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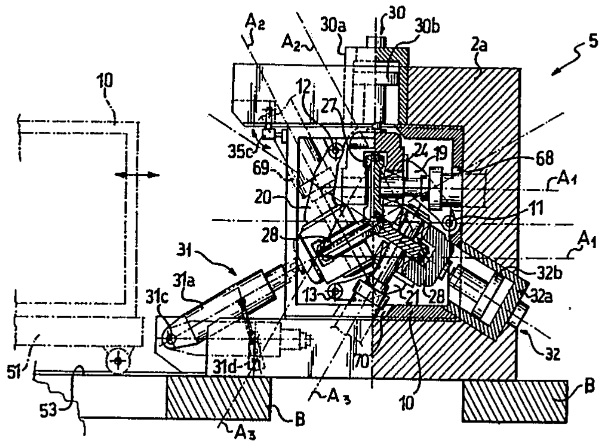

(57) Abstract

A rolling stand (5) comprises at least three driven rolls (27, 28, 29), having their axes (A1, A2, A3) of rotation which are concurrent one another and lie in a plane perpendicular to a rolling axis along which the rolling stand is located; these rolls (27, 28, 29) are mounted on respective lever arms (19, 20, 21) pivoted on a roll-carrier (10), substantially in the form of a frame, which can be pulled out of a C-shaped support structure (2a, 3) of the stand. The stand of this invention provides the possibility of driving the rolls (27, 28, 29) simultaneously with their single adjustment, together with a great simplification of the operations for their removing and replacement. As a consequence of its features, the stand of this invention can be usefully applied in tube rolling mills, either with or without mandrel, as well as in rolling mills for wires, rods and similar.

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A ROLLING STAND FOR GENERIC ROLLING MILLS HAVING THREE OR MORE ADJUSTABLE DRIVEN ROLLS

This invention relates to a rolling stand of a type which comprises at least three driven rolls having respective axes of rotation which are concurrent one another and lie in a plane perpendicular to a rolling axis along which said rolling stand locates, an outer main support structure, driving means and associated mechanical transmission means for operating the rolls.

Such a rolling stand has an application, in the current state of the art and with some obvious modifications as may be required to adapt it for different operating conditions, in rolling machines employed to process tubular or rod-shaped bodies in the steel industry and the like.

The terms rod-shaped or tubular bodies refer here to those finished or semifinished products having a major longitudinal dimension, such as tubes, hollow blanks, rods, etc.

In rolling mills for wire or rod making, for example, a stand as above is already known; a similar stand is also known, in a substantially similar form, for tube rolling mills. In either cases, such stands are used substantially for the same purposes, as it will be explained in detail in this specification.

Further, in this specification, reference will be made, for brevity and convenience of illustration, only to rolling stands intended for seamless or normal tubes rolling mills, and more specifically a finisher rolling mill provided with a mandrel. Of course, as a consequence of the foregoing remarks about the the different applications of this type of rolling stand, the considerations made hereinafter should be taken in a substantially general sense, and can be extended to analogous rolling machines which belong to the general state of the art and in which such stands are used.

Additionally, notice that the term rolling stand is used, throughout this specification and the appended claims, to designate that intermediate unit of a rolling mill which accommodates the rolls designed to apply their action to a product being rolled, be it tube, wire, bar or else.

In conventional tube rolling mills, the rolling stands are generally independent, from a structural point of view, one from another and can be individually moved off the mill to allow their replacement in order to carry out the changing of the rolls or, where such a changing is made in a different manner, for providing the maintenance. In a preferred embodiment, the rolls of such stands have coplanar axes of rotation which lie in a plane orthogonal to the rolling axis; such a rolling mill is commonly referred to as a continuous rolling mill.

In the tube rolling industry, it is recognized that the proper performance of the rolling process is strictly dependent on the action applied by the grooves of the rolls of each rolling stand.

More particularly, it is known from theory that either the geometric tolerance and surface finish of a tube depend on the difference between the tube rate of advance along the rolling axis and the peripheral speeds of the rolls as measured at several locations of their grooves where the tube is in contact.

The industrial production of seamless tubes is currently carried out on continuous rolling mills provided with a mandrel and having a set of successive stands, each provided with a pair of driven rolls; such rolls are supported by an external structure, opposite one to the other, and have parallel axes of rotation. In this specific case, the contact of the tube being processed with the groove of one of these rolls, occurs approximately over one half of the tube outer circumference.

Recently, on a purely experimental basis and alternatively to the above-mentioned approach, the feasibility of continuous rolling mills equipped with rolling stands having more than two rolls was investigated.

This happened because, in such an embodiment of rolling mill, the contact between the profile of the roll grooves and the tube being processed occurs over an arc of said outer circumference of the tube, whose length is inversely proportional to the number of the rolls in each stand. Thus, in the particular instance of a three-roll stand, the profile of the roll grooves of the latter will be active over an arc being approximately one third of the tube outer circumference; in practice, the larger is the number of the rolls in each rolling stand, the more uniform becomes the speed of the points of the roll groove which come into contact with the tube being processed, since the contact arc of the groove with the tube becomes shorter. Thus, the aforementioned demand for a limited difference between the tube rate of advance and the roll peripheral speeds can be better fulfilled.

Therefore, the development of rolling mills equipped with stands having more than two rolls is of great interest because it has been verified, both theoretically and experimentally, that the shorter is the length of the arc of the tube outer circumference being worked upon by a single roll, the better are the resulting tube surface finish, the thickness tolerances and the properties of material deformation.

This explains the efforts being currently made in the art in order to provide rolling mills which embody this novel technological concept.

It should be considered, however, that while on the one side a number of rolls greater than two will enhance the mill performances, on the other side, as the number of rolls in each rolling stand is increased, the technical difficulties encountered in engineering the rolling mills, also increase significantly. As an example, the construction of three-roll stands already involves technical difficulties which still have to be fully overcome; among these latter there are the problems posed by the simultaneous driving of the three rolls and independent adjustment of their distances from the rolling axis.

In fact, three-roll stand mills experienced or known heretofore, have failed to provide that adjustment feature combined with the aforesaid roll driving in such a suitable way as to render the rolling mills applicable in the industry; in other words, the mills provided are too inflexible and unsuitable to cope with the different operating conditions met in the tubes industrial manufacturing.

It is the object of this invention to provide a rolling stand having at least three driven rolls, an outer main support structure, driving means and associated mechanical transmission means for operating the rolls, with such constructional and functional features as to overcome the drawbacks mentioned above with reference to the prior art.

This problem is solved, according to the invention, by a rolling stand as indicated above and characterized in the appended claims.

Further features and the advantages of this invention can be more clearly understood from the following description of an embodiment thereof, to be taken by way of non-limitative example with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of a rolling mill incorporating rolling stands according to the invention;

Figure 2 is a partially cut-away front view of a rolling stand according to the invention;

Figure 3 is a partially cut-away perspective view of a detail of the rolling stand in Figure 2;

Figure 4 is a detail view of the rolling stand in Figure 2, shown in different conditions of its operation;

Figure 5 is a partially cut-away side view of the rolling mill in Figure 1.

