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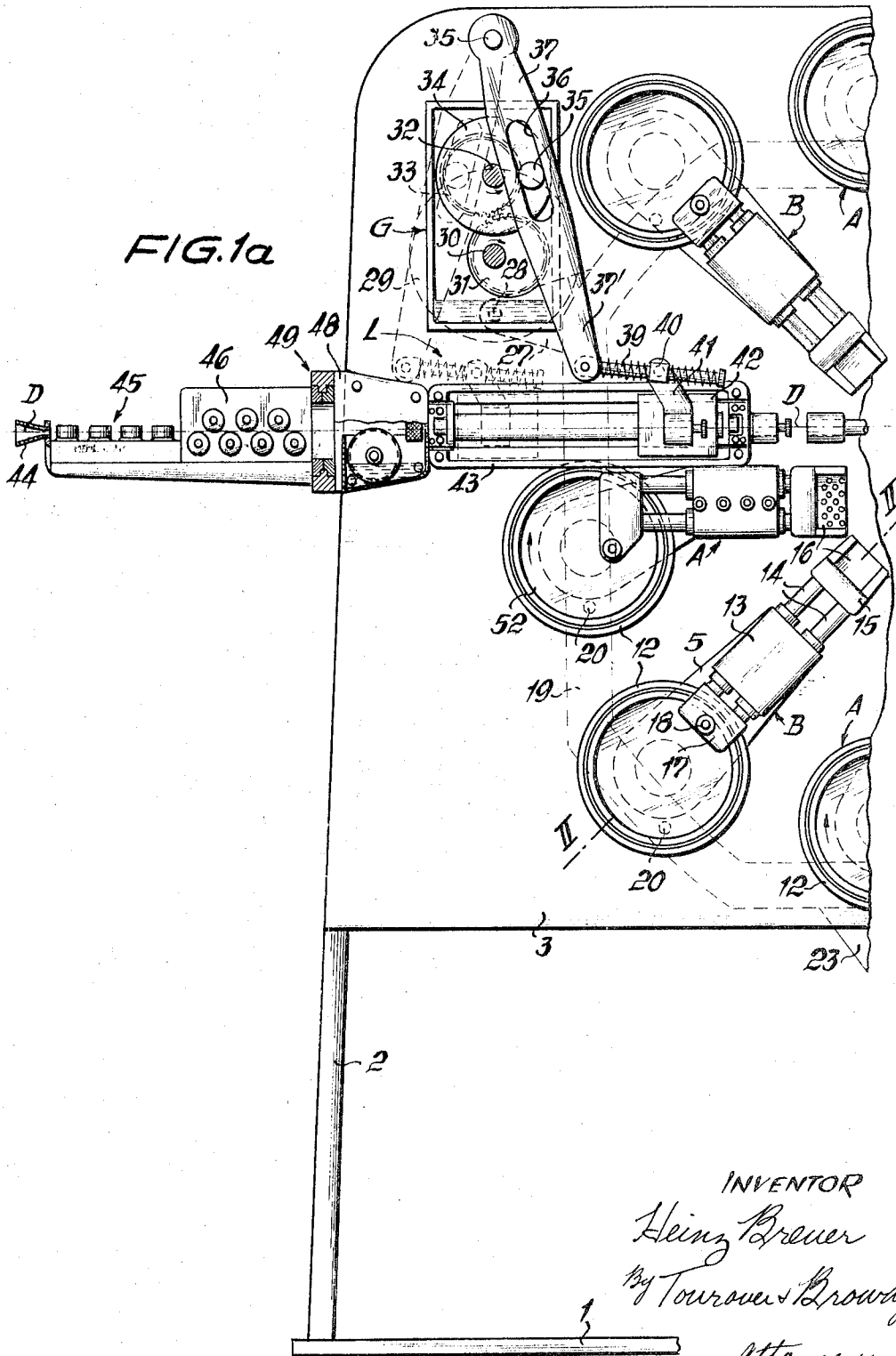
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3,296,851

