March 14, 1967 W. VOM DORP 3,308,644

DRIVE FOR TUBE REDUCTION MILLS

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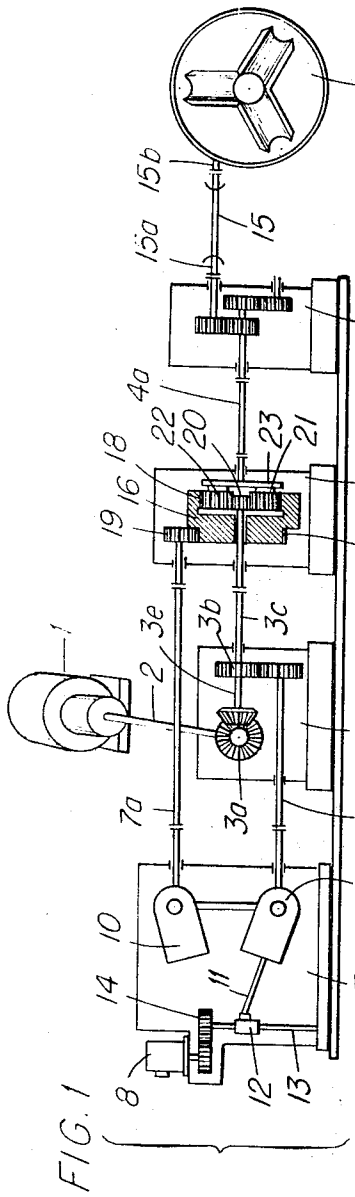


