Nov. 14, 1933. W. C. ANTHONY ET AL 1,935,173

PRESS BRAKE

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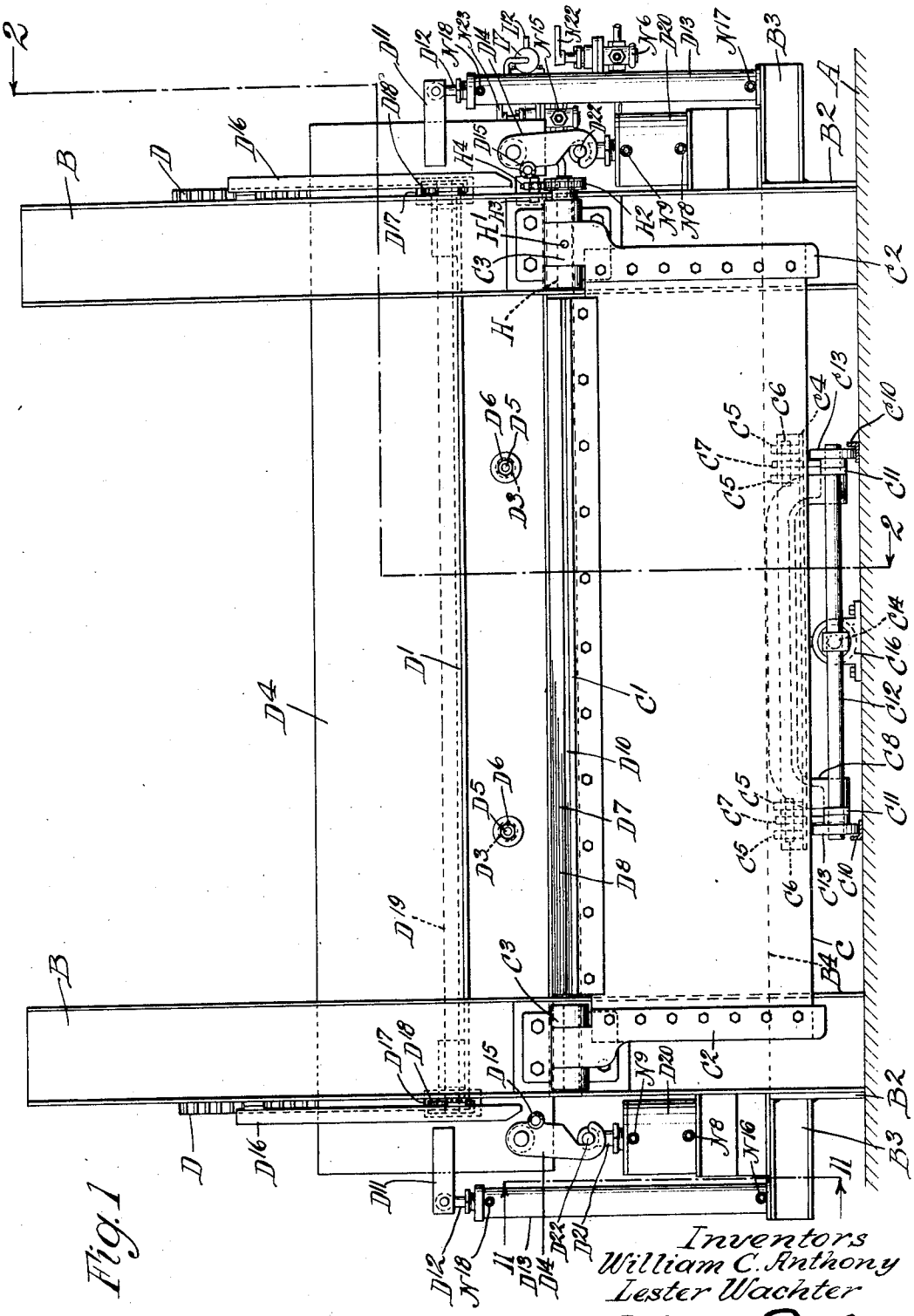