WIRE-BENDING MACHINE

Filed April 20, 1964

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Jan. 10, 1967

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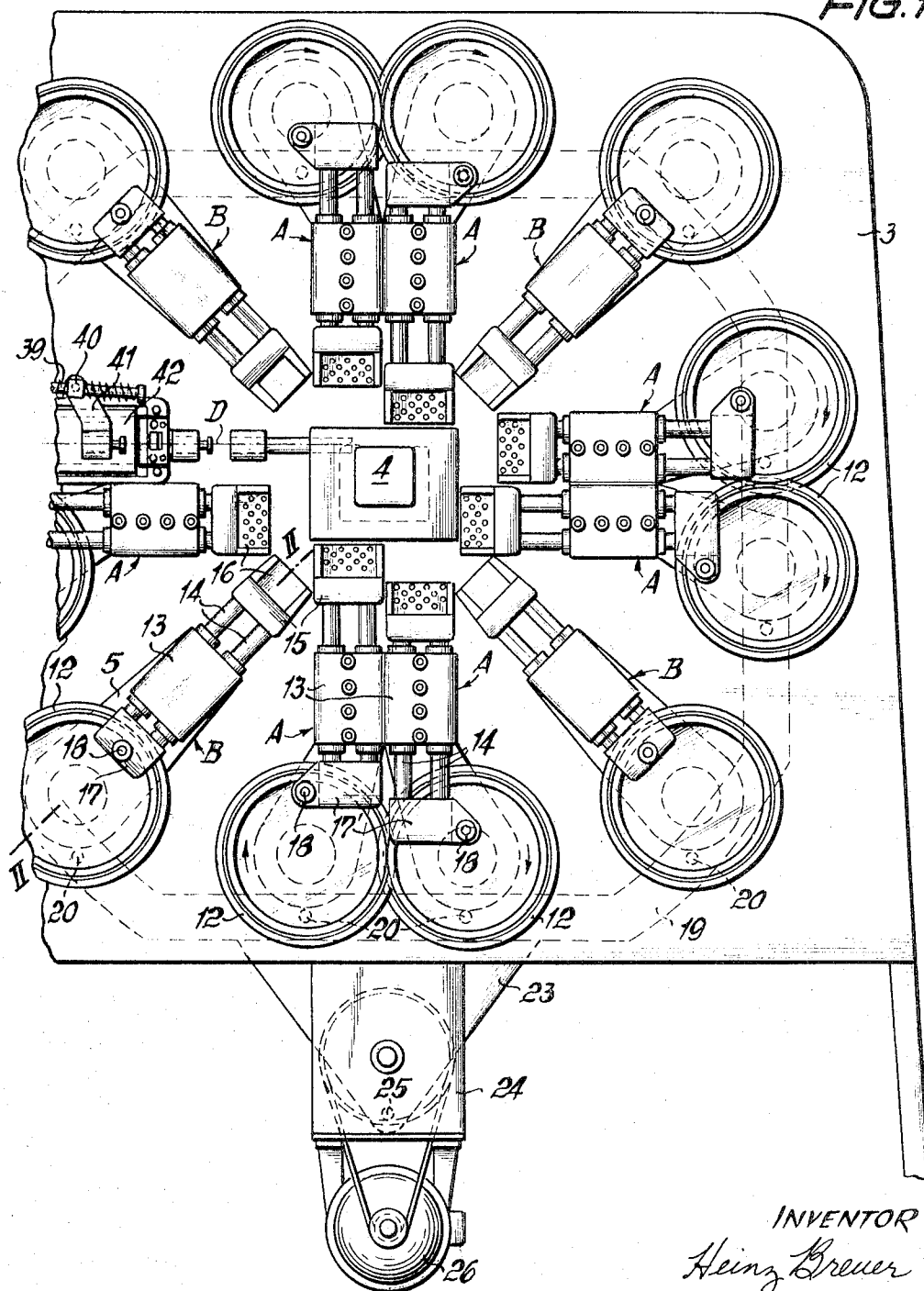
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WIRE-BENDING MACHINE

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7 Sheets-Sheet 2

FIG. 16



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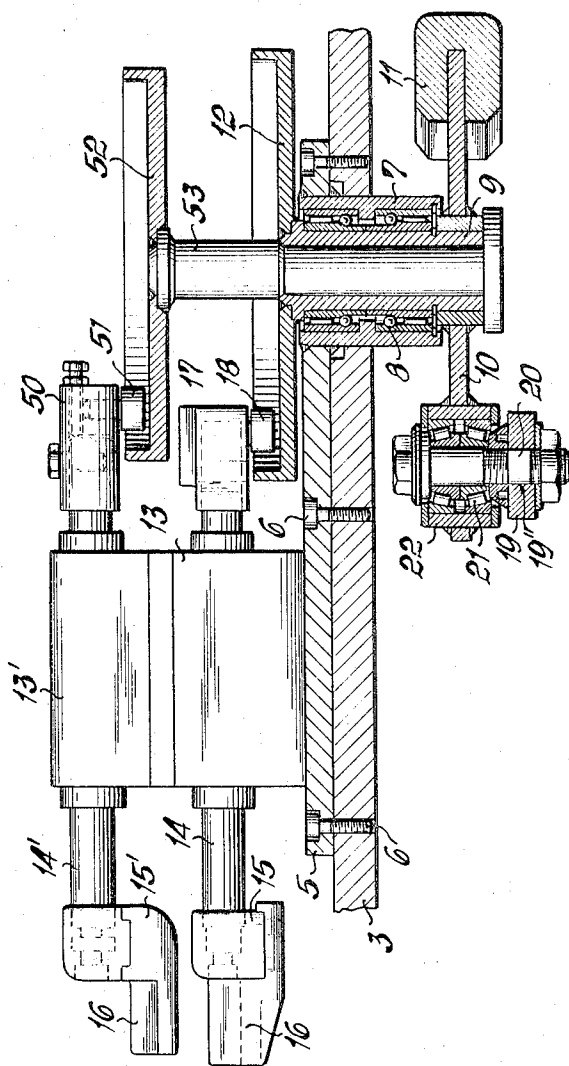
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7 Sheets-Sheet 3

FIG. 2



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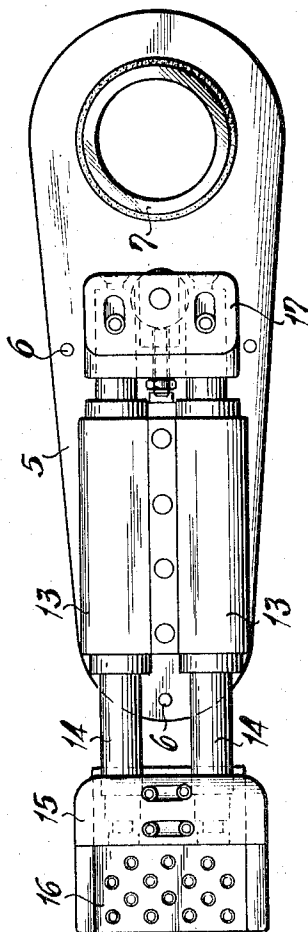
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WIRE-BENDING MACHINE

