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Ritter et al.

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[54] **BENDING MACHINE FOR WIRE OR STRIP**

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Apr. 12, 1972 Austria 3181

[52] **U.S. Cl.** **72/384,** 72/217, 72/450

[51] **Int. Cl.** **B21d 17/02**

[58] **Field of Search** 72/384, 450, 149, 158, 217, 72/388, 459, 306; 140/140, 105

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Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—Ernest F. Marmorek

[57] **ABSTRACT**

The invention is concerned with a bending machine for wire or strip in which the raw material is advanced through the machine step by step and, between each step, a bend is made by a mobile bending tool. The bending tool is driven through a linkage which incorporates a control that can be operated whilst the machine is working to make a continuous adjustment to the working stroke of the bending tool and thus to the angle of bend made.

9 Claims, 3 Drawing Figures

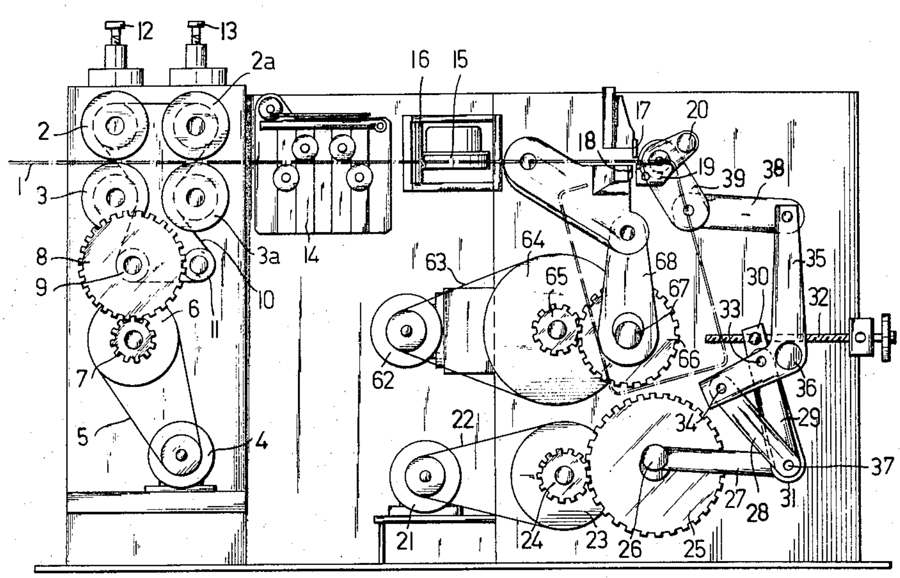
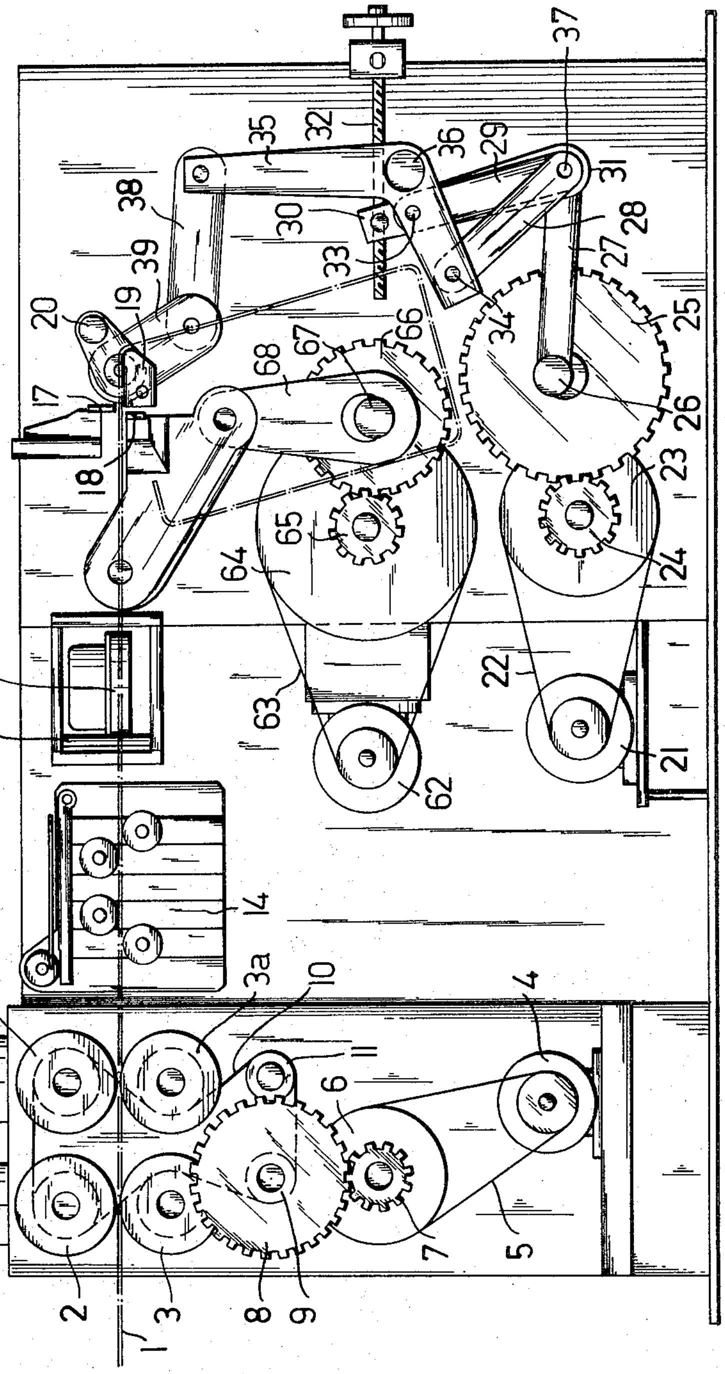


