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[11] **3,857,271**

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[54] **BENDING MACHINE FOR ROD OR STRIP MATERIAL**

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[52] **U.S. Cl.** **72/383,** 72/306, 72/384, 140/105

[51] **Int. Cl.** **B21d 5/02**

[58] **Field of Search** 140/105; 72/383, 305, 306, 72/384

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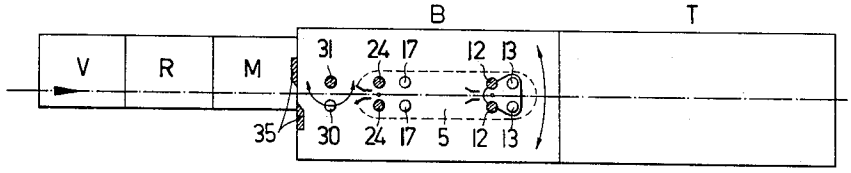
[57] **ABSTRACT**

The invention is concerned with a bending machine for rod or strip material, such as reinforcement pieces for concrete. In order to produce a skew bend between parallel sections of rod, two bending heads of adjustable separation are provided. The bending heads are coupled together so that they bend the rod in opposite directions simultaneously but are displaceable out of the plane of bend so to allow advance of the rod between bending.

6 Claims, 7 Drawing Figures



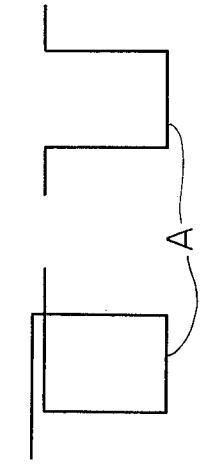


FIG. 1

FIG. 2

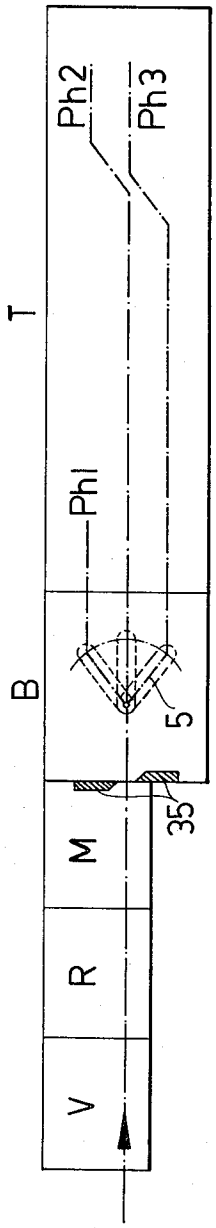


FIG. 3

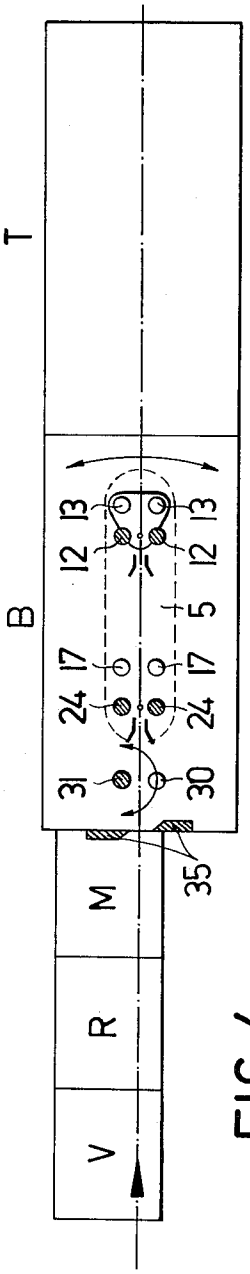
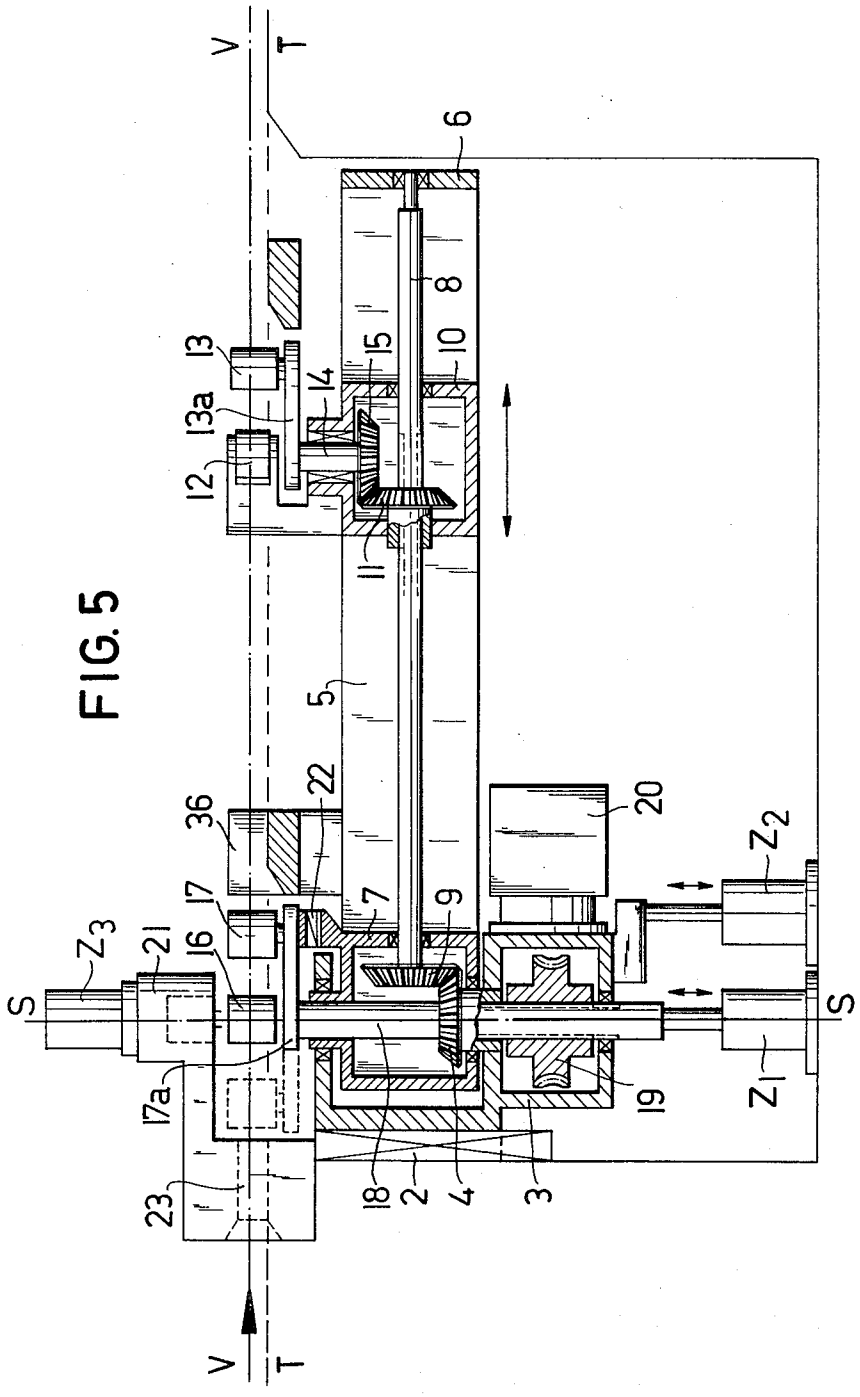