Fig. 1

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PRESS BRAKE

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Fig. 3

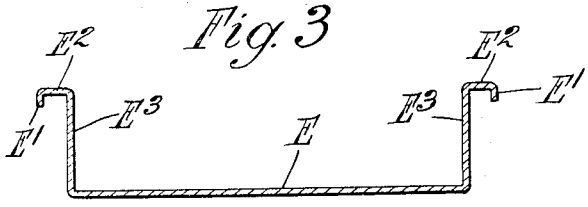


Fig. 2

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PRESS BRAKE

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Fig. 4

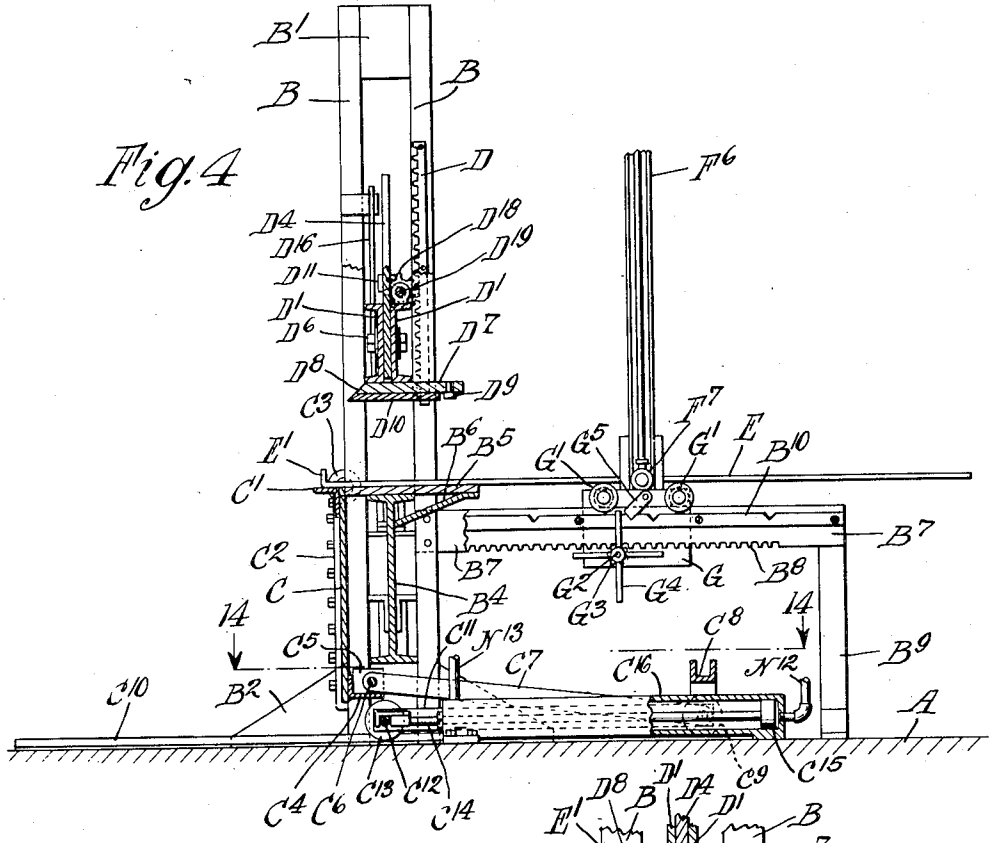
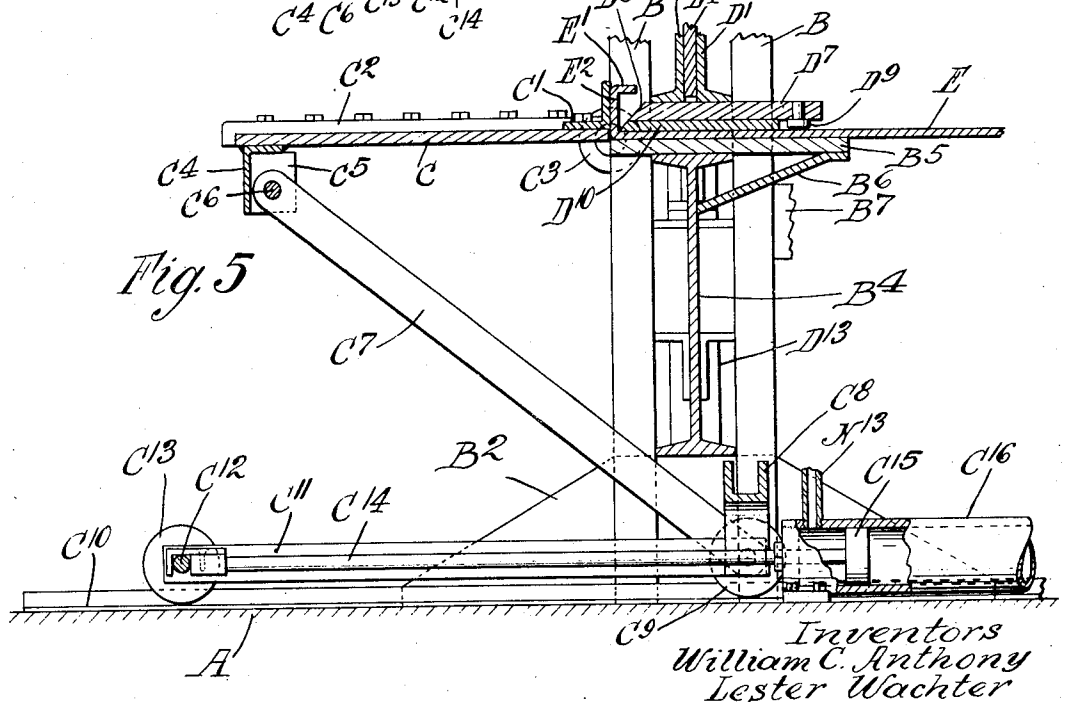