FIG. I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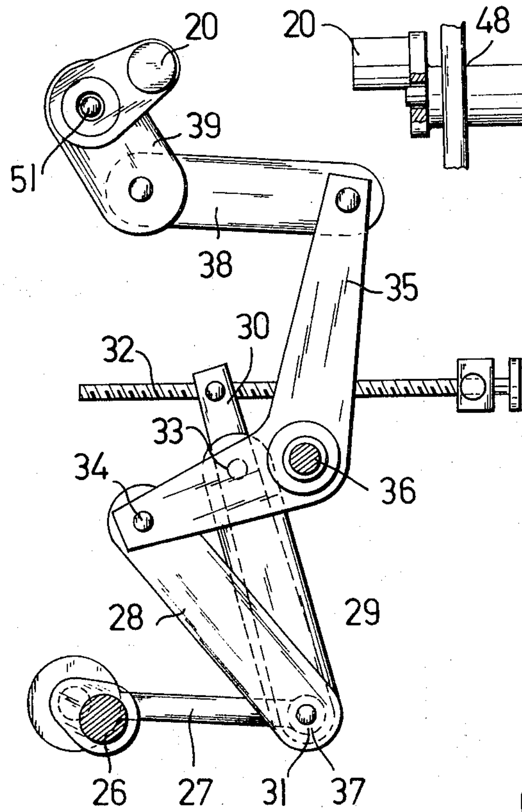
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FIG. 2