FIG. 4

FIG. 5


V
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12
11
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36
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Z2
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S
17a
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Z1
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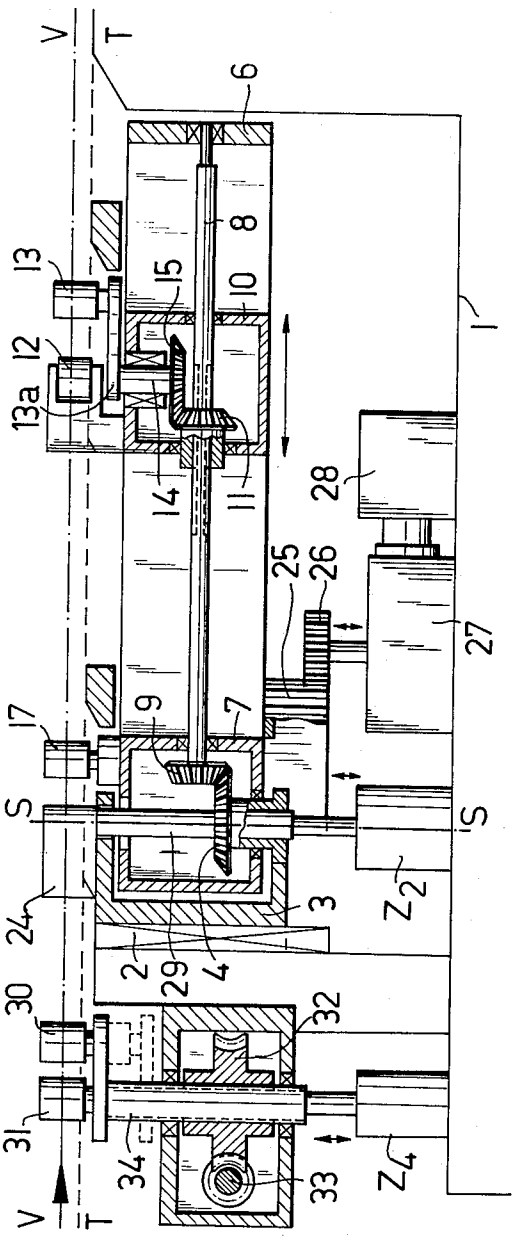
V
T


V
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Z2
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FIG. 6

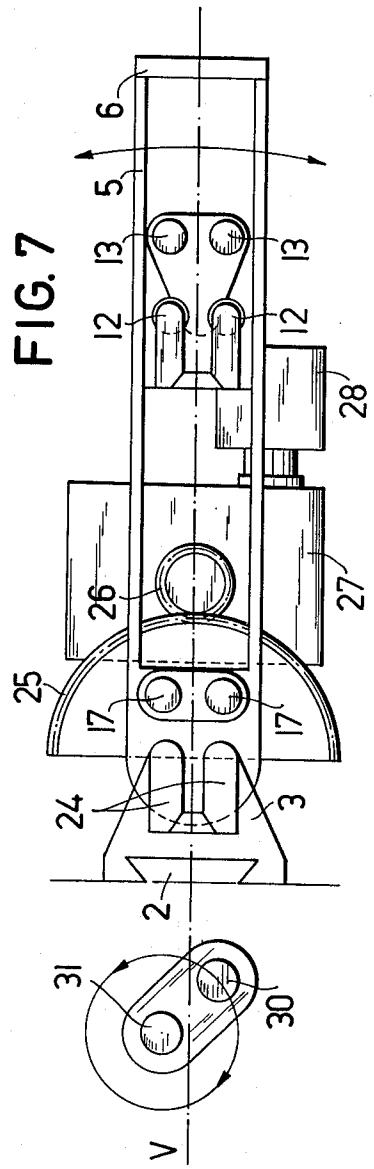
6
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FIG. 7

BENDING MACHINE FOR ROD OR STRIP MATERIAL

A bending machine for rod or strip material has already been proposed, in which it is possible to perform bending processes in opposite directions out of the path of advancement of the material by means of a movable bending tool common to both directions of bending. The tool is slidable perpendicular to the plane of bend and can be transferred on a lateral bypass from a position on one side of the path to a position on the opposite side of it.

This prior art machine was primarily developed for the bending of loops for concrete reinforcement and is not suited to the bending of the usual reinforcing bars for steel concrete construction because the whole of the bent extension of the rod follows all the movements of the bending tool.

To assist the understanding of the invention, reference will now be made to FIGS. **1** and **2** of the accompanying drawings which illustrate various shapes of rod reinforcement.