Fig. 5

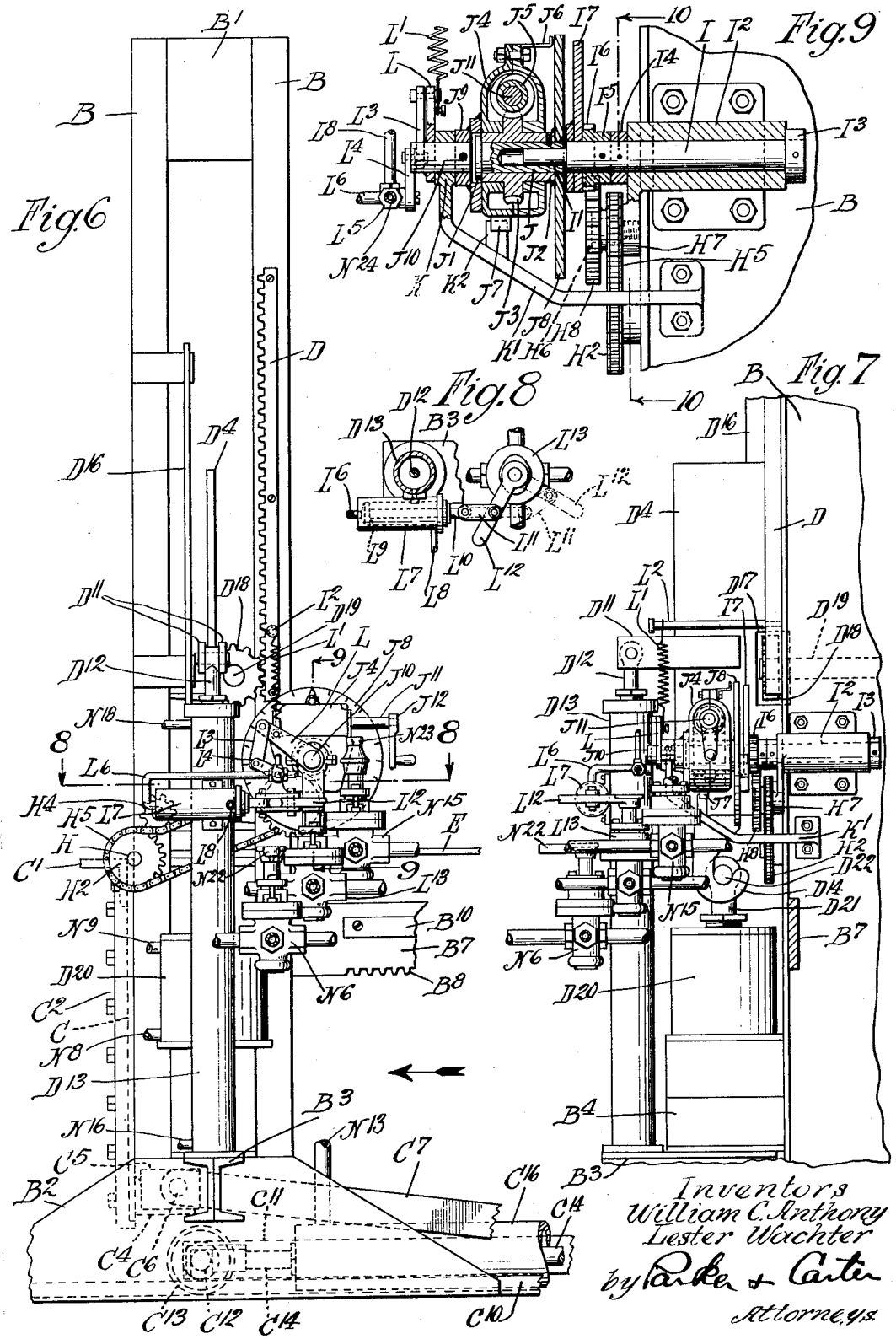


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