With reference to the drawing views, and particularly to Figure 1, generally shown at 1 is a rolling mill according to the invention, intended for seamless tube making.

The rolling mill 1 comprises an outer main structure, extending longitudinally along a rolling axis L and laying on a basement B. In this embodiment, the rolling mill structure 2 comprises a plurality of flat elements 2a, which will be better described in the continuation, rigidly are interconnected by spacers 3.

The rolling mill 1 is of a type which comprises a plurality of rolling stands 5 aligned along the longitudinal axis 1 between an input end 6 and an output end 7 for tubes to be processed; said ends 6 and 7 are respectively located at the opposite ends of the structure 2.

Each rolling stand 5 according to the invention comprises a pair of said flat elements 2a laid side-by-side and being connected together by spacers 3 in the main structure 2, a plate 9, and a roll-carrier 10. Specifically, said flat elements 2a have a shape referred to as C-shape hereinafter for simplicity, and each of them carry a pair of linear guide bearings 4, extending from opposite faces of the element 2a, parallel to each other along a perpendicular direction to the rolling axis

L, towards the open side of the C-shape of said flat elements 2a. In practice, two consecutive elements 2a in the rolling mill and their associated spacers 3 define the supporting structure for each stand; in this example of the rolling mill, all the stands and their supporting structures are joined together in a continuous manner, so that two faces of a single element 2a are parts of two adjacent stands along the rolling axis L.

Furthermore, the roll-carriers 10 are arranged in a package wherein the roll-carrier 10 associated to a rolling stand is basically in the form of a square frame, which is housed between two consecutive of said flat elements 2a in the rolling mill 1, that are parts of the structure of each stand 5.

The plate 9 is interposed between two roll-carriers 10 lying side-by-side in the mill; the plate 9 is basically in the form of a sheet having a predetermined thickness and being centrally provided with a hole 9a to let a tube passing through the stand. Further, the plate 9 is housed within the stand at the location of each element 2a and can be pulled radially out of the rolling mill, as it will be explained afterwards in connection with the operation of the stand 5.

In this embodiment of the invention, the linear guide bearings 4 are straight guides engaged by a corresponding pair of projections 8 formed on the exterior of each roll-carrier 10, on the part of the latter next to the flat elements 2a; the roll-carriers 10 are slidable along said linear guide bearings 4 as well as supported thereby.

Secured on the roll-carrier 10, at the apices of an equilateral triangle inside its square cross-section, are three pivots 11, 12 and 13 on which respective lever arms 19, 20 and 21 are mounted pivotally.

Said pivots 11, 12 and 13 are the fulcra for the corresponding lever arms and are secured on the roll-carrier 10 in an adjustable manner to be described.

In a preferred embodiment, the arms 19, 20 and 21 comprise two flat half-arms 19a, 20a and 21a extending parallel and opposite to each other, and carrying a respective chock 19b, 20b and 21b being mounted adjustably therebetween on the remote side from said pivots 11, 12 and 13.

In particular, each chock is fastened to its arm by bolts 22 which connect the chock to a backing plate 23 attached frontally to said flat half-arms; advantageously, this backing plate 23 is formed with slotted holes for engagement with the bolts 22.

Housed in each of the chocks 19b, 20b and 21b are corresponding journal bearings 24, 25 and 26 in which respective rolls 27, 28 and 29 are journalled; said rolls are rotatable in their journal bearings, each about a respective axis of rotation, A1, A2 and A3, which axes are coplanar with one another and lie in a perpendicular plane to the rolling axis L.

Provided for each of said rolls 27, 28 and 29, in each of the rolling stands 5 is an adjuster device 30, 31 and 32 for controlling the distance of their respective axes A1, A2, A3 of rotation from the rolling axis L; this device acts on the support means of the rolls 27, 28, 29 which comprise, as mentioned, the arms 19, 20, 21 and the chocks 19b, 20b, 21b with their journal bearings 24, 25, 26.

In this embodiment of the invention, the adjuster devices 30, 31 and 32 are preferably of a hydraulic type and each comprises an oil-operated cylinder/piston assembly which has a stationary part 30a, 31a and 32a, respectively, attached to a pair of said flat elements 2a laid side-by-side, and a moving part 30b, 31b and 32b which is reciprocable relative to the stationary part along a radial direction extending through the rolling axis L at 120° from the other directions, as it is defined during a pipe rolling phase.

In fact, as to the adjuster device 31, its stationary part 31a is mounted pivotally about a pin 31c fixed between two flat elements 2a of a rolling stand 5, at the location of the linear guide bearings 4 of the latter; further, said adjuster device 31 includes a pusher 31d acting on said stationary part 31a and effective to turn the latter about the pin 31c between an operative position where the moving part 31b is slidable along said radial direction at 120° from the other two, and passing through the rolling axis, and a non-operative position where said adjuster device 31 is drawn within the outline of the C-shape of the flat elements 2a (see Fig. 2) thereby clearing off the roll-carrier run.

Further, said moving part 30b, 31b and 32b penetrates openings 33 formed peripherally through the roll-carrier 10, and acts on the corresponding chocks 19b, 20b and 21b; the latter are, moreover, held against the corresponding moving part 30b, 31b and 32b by conventional retaining means 34 consisting, in this embodiment, of ordinary helicoidal springs.

Advantageously, the roll-carriers 10 are housed within the structure 2 so that the slide directions of the moving parts 30b, 31b and 32b of the adjuster devices associated with a roll-carrier 10, will lie at 120° from each other and be rotated of 60° from the analogous directions of the moving parts of the devices 30, 31 and 32 associated with the roll-carrier 10 which is side-by-side in the rolling mill. This rotation is allowed because the axes A1, A2 and A3 of a tern of rolls, except for their displacement during the rolling process, are at 60° from each other similar to the sides of an equilateral triangle, and by the fact that each roll-carrier 10 is turnable upside-down with respect to the adjacent one in the rolling mill about a perpendicular direction to one of said slide directions of the moving parts 30b, 31b and 32b; thus, with a single form of the roll-carrier 10, it becomes possible to rotate the roll axes by 60° between the stands. It is, in fact, sufficient that a sliding direction just defined be perpendicular to one of the sides of the frame forming the roll-carrier 10, and then turning upside-down a roll-carrier 10 about a line, parallel to said side, that crosses the axis L, with respect to the adjacent roll-carrier (see Figure 2). Further, always with reference to Figure 2, it can be observed that the aforesaid parallel direction is, for the illustarated stand, horizontal but in connection with the vertical symmetry of the roll-carrier 10, it could be possible to turn the roll-carriers 10 about a vertical direction crossing the axis L.

Conventional locking means 35 are provided in the rolling mill 1, which are effective to lock the roll-carriers 10 within the structure 2. Said locking means 35 consist, in this embodiment, of a bottom 35a located at the end 6 of the structure 2, a first plurality of clamps 35b acting axially with respect to the rolling mill and being located at the tube output end 7, a second plurality of pivotable clamps 35c acting perpendicularly to the axis L and being positioned at the open side of the C-shape of said flat elements 2a.