The difference between loops A as shown in FIG. **1** are necessary in steel concrete construction for accepting thrusts, and the usual reinforcement inserts as shown at E in FIG. **2** lies both in the shape and the dimensions. The loops A are, in the majority of cases, of essentially rectangular shape with sides of lengths less than **2** meters. On the other hand, in the case of the usual reinforcement inserts as shown at E it is important that rods be bent so that they follow the stress paths in a beam subjected to bending forces. Such rods in accordance with FIG. **2** exhibit a number of zones **L1, L3, L4** lying parallel with one another near the upper and lower faces of the beam, and connected together by oblique portions **L2,** the angles between an oblique portion and the two parallel sections of rod bounding it being always opposite angles. Reinforcement inserts of that kind can reach considerable lengths of about 6 to 8 meters and over. At the ends of the rods of the reinforcement, inserts end hooks H are often formed.

If one wished to produce such reinforcement inserts on a bending machine of the kind mentioned above, the already formed portions of the reinforcement inserts projecting beyond the point of bend would, during the bending process, trace out very large curved paths and hence undergo high accelerations, only gives rise to high accelerating forces impairing the bending process, but also significant danger to the attendant personnel.

The object of the invention therefore is to produce a bending machine for rod or strip material, especially for the production of reinforcements for steel concrete construction, in which, in the course of a multiple bending process at angles equal and opposite in pairs, the portions of rod extending beyond the bending tools are compelled to make the smallest possible accompanying movements during the bending processes.

According to the invention, a bending machine comprises two bending heads of adjustable separation, a first one of the bending heads nearer to an feed in path for material to be bent being positioned at a fixed position along the path and the second bending head being pivotable about the axis of bend of the first bending head out of the path of advance of the material, the pivoting motion of the second bending head being coupled with the working motion of the first bending head such

that, in use, the bending heads simultaneously bend the material in opposite senses to the same extent, and the second bending head and at least a bending tool of the first bending head being movable out of the plane of bend intersecting the path of advance of the material.

Examples of machines constructed in accordance with the invention are illustrated in FIGS. **3** to **7** of the accompanying drawings, in which:

FIG. **3** shows diagrammatically the manner of operation of a machine in accordance with the invention;

FIG. **4** is a diagrammatic plan of a further development of the machine in accordance with the invention, shown in FIg. **3**;

FIG. **5** shows in detail the bending device of the machine shown in FIG. **3**;

FIG. **6** shows in detail and in section the bending device of the machine shown in FIG. **4**; and,

FIG. **7** is a plan of FIG. **6.**

The rod necessary to the production of a reinforcement insert in accordance with FIG. **2** is conveyed in accordance with FIG. **3,** for example, from a storage drum (not shown) by a feeder device V into the bending machine. On its way, it first of all passes through a straightener R in which it is made straight, and next through a measuring device M in which the length of feed of the material is measured. The measuring device M is on the one hand coupled with the feed device V and is capable of bringing this to rest from time to time after the advance of a preselected length of rod, and, on the other hand, is connected with a shear of known construction indicated diagrammatically in FIGS. **3** and **4** and designated by **35,** which separates the rod from the strand of material drawn off the storage drum, after feed of the total length of material necessary for a reinforcement piece.

Next, after the shear **35,** comes the actual bending device B, beyond which is arranged a run-out table T for the finish-bent material. The feed, straightening and measuring devices are of known construction. In particular the measuring device can in likewise known manner be programmable, so that the rod can be fed forward in successive feed steps by different preselectable amounts. Such known measuring devices allow the repetition at an optional frequency, of a predetermined cycle of feed steps.

With machines to which rod material precut to length and straightened is fed, the straightener R and the shear **35** can naturally be omitted or not used.

The bending machine displayed diagrammatically in FIG. **4** shows in the essential parts the same construction as that which is shown in FIG. **3.** It differs from the bending machine of FIG. **3** in the presence of an additional bending tool **30, 31,** which is provided for the bending of end hooks H (FIG. **2**).