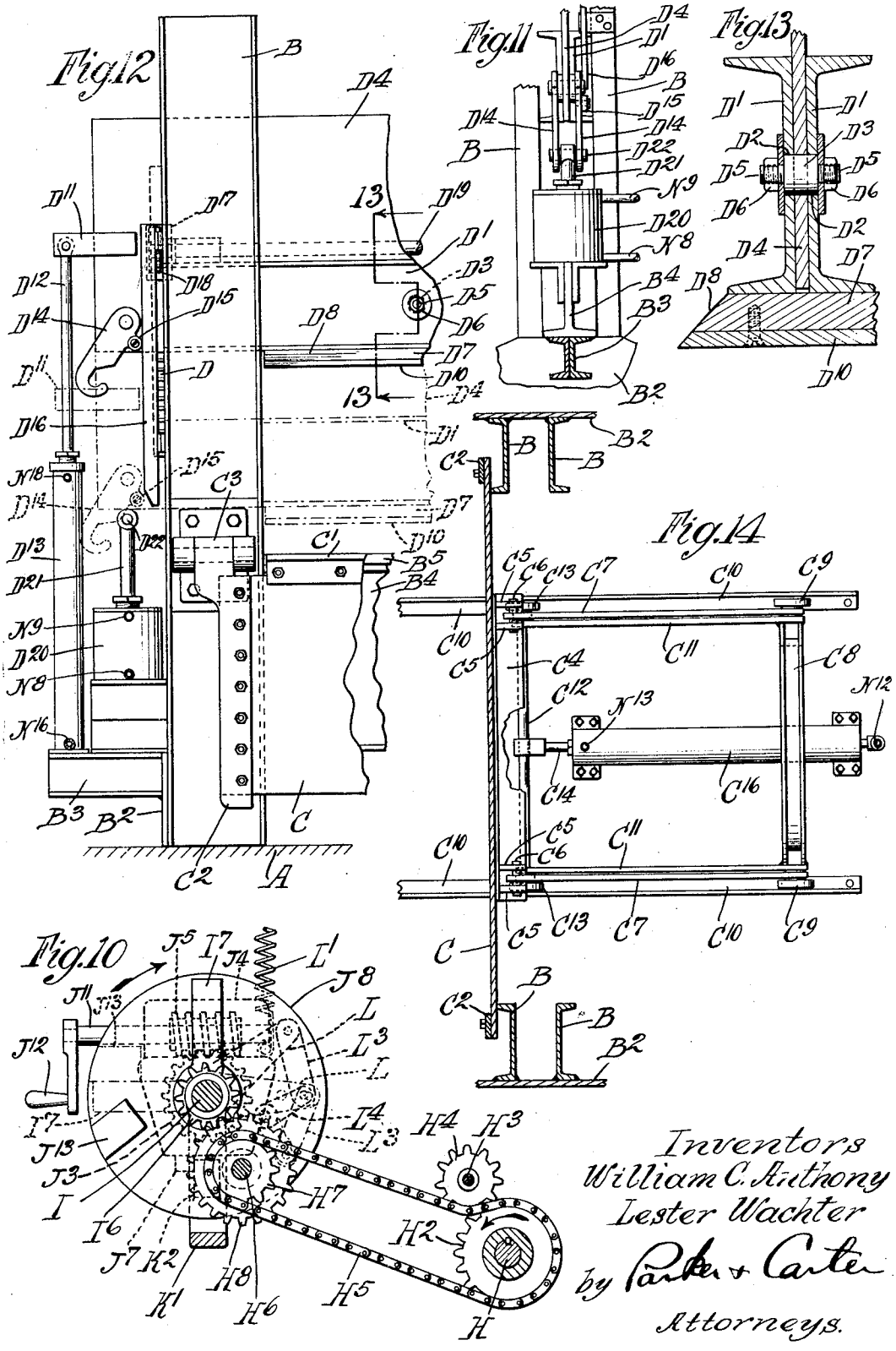
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PRESS BRAKE