With reference to the foregoing, the pivots 11, 12 and 13 are adjustable, and specifically they are mounted on holders 36 carried, in turn, on a pair of brackets 37 attached to the roll-carrier 10 and extending toward the rolling axis L from opposite sides with respect to the holders 36; a first bolt pair 38 fasten the holders 36 frontally to the brackets 37, and a second bolt pair 39 are arranged to clamp the holders 36 tight as explained herein below (see Figure 4).

The pivots 11, 12 and 13 are adjusted in position along a parallel line to the slide direction of the moving part 30b, 31b, 32b of the corresponding adjuster device to the pivot, and the adjustment is carried out by adding or removing wedges 36a on the holders 36 after loosening the two bolt pairs 38 and 39.

The rolling mill 1 is also provided with a mandrel 40 driven along the rolling axis L by conventional means consisting, in this embodiment, of a rack-and-pinion arrangement only shown schematically in the accompanying drawings.

Furthermore, the rolling mill 1 is here a retained mandrel type and provided, at the location of a tang 40a of the mandrel 40, with conventional retainer means; these latter consist here of a spindle head engaged with the mandrel tang 40a.

The mandrel 40 also has an internal cavity 43 connected hydraulically to conduits 44 for supplying a coolant fluid into the cavity interior; this fluid is fed in by pumping means not shown. The rolling mill of this invention further comprises a mandrel device 45 for the rolls, and therefore also roll-carriers, replacement comprising a platform 51 which is movable on rails 53 laid laterally of the structure 2 in the plane of the rolling mill basement B.

Also provided in the rolling mill of this invention are a plurality of conventional driving means 55 being each intended to drive the rolls of the rolling stands 5. In particular, the driving means 55 are, in this embodiment, connected to a respective one of the rolls 27, 28 and 29 in each rolling stand 5 by a corresponding shaft 56, 57 and 58 provided with swivel connection means 60, 61 and 62, such as a cardan joint or the like, effective to drive the rolls even while their position changes during the rolling process.

Furthermore, conventional coupling means 65 are provided on the ends of the shafts 56, 57 and 58 for releasably coupling each roll 27, 28 and 29 to its corresponding shaft.

For connecting the shafts 56, 57 and 58 to their corresponding rolls 27, 28 and 29 of each rolling stand 5, each roll-carrier 10 is provided with holes 68, 69 and 70 through which said shafts are passed.

The operation and advantages of the invention will now be described with reference to the above rolling mill, which is assumed to be in a condition with a hollow blank, i.e. a semifinished tube, not shown, being rolled in association with its mandrel 40 retained by the means 42; the hollow blank is located, therefore, among the rolls 27, 28 and 29 of the various rolling stands 5 driven by the mechanical transmission and driving means 55-58 and 60-62. It should be noted first, that the outer structure 2 applies a strength which counteracts and absorbs the forces tending to radially separate the rolls being transferred thereto during the rolling process, whereby these forces are prevented from imposing loads on the basement B and the rolling mill surrounding environment.

This because the adjuster devices 30, 31 and 32 of the rolls of each rolling stand 5 have their respective stationary parts 30a, 31a and 32a secured to the flat elements 2a which make up the structure 2; in fact, the rolling forces exerted by the hollow blank on the rolls 27, 28 and 29 are transferred by the bearings 24, 25 and 26 to the corresponding chocks 19b, 20b and 21b. Thence the rolling force is transferred to the moving part 30b, 31b and 32b of the associated adjuster device 30, 31 and 32. The moving part then transfers its load to its corresponding stationary part 30a, 31a and 32a and, hence, to the flat elements 2a on which that stationary part is mounted.

It should be further noted that the plates 9 placed between a carrier 10 and the adjacent ones in the rolling mill, act as partitions between the stands 5; specifically, the arms 19, 20 and 21 and their chocks 19b, 20b and 21b are guided, pivotally about their pivots 11, 12 and 13, by said plates. Additionally, the axial loads developed during the rolling process, which would tend to load the arms 19, 20 and 21 in that axial direction, are compensated by these plates 9; the latter, in practice guide the movements of the roll chocks, and since the package of the roll-carriers 10 with the plates 9 is held axially by the bottom 35a at the mill end 6 and by the first plurality of clamps 35b at the second mill end 7, said axial loads will be transferred from said package to the structure 2 and thence to the machine basement B on which it bears.

Notice, moreover, that by having the rolling loads transferred to an outer main structure, the roll-carriers 10 can be made lighter because they have not to withstand the loads from the rolling process but merely to provide support for the rolls; this makes easier movement on the linear guide bearings 4, and more generally, easier the replacement of the roll-carriers 10.

Additionally, the above-mentioned weight reduction is increased by the provision of plates 9 between the carriers; in fact, each of these plates acting as a guide member for the rolls of the two carriers 10 on either sides, could be also made integral with the roll-carriers or one element 2a of the stand. The solution provided by this invention contemplates instead that the plates 9 be removable at each stand and, therefore, enables the carriers 10 to be made as simple frames, that is to say with no side walls, to guide the roll with its associated chock movements during the rolling process.

As regards the roll replacement, it should be noted that, in the rolling mill of this invention, the roll change operation is carried out along a radial direction to the rolling axis L. With reference to one stand, in fact, the rolls can be changed by removing the roll-carrier 10 which, once uncoupled from its shafts 56, 57 and 58, becomes released from the working position it occupies within its respective stand 5; this release is accomplished by first releasing the first and second pluralities of clamps 35b, 35c which hold the carrier and its associated plate 9, and then lowering the adjuster device 31, that is moving it into its non-operative position.

Subsequently, the mandrel device 45 is connected to the roll-carrier 10, and by moving it along the guide bearings 4, the carrier 10 is loaded onto the platform 51 which will take it away from the mill, thereby allowing of its transport and replacement with a new carrier.

A new roll-carrier 10 is installed on the rolling mill in the reverse order of its removal operations.

Another result achieved by this invention is that improved flexibility is afforded in controlling the distance settings of the axes A1, A2 and A3 of rotation of the rolls 27, 28 and 29 in each stand from the longitudinal axis L of the rolling mill 1.

In fact, it can be seen in Figure 4 that, with the aid of the devices 30, 31 and 32 and by swinging their associated lever arms 19, 20 and 21 about the corresponding fulcra provided by the pivots 11, 12 and 13, accurate adjustment becomes possible which is usefully effective in the presence of small dimensional variations in hollow blanks being processed. Furthermore, the positional adjustment of the pivots 11, 12 and 13 along a parallel line to the slide direction of the moving parts 30b, 31b and 32b of the corresponding adjuster device 30, 31, 32 (see Figure 4), allows said rolls to be set at optimum positions even where the range of the adjustment is large, as when rolls are to be reset after they have been turned off line. Of course, whereas the adjustment made using the devices 30, 31 and 32 is applied with the rolling mill and the roll-carriers 10 ready for a rolling phase, or even during the latter, the pivots 11, 12 and 13 are adjusted with the roll-carriers 10 pulled out of the rolling mill.