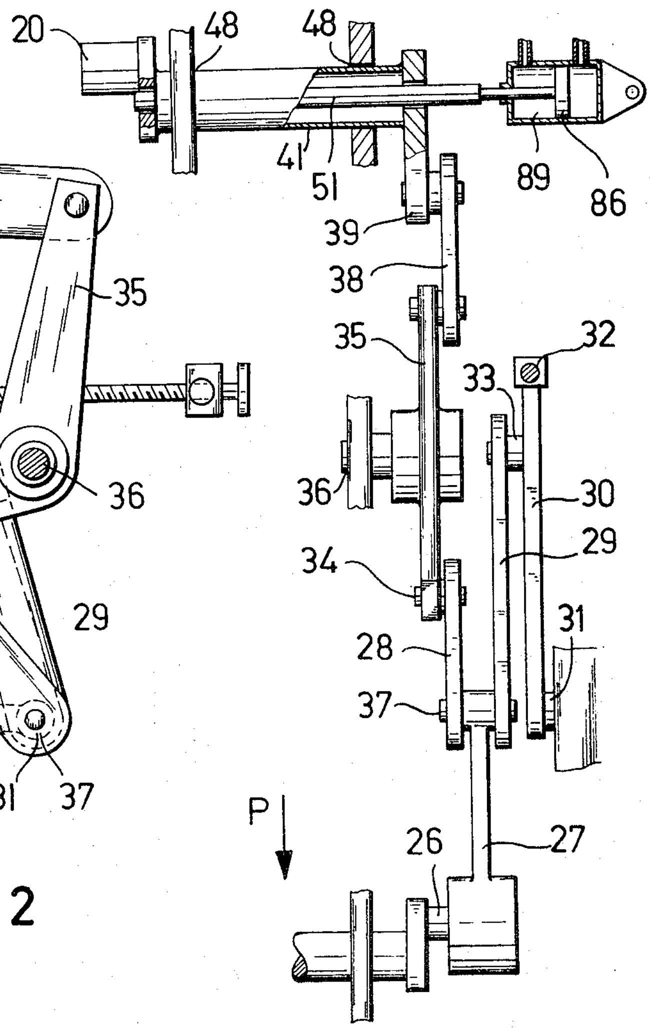
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FIG. 3

BENDING MACHINE FOR WIRE OR STRIP

The invention relates to a bending machine for wire or strip, in which the raw material for bending is advanced through the machine intermittently, step by step, the length of each step being the desired distance between each two successive bends, a bend being made, after each step of advance, by an intermittently driven mobile bending tool which bends the wire or strip through the desired angle around a stationary yoke. The machine preferably has a shearing device for cutting the wire or strip after the desired number of bends have been made. The machine is intended particularly for making bent hoops for reinforced concrete structures.

In known bending machines of this kind the movement of the mobile bending tool is interrupted, once the material has been bent through the desired angle, by the response of an adjustable microswitch which interrupts the electric current supplied to a drive motor, or disengages a clutch. This method is inaccurate and cannot consistently ensure bends of precisely the desired angle, due to the irregular delays characteristic of all switching and coupling processes and due to the need to decelerate considerable masses. A further disadvantage of the known bending machines is that the bending angle can be adjusted only when the machine is at a standstill, unless costly mechanical or electric control devices are used.

The object of the invention is to remove these difficulties and to provide a bending machine of the kind described but which, by simple constructional means, allows the bending angle to be varied during operation of the machine.

The problem is solved according to the invention in that drive is transmitted from a motor through a clutch to one end of a connecting rod which in turn drives the mobile bending tool, the drive being arranged in that the other end of the connecting rod is pivoted by a double pivot to one end of a swing link and also to one end of a working link, the other end of the working link being pivoted to a rocker which rocks in a stationary bearing and is directly or indirectly connected to the mobile bending tool, the other end of the swing link being pivoted to an adjustment lever which is itself pivoted in a stationary bearing and controlled in such a way that the position of the adjustment lever relative to the stationary bearing of the rocker and relative to the pivot at which the working link is pivoted to the rocker, is variable for the purpose of adjusting the angular working stroke of the mobile bending tool and thus the angle of the bend made.

By virtue of this continuously adjustable transmission system the end of the bending process is no longer determined by the instant of response of a switch or a clutch, for switching off or disengaging the motor but rather, as will be described in greater detail further below, with the help of the drawings, by the adjustable dead-centre of a reciprocating working movement. The position of the dead-centre is adjusted, during operation of the machine, simply by adjusting the position of a stationary device, that is to say the adjustment lever.

