(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 085 806**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 82306141.1

(22) Date of filing: 18.11.82

(51) Int. Cl.^{3}: B 21 C 37/00
B 21 D 11/15

(30) Priority: 18.11.81 GB 8134661
18.11.81 GB 8134662
18.11.81 GB 8134663

(43) Date of publication of application:
17.08.83 Bulletin 83/33

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(71) Applicant: Allied Steel and Wire Limited
P.O. Box 83
Castle Works Cardiff CF1 5XQ(GB)

(72) Inventor: Davies, Peter Gough
11 Waterloo Road
Cardiff South Glamorgan Wales(GB)

(74) Representative: Cundy, Anthony Brian
Anthony Cundy & Company 384 Station Road Dorridge
Solihull West Midlands B93 8ES(GB)

(54) **Apparatus for cold working of metal rod.**

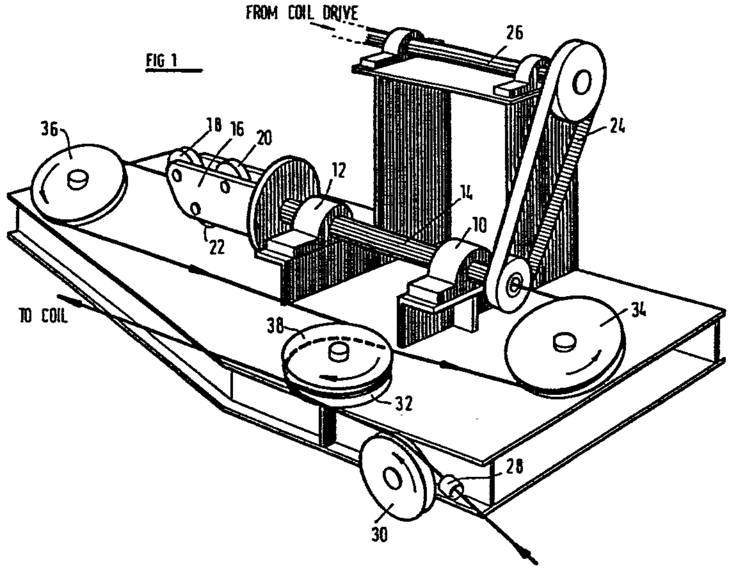
(57) Apparatus for the cold working or hot rolled steel rod comprises a set of freely rotatable pulleys (18, 20) around which the rod runs. The set of pulleys as a whole is driven for orbital revolution. The rod is twisted in one direction as it enters the pulley system and is untwisted as it leaves. The rod is pulled through the pulley system by a rotatable coiler downstream of the system against braking effort imparted to the rod upstream of the system whereby the rod is pulled through under tension. Drive (24,26) for the orbital motion is from the coiler such that the orbital speed and rod feed are in a fixed relationship. Control of the transverse dimensions of the rod is imparted by a sensor downstream of the pulley system, the output from which is used to adjust the tension imparted by the braking pulley (34). The apparatus operates also to descale and straighten the rod continuously and is particularly useful in the production of steel rod for welded mesh in reinforcing concrete.

EP 0 085 806 A1

./...

Croydon Printing Company Ltd.

FIG 1



Apparatus for Cold Working of Metal Rod

The invention relates to apparatus for cold working of metal rod.

It is known that the cold working of for example steel rod will improve its mechanical properties, in particular its tensile strength, and such cold working is usually effected either by rolling or drawing. Thus in the production of steel rod for use in forming welded mesh for concrete reinforcement, the material may initially be hot rolled and then cold drawn or cold rolled in order to achieve the necessary standard specification relating to its tensile strength. Such specifications usually state that the ratio of the ultimate tensile stress to the proof stress shall be more than a specified value. For rod used in concrete reinforcing meshes the ratio specified is 1.05 : 1 in most European specifications.

Such rods may have a smooth surface or may be provided with surface deformations such as ribs to improve their keying or bonding capability to the concrete.

The most convenient way of introducing surface deformations such as ribs is during the hot working stage, but these deformations do not survive the normal cold working techniques of cold drawing or cold rolling. Deformations can be introduced during a final cold rolling operation but their production requires excessive local working of the material and there is a high mechanical energy requirement. It is difficult or impossible to provide suitable deformations in a cold drawing operation.