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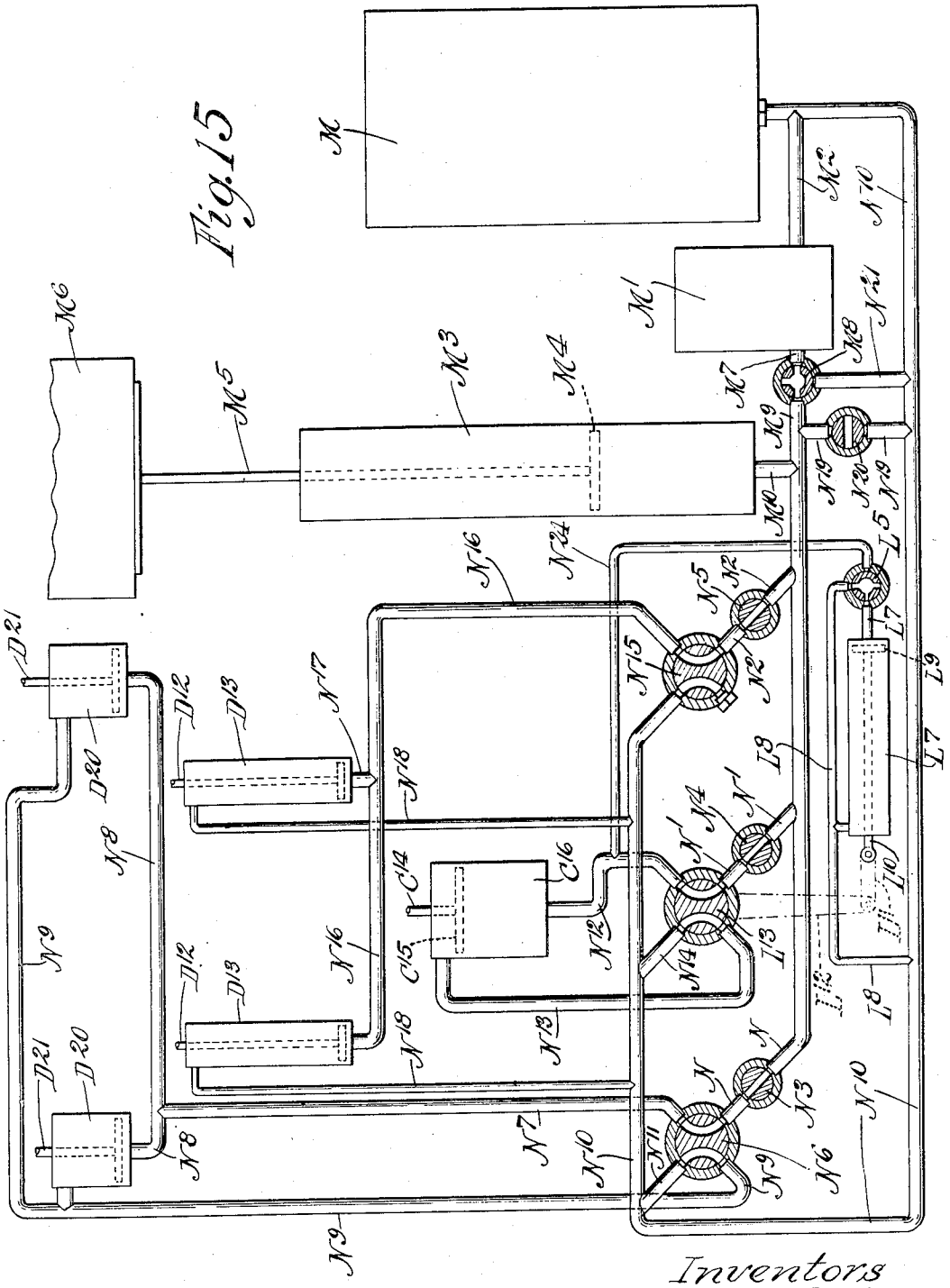


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PRESS BRAKE

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Fig. 15



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Patented Nov. 14, 1933 1,935,173

UNITED STATES PATENT OFFICE

1,935,173

PRESS BRAKE

William C. Anthony and Lester Wachter, Streator, Ill., assignors to Anthony Development Company, Streator, Ill., a syndicate

Application April 23, 1931. Serial No. 532,239

18 Claims. (Cl. 153—16)

This invention relates to a press brake. It has for one object to provide a machine capable of bending metal or other material. Another object is to provide, in connection with such a machine, means for bending a given piece of material a number of times. Another object is to provide, in connection with such an apparatus, means for operating its various parts automatically. Another object is to provide, in connection with such a machine, material holding means and material bending means and separate operating mechanism for each of said means.

