(No Model.) 4 Sheets—Sheet 1.

H. LEFÉVRE.

MACHINE FOR BENDING METALS.

No. 567,811. Patented Sept. 15, 1896.

Fig. 1.

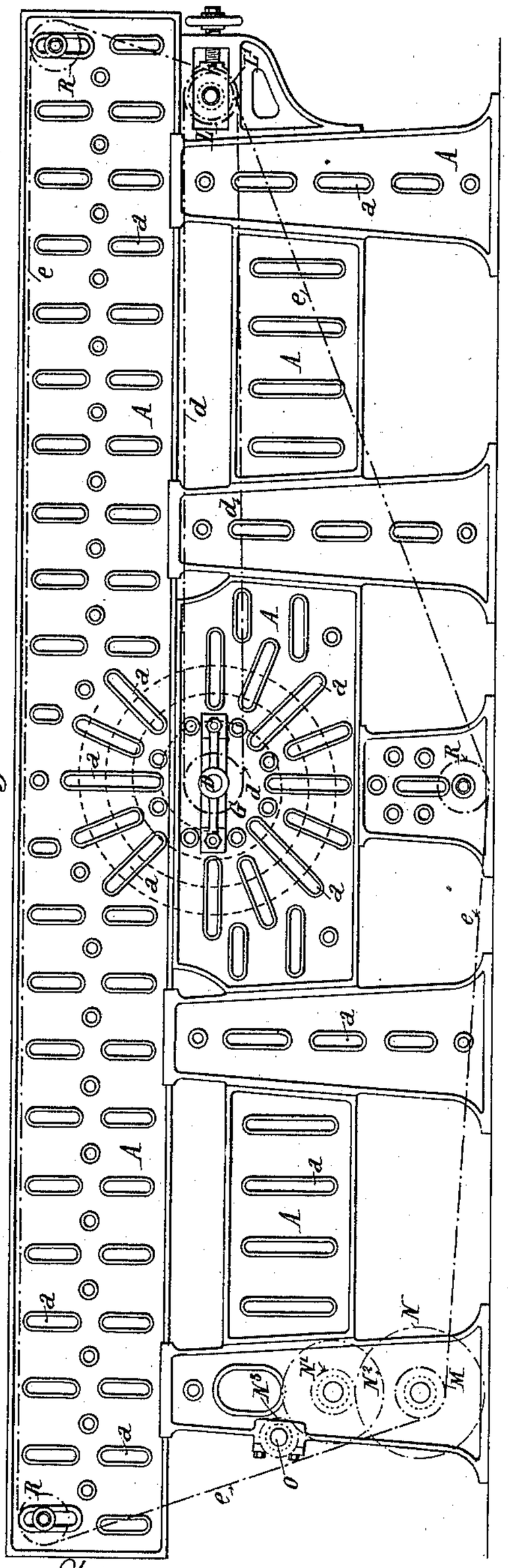


Fig. 5.

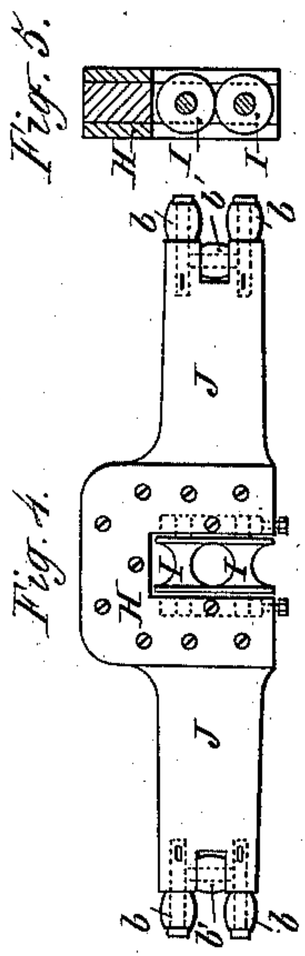


Fig. 6.

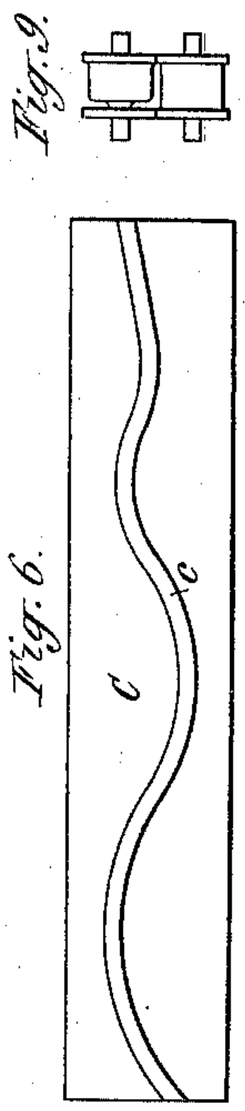


Fig. 9.

Fig. 4.

