by a predetermined distance.

The other part of the circumference of the work rolls **5** is supported by back-up rolls **10** (FIG. **2**) which, in turn, roll along support plates **11** attached to the rails **2** mounted on mill screws **12** arranged in nuts **13** fastened to the stationary frame **1.** The screws have a drive **14** connected therewith via line shafts **15** (FIG. **3**).

Bearing supports (not shown) of the work and back-up rolls are mounted in a cage **16** (FIGS. **2** and **3**) which is linked with connecting rods **17** (FIGS. **1** and **2**) of the slider-crank mechanism **4.** To impart a synchronous rotational motion to the work rolls, these have pinions (not shown) at their ends, the pinions being in mesh with racks (not shown) fixed on the frame **1.**

A crankshaft **18** of the slider-crank mechanism **4** is mounted in bearings (not shown) on a bed plate **19** (FIGS. **2** and **3**), whereupon is installed the frame **1**, the crankshaft being driven through a reducing gear **20** (FIG. **1**) and couplings **21** and **22** from an electric motor **23.**

The same electric motor **23**, acting through the reducing gears **20, 21** and couplings **25, 26** and **27**, transmits a continuous uniform rotational motion to a driven cam shaft **28** (the input shaft of the means for conversion of a rotational motion into an intermittent forward movement) (FIG. **1**) of a feed apparatus **29** which uses a feed device **30** (FIGS. **1** and **2**) to effect stripping of the tube **8** being rolled off a tapered mandrel **31** (FIG. **2**) and to feed this tube by a predetermined distance when the roll stand is in its extreme rear position.

During the roll stand travel the mandrel **31**, on which the tube **8** is reduced from its initial diameter to that of the finished tube by the dies **6** owing to varying cross-section groves provided therein, is held from longitudinal displacement by a bar **32** (FIGS. **2, 4**) being secured to a movable support (not shown) at the end opposite to the mandrel.

Upon matching the tube being rolled with the axis of rolling **0—0**, the movable support of the mandrel bar **32** is withdrawn by a chain drive (not shown) together with the bar and the mandrel in the direction opposite to that of rolling.

The feed apparatus **29** comprises means **33** for conversion of a continuous rotational movement into an intermittent forward movement having the cam shaft **28** whereupon are mounted a cam **34**, a counter cam **34** and a pinion **36.** The cam **34** is followed by a roller **37** fastened to an arm **38***a* of a double-arm lever **38** whereas the counter cam is followed by a second roller **39** fastened to a second arm **38***b* of the double-arm lever **38.** The profiles of the cam **34** and that of the counter cam **35** are so selected that the rollers **37** and **39** following them do not go out of continuous contact with the surfaces thereof while the lever **38** swings together with a shaft **40** whereon is mounted a planet carrier **41** with rotating thereon planet bevel wheels **42** of a differential bevel gear **43.**

Continuous uniform rotation is transmitted from the cam shaft **28** through a pinion **36** and a cluster gear **44** to a bevel gear **45** of the differential gear **43.** The profile of the cam **34** is so designed that when the lever **38** swings together with the planet carrier **41** in a direction coinciding with that of rotation of the bevel gear **45** of the differential gear **43**, the planet carrier **41** has such a constant speed that the planet bevel wheels **42** rolling ever the bevel gear **45** transmit no motion to an output bevel gear **46** of the differential **43** whereas when the lever **38** swings in the other direction opposite to the direction of rotation of the gear **45**, the planet bevel wheels transmit rotation to the output gear **46** of the differential gear **43.** Thus, a uniform rotational motion transmitted onto the cam shaft **28** is converted into an intermittent rotational motion imparted to the output bevel gear **46** of the differential gear **43.**

Further, the intermittent rotational motion is converted into an intermittent forward movement, by means of screws **47** moving progressively and constituting the output member of the conversion means and also via gear-nuts **48** being imparted an intermittent rotational motion by the bevel gear **46** of the differential gear **43** through a shaft **49**, change pinions **50** and **51** serving to vary the amount of feed, a shaft **52**, a gear **53**, cam gears **54** and **55** which are brought in engagement and disengaged by a power cylinder **56** through a bearing clutch **57.** Simultaneously, rotation of the nuts **48** is effected by means of a gear **58**, the gear-nuts **48** being in engagement therewith.

The screws **47** are threaded through the gear-nuts **48**, the screw ends on one side being connected with the feed device **30**, and thus the screws move progressively in the direction of rolling.