FIG. 1

PRIOR ART

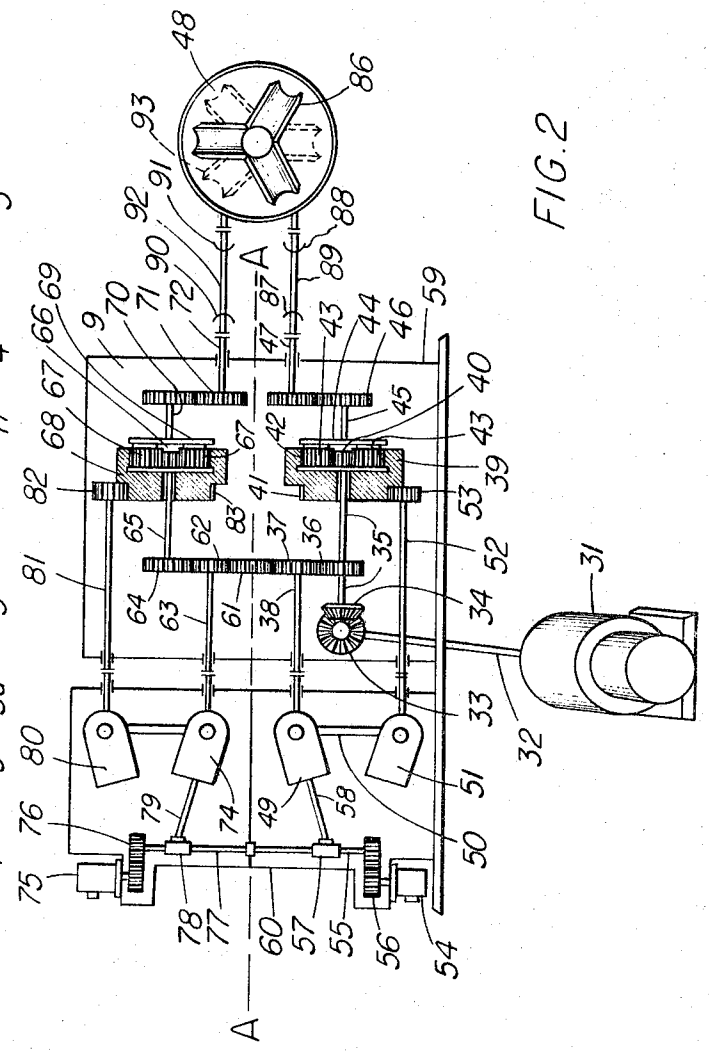


FIG. 2

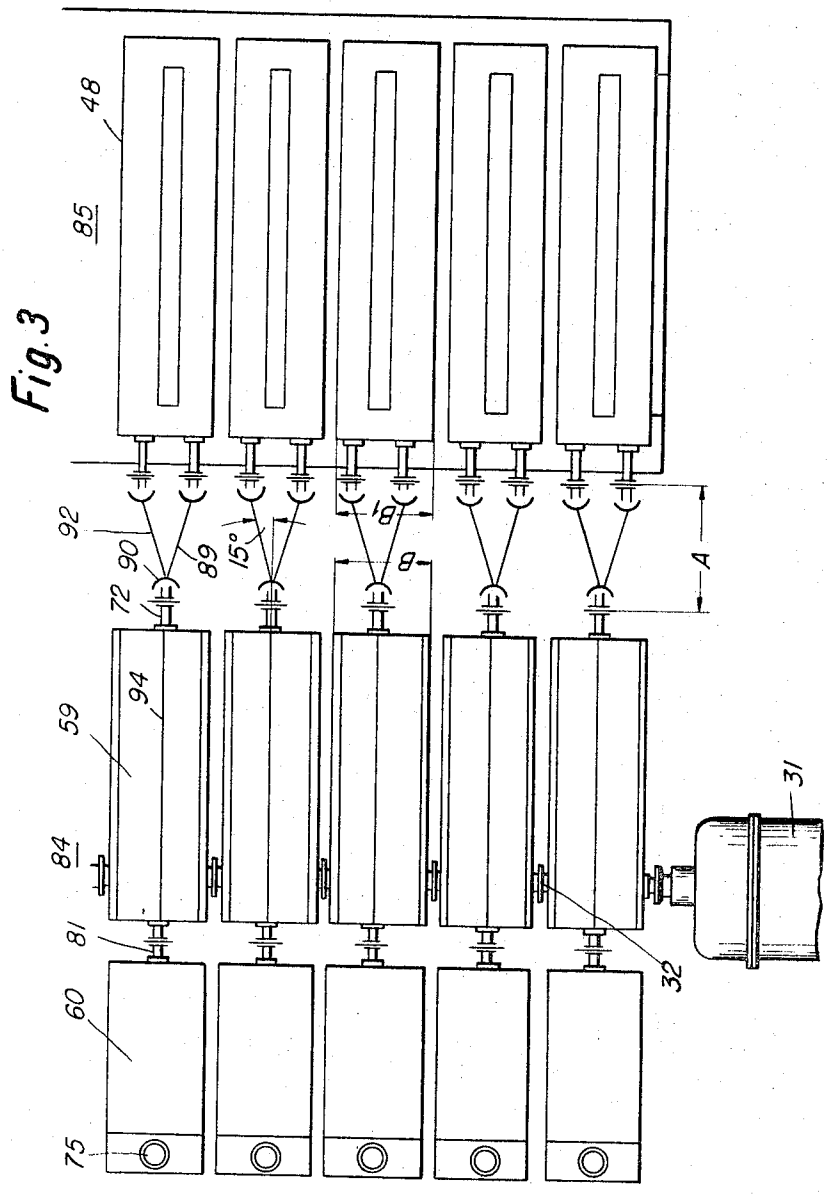
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Fig. 3



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DRIVE FOR TUBE REDUCTION MILLS

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In the continuous production of tubing, a tube is reduced by being passed through a series of roll stands, each having two roll heads, one directly behind the other in the direction of rolling. These stands are driven by a prime mover, normally a motor, through a main shaft which in turn activates geared drives, one for each roll head. The geared drives are of conventional construction and are connected to the roll heads, whereby power is transmitted from the main shaft to the roll heads. The geared drives conventionally have an auxiliary adjustable element by means of which the output of the geared drives can be varied. These adjustable elements (which may be controllable individually or in common) are conventionally hydraulic-mechanical in character.

Each roll stand, then, conventionally has two geared drives and two auxiliary drives, one each for each roll head, associated with it, and the characteristics of these drives influence not only the cost of the drives themselves but also the economics of the entire installation through their bearing on roll distance, roll head construction, ease of inspection, ease of access and space required.

Many efforts have been made hitherto to improve the economics of rolling mills. However, these efforts have the defect that the conventional drives used with the roll stands have not been examined as critically as the roll stands themselves. For example, progressive ideas advanced in regard to the economical erection of roll stands have been combined with conventional drive arrangements so that the overall installations have offered no possibility to the work planner for laying out a rational space distribution. For example, attempts have been made for some time to keep the distance between roll stands as small as possible to limit the scrap at the thickened ends of the stock being rolled to a minimum. In the case of a multi-stand mill this has resulted in a shortening of the depth of the row of roll stands in the direction of rolling. However, the associated drives have always occupied the same space and hence, the depth of the drive row remained the same.