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7 Sheets-Sheet 4

FIG. 3



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3,296,851

WIRE-BENDING MACHINE

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7 Sheets-Sheet 5

FIG. 4

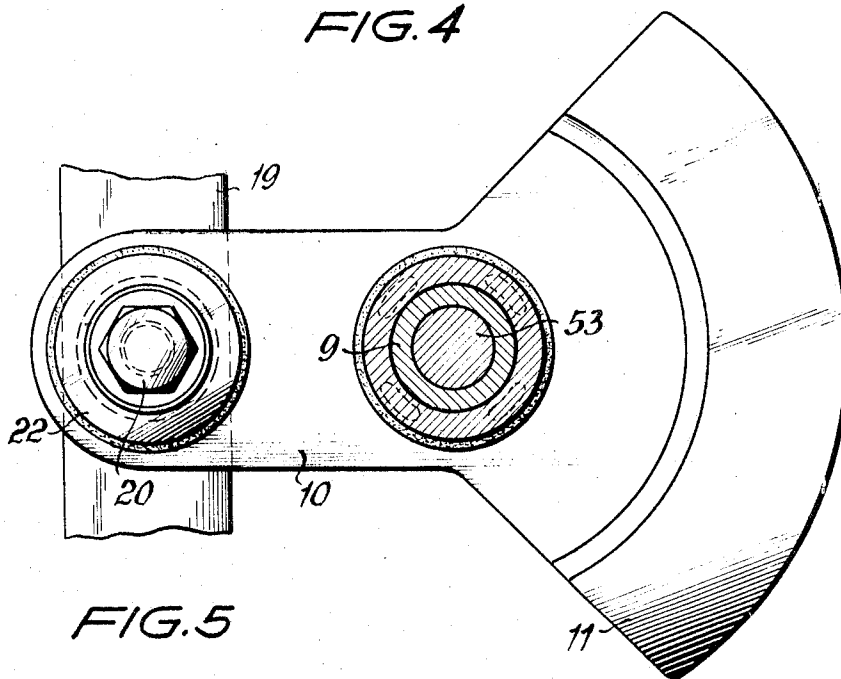


FIG. 5

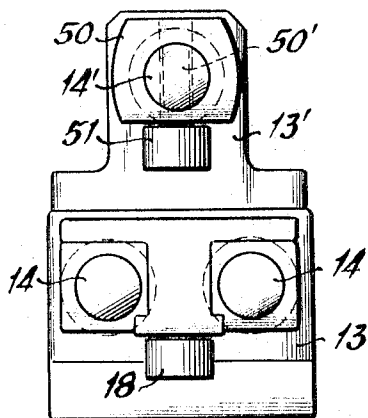
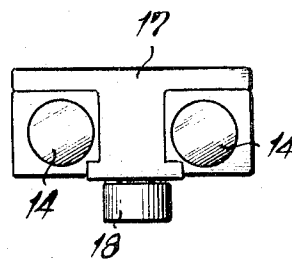


FIG. 6



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3,296,851

WIRE-BENDING MACHINE

Filed April 20, 1964

7 Sheets-Sheet 6

FIG. 8

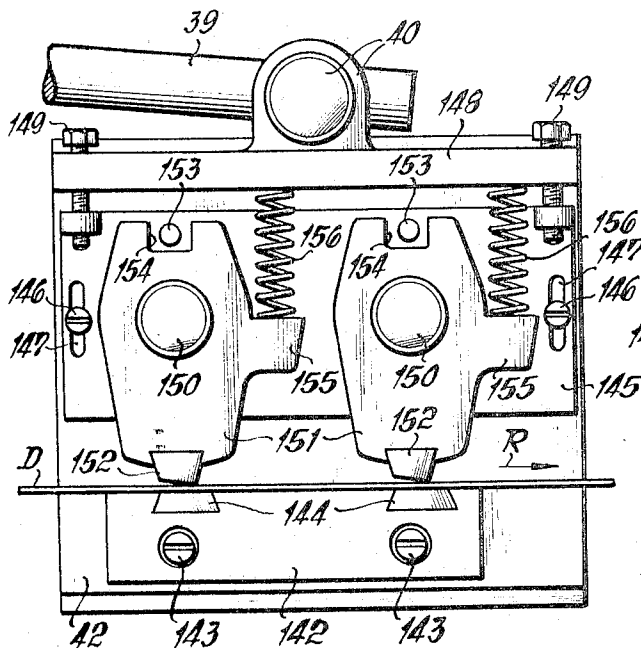


FIG. 9

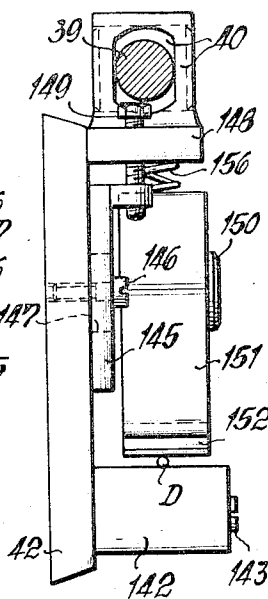
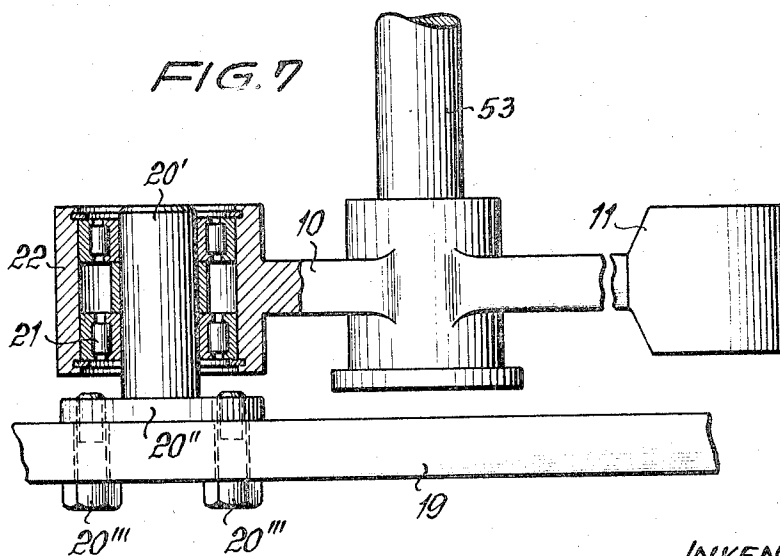