For this reason, the last-mentioned adjustment is specially effective to accommodate large variations in the roll size due to wear or after turning, whereas the swinging movements of the lever arms 19, 20 and 21 enable fine adjustment for precision rolls setting.

Additionally, the provision of three rolls per stand in the rolling mill of this invention and the alternate layout of the roll terns in a stand, which layout provides a 60-degree rotation of the rolls in a stand relative to those in an adjacent stand, and allows using a mandrel having lower mechanical properties. This fact enables a hollow construction for the mandrel with a peripheral outer wall which can be significantly thinner than all of the other prior art hollow mandrels. As a result, the mandrel can be cooled to an optimum degree, so that it will not require replacement at each successive rolling cycle; this understandably results in a lower mandrel supply and, therefore, in lower investment costs.

More generally, it should be emphasized that the rolling stand according to the invention can be advantageously used to provide high-performance rolling mills by virtue of that a single main structure 2 can be formed by the single stand supporting structures connected in a continuos manner, which mills are highly flexible in operation on account of the ease with which the roll terns can be handled; all these advantages are brought out in the rolling mill according to the previous embodiment, as well as in the mill version wherein the roll terns can be rotated of 60° by just turning upside-down the roll-carriers 10 of side-by-side stands.

Naturally, constructional changes may be made to the above-described embodiment of a rolling stand without altering, however, its principal features; as an example, the rolls could be mounted other than on arms pivoted on the roll-carrier, e.g. with the intermediary of parallel linear supports for the roll chocks, to be attached to the roll-carrier and laid to extend toward the rolling axis L. Of course, the adjuster devices for controlling the distance from the rolling axis of the roll axes, would remain unaltered; that is, there would still be stationary and moving parts 30a, 31a, 32a and 30b, 31b, 32b, with the former being attached to the structure 2 and the latter acting on the roll chock which would be slidable on the parallel supports, towards and away from the axis L.

Further, it could be thought a different construction for the adjuster devices 30, 31 and 32; for instance, electromechanical adjuster devices of conventional type could be used, which would however comprise a stationary part to be connected rigidly to the outer rolling stand structure according to the foregoing teachings, and a moving part which would be reciprocable along a radial direction to the rolling axis.

Another variation from the illustrated embodiment above may suggest that the rolls in the stand be driven by one main motors and a set of appropriate transmissions, rather than by single independent motors.

On a more general basis, as regards the roll operation, it could be foreseen of providing an indefinite number of combinations whereby conventional means such as differential gears, bevel gear, transmissions, layshafts, and whatever else, would be used to provide an almost endless range of constructional solutions, useful in the different logistic conditions for which the rolling mill and the stands of this invention are designed.

Furthermore, also as regards the housing of the roll-carriers 10 within each rolling stand 5, all those variations must be considered which foresee, instead of the linear guides 4 and the projections 8 previously described, friction-attenuating means such as shoes, bearings and the like, arranged to run on runways to be formed either on the flat elements 2a of the stands or of the roll-carriers. It should be noted that, as relates to the arrangements for handling and pulling the roll-carriers 10 out of the rolling stands 5, for which the mandrel device 45 in the form of an articulated arm hydraulically operated and the loading/unloading device 50 have been used in the foregoing embodiment, a broad range of equivalent, alternative solutions may be provided.

Lastly, there is an important remark to be made in the respect of the flat elements 2a contained in each rolling stand; in the example reviewed hereinabove, such flat elements 2a are provided, for each stand, in juxtaposed pairs joined by a plurality of spacers 3; this allows a main supporting structure to be obtained for each stand which is light and is advantageously suitable for the mounting of the stationary part of the adjuster devices 30, 31 and 32. It cannot be excluded, however, that such interconnected flat elements 2a may be replaced with a monolithic structure or with more complex reticular structures, for example. Furthermore, it is also foreseen that additional elements may be introduced into each rolling stand to enhance its strength features; such elements could be, for instance, uprights preloaded by tie rods joining the free ends of the C-shape of said flat elements 2a. It is evident, however, that these additional elements should form no hindrance to the movement of the roll-carrier 10 along its respective linear guide bearings.

Also, it is barely worth remarking that both the C-shape of the flat elements 2a and the square shape of the frame which forms the roll-carrier 10 could be changed within the teachings provided by this invention; in fact, as for said frame, it is sufficient that it will be provided with a closed shape, which may have a geometry other than a square, such as a polygonal or annular shape, whilst as regards the flat elements 2a, it matters that they have a shape with an open side effective to ensure for the stand formed thereby, a capability to let the roll-carrier 10 slide outwards.

It should be also noted that, as previously specified, in the rolling mill 2 just considered the rolling stands 5 are interconnected in a continuous fashion, whereby a flat element 2a of a stand becomes, over one half thereof, part of the supporting structure for that stand, and over the other half, part of the adjacent stand structure; it would be obviously possible to provide a rolling mill wherein such stands, and hence their flat elements 2a, are isolated from one another, and conventional means of supporting the mandrel during the rolling process may optionally be disposed between one stand and its spaced adjacent one. Of course, such a solution would be mainly useful in applications of the inventive stand to rolling mills intended for processing using a mandrel.

In connection with the last-mentioned aspect, it matters to point out that the solution to the aforementioned technical problem, as provided by this invention, also has applications in tube rolling mills other than the mandrel type for seamless or normal tubes, and in rolling mills for wires, bars, blooms, and the like, wherein the introduction of the rolling stand of this invention can afford the same advantages mentioned above and, perhaps, some additional ones as well.

A further important advantage of this invention is that the rolling stands can be made with even more than 3 rolls; it will be easily appreciated, in fact, that a roll-carrier 10 can accommodate 4 or more rolls in accordance with the teachings of the previous example, also in view of the layout of the devices 30, 31 and 32 secured to the flat elements 2a, thereby making the stand 5 flexible from an operational point of view and adaptable for a broad range of different applications.

Lastly, it cannot be excluded that this invention may be innovatively used also on working machines other than that described in the foregoing, which has not yet been equipped with rolling stands having three or more rolls. We refer here to tube gauging machines or tube straighteners.

It should be considered, in fact, that it may not be strictly necessary for a rolling stand according to the invention that the axes of rotation of the rolls be strictly coplanar with one another; that is, said axes might be set askew as in the instance of the tube straighteners just mentioned.

In other words, coplanarity of 3 or more concurrent axes in a perpendicular plane to a rolling axis is a design feature effective to better define rolling mills for making tubular or rod-like bodies, setting them apart from strip or bands rolling mills wherein this feature would be of no interest.

CLAIMS

1. A rolling stand of a type which comprises an outer support structure (2a,3), at least three driven rolls (27,28,29) having respective axes (A1,A2,A3) of rotation which are concurrent with one another and lie in a plane perpendicular to a rolling axis (L) along which said rolling stand locates, driving means (55) and associated mechanical transmission means (56,57,58 and 60,61,62) for operating said rolls (27,28 and 29), characterized in that it comprises a roll-carrier (10) substantially in the form of a frame inside which said rolls (27,28,29) are mounted rotatably with respective axes (A1,A2.A3) of rotation set adjustably apart from the axis (L), said roll-carrier (10) being slidable along a first radial direction to said axis (L) between an operative position occupied during the rolling process and where it is locked inside said structure (2a,3) and a non-operative position where it is pulled out of said structure (2a,3), which is open about said first radial direction, guiding means (4,8) for guiding the movement of the roll-carrier (10) and locking means (35) for locking the roll-carrier (10) in said operative position, being provided in said stand.