Fig. 7.

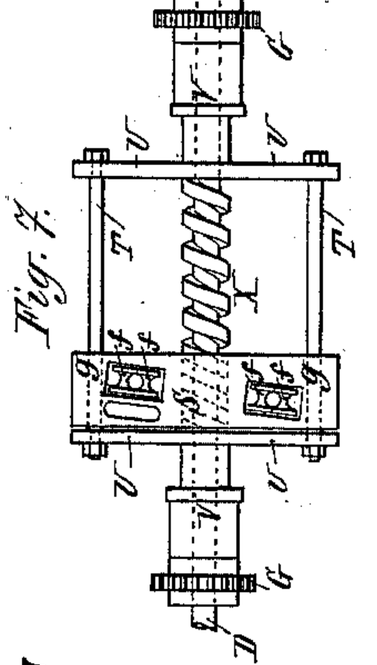


Fig. 8.

Fig. 3.

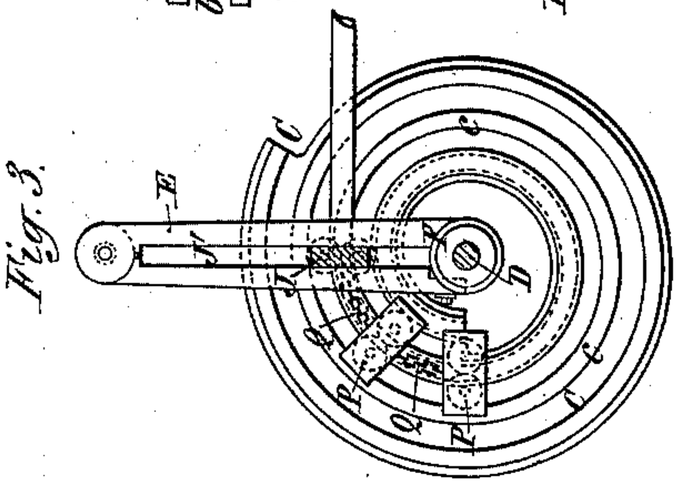


Fig. 10.

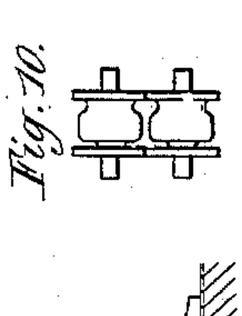
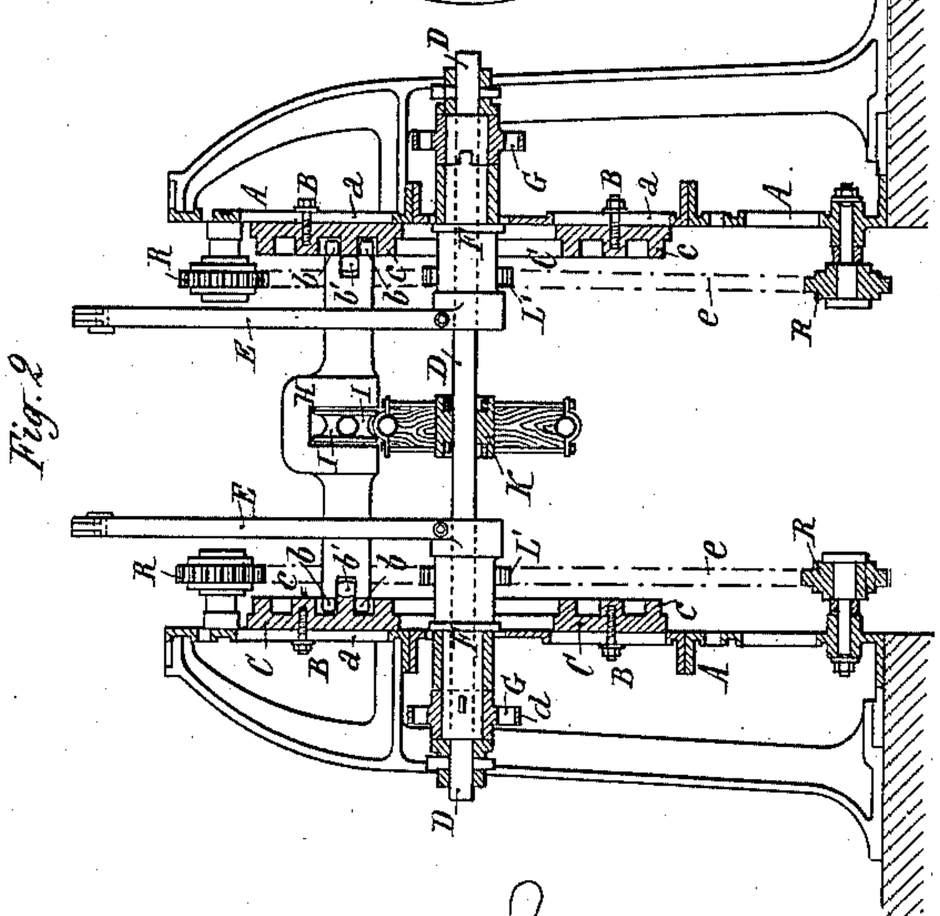


Fig. 2



Witnesses:
Jno. E. Parker
J. Henderson.