FIG. 7



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3,296,851

WIRE-BENDING MACHINE

Filed April 20, 1964

7 Sheets-Sheet 7

FIG. 10

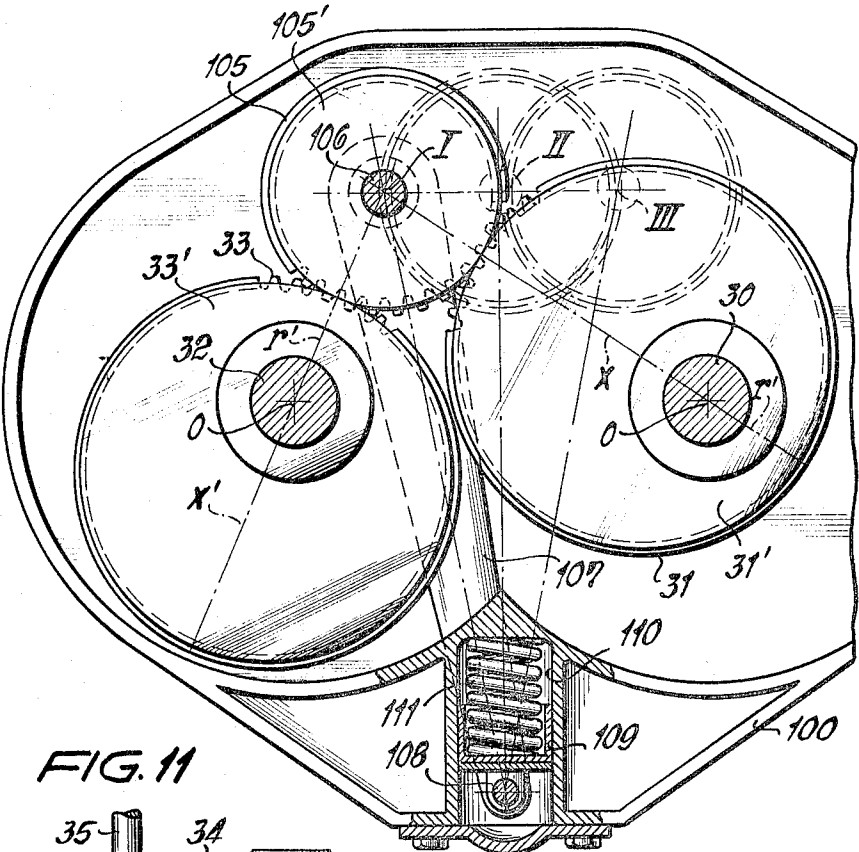
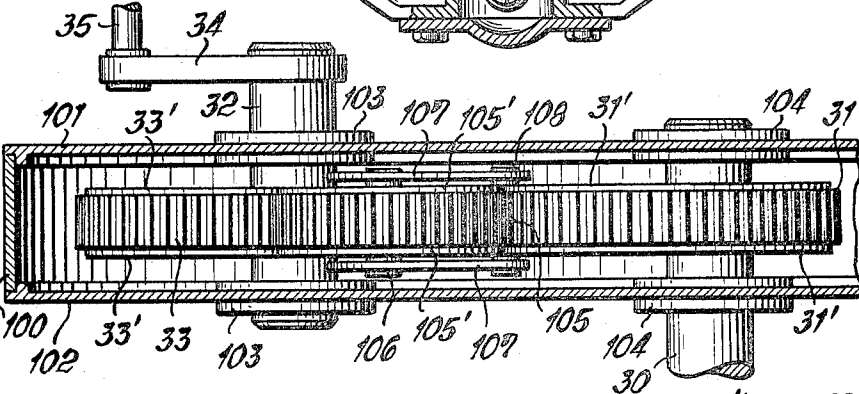


FIG. 11



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1

3,296,851

WIRE-BENDING MACHINE

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R 34,989

15 Claims. (Cl. 72—383)

Articles made of wire or round or triangular or square or flat or strip material or material of similar sections are often produced on bending machines comprising a mandrel which can pivot but which usually remains stationary during bending, the machine also comprising a number of bending tools which can be moved towards the mandrel and which press the piece of wire or the like which it is required to shape against projections of the mandrel or into recesses therein to shape the object in the required manner. As a rule, the carriage which bears the bending tools is operated by a common motor-driven power-transmitting element through the agency of cam discs or eccentrics or the like so that the tools make the various bends in the piece of wire in the required sequence. Finally, the finished article is ejected from the machine; for instance, after the various tool carriages have returned, the mandrel is bent back so that the article is scraped off and drops out of the machine. Machines of this kind will be referred to herein by the general term of "wire-bending machines."

Wire-bending machines are known wherein the tool carriages are driven by eccentric shafts which are disposed at right-angles to one another and which are disposed around the work plate (tool plate) of the machine or around the mandrel. A serious disadvantage of this kind of drive is that in practice it allows bends to be made only in directions which extend away from one another substantially at 90°. Bending at other angles is difficult and requires expensive extra driving means whose fitting slows down the operation of the machine.