2. A rolling stand according to Claim 1, characterized in tha said structure (2a,3) comprises at

least two juxtaposed flat elements (2a), substantially C-shaped, lying in respective perpendicular planes to said rolling axis (L) and being rigidly connected together by a plurality of spacers (3).

3. A rolling stand according to Claim 2, characterized in that said guiding means (4,8) for the roll-carrier (10) movement comprise at least one pair of linear guide bearings (4) extending perpendicularly to the rolling axis (L) and parallel to each other, being associated with said flat elements (2a) and disposed inside said rolling stand support structure (2a,3), said linear guide bearings (4) being engaged by corresponding projections (8) formed on the roll-carrier (10) associated therewith.

4. A rolling stand according to Claim 3, characterized in that it comprises, for each roll (27,28 and 29) in the roll-carrier (10), at least one adjuster device (30,31,32) for adjusting the distance of the rotational axis (A1,A2,A3) of a respective roll from the longitudinal rolling axis (L), said device (30,32) being connected rigidly to the structure (2a,3) and acting on support means (19a-21a,19b-21b) for the associated roll (27,28 and 29) attached to the roll-carrier (10).

5. A rolling stand according to Claim 4, characterized in that it comprises:

three lever arms (19,20,21) mounted pivotally on respective pivots (11,12,13) attached to said roll-carrier (10) at the apices of an equilateral triangle inside the cross-section of said roll-carrier (10), said arms (19,20,21) extending longitudinally inwards of said roll-carrier (10);

three rolls (27,28,29) having respective journal bearings (24,25,26) mounted respectively on chocks (19b,20b,21b) located on said arms (19,20,21) at the remote ends thereof from the pivots (11,12,13);

three adjuster devices (30,31,32) for controlling the distance of the rotational axis (A1,A2,A3) of a corresponding roll (27,28,29) from the longitudinal rolling axis (L), each of said devices (30,31,32) being arranged to act on the arm (19,20,21) of the corresponding roll (27,28,29).

6. A rolling stand according to Claim 5, characterized in that said pivots (11,12,13) are mounted adjustably on said roll-carrier (10), supporting (36,37) and adjustment (36a,38 and 39) means being provided for each of them.

7. A rolling stand according to either Claim 5 or 6, characterized in that each of said adjuster devices (30,31,32) comprises a stationary part (30a,31a,32a) attached rigidly to the structure (2a,3) of the stand and

a moving part (30b,31b,32b) reciprocable along a respective second radial direction lying 120° to the others analogous directions and crossing the longitudinal rolling axis (L), said moving part (30b,31b,32b) extending through corresponding openings (33) provided in said roll-carrier (10).

8. A rolling stand according to Claim 7, characterized in that the adjuster device (31) is mounted on said structure (2a,3) where the latter is open about said first radial direction with its stationary part (31a) attached pivotally to a pin (31c) extending between said flat elements (2a) of the stand (5) and is moved by a hydraulic cylinder (31d) between an operative position where the moving part (31b) associated therewith is slidable along the corresponding second radial direction crossing the rolling axis (L), and a non-operative position where said adjuster device (31) clears off the roll-carrier (10) run between said positions.

9. A rolling stand according to Claim 8, characterized in that each lever arm (19,20,21) respectively comprises two flat half-arms (19a,20a,21a) being parallel and juxtaposed to each other and mounted pivotally with a first end on their respective pivots (11,12,13) and provided, on a second end opposite to the first, with a backing plate (23) whereto a chock

(19b,20b,21b) housing the roll (27,28,29) journal bearings (24,25,26) is fastened rigidly by bolts (22).

10. A rolling stand according to Claim 9, characterized in that said chock (19b,20b,21b) is mounted adjustably on the backing plate (23) using bolts (22) engaged in slotted holes provided in the backing plate (23).

11. A rolling stand according to Claim 10, characterized in that it comprises retaining means (34) for each of said arms (19,20,21) effective to hold the associated chock (19b,20b,21b) against said moving part (30b,31b,32b) of the adjuster devices (30,31,32).

12. A rolling stand according to Claim 11, characterized in that said adjuster devices (30,31,32) are of the hydraulic type.

13. A rolling stand according to Claim 11, characterized in that said adjuster devices are of the electromechanical type.

14. A rolling stand according to Claim 4, characterized in that said rolls (27,28,29) with their associated chocks (19b,20b,21b) and journal bearings (24,25,26) are mounted rotatably on respective pairs of parallel linear supports attached to the roll-carrier (10) and extending toward said rolling axis (L).

15. A rolling stand according to one of the

preceding claims, characterized in that said stand (5) comprises at least one plate (9) substantially in the form of a sheet disposed perpendicularly to the axis (L) and juxtaposed to the roll-carrier (10), centrally provided with an opening (9a) at the location of the axis (L), removable from said stand in a parallel direction to the running direction of the roll-carrier (10).

16. A tube rolling mill of a type comprising a plurality of rolling stands (5) disposed side-by-side along a longitudinal rolling axis (L), a mandrel (40), means (42) for retaining said mandrel (40), and means (41) for operating the latter connected to the aforesaid means (42) for retaining it, wherein each of said rolling stands comprises at least three driven rolls (27,28,29) having respective axes (A1,A2,A3) of rotation concurrent one another and lying in a plane perpendicular to the axis (L), an outer support structure (2a,3) open about a first radial direction to said rolling axis (L), driving means (55) and associated mechanical transmission means (56,57,58 and 60,61,62) for driving said rolls (27,28,29), said stand further comprising a roll-carrier (10) being substantially in the form of a frame, on the interior whereof said rolls (27,28,29) are journalled with their respective axes (A1,A2,A3) set adjustably apart from the axis (L), slidable along said radial

direction between an operative position occupied during the rolling process where it is locked inside said structure (2a,3) and a non-operative position where it is pulled out of said structure (2a,3), guiding means (4,8) for the movement of the roll-carrier (10) and locking means (35a,35b,35c) for locking the roll-carrier (10) in said operative position, being provided on the rolling mill.

17. A rolling mill according to Claim 16, characterized in that the rolling mill has, at a side where the support structure (20,3) of the stands (5) is open, a roll-carrier (10) load/unload device (50) comprising a platform (51) movable on rails (53) laid laterally of the rolling mill (1), a mandrel device (45) acting on said roll-carriers (10) and operative to drive the latter on said guiding means (4) to load them onto said platforms (51).

18. A rolling mill according to one of Claims 16 and 17, characterized in that the rotational axes (A1,A2,A3) of the rolls (27,28,29) in one stand (5) are rotated substantially of 60° from the corresponding axes (A1,A2,A3) of an adjacent stand (5) in the rolling mill.