Inventor:
Henry Lefèvre.
by his Attorney.
Howard Pellett

(No Model.)

4 Sheets—Sheet 2.

H. LEFÉVRE.

MACHINE FOR BENDING METALS.

No. 567,811. Patented Sept. 15, 1896.

Fig. 13.

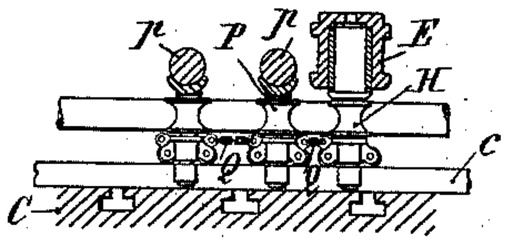
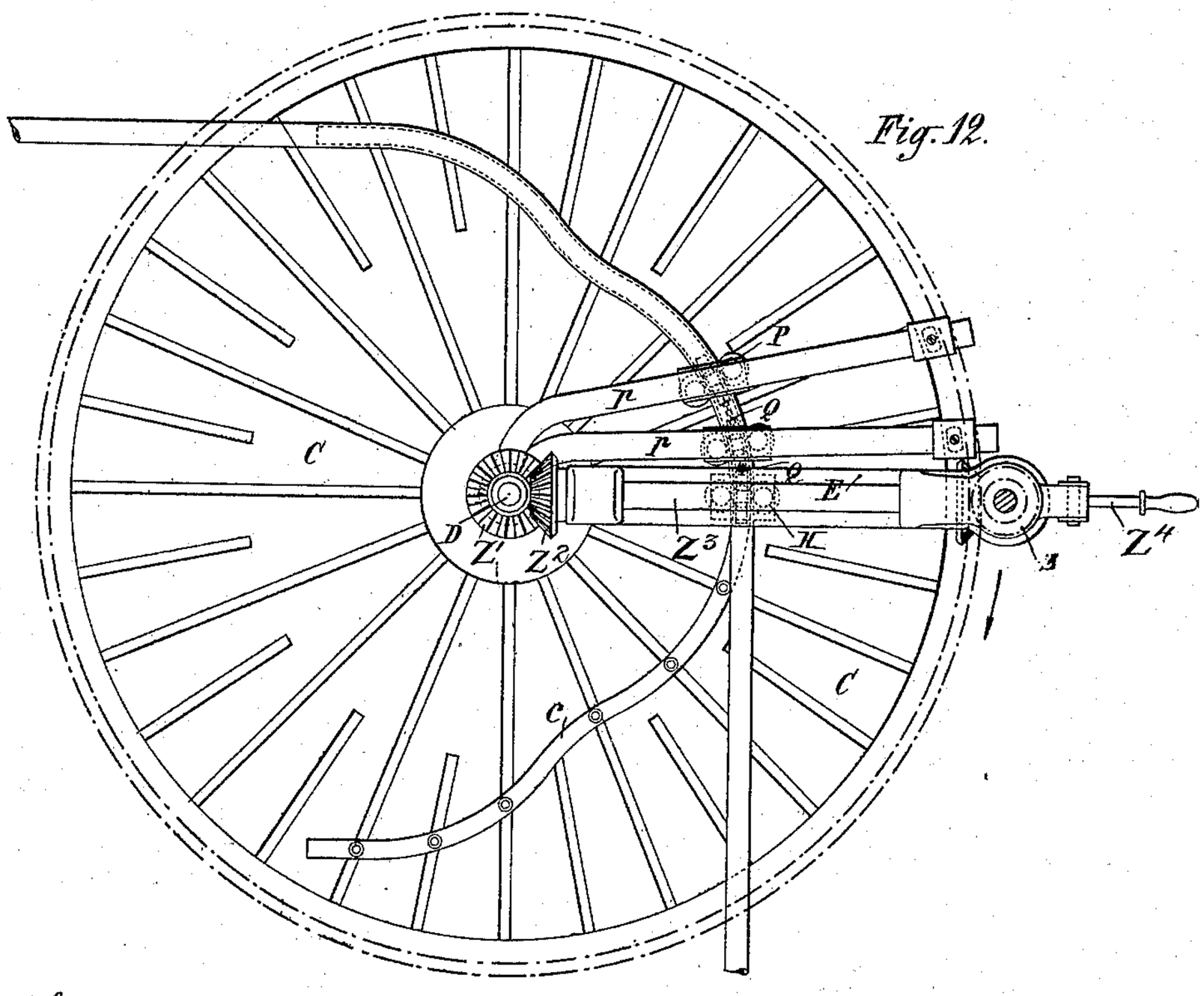


Fig. 11.