It is known to hot roll deformations into reinforcing material, to cut the material into bars of finite length and then cold work by twisting. This procedure is not suitable for long lengths of rod which are normally stored in coil form and require a cold working technique which can be effected on an indefinite length of the rod.

It is known from West German patent specification 909562 to twist and subsequently untwist an indefinite length of thin metal rod by passing the rod continuously through an apparatus incorporating an orbital pulley. The rod is wrapped one complete turn round a pulley which is then arranged to orbit about an axis corresponding to the tangent to the pulley at which the rod joins and leaves the pulley. Power for this orbiting motion is derived from the rotation of the pulley about its own axis caused by pulling the rod through the apparatus. The degree of twist and subsequent untwisting used in this German patent is of the order of one turn in a length equivalent to more than 50 rod diameters. Twisting to this extent is sufficient to achieve the intended purpose of the German specification, namely a breaking up of scale on the surface of the rod to facilitate subsequent removal of this scale. This degree of twist is entirely inadequate for producing a significant increase in strength of the material as can be judged from the German specification itself which utilises the twisting and untwisting as a preliminary to cold working of the rod by drawing it through a die. Thus the apparatus of the German specification is not put forward as a solution to the problem of cold working continuous lengths of rod and would not be suitable for that purpose for several reasons in addition to the limited degree of twist. The part of the rod leaving the pulley rubs closely against the part of the rod entering the pulley which may be helpful as an adjunct to descaling but would cause unacceptable snagging of rod for cold working, particularly for rod which does not have a smooth surface. Also, the power which can be generated by pulling the rod through the apparatus is normally insufficient to carry out the degree of cold working necessary to produce a useful increase in rod strength. The rod tends to break under the high tension which needs to be generated.

According to the present invention apparatus for cold working of metal rod comprising a pulley system having one or more rotatable pulleys around which the rod can be passed continuously from an input side to an output side thereof, the pulley system being orbital about an axis other than the axis of rotation of the or each pulley whereby the rod is continuously twisted in one direction at, the input side of the pulley and continuously untwisted at the output side thereof is characterised by drive means independent of the rod for the orbital movement.

This provision of independent power enables the apparatus to be set to provide a degree of twist and subsequent untwist sufficient to increase the mechanical strength of the rod by cold working by a significant extent. It has been found that a suitable degree of twist for practical purposes is one complete turn in a rod length of between 20 and 5 rod diameters.

Preferably means for pulling the rod through the pulley system is coupled to the drive means for the orbital movement such that the speed of rod through the apparatus has a predetermined ratio to the speed of orbiting of the pulley system. This arrangement allows accurate control of the degree of twist. The takeup means may comprise a rotatable coiler for continuously winding the cold worked rod thereon.

Preferably braking means are provided upstream of the orbital pulley system whereby a predetermined tension can be imparted to the rod as it is pulled through the pulley system by the takeup means. Control of tension in the rod while it is being twisted and untwisted helps to maintain consistent properties for the rod.

The braking means may incorporate a braked member coupled to movement of the rod upstream of the pulley system and engaged frictionally with a reaction member coupled to move with the rod downstream of the pulley system and arranged to travel more slowly than the braked member. With this arrangement, the energy dissipated in the brake for a given tension is much less than the corresponding energy dissipated with a conventional stationary reaction member. This is in turn helpful in reducing the amount of power needed to drive the system. Also, a high tension can be generated within the apparatus without the requirement for a correspondingly high tension outside the system, for example at a coiler.

The braked member may be one sheave of the double sheave pulley and the reaction member may be the other sheave of the double sheave pulley, this second sheave having an effective diameter greater than that of the first mentioned sheave. This provides a simple brake structure in which the required relative speeds of the braked member and reaction member can be selected by selecting the ratio of the diameters of the pulleys.

The apparatus may include a transverse dimension sensor downstream of the orbital pulley system and means actuable in response to said sensor to control tension in the rod upstream of the pulley system. The dimension sensor may be a non-contacting gauge such as a laser gauge. A non-contacting gauge is particularly useful when the rod has a deformed surface in that the deformations could interfere with measurements of a gauge which contacts the rod surface. The rod tension can be controlled in relation to rod diameter (or other transverse dimension) in such a manner that if the rod diameter is significantly greater than that required to meet a specification, an increased rod tension can be employed to stretch the rod longitudinally and so reduce its diameter. This control of diameter or transverse dimension and thus of the weight per unit length can be used to ensure that excess weight of the material in the final product is kept to a minimum.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a top perspective view of a general arrangement of cold working apparatus constructed in accordance with the invention;

Figure 2 is a side view of an alternative form of such apparatus;

Figure 3 is a plan view of the apparatus of figure 2;

and

Figure 4 is a diagram of the gauge control system.