With a bending machine as in FIGS. **5** and **6** a frame **3** is arranged slidably in a vertical guide **2** in a machine bed **1.** A bevel gear **4** is connected rigidly to the frame **3.** A bearer arm **5** is supported in the frame **3** so that it can be pivoted with respect to this frame **3** in a plane lying perpendicular to the direction of slide of the frame **3,** about the axis S—S.

In one end wall **6** and a cross wall **7** of the bearer arm **5,** a shaft **8** is journalled but cannot move in its axial direction. One end of the shaft is connected integrally to a bevel gear **9** which engages with the bevel gear **4.**

In the bearer arm **5,** a housing **10** is supported to be able to slide longitudinally. A bevel gear **11** is so ar-

ranged inside the housing **10** that it is rotatable but unslidable relative to the housing, but is slidable along the shaft **8** and coupled in rotation to this shaft. Because of this arrangement, the bevel gear **11** can both follow movements of the housing **10** along the shaft **8** but also perform rotary movements together with the shaft **8.**

A bending mandrel **12** rigidly fixed to the housing **10** cooperates with a bending tool **13** journalled in the housing **10** and forms with it a bending head. A bevel gear **15** engages with the bevel gear **11** and is connected solidly with a shaft **14** which carries the bending tool **13** on an arm **13***a*.

If the bearer arm **5** performs a pivotal movement about the axis S—S, the bevel gear **9** rolls round on the stationary bevel gear **4.** The rotation of the bevel gear **9** is transferred to the shaft **8** and the bevel gear **11** rotationally fixed to this shaft therefore likewise follows this rotation and transfers it via the bevel gear **15** and the shaft **14** to the arm **13***a* of the movable bending tool **13.**

If all the bevel gears **4, 9, 11** and **15** have the same tooth pitch, or more generally, if the bevel gear pairs **4 - 9** and **11 - 15** have equal gear ratios, during a pivotal motion of the bearer arm **5** the arm **13***a* of the bending tool **13** carries out a pivotal motion through the same angle as the bearer arm, though in the opposite direction; hence the arm **13***a* is moved in the plane of the pivotal motion parallel with itself.

In the zone of the axis of rotation S—S of the bearer arm **5,** a fixed bending mandrel **16** is provided, which cooperates with a movable bending tool **17** and likewise forms a bending head. The bending mandrel **16** is withdrawable upwards into its carrier **21** into the position shown dotted, by means of an operating cylinder Z_3.

The bending tool **17** is connected solidly with the shaft **18** by means of an arm **17***a* and is likewise pivotable by this about the axis of rotation S—S of the bearer arm. A claw coupling **22** one segment of which is applied to the underside of the arm **17***a* and the complementary segment to the top of the crosswall **7** of the bearer arm **5,** in the working position as shown locks the arm **17***a* rotationally to the bearer arm **5.**

The shaft **18** is supported relative to the bearer arm **5** and the frame **3** to be slidable in its longitudinal direction. In order to be able to slide the frame **3** together with the bearer arm **5** in the vertical direction along the shaft **18,** an operating cylinder Z_2 is provided. Independent of this sliding motion of the frame **3,** the shaft is likewise slidable in the vertical direction by means of a further operating cylinder Z_1.

The shaft **18** is connected to a wormwheel **19** which can be driven via a worm (not shown) from a motor **20,** so that relative to the wormwheel **19** the shaft **18** can be slid axially but cannot be rotated. The direction of rotation of the motor **20** is reversible, so that bending movements both in the clockwise and also in the opposite sense can be performed.

The bending tools **12, 13** and **16, 17** respectively, each forming a bending head, are arranged in pairs at a small distance on opposite sides of the path of advance V—V of the rod to be bent, and in such a way that in the normal position of the bearer arm **5** shown in FIG. **7** the axes of rotation of the arms **13***a*, **17***a* of the movable bending tools **13** and **17** intersect the path of advance of the rod.

In the bearing of reinforcement inserts as in FIG. **2** for steel concrete structural members, in general, as already mentioned, two different bending processes come in question:

Firstly, the bending of end hooks H bent round 180° for the end anchoring of the insert.