Fig. 12.



Witnesses:
Jno. E. Parker
J. Henderson.

Inventor:
Henry Lefèvre
by his Attorney
Howell Pellé.

(No Model.)

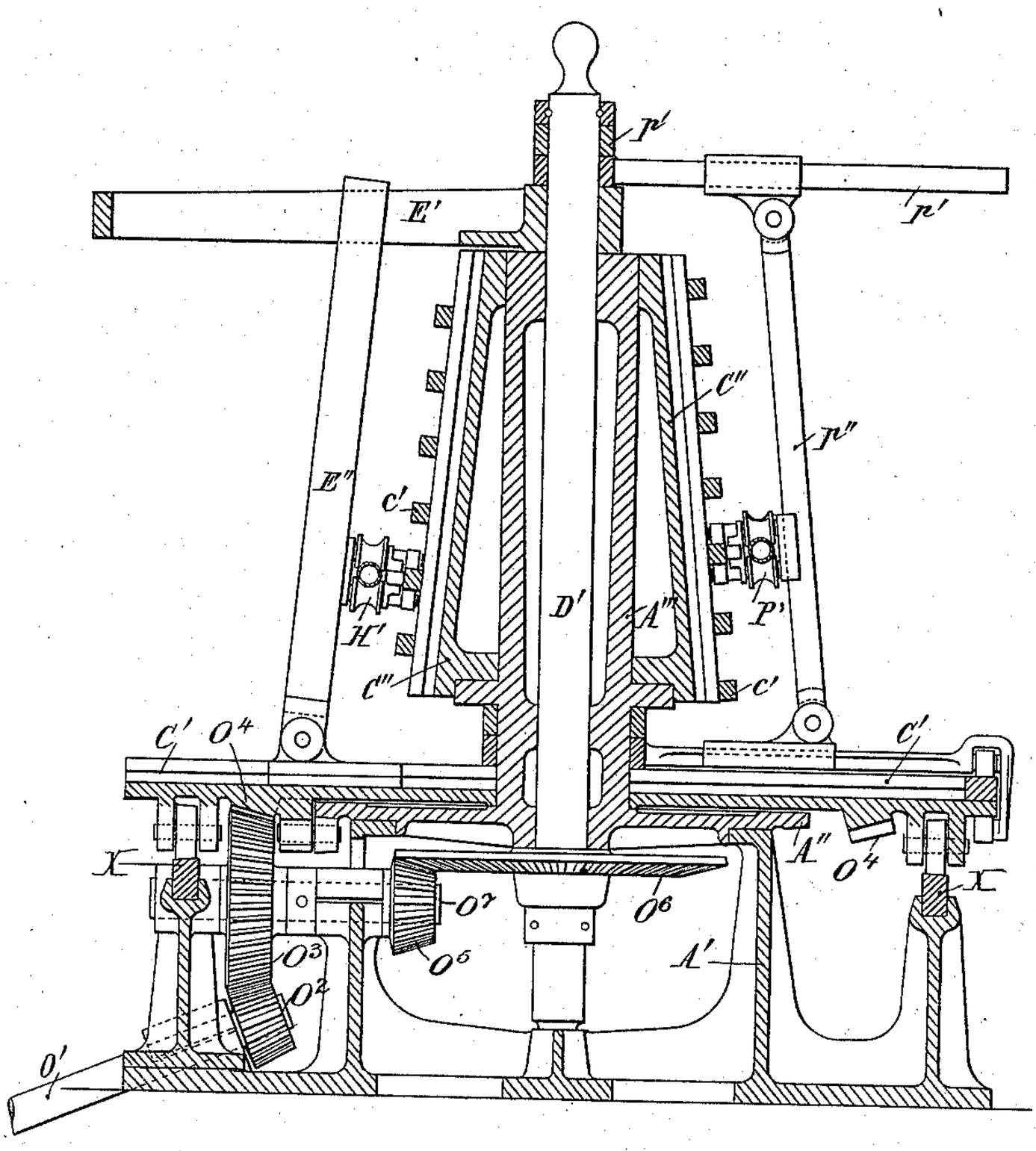
4 Sheets—Sheet 3

H. LEFÉVRE.

MACHINE FOR BENDING METALS.

No. 567,811. Patented Sept. 15, 1896

Fig. 14



Witnesses:
Jno. E. Parker
J. Henderson

Inventor:
Henry Lefévre,
By his Attorney,
Homer Pellit.