Moreover, each roll stand and its associated drives are normally connected by a shaft containing a universal joint. Since the row of stands is of a different depth than the row of drives these shafts assume a fan-like pattern. But since the angle that can be tolerated for the universal joint in the extreme stand-drive coupling is limited, the distance between the drive row and the stand row cannot be decreased below a certain minimum, thus setting a minimum width for the entire installation. This minimum is magnified because in the conventional installations the various elements of each drive are arranged one after the other, spreading the drive out so that the entire plant requires an area which has no relation to a rational space economy.

The present invention overcomes these shortcomings by making it possible to erect, for a modern tube reducing mill with the smallest possible distance between stands, an asociated drive which is not only equal in depth to the roll stands, but also is considerably shorter in width. A unit in accordance with the invention is disposable within the smallest space in a manner permitting economical production, thus favorably influencing

the cost factor, whilst still being capable of simple operation and easy inspection.

In accordance with the invention, these and other objects are achieved by means of a drive in which the drive elements for the two roll heads of a roll stand including the totalizing or differential gear element, bevel gear means for transmitting power from the prime mover to the differential, a superimposed drive associated with the differential drive, and a subsequent step-down drive are included in a single housing, the elements for one of the roll heads being positioned above those for the other in mirror symmetry about a horizontal plane separating them. This arrangement enables the depth of the drive housing (in the direction of rolling) to be equal to two roll heads, and it follows that the depth of the drive row is equal to the depth of the roll stand row. This obviates the need for fanning the universal joint shafts connecting the drives to their associated stands. Furthermore, the distance from stand to drive may be shortened as much as the maximum bending angle of the universal joint shafts at the load to be transmitted, permits. With a permissible bending angle of 15° this may mean a space saving of about 50% as compared to prior arrangements, so that a shortening of the total width of the installation may be reduced thereby.

Costwise, producing a well thought out housing results not only in a saving in material and work hours, but also in the square feet required in the producing area. This offers a substantial contribution toward the rational over-all planning of the plant, which is expressed economically in the lower cost and high quality of the installation as well as better accessability and ease of inspection.

The invention is further described in connection with the drawings in which

FIG. 1 is a schematic view in elevation of a conventional rolling mill installation;

FIG. 2 is a schematic view in elevation of a rolling mill installation in accordance with the invention.

FIG. 3 is a schematic plan view of the installation of FIG. 2.

Conventional roll mills have been constructed on the assumption that the required drive units must be housed separately in order that a breakdown may be quickly repaired. This problem makes a complete substitution for each unit necessary, so that keeping a replacement stock is a costly matter. Experience shows that most replacement requirements are for small, highly stressed parts, hardly making it worthwhile to maintain so large a stock pile. A consequence of maintaining a collection of units, because of the necessary connections between them, is that the room required for storing spare parts is very great.

FIG. 1 shows such a conventional installation. Referring to that figure, a prime mover, shown as an electric motor **1**, drives a shaft **2** which constitutes the input of a transmission assembly **3**, which, as shown, comprises a bevel gear unit **3***a* and a spur gear unit **3***b*. Power is transmitted from the transmission assembly **3** to a totalizing or differential drive (Summengetriebe) **4** via a shaft **3***c* and to an auxiliary drive **7** via a shaft **3***d*. The auxiliary drive **7** also feeds an input to differential drive **4** via a shaft **7***a*. The output from the differential drive **4** is sent via a shaft **4***a* to a step down gear train **5** and thence via shaft **15**, which includes universal joints **15***a* and **15***b*, to a roll stand **6**.

The units described above are entirely conventional and will readily be recognized by those skilled in the art.