Figure 1 shows an apparatus comprising a fixed base frame with two co-axial plummer block bearings 10 and 12 for a hollow rotatable shaft 14. Outboard of the downstream bearing 12 a stirrup shaped yoke 16 is mounted on the end of the shaft 14 for rotation therewith. The yoke includes two opposed parallel side plates between which are mounted two freely rotatable pulleys 18 and 20 carried in the yoke adjacent one edge thereof whilst at the other edge a counter-balance weight 22 is mounted. Preferably the axes of the pulleys 18 and 20 are skewed relative to each other either side of an axis normal to the axis of the shaft 14.

The shaft 14, and hence the pulley system 18 - 20, is driven for rotation in the bearings 10 and 12 by a belt drive 24 from an input drive shaft 26.

As shown in figure 1, rod to be cold worked is fed through the apparatus in the direction of the arrows, entering through a guide tube 28 and guide pulley 30, passing around the lower sheave 32 of a double sheave pulley, around a restraint pulley 34 so that the rod is angled with respect to the axis of orbital motion of pulley system 18 - 20 and restrains the rod against rotation, through the rotatable shaft 14, around the pulley system 18 - 20, round a further restraint pulley 36 downstream of the apparatus to restrain the downstream part of the rod against rotation, and exiting to the coiler around the upper sheave 38 of the double sheave pulley. From this upper sheave 38 the rod is fed to a coiler (not shown). A motor (not shown) drives not only the coiler to wind the cold worked rod thereon but also drives the pulley system 18 - 20 for orbital rotation about the axis of the hollow shaft 14 via the input shaft 26 and drive belt 24. The drives are such that the rod is pulled by the coiler through the pulley system at a speed having a predetermined ratio to the speed of orbiting of the pulley system. This speed relationship ensures that the rod is always twisted consistently to the same extent and in a typical case the twist should be such that there is one complete turn in a rod length of between 20 and 5 rod diameters. Also, when the coiler stops, the orbiting pulley system also stops thus obviating the possibility of orbital twisting being accidentally imparted to the rod when the rod is not actually running through the system.

The double sheave pulley comprises two sheaves 32 and 38 which together are freely rotatable and which are rotatable with respect to each other against a controllable degree of friction braking between the two sheaves. The degree of braking is adjusted by adjusting a clamp load acting between the two shaves on friction linings interposed between them. The effective diameter of the upper sheave 38 at the output side of the rod is slightly larger than that of the input sheave 32 so that the linear rod speed at the output would, without slippage, be higher than that of the input. This causes the input to drag behind the output and for slip to occur between the two sheaves. Thus tension, dependent on the controllable friction drag, is generated in the rod passing through the pulley system. The work done against the frictional drag is at the difference in speeds between the two sheaves and thus is much less than would be required by a simple friction drag at the input to the system.

Looked at in another way, the input side sheave 32 forms a braked member and the output side sheave 38 forms a brake reaction member. Instead of being held stationary, the brake reaction member is coupled to the rod on the output side and travels at a (rotational) speed which is only slightly slower than the rotational speed of the braked sheave 32. Other forms of braked member and reaction member and of friction braking between them may be employed as an alternative.

Thus rod is fed continuously through the system from a stock coil thereof and is twisted in one direction between the restraint pulley 34 and the orbital pulley system 18 - 20 at the input side thereof and is then twisted in the opposite direction, that is untwisted, between the restraint pulley 36 and the pulley system at the output side thereof, thereby imparting a substantial degree of cold working to the rod.

An alternative form of the apparatus is shown in figures 2 and 3 of the drawings comprising a frame structure having a pair of aligned apertured plummer block bearings 40 and 42 thereon between which is mounted an orbital pulley system comprising three in-line freely rotatable pulleys 44 - 46 - 48 which are spaced out longitudinally of the pulley system. The pulleys are mounted in a yoke 50 with their axes of rotation parallel to one another and normal to the orbital axis of rotation of the system i.e. the axis of the centre lines of bearings 40 - 42. The yoke 50 with its freely rotatable pulleys 44 - 46 - 48 is driven for orbital rotation through a gear wheel system 52 from an input dirve shaft 54 itself driven from the motor which drives the coiler (not illustrated).