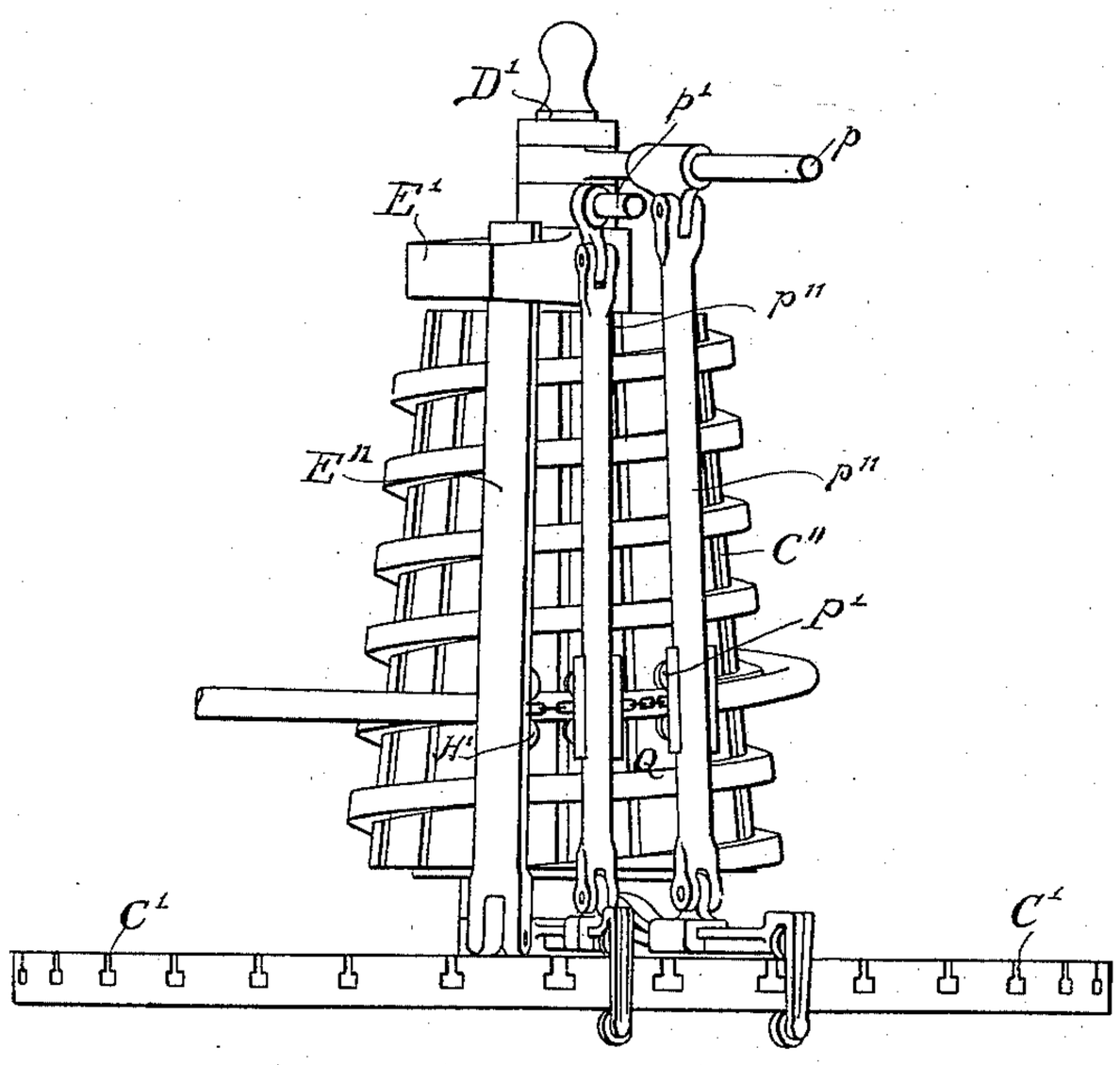
(No Model.) 4 Sheets—Sheet 4.

H. LEFÉVRE.

MACHINE FOR BENDING METALS.

No. 567,811. Patented Sept. 15, 1896

Fig. 15



Witnesses:
Jno. E. Parker
Wm. A. Pike

Inventor:
Henry Lefévre,
by his Attorney,
Aimee Pellé.

UNITED STATES PATENT OFFICE.

HENRY LEFÉVRE, OF PARIS, FRANCE.

MACHINE FOR BENDING METALS.

SPECIFICATION forming part of Letters Patent No. 567,811, dated September 15, 1896.

Application filed November 7, 1893. Serial No. 490,264. (No model.) Patented in France March 5, 1891, No. 211,911; in Belgium May 26, 1891, No. 95,005; in Germany November 29, 1891, No. 65,455; in Spain October 4, 1893, No. 15,015; in Italy October 5, 1893, No. 35,011; in England October 7, 1893, No. 18,854, and in Switzerland October 7, 1893, No. 7,743.