Other objects will appear from time to time in the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:—

Figure 1 is a front elevation of the press brake, with parts in section;

Figure 2 is a longitudinal vertical cross section, taken at line 2—2 of Figure 1 and showing a portion of the material handling means as well;

Figure 3 is a sectional view, showing one type of bend which can be made by the machine;

Figure 4 is a longitudinal vertical cross section, generally similar to Figure 2, showing the parts in a different position, in which the material holding member is raised;

Figure 5 is a longitudinal vertical cross sectional detail, taken on an enlarged scale, showing the bending parts at or near the completion of a bending movement;

Figure 6 is a side elevation on an enlarged scale, showing particularly the controlling mechanism;

Figure 7 is an elevational view taken at right angles with respect to Figure 6, showing the same parts and looking in the direction of the arrow in Figure 6;

Figure 8 is a detailed longitudinal horizontal cross section, taken at line 8—8 of Figure 6;

Figure 9 is a transverse vertical cross sectional detail, on an enlarged scale, taken at line 9—9 of Figure 6;

Figure 10 is a longitudinal vertical cross sectional detail, taken at line 10—10 of Figure 9;

Figure 11 is a transverse vertical cross section, taken at line 11—11 of Figure 1, showing the hold-down cylinder in elevation;

Figure 12 is a detailed elevation of one side of the machine, showing the material holding assembly raised;

Figure 13 is a longitudinal vertical cross sectional detail, taken on an enlarged scale at line 13—13 of Figure 12;

Figure 14 is a longitudinal horizontal cross sectional detail, taken at line 14—14 of Figure 4, and showing, in elevation, the operating means for the bending apron; and

Figure 15 is a piping diagram illustrating diagrammatically the operating means and the piping connections therefor.

Like parts are designated by like characters throughout the specification and drawings.

A is a floor or foundation upon which the machine is positioned. It may be of any suitable material or nature. For the purposes of the invention, it is sufficient that the machine be supported upon a firm base, adequate to carry its weight and of sufficient strength to endure shocks and jars incident to the operation of the machine.

The frame of the machine is made up essentially of two pairs of vertically positioned members B, B. These members may be channels as shown. They are suitably secured to the base or foundation and each pair is preferably joined adjacent its upper ends, at least, by cross members B^1. At their lower ends the members B are joined by laterally extending plates B^2. Projecting outwardly from the members B^2 and lying in a generally horizontal position, are supports B^3 which, as indicated particularly in Figure 6, may be made up of pairs of channels joined together, back to back. The members B^3 serve to support portions of the operating mechanism. A bed supporting member B^4 which may be an I-beam, as shown for example in Figures 2, 4 and 5, extends in a generally horizontal position across between the two pairs of vertical supports B and is suitably fastened to them. On its upper surface, it carries a laterally extended bed plate B^5. B^6 is a bracing member joined to the bed plate B^5 and the bed support B^4. Fastened to the rear or right hand members B, as shown for example in Figures 2, 4, 5 and 6, are side frame members B^7. These members are provided on their under surfaces with rack portions B^8. At their rear ends they are supported by members B^9 and they are provided with means for receiving guiding and placing members B^{10} which are removably positioned upon them for reasons which will be described below.

C is a bending apron. Along its upper edge it carries an angle member C^1 which provides a flange at the upper edge. At its sides the apron C is fastened to and supported by hinge members C^2 which are themselves hinged to the forward or left hand members B, as indicated for example in Figure 2, as at C^3. In its rear the

apron C has secured to it an angle C^4 which may have one or more bearing supports C^5 in which are positioned pins C^6, upon each of which is pivotally mounted a link C^7. C^8 is a carriage member upon which the opposite ends of the links C^7 are pivoted. The carriage member may carry rollers C^9 which are run in tracks C^{10}, fixed or supported upon the foundation A. Extending forwardly or to the left, as shown in the figures, from the carriage member C^8 are frame members C^{11} which carry a rod C^{12} upon each end of which is positioned a roller C^{13}. These rollers, like the rollers C^9 are positioned to run in the tracks C^{10}. Fastened to the rod C^{12} is one end of a piston rod C^{14} which is fastened to a piston C^{15} which is positioned within an hydraulic cylinder C^{16}. The cylinder is arranged to operate the piston and to move it back and forth and thus to move the carriage C^8 and its associated parts, and so to move the apron up and down, suitable hydraulic connections being made to the cylinder to cause the back and forth movement of the piston within it. The cylinder is fastened to any suitable fixed support and, as here shown, is fastened to the foundation or floor A.