It is also known to drive the eccentric shafts by one or more endless chains. The disadvantage of this arrangement is that tensioning rollers must be provided. Also, chain-driven wire-bending machines can perform only the lighter kind of work; if they are used for heavy work, wear is heavy and there is therefore a backlash or mutual hindrance of the tools during fast operation. At least, however, the bending tools can be arranged in any angular position in chain-driven machines, but this advantage is achieved at the cost of considerable disadvantages.

The invention discloses a much more advantageous way of constructing wire-bending machines or the like in which high output or high-speed operation are combined with accuracy and reduced wear.

According to a main feature of the wire-bending machines or the like according to the invention, one crank drive each is associated, as actuating element, with the various tool elements, and the crank radius of the crank drive is the same for all the tool elements, while the crank bearing can be disposed anywhere on the stationary machine plate; and the crank pins at the free end of the cranks are mounted in a plate-like or frame-like driving member which is common to all the crank pins and which transmits the torque of the driving motor to the cranks.

This basic construction of the wire-bending machine according to the invention provides considerable advantages. First, the various cranks all run in complete synchronism with one another; consequently, all the tools operate in the correct sequence, the intervals between the various bending events being very short. The output of the machine according to the invention is therefore very high and remains high for a prolonged operating time without any impairment of accuracy. The various tool

2

elements can be disposed in substantially any angular position and closely together, so that a large number of tools can be made available for production and can be placed wherever required on the machine plate without the main drive having to be modified.

The bending machine according to the invention can therefore produce wire elements having a very wide variety of shapes and a very large number of bends, in a way which has previously been impossible in the known machines, at least in a single working step.

According to another feature of the invention, to enable the machine according to the invention to operate at high speed the tool carriers are disposed on rod guides guided in closed guiding casings by means of anti-friction bearings. According to another feature of the invention, these anti-friction guides with the tool carrier rods, and the associated cam disc and the cup-shaped member for receiving the same, such member being disposed on a crankshaft, are disposed on a special baseplate. A constructionally unitary bending-tool element is therefore provided which contains all the guiding and driving components and which can be disposed, for instance, clamped, as a whole on the machine plate in any position.

Advantageously, the wire-feeding device of the bending machine according to the invention is also driven by the plate-like or frame-like main driving element which accordingly has an extra crank drive.

According to the invention, the driving element for the wire-feeding device is a novel transmission providing a non-uniform angular velocity of the crank drive operating the wire-feeding device. This novel transmission will be described in greater detail hereinafter and has other advantageous uses where a shaft or the like is required to perform a non-uniform rotation.

When the machine according to the invention is running at its very highest speed, it is essential that the wire to be processed be supplied satisfactorily straightened. To this end, the invention uses a straightening device which comprises a number of roll sets and which is disposed concentrically of the wire axis and rotatably mounted on the machine frame. This straightening device is rotated continuously or intermittently to prevent the wire from bending in one direction in the manner which, with stationary straightening rollers, is almost unavoidable, and the wire supplied to the bending mandrel is always straight.

According to another important feature of the invention, all the drive elements—i.e., the plate-like or frame-like orbiting main drive element and the associated cranks and crank pins—are disposed below or on the back of the machine plate, while the bending elements and the special driving elements for the wire-feeding device or the like are disposed on the front or top of the machine plate.

Other important features of the invention will be disclosed by the following description of preferred embodiments of the invention. One preferred embodiment of the subject matter of the invention is shown in the drawings wherein:

FIGS. 1a and 1b are views in front elevation of the wire-bending machine according to the invention;

FIG. 2 is a view to an enlarged scale and in section along the line II—II of FIG. 1;

FIG. 3 is a plan view of a tool element as shown in FIG. 2 after removal of the dished member for receiving the cam disc;

FIG. 4 is an inverted plan view of a part of FIG. 2;

FIG. 5 is an end elevation of a part of FIG. 2;

FIG. 6 is a section taken along the line A—B of FIG. 3;

FIG. 7 is a section to an enlarged scale through another embodiment of the connection between the crank pins and the driving frame;

FIG. 8 is a front elevation, to an enlarged scale, of the carriage of the wire-feeding device;

FIG. 9 is a side elevation of the device shown in FIG. 8;

FIG. 10 is a side elevation, to an enlarged scale, of the transmission for driving the wire-feeding device, and

FIG. 11 is a plan view of the transmission shown in FIG. 10 with a section through the casing.

The wire-bending machine shown in the drawings comprises a baseplate 1 on which a flat steel plate 3 is so mounted with the interposition of columns 2 as to be disposed in a vertical or substantially vertical plane when the baseplate 1 is secured to some conventional form of foundation. However, this arrangement of the plate 3 is not limitative and the same can be disposed horizontally or inclinedly. The advantage of the vertical arrangement illustrated is that wire articles produced on the machine can readily be removed from the operative range of the bending tools and other parts of the machine. Disposed on the plate 3 around a mandrel 4 placed substantially at centre of the plate 3 are a number of tool elements having the general references A and B; the elements A are devised for a lateral arrangement of the eccentric roller and the elements B are devised for axial arrangement of the eccentric roller.