Power transmitted from the prime mover **1** turns shaft **3***c* via bevel gears **3***a* and thus turns spur gears **3***b* and shaft **3***c*. Spur gears **3***b* drive shaft **3***d* which operates

a fluid pump 9 which in turn drives an hydraulic motor 10. The pump 9 and motor 10 are of known design and are described in the United States patent to Thoma 2,177,613. See also "Oil Power and Its Industrial Applications," Ernst, McGraw-Hill, New York, 1949, pp. 124, 132, 133, 183. Taken together they are sometimes known as a Thoma transmission. The speed of the motor 10 is controlled via an arm 11 which is pivotally mounted on a sleeve 12 which is threaded on a shaft 13. A small electric motor 8 is provided for rotating shaft 13 via gears 14 and thus adjusting the setting of pump 9, and hence the speed of the hydraulic motor 10.

As shown in the drawing, the motor 10 drives shaft 7*a*, which, with shaft 3*c*, constitutes an input to the differential or totalizing drive 4 which is superimposed on the input delivered by shaft 3*c*. The particular type of differential disclosed comprises a ring gear 16 which is provided with outer gear teeth 17 on its outer rim and also inner teeth 18 on an inner face. The outer teeth 17 are egaged by a spur gear 19 which is turned by the shaft 7*a*.

The shaft 3*c* carries a sun gear 20 which is positioned at the center of ring gear 16. A plurality of planetary gears such as 21, 22 rotatably mounted on a plate 23, are interposed between sun gear 20 and the inner teeth 18 of the ring gear 16, engaging both gears. The shaft 4*a* is fixed to the center of plate 23 and drives, through step down gearing 5 and shaft 15, a roll head of roll stand 6. It will be obvious that the power transmitted from differential drive 4 through shaft 4*a* is a resultant of the power transmitted directly from the prime mover through shaft 3*c* and that transmitted through the auxiliary drive through shaft 7*a*. This latter is, of course, controllable by controlling the setting of pump 9.

As can be seen from FIG. 1, the conventional arrangement is spread out over a comparatively large space and requires a large area. Moreover, one of these assemblies is required for each of the roll heads of each roll stand.

FIG. 2 represents an arrangement according to the invention. As will be seen readily from a comparison of FIGS. 1 and 2, all of the individual drive units except the auxiliary drive have been combined in a single housing. This single large housing, moreover, encloses not only the drive units for a single roll head but for the two roll heads of a roll stand. Broadly speaking, this effect is obtained by locating the drive units for the two roll heads of a roll stand, above one another in mirror symmetry about a horizontal plane. This pattern is carried out in one housing for the auxiliary drive and in a second housing for the other drive units. It is further essential that the drive housing is symmetrically divided in the vertical plane to allow for the far reaching simplified construction.

Considering now the construction of FIG. 2 in detail:

Prime mover 31 which may be an electric motor, drives a main drive shaft 32. Mounted on the main drive shaft is a beveled gear 33 which engages and drives a second beveled gear 34 mounted on a shaft 35. Also mounted on the shaft 35 is a spur gear 36 which engages a second spur gear 37 mounted on a shaft 38.

The shaft 35 is mounted to pass through a ring gear 39 and has fixed on its end, positioned inside the ring gear 39, a sun gear 40. The ring gear 39 has outer teeth 41 and inner teeth 42. A plurality of planetary gears 43 are interposed between the sun gear 40 and the inner teeth 42 of ring gear 39. These planetary gears 43 are each rotatably mounted on a plate 44 which is in turn fixed to a shaft 45. The shaft 45 provides the input of a reducing gear train 46 through which a shaft 47 is driven. Shaft 47 drives (through connections not shown), one roll head 86 of a roll stand 48 through universal joints 87 and 88 and a connecting shaft 89.

The shaft 38, which, as noted above, is driven from shaft 35 through gears 36 and 37, drives a Thoma pump 49 (see above) which is coupled via line 50 to an hydraulic motor 51 of the same type. Motor 51 in turn drives a shaft 52 to which is fixed a gear 53. The gear 53 is arranged to mesh with outer teeth 41 on ring gear 39.

The input furnished through shaft 52 is varied in known manner by varying the angle of pump 49. Thus an auxiliary servo-motor 54 is arranged to drive a threaded shaft 55 by means of gearing 56. A nut 57 on shaft 55 is connected to pump 49 via an arm 58. The angle of the pump 49 may thereby be varied and the rate at which motor 51 and shaft 52 are driven, adjusted.