Fixed on the outside of the rear or right hand member B, as shown in the figures, is a rack D. A pair of channels D^1 are fastened together and these channels are mounted to move up and down along the rack and along the members B, in a manner and by means which will be described below. As will be noticed, particularly from Figure 12, and generally from a number of the other figures, the members D^1 are perforated as at D^2 and may carry a sleeve-like member D^3. The members are spaced apart sufficiently to receive a plate D^4 which extends above them and stops short of their lower edge. This member is also correspondingly perforated to receive the sleeves D^3 and the parts are held in position by bolts D^5 and nuts D^6. At their lower edges the members D^1 have fixed to them a plate D^7 which is provided with an inclined front edge D^8. It may carry in its rear a spacing pin or member D^9 and has fixed to its lower surface, and preferably removably, a contact plate D^{10}. At its outer ends the plate D^4 carries projections D^{11}, to each of which is fastened a piston rod D^{12} which is fastened to a piston running in an hydraulic cylinder D^{13} which is itself supported upon one of the members B^3. Suitable hydraulic connections are provided for moving the piston up and down. Pivotally connected to the ends of the plates D^4 are hooks D^{14} which are preferably double, as shown especially in Figure 11. Each is provided with a cam portion or nose D^{15} adapted to contact a cam member D^{16} which is fixed adjacent the plate D^4 to one of the members B. The plate D^4 is provided adjacent each of its ends with a perforation or opening D^{17}, through which projects a pinion D^{18} positioned to engage the rack D. The pinions D^{18} are carried on a shaft D^{19} which is journaled in suitable bearings on the plate D^4 or on the members D^1. D^{20} is an hydraulic pull-down cylinder, within which is mounted a piston. Suitable hydraulic connections are provided whereby the piston may be moved up and down. A piston rod D^{21} projects from the cylinder and is provided adjacent its top with a hook engaging member D^{22} by means of which the hook D^{14} may engage the member D^{22}.

For purposes of illustration, a plate E, which is being bent, is shown in several of the figures. As shown in Figure 2, the plate has not yet been bent or otherwise acted upon. It is being inserted into the machine. In Figure 4 the plate is shown as having been bent to provide a flange or relatively narrow bend E^1. As shown in Figure 5, the plate has been further bent to provide a bent portion E^2 and as a result of this, the flange E^1 is bent back generally parallel to the main body of the plate. As shown in Figure 3, each side of the plate has been bent to provide a flange E^1 and a portion E^2 and the plate has been further bent to provide other portions E^3. The form shown in Figure 3 is suitable for use as a receptacle or dumping body. Such a member may be completed by providing an end plate, to close one end, and an end plate or gate or other closure, to close the other end.

Many different means of handling plate and other shapes which are to be bent in the machine will suggest themselves. Only one is shown and it is shown diagrammatically herewith, as its particular details form no particular part of the present invention. It is sufficient for the purposes of the present invention that means be provided to engage and support the plate or other shape which is being worked upon.

F represents a track upon which a carriage F^1 is supported by means of rollers or wheels F^2. From this carriage depends hoisting and supporting members F^3, F^4. These may embody electrical, mechanical or hydraulic parts and controlling and actuating connections F^5 may be made. These parts may be of any suitable design. A trapeze-like frame F^6 may depend from the supporting carriage. It may have separated ends which carry clamps F^7, the clamps being hydraulically or otherwise actuated. Thus two clamps may be used, one to engage the plate E on each side. For convenience it is frequently preferable to engage the plate at about its middle point.

Co-operating with the trapeze-like arrangement is a carriage mounted to run along the frame members B^7. This carriage comprises side portions G, each of which has at its top a pair of rollers G^1 which are preferably flanged and arranged to run upon the upper surface of the members B^7 which serve as tracks. A shaft G^2 extends across the assembly from one side of the carriage to the other and carries adjacent each end a pinion G^3 which meshes with the rack portions B^8 of the members B^7. A hand wheel or turning member G^4 is provided to rotate the shaft G^2 and thus to rotate the pinions G^3 and move the carriage back and forth along the members B^7. A pivotally mounted dog G^5 is positioned on the frame members which support the rollers G^1 and this dog may be moved to engage one of the notches in the notched member B^{10}. The trapeze is arranged to engage the carriage and thus, when the plate is carried by the trapeze and the trapeze itself is moved into engagement with the carriage, the carriage may then be moved and will carry the plate with it. As explained above, any form of mechanism for carrying, moving and adjusting the plate may be used in connection with the device of the present invention. The trapeze structure, just briefly described, is merely one suitable form. The detachable notched member B^{10} is provided with notches suitable for the particular bends which it is desired to give to any plate and for each particular operation the carriage is moved so that the dog G^5 engages a given notch and the plate is thus carried to a suitable position for making

the particular bend which it is desired at that time to make.