Secondly, the production of so-called jogs or skews L2. These run in general at an inclination of 45° to the remaining portions L1, L3, L4 of the rod, though other angles are used. In any case, on both sides of the jogs they are connected to sections of rod which run parallel with one another, inclined at equal and opposite angles to the jogs.

In order to bend an end hook, the rod is pushed in by means of the feed device V through a guide **23** into the bending device B just so far that its front end projects by a distance corresponding with the length of the hook, beyond the axis of bend S—S of the stationary bending mandrel **16** of the first bending head.

By actuation of the operating cylinder Z_2 the frame **3** and all the parts connected to it, especially the bearer arm **5** and the second bending head with the bending tools **12, 13** is lowered to the point that these bending tools come to lie below the plane T—T of the bending table. The claw coupling **22** is thereby uncoupled, so that the bearer arm **5** does not follow the subsequent bending motion of the movable bending tool **17.** By actuation of the motor **20,** the movable bending tool **17** is passed round the bending mandrel **16** as far as is necessary for the production of the required end hook.

Next, the movable bending tool **17** is brought back to its normal position by reverse rotation of the motor **20.** Devices for limiting the angle of bend as well as devices for programming different consecutive angles of bend are known and need not be described in this connection, since they are not part of the invention.

By actuation of the operating cylinder Z_1 the movable bending tool **17** which has returned to its normal position is also lowered until it likewise comes to lie below the plane T—T of the bending table, the claw coupling **22** being re-engaged at the same time.

Now the longitudinally slidable second bending head consisting of the bending tools **12, 13** and the housing **10** is slid along the bearer arm **5** until the distance apart of the bending mandrels **12** and **16** equals the necessary length L2 of the skew to be bent.

The shifting of the longitudinally slidable bending head is carried out by known means not shown, such as motor-driven endless chains, cable tackle or spindles, and this shifting can also take place under programmed control.

At the same time, the rod itself is advanced until the first point of bend **P1** lying behind the end hook H which has just been formed, comes to lie against the bending mandrel **12** of the second bending head. After the advance has taken place the bending tools **12, 13, 17** together with the bearer arm **5** and all the parts supported by this are again raised by actuation of the operating cylinders Z_1 and Z_2 into the operation position as shown, so that the rod comes to lie between the bending tools **12, 13** respectively **16, 17** arranged in pairs.

Now, another bending process at a preset angle in either direction can begin, in which the bending tools **12, 13** and **16, 17** move in opposite directions and effect opposed bends at the points **P1** and **P2,** since the claw coupling **22** is now engaged (compare the operating phase Ph1 in FIG. **3**). In any bending process, the bend-

ing tools of each bending head cooperate on the cross, i.e., the bending mandrel on the one side of the rod to be bent — on the concave side of the bend to be performed — cooperates with the movable bending tool on the opposite side of the rod to be bent. The two stationary bending mandrels of each bending head moreover form a guide for the rod.

After carrying out the bending of the skew L2, the bending tools **12, 13** and **17** are lowered once again below the surface T—T of the bending table and in this position moved back into the normal position, whereupon the rod is advanced again (operating phase Ph2 in FIG. 3) by the distance L2 + L3 (distance between the points P2 and P4) and another bending process begins, with pivoting of the bearer arm **5** for the second bending head in the opposite direction (operating phase Ph3 in FIG. 3).

It is seen from FIg. 3 that, in all the operating phases Ph1, Ph2 and Ph3 the main extent of the partially respectively completely bent reinforcement insert coincides with the feed direction of the rod material.

After carrying out all the required bending processes, the rod is cut off by means of the shear **35** arranged preferably at the outlet end of the guide **23,** as shown only in FIGS. **3** and **4,** after which the remainder of the rod can be formed in the manner already known, into an end hook H, while an abutment **36** arranged rigidly on the bearer arm **5** secures the rod.