Details of tool element construction can be gathered from FIGS. 2 and 3. Each tool element has a baseplate 5 secured by screws at places 6 to the steel plate 3 in the desired position; the same is accordingly formed with tapped bores or the like at the required places. Near one end the baseplate 5 has a bush 7 which extends through an aperture in the plate 3. Rotatably mounted in the bush 7 with the interposition of a ball bearing 8 is a hollow shaft 9 having non-rotatably mounted at one of its ends a crank arm 10 connected to a counterweight 11. The other end of the shaft 9 bears a dished or cup-shaped member 12 for receiving a disc (not shown) which can be a cam disc or a disc formed with a cam groove and which is non-rotatably connected to the member 12. The shape of the disc depends upon the bends required in the finished wire article. A double guide 13 for two longitudinally movable rods 14 having parallel axes is also provided on the baseplate 5. The two rods 14 are interconnected at one end by a yoke 15 having, on the side near the mandrel 4 (FIG. 1), a bracket-like extension 16 formed with fixing apertures via which the required tools can be releasably secured to the extension 16. The other end of the rods 14 is connected by a yoke 17 having rotatably mounted on it a roller 18 which extends into the zone of the cup-shaped member 12 and of the cam disc secured thereto.

As can be gathered from FIGS. 2 and 3, when the crank drive 10 rotates, the member 12 with the cam disc or the like therein is rotated; during one complete revolution the tool carrier 16 is, one or more times and in one or more predetermined angular positions of the crank, drawn back, to an extent determined by the pattern of the cam disc or the like, from the operative position shown and advanced, in some other angular position, back to the operative position, the rods 14 reciprocating axially in their guides 13. Advantageously, the guides 13 are anti-friction guides so that the tools have to overcome only a reduced friction in their movement.

The tool elements described are driven via ring or frame 19 which is common to all the elements and which, in the particular embodiment shown, is disposed on the back or underside of the steel plate 3. Basically, the frame 9 can be of any shape and possibly even be in the form of a plate formed with a central aperture or the like if this feature is necessary for operation of the central mandrel 4. The frame 19 is formed at an appropriate place with apertures 19' in each of which the crank pin 20 can be releasably secured. A bearing lug 22 of the crank arm 10 is mounted on the crank pin 20 with the interposition of a ball bearing 21. The crank pins 20 are shown in FIG. 1 only in diagrammatic form, but details can be gathered from FIG. 2.

Advantageously, and as shown in FIG. 7, the crank pins, instead of being received directly in the bores in the frame 19, can be secured to a plate 20'' releasably secured to the frame 19 by screws and/or pins 20''' or the like. This construction facilitates the assembly of the crank pins on the frame 19. At the bottom end of the plate 3 is a stationary extension 3' in which a pulley 24 or the like is rotatably mounted. The pulley 24 has a crank pin 25 which is similar to the pins 20 and which is rotatably mounted, with the interposition of a ball bearing, either directly in the frame 19 or in a part 23 rigidly connected thereto. The distance between the crank pin 25 and the axis of the driving pulley 24 is exactly equal to the distance of the crank pins 20 from the axis of rotation of the cup-shaped members 12 associated with them.

When the pulley 24 is rotated, for instance, by means of an electric motor 26, the frame 19 and with it the crank drives of all the tool elements perform an orbiting motion in which the angle between the frame 19 and the horizontal or vertical stays unchanged and the counterweights 11 on the crank arms provide compensation for the inertia forces produced by the frame 19. As will be apparent, it is immaterial whether the individual tool element A or B is disposed on the plane 19 or what the angle of each such element is to the mandrel 4, provided that the crank pin 20 associated with the individual tool element stays within the orbiting zone of the frame 19. This proviso can readily be met by an appropriate choice of the width of the frame 19 or of the length of the various tool elements, more particularly of the extensions 16.

With the basic arrangement according to the invention as illustrated, therefore, the tool elements can be disposed on the machine plate 3 in any angular position relatively to the bending mandrel 4 as required to bend the wire up and down in the manner necessary to produce the finished article. Since all the tool elements are driven in common by the functionally unitary frame 19, all the bending operations are correctly timed, as are the necessary return movements of the tools. To enable the tool elements to be placed very close together on the plate 3, the yokes 17' which bear the rollers 18 and which are associated with the tool elements A are extended laterally so that the rollers 18 engage one-sidedly with the yokes 17' and the crank pins 20 transmit identically directed forces to the two adjacent tool elements.

According to the invention, the frame 19 also drives those parts of the machine responsible for feeding the wire D to be processed in the machine. Accordingly, the frame 19 has a portion 27 in which a crank pin 28 arranged similarly to the pins 20 is rotatably mounted. The pin 28 is mounted on a disc 29 which is on the back of the plate 3 and is disposed on an input shaft 30 of a transmission; the same has the general reference C in FIG. 1 and is also secured to the plate 3. A shaft 32 of the transmission C bears a disc or arm 34 having secured to it a crank pin 35 engaging in a slot 36 in a single-armed lever 37 rockable around a pin 38 adjustably mounted in the plate 3. The free end 37' of the lever 37 is articulated to a rod 39 displaceable in a rotatable entraining member 40 mounted on a side arm 41 of a carriage 42. The same can be moved parallel with itself in a guide 43 and has appropriate clamping elements known per se, such as clamping balls, which retain the wire D in the longitudinal channel of the carriage 42 for movement thereof in one direction and release such wire for movement of the carriage in the other direction.

A preferred embodiment of the wire-feeding device is shown in FIGS. 8 and 9. In this embodiment, a ledge or ridge or the like 142 is secured by screws 143 to the carriage 42. Abutments 144 of carbide metal or some other appropriate substance are provided in the top of the ledge 142. Disposed on the carriage 42 above the ledge 142, with provision for vertical movement, is a plate 145 which is secured to the carriage 42 by screws 146 which extend through slots 147 in a plate 145. Thereabove the

carriage 42 has a bearing ledge or ridge or the like 148 which is either rigidly secured to the plate 145 or unitary therewith and in which adjusting screws 149 are disposed for adjusting the plate 145 into a desired position and retaining the plate 145 in the required position. The entraining member 40 of the rod 39 is secured to the ledge 148. The plate 145 has two horizontally adjacent bearing pins 150 whose axes are parallel with one another and on which one clamping lever 151 each is pivotally mounted. At the bottom end each lever 151 has a thrust element 152 which is, with advantage, made of carbide metal and whose bottom end surface is inclined. Pivoting of the levers 151 is limited by abutments 153 of the plate 145, such abutments engaging in notches 154 in the levers 151. The same have on one side a projection 155 against each of which bears a compression spring 156 whose other ends bear against the underside of the top ledge 148.