Rod to be cold worked enters the apparatus around a guide pulley 56, over a brakable rotational restraint pulley 58, through the upstream plummer block bearing 40, around the pulley system 44 - 46 - 48, through the downstream plummer block bearing 42 and exits to the coiler around a further restraint pulley 60 and guide pulley 62. Pulleys 44 and 48 are each arranged so that they have a tangent generally along the pulley system axis so that rod enters and leaves the pulley system along this axis. The rod path is deflected from the pulley system axis around pulley 44, passes over pulley 46 and is then deflected back along the pulley system axis around pulley 48. Because the orbital drive to the pulley system is derived from and made to be in synchronism with the drive to the coiler which pulls rod through the system, orbital rotation of the pulley system is in synchronism with the passage of rod through the system. This ensures that the pitch of twisting and untwisting of the rod always remains constant, regardless of the speed of operation of the apparatus. Predetermined tension is imparted to the rod by the brakable pulley 58 which has means associated therewith for adjusting the degree of braking effort imparted to the rod.

Figure 2 shows that the centre pulley 46 of the three freely rotatable pulleys in the orbital system is withdrawable downwardly of the yoke 50 to facilitate initial threading of the rod through the system and is thereafter moved upwardly into the position shown in figure 2 so that, in the orientation of the yoke shown in this drawing, the rod passes over the centre pulley 46 and under the two outer pulleys 44 and 48.

Thus, in use, the rod is fed from a stock coil thereof continuously through the apparatus and is twisted in one direction between the brakable pulley 58 and the pulley system at the input side thereof and is then twisted in the opposite direction as it leaves the output side of the pulley system between it and the guide pulley 60 thereby imparting a substantial degree of cold working to the rod.

Cold worked rod produced by the apparatus is particularly suitable for use in concrete reinforcing mesh where cut lengths of the cold worked rod have to be welded together. In particular, the rod fed through the apparatus may have previously been ribbed transversely, as is known practice in use of reinforcing rod for concrete. The rod is not only cold worked but effectively descaled as it passes through the apparatus. If the rod is also pulled through the apparatus by a straight line puller rather than being coiled onto a rotating pulley, the untwisting at the output side of the pulley system straightens the rod prior to cutting to length and welding into mesh. Such a straight line puller should of course be driven in synchronism with the drive to the orbital pulley system.

Figure 4 is a block diagram of the gauge control system as applied to the apparatus of either figure 1 or figures 2 and 3. The control apparatus comprises a sensor 70, which may conveniently be a laser gauge or other form of non-contacting gauge, directed at the wire downstream of the orbital pulley system 72. The output from the sensor 70 is supplied to a control and calibration unit 74 which generates a brake control signal and applies it to the braking means 76. Braking means 76 represents either the braking means between the sheaves 32 and 38 of the double sheave pulley of figure 1 or the single braking pulley 58 of figures 2 and 3. As previously described, the rod is pulled through the orbital pulley system 72 by the coiler 78 under tension imparted to the rod by the braking means 76. The gauge of the rod downstream of the orbital pulley system 72 is detected by the sensor 70 and, if the gauge of the rod varies from a predetermined value, the output from the sensor adjusts the braking tension on the rod at the input side of the orbital pulley system. The increased tension in the rod occurs in the regions where the rod is being deformed by twisting as a result of which less tension is needed to stretch the rod longitudinally and reduce its cross section than would be the case with only a direct tensile load on the rod. The control system is set so that the tension and thus the extension of the rod matches the requirement for reduction in cross-section of the rod to very fine limits.

Rod produced in accordance with the invention may be used for concrete reinforcement in the form of simple rods. Alternatively, lengths of rod may be secured together, preferably by welding to form concrete reinforcement mesh.

CLAIMS

1. Apparatus for the cold working of metal rod comprising a pulley system having one or more rotatable pulleys around which the rod can be passed continuously from an input side to an output side thereof, the pulley system being orbital about an axis other than the axis of rotation of the or each pulley whereby the rod is continuously twisted in one direction at the input side of the pulley system and continuously untwisted at the output side thereof characterised by drive means independent of the rod for the orbital movement.