Preferably the effective length of the working link is the same as the effective length of the adjustment lever and preferably the same as the distance between the stationary bearing of the adjustment lever and the stationary bearing of the rocker connected to the mobile bending tool. The arrangement provides a particularly effective power transmission system. This system can be arranged in such a way that the pivot where the swing link is pivoted to the adjustment lever is adjustable in position all the way from a location at which this pivot coincides in position with the pivot where the working link is pivoted to the rocker, to a constructionally determined final limiting location. In the course of this adjustment the bending angle varies continuously all the way from **0°** to its own constructionally determined final value.

The angular position of the adjustment lever can be adjustable by means of an adjustment spindle which engages with the adjustment lever, the adjustment spindle being actuated either manually or by means of a preferably programmed controlling servo motor.

The rocker connected to the mobile bending tool may be in the form of a bell crank connected through a connecting link and a crank lever to the shaft to which the bending tool is fixed.

The shaft to which the bending tool is fixed can conveniently be a hollow shaft and it can contain an axially slidable, automatically actuated ejector pin. This simple and compact arrangement provides automatic ejection of the completed wire hoops or other bent wire or strip articles.

One example of a machine constructed in accordance with the invention is illustrated in the accompanying drawings, in which:

FIG. **1** is a diagrammatical overall view of the machine;

FIG. **2** represents diagrammatically the adjustable driving system; and,

FIG. **3** is a front view corresponding to FIG. **2**, but stretched out in the direction of the arrow **P** to make the individual parts easily visible without overlap.

In FIG. **1**, a wire **1**, which is to be used for making bent hoops, is conveyed into the machine by two pairs of conveyor rollers **2, 2*a*** and **3, 3*a***, which drive the wire along by a frictional grip.

The conveyor rollers are driven by an electric motor **4** through a V-belt **5**. The V-belt drives a flywheel **6** which is coupled by a clutch (not shown) to a pinion **7** which engages with a toothed wheel **8**.

The toothed wheel **5** is fixed to a shaft to which is also fixed a chain sprocket wheel **9** over which runs an endless chain **10** which is kept under constant tension by a tensioning roller **11**. The chain **10** drives four sprocket wheels, over which it is partly looped, the sprocket wheels being fixed to the conveyor rollers **2, 2*a*** and **3,3*a***, so that in effect the electric motor **4** drives the conveyor rollers whenever the clutch which couples the two parts **6** and **7** together is engaged.

Engagement of the clutch between the flywheel **6** and the pinion **7** advances the wire through the desired distance, whereupon the clutch is automatically disengaged and a brake (not shown) is automatically applied, immediately bringing the pinion **7** to a standstill, interrupting the advance of the wire and holding it at a standstill. The two upper conveyor rollers **2** and **2*a*** are vertically mobile within limits and are thrust resiliently downwards against the upper surface of the wire by springs, whose spring loads are adjustable by means of the two adjustment screws **12** and **13**.

Downstream of the conveyor rollers **2, 2*a*** and **3, 3*a*** the wire **1** passes through a straightening device **14** of known kind, which straightens the wire out. Downstream of the straightening device 14 the wire drives, by frictional contact, a measuring drum 15 which is pivoted on an axle 16 and thrust into contact with the surface of the wire by a spring. The measuring drum 15 drives the pulse generator of an electronic length measuring device of the kind described in our British Pat. application No. 59144/71. This electronic device measures the distance advanced by the wire and controls a shearing device which automatically cuts off the desired lengths of wire.

Downstream of the measuring drum the wire passes between a stationary blade 17 and a mobile blade 18 of the shearing device, after which the wire reaches the bending device proper, consisting essentially of a stationary bending anvil 19 and a mobile bending tool 20.