A comparison of that portion of FIG. 2 which has just been described, with FIG. 1, will show that the gears 33, 34, 36 and 37 correspond to the transmission assembly 3 of FIG. 1, the gears 39, 40, 42 and 53 to the differential drive unit 4 of FIG. 1, the gear train 46 to the gear train 5 of FIG. 1 and the pump-motor combination 49, 51 to the auxiliary drive unit 7 of FIG. 1. In the device shown in FIG. 2 all the elements, except the hydraulic pump and motor 49, 51 are enclosed in a common housing 59. A separate housing 60 encloses the hydraulic pump and motor 49, 51. Moreover, in accordance with the invention, the housing 59 includes a second complete set of driving elements corresponding to the transmission assembly, differential drive and reducing gear train and the housing 60, a second complete auxiliary drive. In each case these are arranged above the units already described in such a position as to be in mirror symmetry with the lower units about a horizontal plane indicated, as A—A in FIG. 2.

Thus, the gear 37 which, as described above, is driven from the prime mover 31 via bevel gears 33, 34 and spur gear 36 meshes with an intermediate spur gear 61, and through this gear 61 drives a spur gear 62 and shaft 63. The gear 62 in turn meshes with a gear 64 and through it drives a shaft 65. The shaft 65 carries a sun gear 66 which meshes with planetary gears 67 which engage the inner teeth of the ring gear 68. The planetary gears 67 are rotatably mounted on a plate 69 to which is fixed a shaft 70. The shaft 70 drives reducing gear train 71 and through it shaft 72. Shaft 72 through universal joints 90 and 91, and connecting shaft 92 drives a second roll head 93 in the roll stand 48.

The shaft 63, driven by gear 62, drives a pump 74 which is adjusted by auxiliary servo-motor 75, gearing 76, shaft 77, nut 78 and arm 79, in the manner described above. The pump 74 drives hydraulic motor 80, which in turn drives shaft 81 and gear 82 which meshes with outer teeth 83 of ring gear 68.

Thus, it will be seen that the device according to the invention as shown in FIG. 2 comprises two complete drive units for the two roll heads of one roll stand located one above the other, in mirror symmetry about a central horizontal plane. The effect of this arrangement is shown more fully in relation to space requirements and ease of inspection, in FIG. 3.

Referring to FIG. 3, it will be observed that the drive unit output shafts 72 and 47 are arranged vertically above one another in the plane of the vertical seam 94 of the drive housing 59. The shafts 81, 63, 38 and 52 connecting the auxiliary drive and the drive unit are also arranged one above the other in this vertical plane.

The thing which is immediately apparent from FIG. 3, however, is that the usual fanning out of the connecting shafts 89, 92 connecting the drives with the roll stands which require bending solely in the horizontal plane, is eliminated; if an angle of 15° is used as shown in the drawing, a saving in the distance A of about 50% is possible.

Also the total depth of the row of drives 84 corresponds to the total depth of the row of roll stands 85, a fact that is made possible by the double drive of the invention, whose individual depth B is equal to the depth B, of the roll stands each containing two roll heads.

In addition, the width can be reduced because within the double drive housing 59, all mechanical drives are combined; and because the length of the universal joint connecting shafts such as 89 and 92, can be shortened due to the fact that the depths of the drives and roll stands are equal.

Equipment constructed in accordance with the invention makes it possible to double the effectiveness of the installation which can be put in a given space.

What is claimed is:

1. In a rolling mill installation comprising a plurality of roll stands, each having two roll heads, and a drive assembly comprising a main drive shaft from which drive units are driven, one drive unit for each roll head, each drive unit having a transmission element comprising bevel and spur gear assemblies, a totalizing drive element with a mechanical super-imposed drive element and a step down gear train element, the improvement which comprises positioning the transmission element, totalizing drive element and step down gear train element for the two roll heads of a roll stand in a single housing in mirror symmetry to one another with respect to a horizontal plane passing through the center of the housing, and driving one of said drive units by means of a spur gear driven by the transmission element of the other unit.

2. Apparatus as claimed in claim 1 and comprising an hydraulic auxiliary drive furnishing the super-imposed drive for the totalizing drive element, and being driven from the transmission element of said drive unit, the auxiliary drives for the two roll heads of a roll stand being located in a single housing in mirror symmetry to one another with respect to a horizontal plane passing through the center of said housing.

3. Apparatus as claimed in claim 2 wherein the auxiliary drives are connected to the drive units by shafts and shafts are provided for driving the roll heads from the drive units, all of said shafts being positioned in a vertical plane passing through the center of the drive unit.

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