Returning of the feed device **30** to its initial position is accomplished at an increased speed, the drive being taken from an individual electric motor **59** via a V-belt drive, a friction clutch-pulley **61** actuated and disengaged by a power cylinder **62** through a bearing clutch **63** and further via a shaft **64**, a gear **65**, the gear-nuts **48** rotated in the reverse direction, and the screws **47.**

The second part of the feed apparatus **29** is the feed device **30** consisting of a housing **66** (FIG. **1**) moving on guides (not shown) wherein is arranged a stop or tube clamps (not shown) engaging the tube **8** being rolled. The feed device is imparted an intermittent forward movement by the screws **47** coupled therewith through the housing **66.** A hydraulic cylinder **67** is connected by a hydraulic drive **68** with a fluid delivery source (not shown) wherefrom fluid pressure is constantly transmitted via a piston rod **69** onto the feed device over the entire length of its travel in the rolling direction due to which the screws **47**, the gear-nuts **48** and all the components of the conversion means **33** are relieved from some portion of the load acting thereupon at the moment of feed as the tube **8** is being stripped off the mandrel **31.**

FIG. **4** shows a version of the assembly A (FIG. **1**) of the feed apparatus **29** wherein the function of the hydraulic cyclinder **67** is taken up by the screws **47** being the output member of the means **33** for conversion of a uniform rotational motion into an intermittent forward movement, and provided with inner chambers wherein pistons **70** are placed with their ends fastened on one side to a support **71**. The pistons **70** have through passages **72** extending along their entire length through which fluid under pressure is constantly supplied into the chambers of the screws **47** by hydraulic drives **73** from a fluid delivery source (not shown).

The screws **47** are mounted in the gear-nuts **48**, their ends being connected on one side to the feed device **30**. Since fluid pressure is constantly transmitted through the screws **47** to the feed device, the load on the gear-nuts **48** decreases and consequently, there occurs a reduction in the load acting on other parts of the means for conversion of a uniform rotational motion into an intermittent forward movement at the moment of feed of the tube **8** being rolled.

Such design of the feed apparatus simplifies its construction and enables fluid pressure to be transmitted via the screws **47** arranged symmetrically to the axis of rolling **0—0**.

The feed apparatus operates as follows.

The electric motor **23** through the coupling **22**, the reducing gear **20** and the couplings **21** actuates the crankshaft **18** of the slider-crank mechanism **4** which, through connecting rods **17**, imparts a reciprocating motion to the roll stand **3**. Simultaneously, the inserted dies **6** of the work rolls **5** roll over the tube **8** fited on the mandrel **31** and entered into the deformation zone, with their varying cross-section grooves **7** so that, during the stand travel the tube is reduced from its initial diameter to that of the finished tube due to reduction both on its diameter and wall thickness. In this way, the tube being rolled elongates and exits in the form of the finished tube **9** on the side of the slider-crank mechanism **4**.

A force arising due to reduction of the tube **8** is transmitted from the work rolls **5** through the back-up rolls **10** to the plates **11** along which the rolls **10** roll. Then, this force is transmitted, through the support rails **2** wherein are secured the plates **11**, the mill screws **12**, the nuts **13**, to the stationary closed-type frame **1**.

The outside diameter of the finished tube **9** can be controlled in the process of rolling by means of bringing the work rolls **5** close or apart together with the back-up rolls **10**, the plates **11** and the support rails **2** relative to the axis of rolling **0—0** using the mill screws **12** operated from the drive **14** through the line shafts **15**.

The inside diameter of the finished tube is controlled by the movement of the tapered mandrel **31** in the axial direction.

During each double stroke of the roll stand **3**, with the stand in its extreme rear position in respect to the direction of rolling, the feed apparatus **29** effects, by means of the feed device **30** engaging the tube **8** via a stop or clamps, stripping of the tube off the tapered mandrel **31**, and feeds it by a predetermined distance in the rolling direction.

In order that feed of the tube **8** being rolled be regularly effected at the moment required with the roll stand **3** in its extreme rear position, the driven shaft **28** of the feed apparatus **29** is kinematically connected to the roll stand drive so that the electric motor **23** transmits through a reducing gear **20**, the couplings **25** and **26**, the reducing gear **24** and the coupling **27**, such kind of rotation onto the driven shaft **28** that it makes one revolution during the time in the course of which the roll stand makes one double stroke.

The shaft **28** is coupled with the reducing gear **24** through the coupling **27** in such a way that the cam **34** mounted on the shaft **28** swings at the moment of feed in such a direction which coincides with that of rotation of the gear **46** of the differential gear **43** which rotation being transmitted through the shaft **49**, change gears **50** and **51**, the shaft **52**, the gear **53**, cam gears **54** and **55** actuated by the cylinder **56** via the clutch **57**, to the gear-nuts **48**.

The gear-nuts **48**, by turning through a definite angle, displace the screws **47** which together with the feed device **30** will advance in the direction of rolling and accomplish feed of the tube **8** being rolled.