2. Apparatus as claimed in claim 1 wherein means for pulling rod through the pulley system is coupled to the drive means for the orbital movement such that the speed of rod through the apparatus has a predetermined ratio to the speed of orbiting of the pulley system.

3. Apparatus as claimed in claim 2 wherein the predetermined ratio is such that the degree of twist is one complete turn in a rod length of between 20 and 5 rod diameters.

4. Apparatus as claimed in any one of claims 1 to 3 wherein the takeup means comprises a rotatable coiler for continuously winding the cold worked rod thereon.

5. Apparatus as claimed in any preceding claim wherein braking means are provided upstream of the orbital pulley system whereby a predetermined tension can be imparted to the rod as it is pulled through the pulley system by the takeup means.

6. Apparatus as claimed in claim 4 wherein the braking means incorporates a braked member coupled to move with the rod upstream of the pulley system and engaged

frictionally with a reaction member coupled to move with the rod downstream of the pulley system and arranged to travel more slowly than the braked member.

7. Apparatus as claimed in claim 5 wherein the braked member is one sheave of a double sheave pulley and the reaction member is the other sheave of the double sheave pulley and has a diameter greater than that of the first mentioned sheave.

8. Apparatus as claimed in any preceding claim including a transverse dimension sensor downstream of the orbital pulley system and means actuable in response to said sensor to control tension in the rod upstream of the pulley system.