The device shown in FIGS. 8 and 9 operate as follows:

The wire D or other section material to be processed is placed on the top of the ledge 142 and, after the clamping levers 151 have been pivoted, is clamped between their thrust element 152 and the abutment 144 therebelow of the ledge 142 by the action of springs 156, in the manner visible in FIG. 9. Only one end edge of the thrust elements 152 contacts the wire. When, as hereinbefore described, the carriage is now moved by the rod 39 in the direction indicated by an arrow R (FIG. 7), the carriage entrains the clamped wire with it but releases the wire at the end of the operative movement—i.e., at reversal—the locking levers 151 sliding back along the stationary wire. The wire feeding provided by this device is very reliable since the wire is gripped by clamping elements of the carriage at two places.

When the disc 34 bearing the pins 35 is rotated, through the agency of the crank pin 28, discs 29 and gears 31, 33, during the orbiting movement of the frame 19, the wire-feeding lever 37 reciprocates once in its guide 43. The left-hand end position of the carriage or lever has the reference L in FIG. 1. The carriage 42 can be moved to the left from the front position shown in FIG. 1 without moving the wire D along with it. When the carriage is subsequently returned from the left-hand end position to the right-hand end position shown in the drawings, it moves the wire D along with it correspondingly.

The transmission G (sic) ensures that the lever 37 makes an advancing movement only during a predetermined sector of the orbiting movement of the frame 19—i.e., at a time when all the bending steps have been completed and the wire article has been finish-bent and ejected. Details of the construction of the transmission G can be gathered from FIGS. 10 and 11. The transmission has a casing 100 which is open on both sides but which can be closed by covers 101, 102. Circular gears 31, 33 each having an eccentric spindle 30, 32 respectively are rotatably mounted, through the agency of a respective bearing 103, 104, in the casing 100; in the particular machine shown the gears 31, 33 have the same pitch circle diameter but this need not necessarily be the case; what they must have is the same or mating tooth systems. The two gears 31, 33 do not contact one another but both mesh with a freely rotatable pinion 105 mounted on a pin 106 adapted to be moved transversely and parallel with itself. Circular discs 31', 33', 105' are disposed on both sides and coaxially of the respective gears 30, 33, 105 and have a diameter equal to the pitch circle diameter of the teeth of the associated gear. The gears 31, 33 engage by way of these discs with the discs of the freely rotatable intermediate gear 105 so that the tooth systems of the gears are relieved of radial stress but engage normally with one another to transmit the torque from the input gear 31 via the intermediate gear 105 to the gear 33. To maintain the intermediate gear 105 in engagement with the gears 31, 33, the pin 106 is secured to two lugs 107 which engage forkwise around the gears

and which are pivotally connected at their other end to a pin or the like 108 mounted on a plunger-like member 109 displaceable in a matching cylindrical recess 110 in the casing 100, the member 109 being loaded by a compression spring 111 bearing against the bottom of the recess 110, the pin 108 extending through slots at both ends of the recess 110. Advantageously, the axis of the cylindrical recess 110 and therefore the direction of movement of the piston 109 are such that the intermediate gear 105 is drawn into the gusset-shaped space between the gears 31, 33 by the spring 111 whatever the position of the gears 31, 33. As the gears 31, 33 rotate, the rotational axis I of the intermediate gear reciprocates as denoted by the broken line I-II-III in FIG. 10.

The irregularity of the angular velocity of the gear 33 mainly depends, in the transmission illustrated, upon the distance r' between the rotational axis o of the gears 31, 33 from the periphery thereof and increases as the last-mentioned distance decreases. For a given distance r' , the irregularity is greatest when the elongated diameter x, x' of the gears 31, 33 intersect on the axis of the intermediate gear 105 (cf. FIG. 10).

The transmission illustrated in FIGS. 10 and 11 can be embodied in other ways. For instance, the intermediate gear 105 can be loaded by a tension spring or some other spring device. The transmission shown in FIGS. 10 and 11 can also be used with advantage for other purposes, more particularly in cases where it has previously been necessary to provide a transmission having elliptical gears.

In order that the feeding movement imparted to the wire by the lever may be adapted to the length of the piece of wire required for the particular object being manufactured, the pivot pin 38 of the lever 37 is adjustable in the plate 3. The fact that the pin 38 is adjustable in this way also means that the range of movement of the free end 37' of the lever 37 can be such in the carriage guide 43 that the right-hand position of the carriage 42 always corresponds to the position shown in the drawings. The advantage of this feature is that only a proportion of the wire D is unguided before the mandrel 4.

The subject matter of the invention includes, on the left-hand side of the plate 3, an arrangement for straightening the fed-in wire D which has usually been unwound from a coil or reel. The straightening device comprises an entry funnel 44 from which the wire D is supplied to two systems 45, 46 each comprising seven straightening rollers, the systems 45, 46 having their axes at 90° to one another. The straightening rollers are mounted in a special frame 47 rotatably mounted in a side arm 48 of the plate 3 by means of a tongue and groove guide 49. In operation, the system 47 is rotated intermittently or continuously around its longitudinal axis relatively to the arm 48, to offset the unavoidable tendency of the wire gradually taking up a slight bend in one particular direction in the straightening device. The wire D can therefore be supplied to the machine much faster than in the conventional wire-bending machines, a factor which is very important in the light of the high output of the machine according to the invention.