To all whom it may concern:

Be it known that I, HENRY LEFÉVRE, a citizen of the Republic of France, and a resident of Paris, France, have invented certain new and useful Improvements in Machines for Bending Metals, (for which I have obtained Letters Patent in France March 5, 1891, No. 211,911; in Belgium May 26, 1891, No. 95,005; in Germany November 29, 1891, No. 65,455; in Spain October 4, 1893, No. 15,015; in Italy October 5, 1893, No. 35,011; in Great Britain October 7, 1893, No. 18,854, and in Switzerland October 7, 1893, No. 7,743,) of which the following is a specification.

This invention relates to machines for bending metals.

A machine constructed according to my said invention is designed for bending rolled hollow or flat metals by successively curving the linear elements and preserving the curves obtained.

The improved machine comprises a bending-tool which seizes the articles to be curved, such as a tube or the like, between rolls, and is guided in a path identical with the line of bending to be obtained, (spiral, wave-line, serpentine, or the like,) thus curving the said article, while auxiliary bending-tools which are carried away in the same path by the principal tool, and by the intervention of traction parts, keep the portions already bent of the article in course of being manufactured in its form and hold the same in its position and at any desired distance toward the rear, thus preventing this article from losing the bend which it has already received while the principal tool continues to advance.

In the accompanying drawings, Figure 1 is an elevation of my machine. Fig. 2 is a vertical section taken through its middle. Fig. 3 represents a front view of a spiral guide or path of the bending part in combination with the parts which cause it to move, and with the so-called "auxiliary" tools serving to prevent the deformation of the end of the tube already bent. Fig. 4 shows an outer view of a bending-tool principally designed to obtain plain bends, such as spirals, wave-lines, and the like. Fig. 5 shows a vertical central section taken through this bending-tool. Fig. 6 is a plan of the guide of a bending-tool specially adapted for bending longitudinally, (wave-lines.) Fig. 7 illustrates an outer view of a bending-tool specially serving to produce serpentine tubes. Fig. 8 is a vertical section taken through this tool. Figs. 9 and 10 show the form and arrangement of the bending-rolls employed for bending any figured iron. Fig. 11 represents another arrangement of the machine for making plain curves with horizontal guides. Fig. 12 is a plan of the arrangement shown in Fig. 11. Fig. 13 represents a front view of a length of tube held in the principal bending-tool and its two auxiliaries. Fig. 14 represents an arrangement of the machine which is based on the same principle and is specially designed for making cylindrical, conical, and other serpentines and similar articles; and Fig. 15 is an elevation of the upper portion of the same.

The bending-tool comprises a truck presenting the form of a transverse piece H and the two extremities J of which are guided upon rails *c*, Figs. 2, 3, and 6, whose form or path corresponds to that of the bend to be given to the article to be manufactured. If this article has to be bent according to a plain spiral the rails or guides *c*, forming projections upon the plate C, Figs. 2 and 3, constitute similar spirals, so that the bending-tool which advances in these guides will curve the article which it holds between its rolls, thus bending it in accordance with the path formed by the guides, the said article not being able to be carried away in the movement, while its portions which have already been bent are constantly kept in their form and held in their position and are consequently protected against any deformation.

When the article is to be bent in any desired manner in the direction of its length, for example, according to a wave-line, the rails or guides *c* must have the form represented in Fig. 6. The extremities of the tool embrace the three free sides of these rails or guides *c* by three rolls *b b b'*, Figs. 2 and 4.

Figs. 1 and 2 show the arrangement of the

machine when it is specially designed for curving a pipe in a plain spiral. The extremity of the pipe to be bent is passed between the rolls I of the tool H and is fixed upon the periphery of a disk K, keyed upon an axis D, so as not to be able to turn.

The two arms J of the bending-tool are guided in the longitudinal slots J′ of levers E, in which this tool H is moved during the rotation upon the fixed axis D. Being, moreover, guided by its two extremities in the spiral path, it will describe a spiral as it slides in the slots J′ of the levers E, that is to say, it will during this movement curve the tube which passes between its rolls according to a spiral. This pipe is compelled to bend, for the disk K prevents any axial displacement of the same.

When in lieu of presenting a spiral the article to be manufactured must be curved only in the direction of its length, namely, according to an elongated line like that represented in Fig. 6, I displace the tool H by means of two endless traction parts, for instance, endless chains or their equivalents, along guides *c*, Fig. 6. These parts *e*, Fig. 1, are guided upon a certain number of rolls R, which cause them to assume approximately the desired form for the bending, namely, that of the rails *c*, Fig. 6, in order that the direction of the force of traction may always coincide as much as possible with that of the movement of the tool H, that is to say, perpendicular to the position of the latter.