19. A rolling mill according to Claim 18, characterized in that the roll-carriers (10) are identical with one another, and that the carrier (10) of

one stand (5) is turned upside-down with respect to the one of an adjacent stand in the rolling mill about a horizontal line crossing the axis (L), thereby obtaining said rotation of 60° of the axes (A1,A2,A3) of the rolls (27,28,29) from one stand to another.

20. A rolling mill according to Claim 19, characterized in that it comprises a main support structure (2) formed by joining continuously together said support structures (2a,3) of the single stands (5) laid side-by-side, on the inside whereof are a plurality of said roll-carriers (10) substantially arranged in a package, each of which is separated from the next in the package by a partition plate (9).

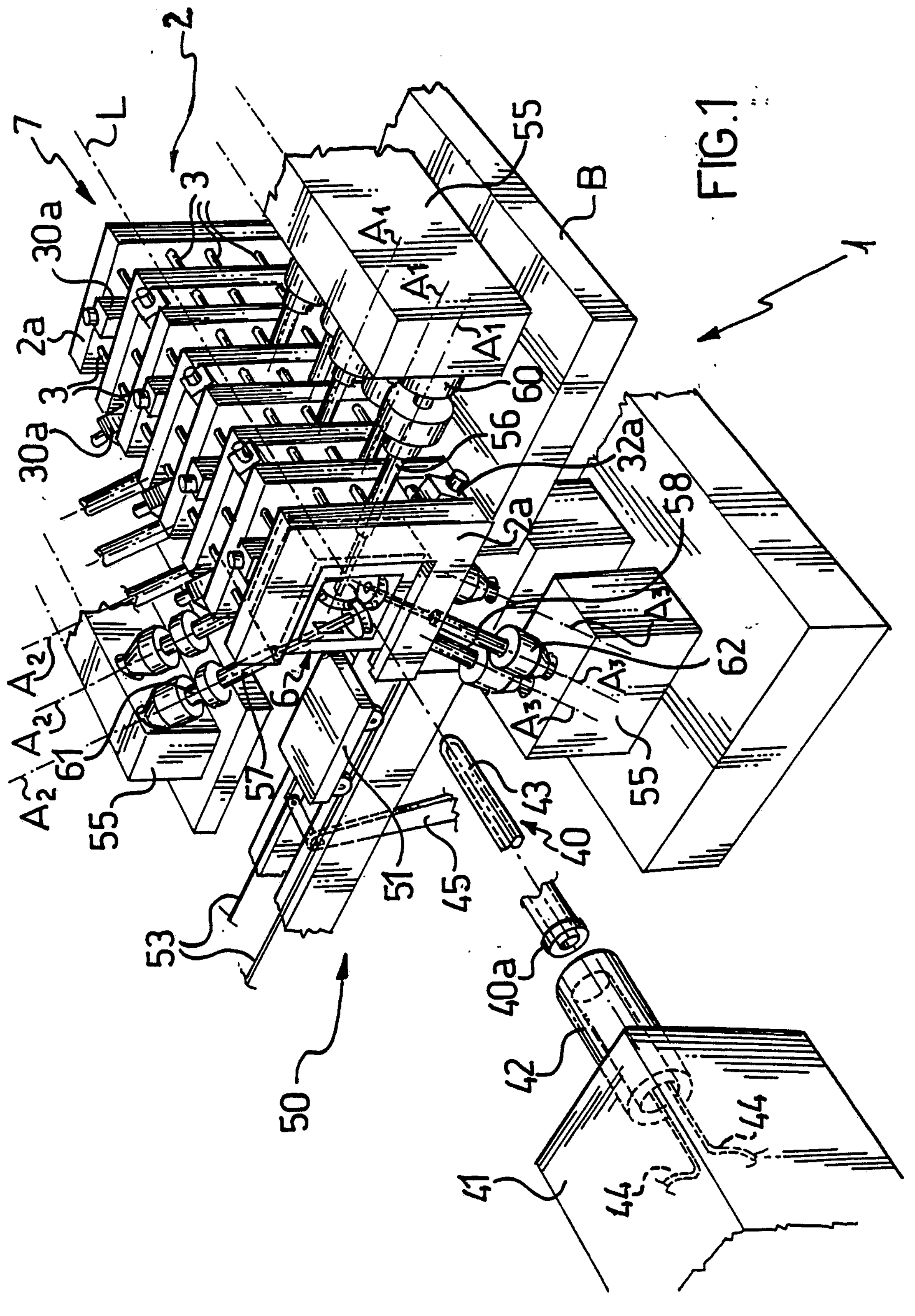
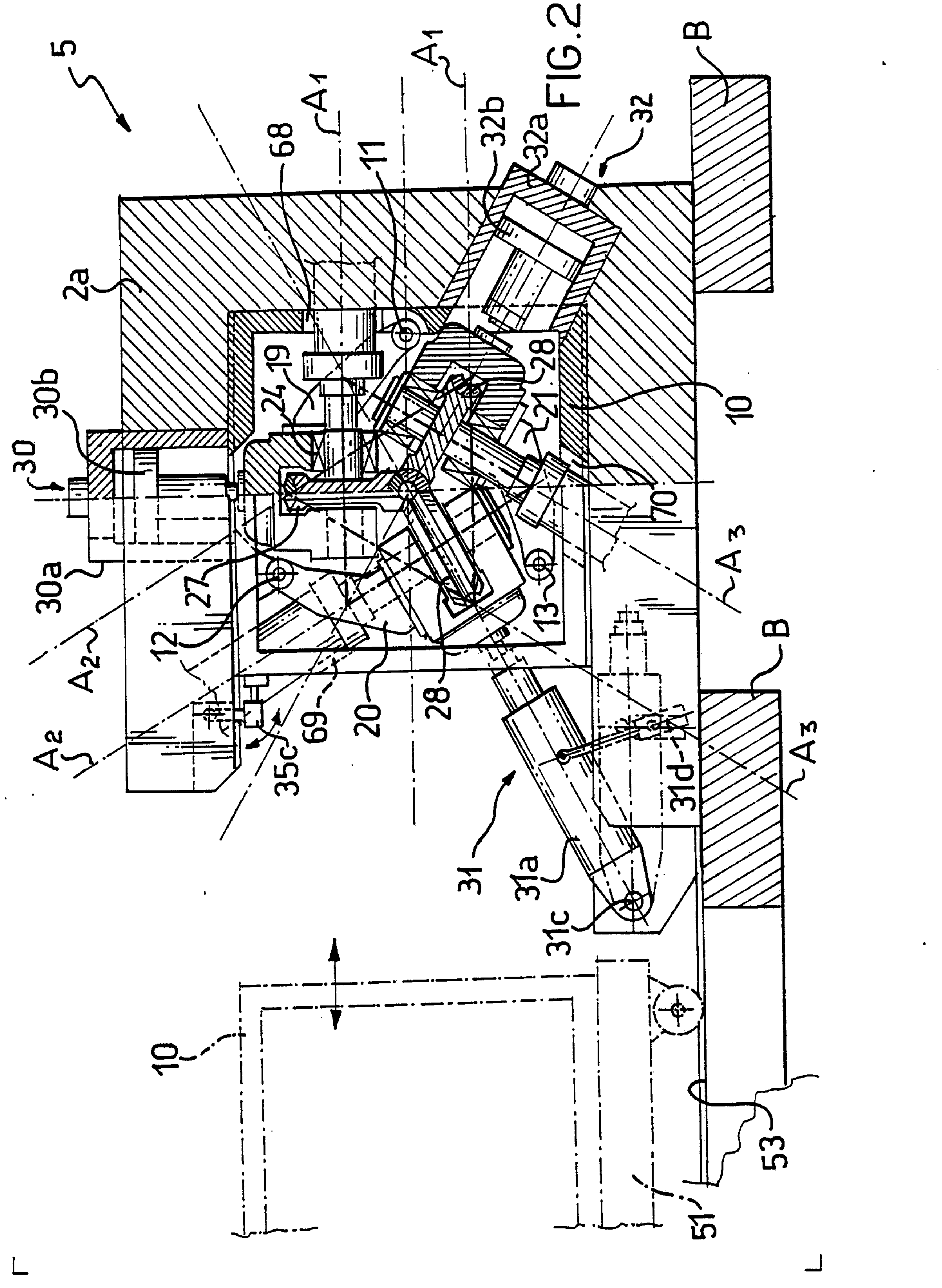