The bending device is driven by an electric motor 21 through a V-belt 22 which drives a flywheel 23 that can be coupled by a clutch (not shown) to a pinion 24 which engages with a toothed wheel 25. The toothed wheel 25 is fixed to a shaft to which is also fixed an eccentric 26 which drives the bending tool through a connecting rod 27 and a system of linkages. The other end of the connecting rod 27 is pivoted by a double pivot 37 to a working link 28 and a swing link 29.

As shown in FIG. 2, an adjustment lever 30 is pivoted at its lower end in a stationary bearing 31, the upper end of the adjustment lever 30 being adjustable in position by means of an adjustment spindle 32. Rotation of the adjustment spindle 32 causes the adjustment lever 30 to pivot back and forth in its stationary bearing 31. The swing link 29 is pivoted at its upper end, at 33, to the adjustment lever 30. The upper end of the working link 28 is pivoted at 34 to one arm of a 2-armed rocker 35 which is pivoted in a stationary bearing 36. In regard to dimensions, three equal lengths are preferably used, that is to say the effective length of the working link 28, measured as the distance between its two pivot points 37 and 34 is preferably the same as the effective length of the swing link 29, measured between its two pivot points 37 and 33 and this is preferably the same as the effective length of the adjustment lever 30, measured between its two pivot points 31 and 33.

Moreover this same length is preferably repeated a fourth time, in that the distance between the two stationary bearings 31 and 36 is preferably equal to the effective lengths of the working link 28, the swing link 29 and the adjustment lever 30.

The arrangement allows any desired angular movement of the rocker 35, between 0° and a constructionally determined upper limit, to be obtained, by stepless adjustment, for each half turn through 180° of the eccentric 26. To obtain 0° angular movement of the rocker the free end of the adjustment lever 30 is driven forwards, by rotating the adjustment spindle 32, until the pivot point 33 comes to coincide with the pivot point 34. Under these circumstances rotation of the eccentric 26 merely swings the two links 28 and 29 in common about the coincidence point, no angular movement being applied to the rocker 35 because the distance between the pivot points 37 and 34 would remain the same even if the working link 28 were not present.

On the other hand if the free end of the adjusment lever 30 is brought back, by rotating the adjustment spindle 32, until a finite distance exists between the pivot points 33 and 34, then rotation of the eccentric 26 swings the swing link 29 back and forth, as before, about the pivot point 33, the working link 28 now preventing any change in the distance between the pivot points 37 and 34 by rocking the rocker 35 through a finite angle during each half turn of the eccentric 26. The angle of movement of the rocker 35 depends on the distance between the pivot points 33 and 34 and is greatest when this distance reaches its greatest constructionally possible value.

The other arm of the 2-armed rocker 35 is connected, through a pivoted connecting link 38, to a lever 39 fixed to a hollow shaft 41 to which is also fixed the bending tool 20 so that the rocking movement of the rocker 35 is transmitted to the bending tool. Consequently when the eccentric 26 rotates an oscillatory movement is transmitted, through the linkage system 27 to 34, to the rocker 35, which oscillates in its fixed bearing 36, and through the connecting link 38, the lever 39 and the hollow shaft 41 to the bending tool 20, causing the latter to oscillate about the axis of the hollow shaft 41.

The angular movement of the bending tool 20 is continuously adjustable by adjusting the angular position of the adjustment lever 30 by means of the adjustment spindle 32.

When the machine is in operation the adjustment spindle 32 therefore serves for adjusting the angle through which the wire is bent over, allowance being made, when calculating this angle, for the different spring constants of wires of different qualities, so as to compensate for different rebounding behaviours. If desired the connecting link 38 can be adjustable in length for the purpose of adjusting the position of rest of the bending tool 20 precisely so as to ensure that each bending operation starts out from the same initial position, irrespective of the instantaneous position of the adjustment spindle 32.

The hollow shaft 41, which rotates in bearings 48, contains an ejector pin 51 in the form of the piston rod of a piston 86 working in a cylinder 89. FIG. 2 shows the piston 86 with its ejector pin 51 in the position of rest. A completed hoop is ejected by driving the piston 86 out towards the left, and almost immediately afterwards retracting it.