9. Apparatus as claimed in claim 7 wherein said sensor comprises a non-contacting gauge.

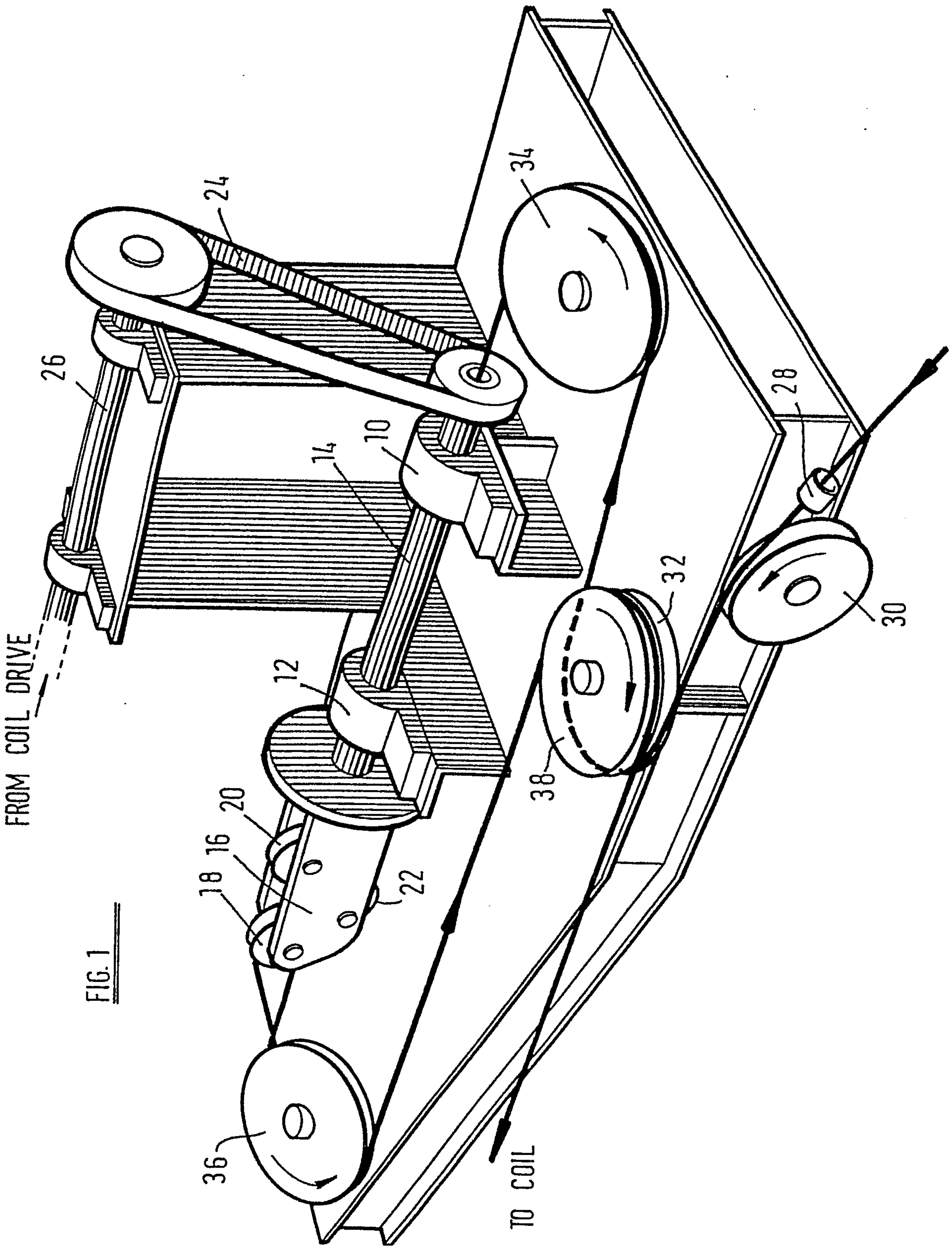