The bending machine as in FIGS. **4, 6** and **7** differs from that of FIGS. **3** and **5** essentially only in that a special auxiliary bending head is provided for forming the end hook H. Unlike the other bending heads the auxiliary bending head exhibits only one movable bending tool **30** and one bending mandrel **31** which are arranged on opposite sides of the path of advance V—V of the rod. Parts with the same duty and manner of operation are referenced with the same reference numbers as in the case of the machine as in FIGS. **3** and **5.**

Through the separation of the bending tools according to their duty, on the one hand for forming end hooks, on the other hand for the production of jogs, it is, in the case of this example, unnecessary to provide a possibility of uncoupling the movable bending tool **17** from the bearer arm **5;** the movable bending tool **17** is therefore in this case attached rigidly to the top of the bearer arm **5.** Since furthermore the bending tool **17** does not any more have to be capable of performing a pivotal motion through 180° round the bending mandrel which forms with it a bending head, in order to be able to bend a hook. The bending mandrel **24** can be formed in one piece with the frame **3** so that it follows the lowering motion of the frame in all cases.

The pivotal drive of the bearer arm **5** can in this case be effected by a simple toothed wheel **25** and a pinion **26** with possible interposition of a gearbox **27,** from a motor **28,** the bearer arm performing its pivotal motion about the shaft **29** stationary in the frame **3.**

The movable bending tool **30** and the bending mandrel **31** the duty of which is merely to bend end hooks, are arranged on a shaft **34** which can be slid in its longitudinal direction by means of an operating cylinder Z_4 in order to raise the bending tool as necessary above the plane T-T of the bending table or lower it below this plane.

A wormwheel **32** driven by a worm **33** is connected slidably with and coupled in rotation to the shaft **34** and transfers the necessary movements to the bending tool **30.**

The bending table T can be arranged pivotally about a horizontal axis or carry conveyor rollers in order to facilitate the removal of the completely bent reinforcement insert.

If reinforcement pieces or end hooks are to be produced or are to be bent into the shape of rectangular or trapezoidal wavetrains, for example, for use in lattice girders, the parts serving for the forming of the end hooks can naturally be omitted from the machine described.

We claim:

1. A bending machine for rod or strip material, such as reinforcing pieces for concrete, said machine comprising feed means for feeding into a feed path material to be bent, a first bending head defining an axis of bend mounted at a fixed position along said path, a second bending head mounted downstream of said first bending head, first movement means adjustably separating said first and and said second bending heads, each of said bending heads comprising a pair of movable bending tools and a pair of fixed bending mandrels forming guides for said material, said pairs of of movable bending tools being actuated in opposite directions, pivot means pivotally mounting said second bending head about the axis of bend of said first bending head out of said path, said pivot means being coupled to said first bending head, whereby said first and said second bending heads simultaneously bend said material in a plane in opposite senses to substantially the same extent, and second movement means for moving said second bending head and at least one of said bending tools of said first bending head out of the plane of bend of said material.

2. A bending machine according to claim **1,** wherein said first movement means comprises a bearer arm pivotable about said axis of bend of said first bending head and on which said second bending head is slideably mounted.

3. A bending tool according to claim **2,** wherein said one bending tool of said first bending head and said bearer arm are moveable together in a common pivotal motion about said axis of bend of said first bending head.

4. A bending machine according to claim **3,** wherein said first movement means comprises a first bevel wheel disposed coaxially with said bending axis of said first bending head, a shaft running in the longitudinal direction of said bearer arm for said second bending head, a second bevel wheel on said shaft engaging said first bevel wheels and a pair of longitudinally slideable bevel wheels connecting said shaft with said one bending tool of said second bending head.

5. A bending machine according to claim **1,** wherein upstream of said first bending head an additional auxillary bending head is provided for the production of end hooks, said auxillary bending head being moveable out of said plane of bend.

6. A bending machine according to claim **1,** wherein said second bending head and said one bending tool of said first bending head are separately moveable out of said plane of bend, said one bending tool of said first bending head being pivotable when uncoupled from said second bending head about a fixed bending mandrel of said first bending head, and said fixed mandrel of said first bending head, being moveable out of said plane of bend.

* * * * *