The machine functions as follows. Let it be assumed that a bent hoop is to be made somewhat as represented in chain lines in FIG. 1. With the help of the clutch, which is not shown in the drawing, the toothed wheel 24 is engaged with the flywheel 23. The clutch remains engaged until the toothed wheel 25, with its eccentric 26, has completed one revolution (360°). The clutch is then automatically disengaged and a brake, which is also not shown in the drawing, is automatically applied, stopping the rotation of the toothed wheel 24 and holding it at a standstill. During the first 180° of rotation of the eccentric 26 the bending tool 20 is swung downwards, by the action of the parts 27 to 41, bending the wire through the desired bending angle, which has been adjusted by means of the adjustment spindle 32. As indicated in FIG. 1 the adjustment spindle 32 can if desired be operated by hand, although it can if desired by operated by an automatically controlled positioning motor. During the second half rotation of the eccentric 26 the bending tool 20 returns to its initial position. The bending operation is repeated until all the desired bends have been made, whereupon the wire is sheared off between the two shearing blades 17 and 18. The shearing device is driven by a drive system similar to those used for advancing the wire and for bending it. An electric motor **62** drives the shearing device through a V-belt **63** and a flywheel **64** connected through a clutch to a pinion **65** which engages with a toothed wheel **66.** The toothed wheel **66** drives the mobile shearing blade **18** through an eccentric **67** and a connecting rod **68.**

We claim

1. In a machine for bending wire or strip, said machine comprising means for intermittently advancing raw material for bending, step by step, the length of each step being the desired distance between two successive bends, a stationary anvil, and an intermittently driven mobile bending tool which bends said wire or strip through a desired angle around said anvil; an improved drive for said bending tool comprising a motor, a clutch operatively connected to said motor, a connecting rod having first and second ends, said first end of said connecting rod being connected to said clutch to be driven by said motor therethrough, a double pivot at said second end of said connecting rod, a swing-link having first and second ends, said first end of said swing-link being pivoted to said double pivot, a working link having first and second ends, said first end of said working link being pivoted to said double pivot, a first stationary bearing, a rocker which rocks in said first stationary bearing, means pivotally connecting said rocker to said second end of said working link, means interconnecting said rocker to said bending tool, a second stationary bearing, an adjustment lever pivoted in said second stationary bearing, means pivoting said adjustment lever to said second end of said swing-link, and means controlling the position of said adjustment lever, relative to said first stationary bearing, and relative to said pivotal connection between said working link and said rocker, whereby said position is variable for the purpose of adjusting the angular working stroke of said mobile bending tool and thus the angular bend made.

2. A machine according to claim **1,** wherein said swing-link and said adjustment lever are both of the same effective length.

3. A machine according to claim **2,** wherein the effective length of said working link is the same as said effective length of said swing-link and said adjustment lever.

4. A machine according to claim **3,** wherein the distance between said first and second stationary bearings is equal to said effective length of said swing-link, said adjustment lever, and said working link.

5. A machine according to claim **1,** wherein said pivotal connection between said swing-link and said adjustment lever is adjustable in position continuously from a location at which said last named pivotal connection coincides in position with said pivotal connection between said working link and said rocker, to a constructionally determined final limiting location.

6. A machine according to claim **1,** wherein said angular position of said adjustment lever is adjustable by means of an adjustment spindle adapted to be actuated manually or by means of a programmed controlling servo motor.

7. A machine according to claim **1,** wherein said rocker is in the form of a bell crank and the invention further comprises a crank lever, a connecting link interconnecting said bell crank and said crank lever, and a shaft connected to said crank lever and carrying said bending tool.

8. A machine according to claim **7,** wherein said shaft is hollow and contains an axially slidable automatically actuated ejector pin for ejecting a bent length of rod or strip.

9. A machine according to claim **1,** having a shearing device for cutting said wire or strip after the desired number of bends have been made.

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