FIG.1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2a
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30
30a
27
12
A2
35c
69
20
28
31
31a
31c
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31d
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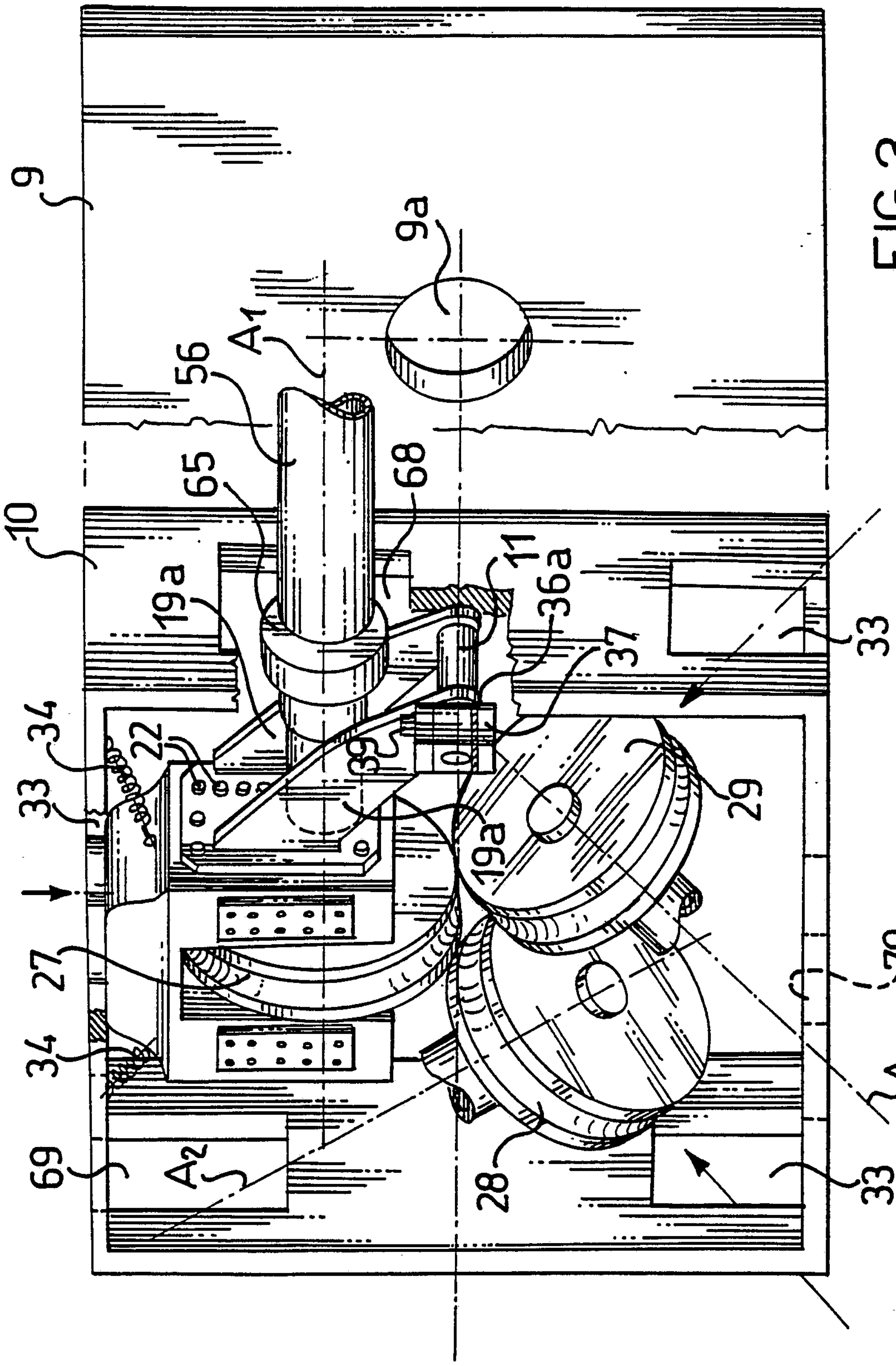
32a
32b
A1
11
68
19
24