For enabling the rolls R to be displaced in accordance with the form of the tube or other article to be curved, that is to say, for enabling the traction part to be guided in accordance with any desired form, I provide in the frame A of the machine numerous slots *a*, receiving the rolls R and enabling them to be displaced, which slots also serve in part for fixing the guides *c*, Figs. 2 and 6. This fixing is effected by means of bolts B, Fig. 2, which pass through the said slots. It is evident that in this mode of operation the portions already bent by the forward movement of the tool H have to be supported and kept in their positions in order to avoid, during the subsequent forward movement of this tool, any action at the rear tending to destroy the bend already obtained. For this purpose a series of trucks, termed "auxiliary bending-tools" P, Fig. 3, are attached to the tool K, the aforesaid tools being connected by chains Q with each other and with the principal tool H. Each of these trucks carries two rolls which embrace the bent article in the same manner as do the rolls of the tool. As these trucks are, moreover, guided upon the rails *c*, Fig. 2, thus occupying positions which correspond exactly to the bending already effected, they prevent the tube, at the points where they are placed, from losing the bend it has received by reason of a counter action of the tool H. In this manner I can prevent to any distance rearward of the tool any deformation of the article in course of manufacture, for I can attach any number of these trucks to each other.

It is clear that the article treated in the before-described manner need not absolutely be a pipe, but may be metallic bars of any form. In this case the bending-rolls and the guide-rolls only change in accordance with the profile of the article to be made. Figs. 9 and 10 represent each a pair of rolls designed, respectively, for bending L-iron and T-iron. This process may be employed in the same manner for bending flat iron.

When it is desired to give tubes the form of serpentines, that is to say, helices, it will be advantageous to arrange the tool as represented in Fig. 7.

Two pairs of bending-rolls *f f* are arranged in a nut S and placed unsymmetrically one relatively to the other, according to the pitch of the helix which is to be obtained. Two rods T, Fig. 8, passing through holes in the nut S and carried away by the plates U during their rotation upon the fixed central axis D, transmit to the nut S a rotary movement, by reason of which this nut is displaced at the same time in the direction of the axis upon its screw-threaded rod X, Fig. 7. The pitch of this screw-threaded rod corresponds exactly to the pitch of the serpentine which is to be obtained and which results from the rotation of the nut S.

When the machine is to serve only for one or the other of these kinds of work, certain parts may be dispensed with. For example, if the bending is to take place only longitudinally, Fig. 6, the central shaft D and its corresponding parts become useless. If, on the other hand, it is intended to manufacture only serpentines, the traction parts *e* and their numerous guide-rolls R become superfluous, the movement having principally to be transmitted to the central parts U S, which are still necessary.

Movement is transmitted from the shaft O, through the medium of toothed wheels N^3 N^2 N′ N, to the shaft M, which actuates the traction parts *e*, passing around the rolls R.

When necessary, I may drive the parts which turn upon the central shaft D from the wheels L by the employment of suitable intervening gearing. Upon this shaft D are loosely mounted wheels G, Figs. 2 and 7, which are keyed to the hubs F of the levers E and through the medium of endless chains *d* or their equivalents receive the movement of the pulleys L and transmit it to the said levers E, Figs. 2 and 3, or to the tool S, Fig. 7, through the medium of the plates U, these parts having to make a rotary movement around the fixed axis D during the bending, as hereinbefore explained. The chains *d* and *e*, which transmit motion to parts of the apparatus, may pass over a pulley mounted in

a movable block L′, having adjusting-screws for enabling the traction parts *e* and *d* to be stretched.

The machine represented in Figs. 11, 12, and 13, designed for bending plain curves, operates exactly on the same principle as that which has just been described. The arrangement of its parts alone differs. This machine comprises a lower frame A, carrying interiorly the transmitting device and serving as a stand for a fixed disk C, toothed at its periphery and possessing radial grooves.

On the upper end of the vertical shaft D is a bevel-gear Z′, intermeshing with a similar gear Z^2 on a radial shaft Z^3, carried by an arm E. At the outer end of the arm E is a vertical shaft Z^5, carrying at its lower end a pinion Z, intermeshing with the teeth on the periphery of the disk C, and on this shaft are mounted two bevel-gears Z^6 Z^7, one or other of which may be moved into engagement with a bevel-gear Z^8 on the outer end of the shaft Z^3 by a clutch-lever Z^4, so that a circular movement in one or other direction may be imparted to the bending-tools.

The bending-tool H slides longitudinally in the lever E, which turns upon the axis D, owing to the rotation of the pinion Z upon the teeth of the disk C. On the axis D are also mounted two or more radial levers *p*, each carrying an auxiliary curving-tool P, which are moved longitudinally on said levers and are connected to the main tool or truck H by the chains Q. These levers are provided at their extremities with rollers which travel over the circumference of the plate C.

The operation takes place on the guides *c* precisely in the same manner as in the machine represented in the preceding figures.

Without departing from the principle of my invention I may also fix the lever H and turn the disk C. The result obtained will be exactly the same.