During each double stroke of the roll stand **3**, one portion of the tube **8** being rolled is fed into the deformation zone.

The feed device **30** moves intermittently until it reaches its extreme front position, in the direction of rolling, specified by the design the tube cold rolling mill.

During the entire travel of the feed device **30** in the direction of rolling, into the hydraulic cylinder **67** (FIG. **1**) coupled therewith or the inner chambers of the screws **47** (FIG. **4**), fluid is continuously supplied under a predetermined pressure which creates pressure transmitted onto the feed device **30** in the direction of feed of the tube **8** being rolled and also relieves the parts of the feed apparatus **29** from some portion of the load arising when stripping the tube **8** off the mandrel and feeding it in the direction of rolling.

Upon the intermittently moving feed device **30** has reached its extreme front position, the cam gears **54** and **55** are disengaged by the hydraulic cylinder **56**, and the feed device **30** stops.

Then, the pressure of the fluid delivered into the hydraulic cylinder **67** or the inner chambers of the screws **47** drops, the friction clutch **61** is switched off by the hydraulic cylinder **62**, the feed device is disengaged from the tube **8** being rolled and accelerated in the reverse direction by the electric motor **59** acting through the V-belt drive **60**, the friction clutch **61**, the shaft **64**, the gear **65**, the gear-nuts **48** and the screws **47** (FIGS. **1**, **4**). At the same time, the fluid filling the hydraulic cylinder **67** (FIG. **1**) or the screws **47** (FIG. **4**) is displaced therefrom by the piston rod **69** moving backward or by the pistons **70** and then drained off.

The electric motor **23** is also switched off, and the roll stand **3**, upon making several strokes on the tube **8** without feeding it to facilitate withdrawing the mandrel **31** thereout, also stops. The mandrel **31** together with the bar **32** is retracted by a separate chain drive.

The feed device **30** and the mandrel **31** are retracted by a distance which enables a next tube to be interposed between the tail end face of the tube **8** being in the dies **6** and the feed device **30**. Upon loading the next tube to be rolled the mandrel **31** is entered therethrough into the rolled tube being in the dies **6**.

The hydraulic cylinder **56** actuates cam gears **54** and **55**. The friction clutch **61** is disengaged by the hydraulic cylinder **62**.

The hydraulic cylinder **67** (FIG. **1**) or the inner chambers of the screws **47** (FIG. **4**) are supplied with fluid under pressure via the hydraulic piping **68** or the pistons **70**, respectively.

The main drive motor **23** is switched on and the process of rolling begins anew.

After the tube **8** has left the zone of the work rolls **5** and is no longer gripped by the dies **6**, it becomes the finished tube **9** and is removed from the axis of rolling **0—0** in any known manner.

The use of a hydraulic cylinder for relieving the parts of the feed apparatus from some portion of loads acting thereupon during the feed of the tube being rolled into the deformation zone, has permitted to make the parts of this apparatus smaller in size and in weight than in case such a decrease in loading is not provided which in turn has made it possible to create a feed apparatus running at a higher speed, employed in tube cold rolling mills with a great number of the roll stand strokes and rolling large-diameter tubing.

What we claim is:

1. A feed apparatus for feeding a tube being rolled into the deformation zone of a tube cold rolling mill with a reciprocating roll stand operated from a drive, comprising: means for conversion of a uniform rotational motion into intermittent forward movement and having an input shaft to which the uniform rotational motion is transmitted by a drive kinematically connected to said drive of the roll stand so that said input shaft makes one revolution during the time in the course of which said roll stand makes one double stroke, and an output member having an intermittent forward motion constant in magnitude and independent of a load applied thereon in the direction of said deformation zone at the end of the backward, to the direction of rolling, travel of said roll stand; a feed device coupled with said output member and being imparted said intermittent forward motion therefrom, said device having means to feed the tube being rolled into the deformation zone; a hydraulic cylinder connected to a fluid delivery source to transmit fluid pressure into said feed device in the direction of said deformation zone and hence to decrease load on the parts of said conversion means at the moment of feed of the tube being rolled.

2. A feed apparatus as of claim **1** characterized in that said output member of the means for conversion of a uniform rotational motion into an intermittent forward movement is provided in the form of screws threaded through nuts located from axial displacement with their ends on one side being connected to said feed device, said screws being made hollow and their inner chambers accommodating pistons with their ends fixedly secured on one side thus forming hydraulic cylinders, said pistons having along their entire length through passages being connected to the fluid delivery source through which passages fluid is being supplied into said inner chambers of the screws such that the fluid pressure is constantly transmitted through said screws onto said feed device thereby decreasing load on said nuts and hence on other parts of said means for conversion of a uniform rotational motion into an intermittent forward movement at the moment of feed of the tube being rolled.

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