FIG.2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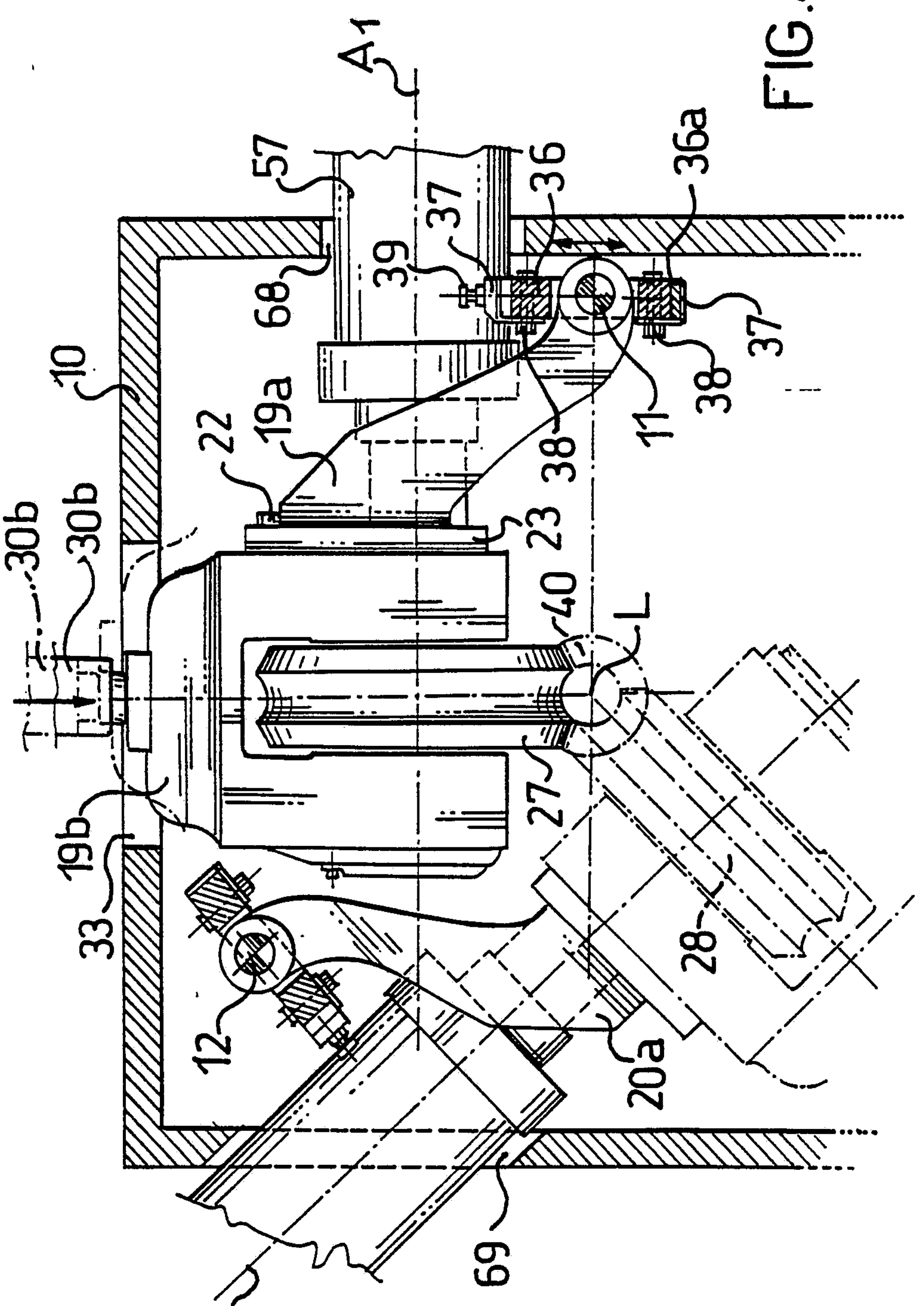
33

FIG.3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40
L
30b
30b
19b
33
12
27
28
20a
69
A2

FIG.4

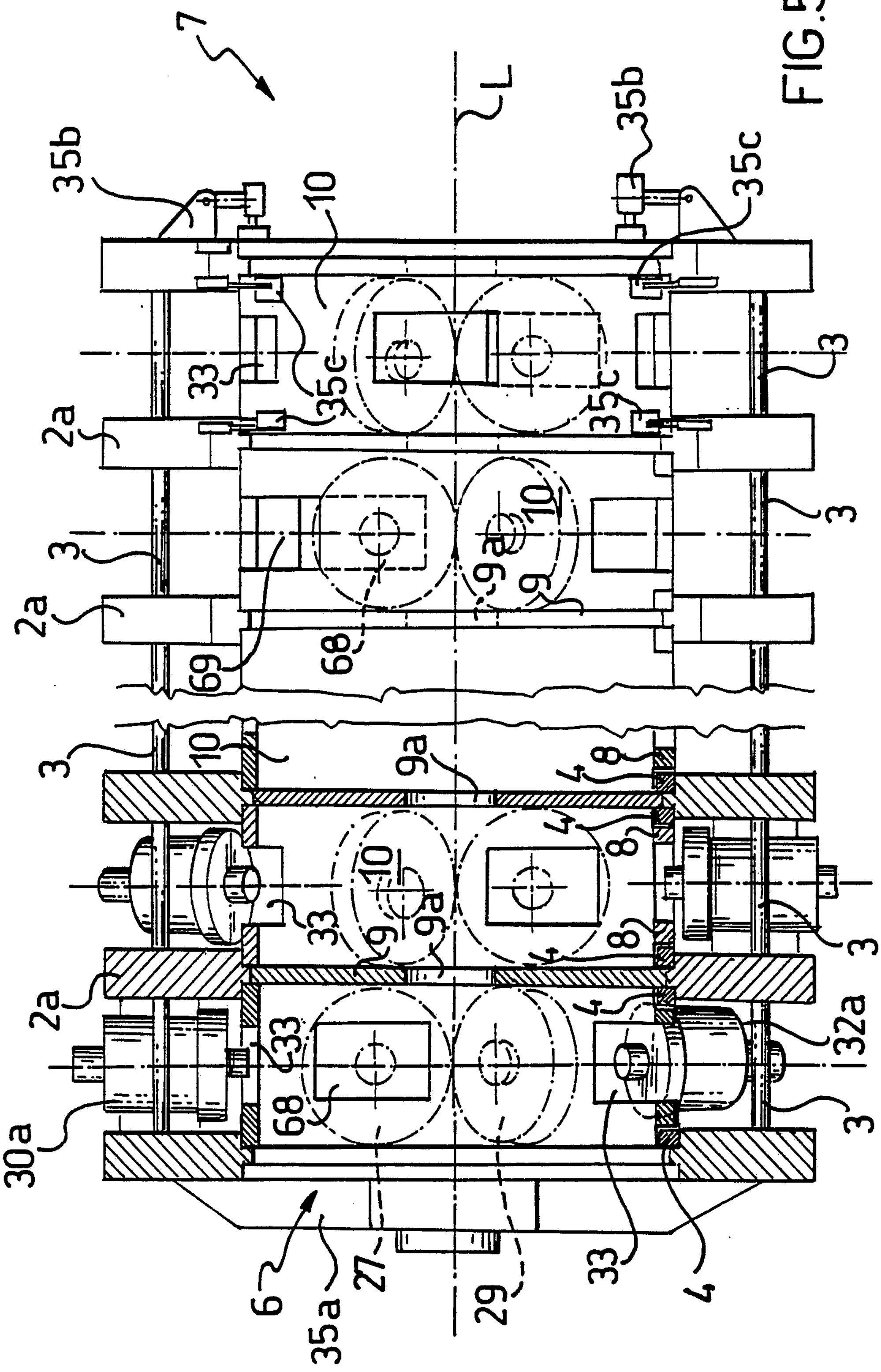

FIG.5

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 93/00898

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B21B13/10; B21B31/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B21B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	DE,A,2 845 052 (KOCKS) 24 April 1980 see claim 1; figure 1 ---	1
X	DE,U,7 023 449 (KOCKS) 17 December 1970 see claim 1; figure 1 ---	1
A	DE,A,2 839 687 (MANNESMANN) 13 March 1980 see claim 1; figure 1 ---	1
A	GB,A,2 021 021 (KOCKS) 28 November 1979 see claim 1; figure 4 ---	1
A	DE,C,917 963 (SCHLOEMANN) 28 January 1954 see figure A -----	1

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27 JULY 1993	13. 08. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	SCHLAITZ J.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

EP 9300898
SA 73382

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-2845052	24-04-80	None	
DE-U-7023449		None	
DE-A-2839687	13-03-80	None	
GB-A-2021021	28-11-79	DE-B- 2821888 US-A- 4255956	31-10-79 17-03-81
DE-C-917963		None	

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82