The machine according to the invention can also readily be used to make wire bends in various planes. To this end, and as shown in FIG. 2, the guides 13 have fitted to them guides 13' whose bearing rods 14' operate in parallel with the rods 14 of the guides 13. If required, the rods 14' can be provided individually and have a head or yoke 15' for an extension 16' substantially identical to the extension 16.

If only one guide 13' having one rod 14' is used, a bearing member 50 for a driving roller 51 has the form shown in FIG. 5, the member 50 being connected by a screw 52 to the rod 14'. A special dished member 52 is provided to receive a driving roller 51; the member 51 is secured to a solid shaft 53 which extends through

the interior of the hollow shaft 9 and which is non-rotatably connected thereto in some appropriate fashion so that the two members 12, 52 rotate synchronously when the crank arm 10 is turned.

In the embodiment shown in the drawings, the crank pins of the tool drives are rigidly mounted in the frame 19 and the crank spindles are rigidly mounted in the plate 3. Alternatively, the pins and the crank shaft mounting in the frame 19 and plate 3 respectively can be resilient; for instance, these elements can be mounted in bushes made of a resilient substance, such as rubber. The crank drives then have some resilience and the machine drive continues to run easily even after a prolonged period of operation.

The frame-like driving element 19 can, if required, be used to provide other drives, for instance, to move the mandrel 4, for ejectors for moving the finish-bent wire element laterally away from the zone of the mandrel 4 and bending tools or to provide a uniform or non-uniform rotation of the sets of aligning rollers 45, 46 or their casings 47.

The arrangement of the tool elements A, B which is shown is purely exemplary. The actual position and number of the tool elements will depend upon the horizontal, vertical or inclined bends required to manufacture the article.

The crank drives which the invention provides and which are connected to the driving frame or the like, or similar arrangements, can also be used to drive embossing, stamping and perforating devices, more particularly in the processing of band or strip material.

I claim:

1. Wire-bending machine for the production of articles made of wire or flat material or the like, the machine comprising a mandrel which is stationary during the bending operation, a number of carriages being provided which are movable towards the mandrel and which bear the bending tools and which are operated by a common motorised driving element through the agency of cam discs or eccentrics or the like, characterised in that the torque of the driving motor is transmitted to the crank drives, which are associated with the various tool elements and which all have the same crank radius, by a substantially frame-like driving member to which the crank pins are secured and which the driving motor causes to orbit at the radius of the crank drives.

2. Wire-bending machine as set forth in claim 1, characterised in that the crank pins are so mounted in the frame-like driving member as to be radially adjustable, and the mounting of the crank drives of the tool elements in the machine plate can be varied relatively to the mandrel and to one another.

3. Wire-bending machine as set forth in claim 1, characterised in that the crank drive is connected to a number of cup-shaped members which are disposed coaxially of one another and which are each adapted to receive a cam disc, the guides for the tool holder rods being disposed one upon another.

4. Wire-bending machine as set forth in claim 1, characterised in that the crank arms associated with the frame-like driving member are connected one each to a rotating counterweight.

5. Wire-bending machine as set forth in claim 1 characterised in that the sets of aligning rollers, secured to the machine plate are disposed in a casing rotatable around the axis of the feed wire.

6. Wire-bending machine as set forth in claim 1, characterised in that the frame-like driving member and the crank drives connected thereto are disposed on the underside and back respectively of the machine plate, while the tool elements and the wire-feeding system are disposed on the top and front respectively of the machine plate.

7. Wire-bending machine as set forth in claim 1, characterised in that the guide for the axially movable bearing rods retaining the bending tools, and the associated crank drive, which has a cup-shaped member for receiving the replaceable driving cam disc adapted to be secured at various angular positions to the crank arm, are disposed on a baseplate adjustably mounted on the machine plate.

8. Wire-bending machine as set forth in claim 7, characterised in that the axially movable bearing rods are guided in an anti-friction mounting.

9. Wirebending machine as set forth in claim 7, characterised in that two parallel-operating bearing rods are associated with each tool holder and are non-positively connected, via a yoke and a roller mounted thereon, to the cam disc of the driving crank.

10. Wire-bending machine as set forth in claim 9, characterised in that the yoke extends on one side above the two associated bearing rods so that the roller is disposed laterally of the rod guide.

11. Wire-bending machine as set forth in claim 1, characterised in that the frame-like driving member is connected to an extra crank drive for driving the wire-feeding device.

12. Wire-bending machine as set forth in claim 11, characterised in that the crank drive is connected to the reciprocating carriage bearing the means for retaining the feed wire in one direction of its movement, through the agency of a single-armed lever whose pivoting range can be varied by radial adjustment of its pivot pin.

13. Wire-bending machine as set forth in claim 12, characterised in that gearing for producing an irregular motion of the lever is provided in the line of drive between the wire-feeding crank drive and the lever.

14. Geared transmission whose input side runs at a uniform angular velocity and whose output side runs at a non-uniform angular velocity, for the arrangement as set forth in claim 13, characterised in that two eccentric circular gears on parallel spindles, and a freely movable intermediate gear meshing with the first-mentioned two gears, are provided; and each such gear has associated with it a stationary running plate whose diameter is equal to the pitch circle diameter of the toothed system of the associated gear, the running plates rolling one upon another.

15. Transmission as set forth in claim 14, characterised in that the intermediate gear is rotatably mounted in a movable bearing element so spring-loaded that the intermediate gear is maintained resiliently in engagement with the toothed systems of the other two gears.

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