The machine represented in vertical section in Fig. 14 is specially designed for bending cylindrical, conical, and other serpentines or similar articles. It comprises a frame A′, to which a plate A″ with a hollow central column A‴ is secured. Upon this frame is mounted a plate C′, having on its upper surface a series of radial grooves similar to those shown in Fig. 12 and provided with rollers adapted to travel upon a circular rail X, secured to or formed integral with the base of the machine. The machine is operated by a power-driven shaft O′, having a bevel-gear O^2, mounted on one of its ends and intermeshing with a bevel-gear O^3 on a radial shaft O^7 under the table or plate C′. The gear O^3 engages the teeth O^4 of a circular rack formed on the under side of the plate C′. On the shaft O^7, which carries the gear O^3, is also mounted a bevel-gear O^5, which intermeshes with a bevel-gear O^6 on the vertical shaft D′, and as the relation between the wheel O^3 and the teeth O^4 is the same as that between the wheels O^5 O^6 it follows that, on starting, the plate C′ and the shaft D′, as well as the carriers E″ *p*″, will turn with equal speed.

Upon the column A‴ is mounted the holder C″ for the helicoidal guides, made cylindrical or conical, according to the form of the serpentine to be manufactured. This guide-holder is provided with longitudinal grooves, by means of which I fix upon it the guides *c*′ in the form of helices.

The column A‴ is traversed by the shaft D′, which receives its movement by toothed wheels and has secured at its top the lever E′. This lever is connected with the plate C′ by the link E″, carrying the principal bending-tool H′.

The levers *p*′, which are attached to the same plate C′ by the links *p*″, carrying the bending-tools P′, are loose upon the shaft D′, the tools P′ being connected by chains to the tool H′. For the sake of clearness of the drawings I have shown in Fig. 14 only one of the connecting-links *p*″, but in reality they follow each other, because their bending-tools are united by short chains. The shaft O′, with a reversing-gear, receives its movement of the general transmitting device and communicates it to the plate C′, the shaft D′, and consequently to the lever E′ and the bending-tool H′, which turn together at an equal velocity. This tool H′, conducted by the guides *c*′, follows regularly, by sliding along the link E″, the curve which it is desired to give to the tube. The levers *p*′ are caused to follow the movement by means of chains, as hereinbefore explained, or by any other suitable device.

For bending a tube I slide the tube prepared at its extremity into the bending-tools. This extremity is fixed to the guide-holder C″.

As soon as movement is communicated the bending-tools act upon the tube to bend it according to the curves indicated by the guides.

When I desire to manufacture serpentines of various dimensions, either cylindrical or conical, it is sufficient to replace the guide-holder C″ by one which is adapted for the type of serpentine to be produced.

Similarly as for the machines before described I may render the plate C′, lever E′, and bending-tool H′ stationary, the guide-holder C″ being adapted to turn.

With these machines I may simultaneously effect the bending and polishing, or the dressing and polishing, of the cold tubes coming from the welding-rollers. I may also combine the parts of the machine for treating several articles at the same time.

What I claim is—

1. In combination, a pair of bending or forming rolls adapted to seize or carry the metal to be bent, a tool or truck carrying said rolls, a frame, and guiding-tracks of a contour similar to the desired contour of the article to be manufactured, said tool or truck being carried or guided by said track.

2. In a metal bending or shaping machine,

the combination of the guiding track or path of a contour similar to the desired contour of the article to be manufactured, a truck or tool guided in said track or path, and a pair of metal-bending rolls carried by said truck or tool and between which the metal to be bent or shaped is passed, substantially as specified.

3. In a metal bending or shaping machine, the combination of a frame, a guiding-track removably secured thereto, a truck or tool guided on said track, metal-bending rolls carried by said truck or tool and adapted to receive the metal to be operated upon between them, and mechanism for effecting the relative movement of the truck or tool and its guiding-track.

4. In a metal bending or shaping machine, the combination of the guiding track or path of a contour similar to the desired contour of the article to be manufactured, a truck or tool guided on said track or path, bending-rolls carried by said truck, auxiliary trucks also guided by said track or path and following in the rear of the main truck, and bending-rolls carried by said auxiliary trucks, substantially as specified.

5. In a metal bending or shaping machine, the combination of a frame, a guiding track or path of a contour similar to the desired contour of the article to be manufactured, a truck or tool guided in said track or path, bending-rolls carried by said truck, auxiliary trucks also guided by said track or path and connected to and receiving their movement from the first or main truck, and bending-rolls carried by said auxiliary trucks, substantially as specified.

6. In a metal bending or shaping machine, the combination of a frame, a guiding track or path of a contour similar to the desired contour of the article to be manufactured, a truck or tool guided in said track, bending-rollers carried by the truck or tool, and a rotated arm on which said truck or tool may slide, said arm acting to travel the truck or tool in its track or path to effect the bending or shaping of the metal, substantially as specified.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

HENRY LEFÉVRE.

Witnesses:
HULLIGE,
CLYDE SHROPSHIRE.