FIG. 1

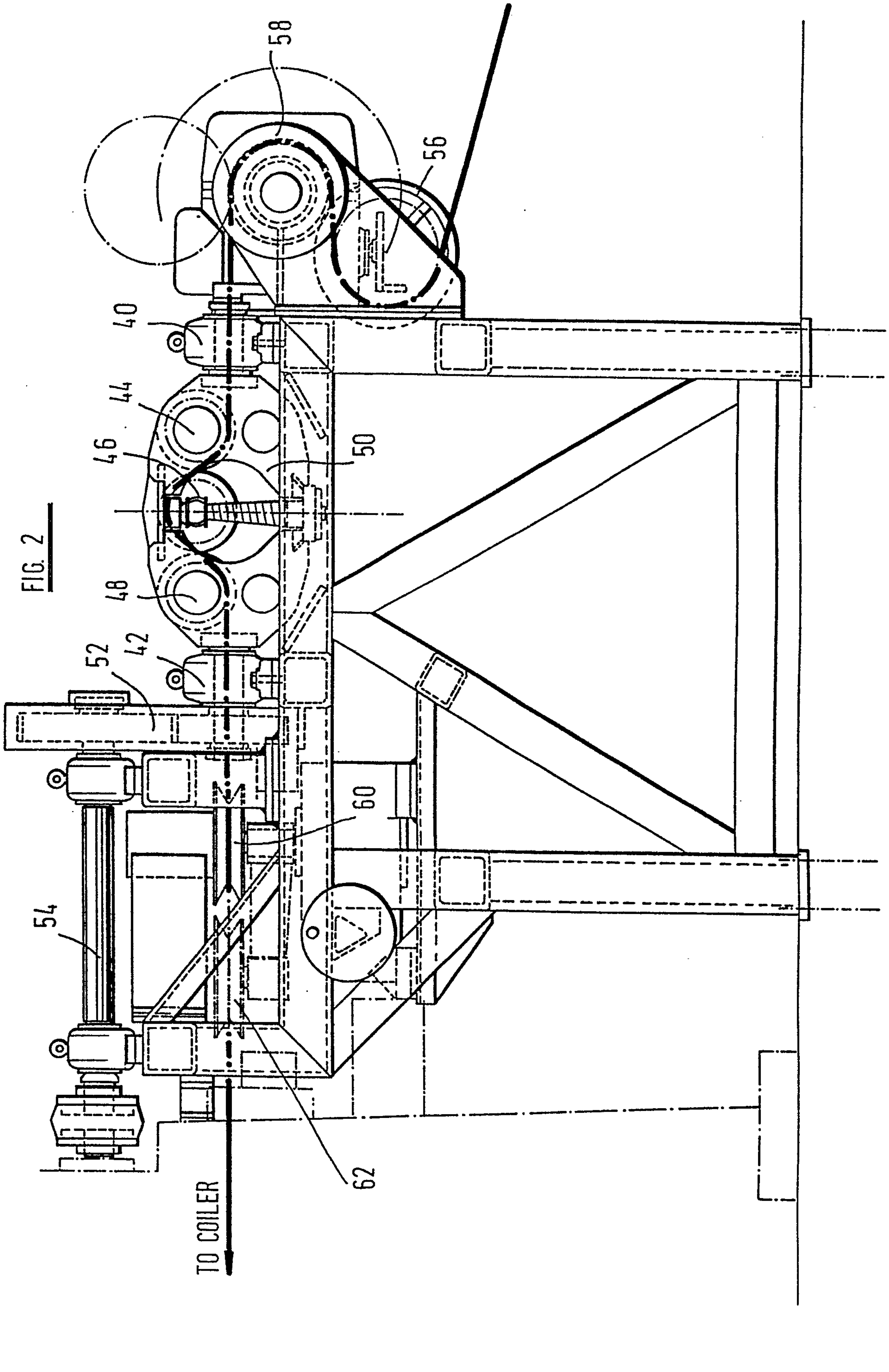
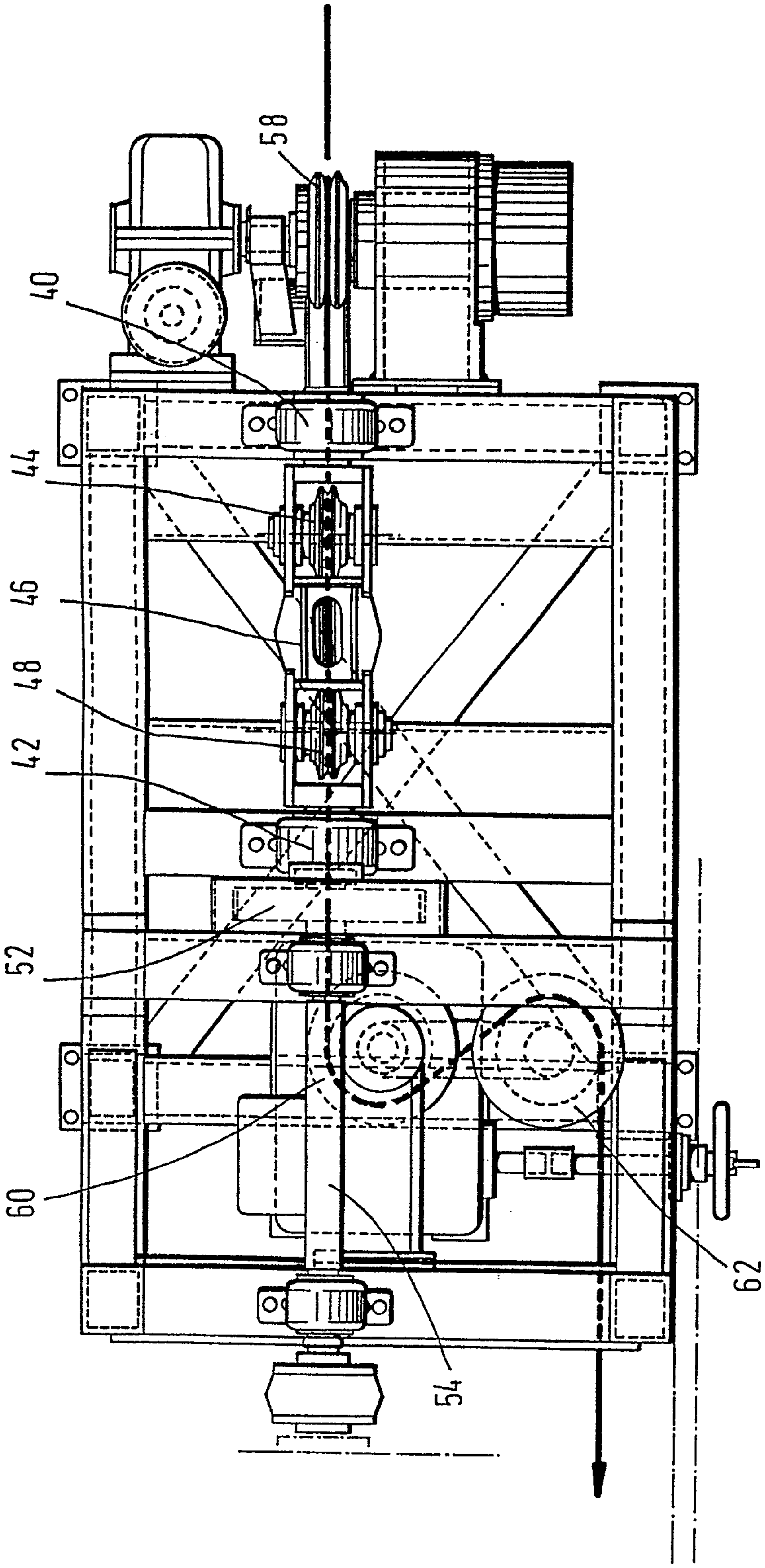


FIG. 2

FIG. 3



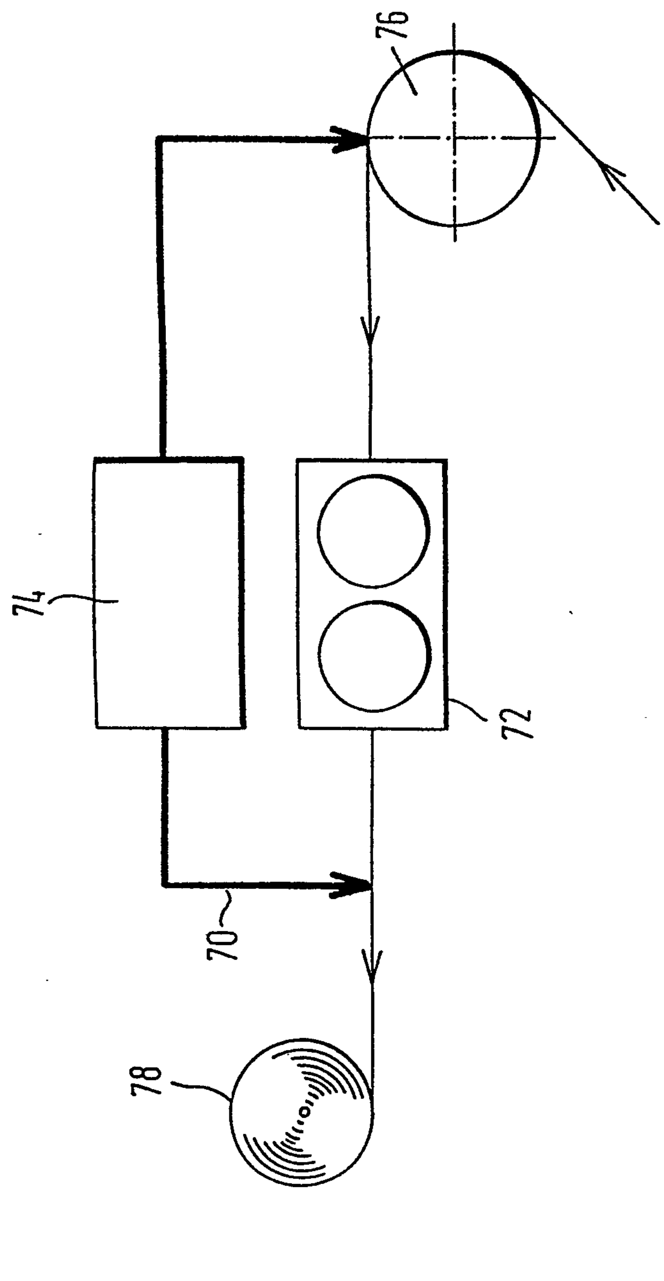


FIG. 4.

European Patent Office

EUROPEAN SEARCH REPORT

0085806
Application number

EP 82 30 6141

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
D,A	DE-C- 909 562 (KOLLING)		B 21 C 37/00 B 21 D 11/15
X	US-A-4 075 880 (COPELAND) * Claims 1-7 ; figures 1, 5 *	1,2,4	
X	GB-A-1 442 097 (VEREINIGTE ÖSTERREICHISCHE EISEN-UND STAHLWERKE) * Claims 1, 4, 5 ; figure 1 *	1,4	
Y	DE-C-1 009 586 (THOMAS) * Claims 1-3 ; figure 1 *	1	
Y	FR-A-1 565 871 (REHM) * Claim 2 ; figures 1, 4 ; page 6, lines 9-12 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	DE-A-1 452 201 (ALBERT) * Figure 1 *	1	B 21 C 37/00 B 21 C 43/00 B 21 D 3/00 B 21 D 11/00
A	DE-C- 825 245 (FELTEN & GUILLEAUME)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	01-02-1983	SCHLAITZ J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503. 03.82