For ordinary purposes, when it is desired to bend a member in the machine, it is put in position upon the bed plate and is gripped and held in the position by the hold-down member which is held in position by the hydraulic cylinders D^{20}. The apron C, with its flange C^1, is then raised toward the position shown in dotted lines in Figure 2, or to a position such as that shown in full lines in Figure 5, and the bend is accomplished as shown in the latter figure. The movement of the apron is stopped at the desired point when the bend has been accomplished. The apron is then usually lowered and the hold-down member raised and the plate may be removed from the machine entirely or else moved for subsequent bending or further treatment. These operations and the operations of the hydraulic cylinders which accomplish them may be controlled manually or in any suitable manner and by any desirable mechanism. In the present case a mechanism is shown which is in some of its operations automatic. This controlling and regulating mechanism will now be described.

Ordinarily there is one control assembly and for convenience it is all mounted upon one side of the press. In the form shown in Figure 1, the left hand hinge C^3 is provided with a pin or shaft H, which, by means of a pin or spline H^1, is fastened to the member C^2 so that it moves with it. Thus, as the bending apron moves, it moves the pin H with it. Upon the outer end of that pin is positioned a sprocket H^2. A stub shaft H^3 is journaled in a suitable bearing which may be mounted upon one of the vertical side frame members B and carries an idler sprocket H^4 which engages a chain H^5 which is positioned about the sprocket H^2. H^6 is a stub shaft journaled in suitable bearings preferably supported from the vertical member B. It carries a sprocket H^7 which is in mesh with the chain H^5. The sprocket pinion H^7 has fastened to it, to move with it, a pinion H^8.

I (Fig. 9) is a stub shaft having a reduced portion I^1 and being supported in a suitable bearing I^2, which is supported on one of the uprights B. At one end it has a retaining member I^3 fastened upon it and intermediate its ends it has a spacing collar I^4 fastened upon it. Fixed upon it also is a member I^5 which carries a pinion I^6 which is fastened to an arm I^7. The pinion I^6 meshes with the pinion H^8.

Positioned about the reduced end I^1 of the shaft I is a short stub shaft J. It has on its outer end a retaining portion J^1 and it carries a sleeve-like member J^2 which is fixed to it to move with it and which has formed upon it a worm gear J^3. Movably mounted upon the sleeve J^2 is a housing J^4 which encloses a worm J^5 which meshes with the worm gear J^3. The housing carries an index pointer J^6 and preferably generally opposite the pointer J^6, it also carries a stop member J^7. An index wheel or plate J^8 is mounted upon the stub shaft J to move with it. An extension J^9 which may be formed with or welded or otherwise fastened to the housing J^4 is positioned upon, fixed to and supported by a stub shaft J^{10}. J^{11} is a shaft journaled in the housing J^4 and carrying the worm J^5. A hand wheel or crank J^{12} is provided for it, by means of which it may be rotated. J^{13} is a stop mounted on the disc or plate J^8 and positioned to be engaged by the arm I^7.

The shaft J^{10} is supported in a bearing K, formed in a supporting bracket K^1 which is supported upon one of the upright members B. K^2 is a stop formed on the supporting bracket K^1 and positioned to be engaged by the stop J^7, of the housing J^4, when the latter moves into contact with it.

L is a lever fixed to the stub shaft J^{10}. Fastened to this lever at one end is a spring L^1 which is fastened at its other end to some fixed point, such as a pin L^2 which is itself fastened to one of the vertical frame members B. Fastened to the outer end of the lever L is a link L^3 which is itself fastened to a valve handle L^4 which controls the movement of a valve L^5. A connection or pipe L^6 runs from the valve L^5 to the hydraulic cylinder L^7. L^8 is a pipe leading from the cylinder L^7 at the end opposite to the connection L^6. It permits fluid to escape from the cylinder. Within the cylinder L^7 is a piston L^9 which has connected to it a piston rod L^{10} which projects beyond the cylinder and by means of a link L^{11} is connected to the handle L^{12} of a valve L^{13} which is formed as shown diagrammatically in Figure 15 and is connected by conduits which will be described below so that it can operate the cylinder C^{16} to raise and lower the bending apron. This operation is automatic or semi-automatic and its details will be described below.

In order to understand the operation of the various hydraulic mechanisms, whether this operation be automatically, semi-automatically or manually controlled, attention is called to Figure 15, which is a diagrammatic showing of the parts and their connections.

In that figure M is a reservoir for oil or other liquid used in the hydraulic system. M^1 is a pump. A supply pipe M^2 leads from the reservoir to the pump. M^3 is an accumulator in which a piston M^4 is positioned. The piston rod M^5 projects beyond the cylinder and carries a weight M^6 of sufficient size to maintain the desired pressure within the accumulator. A connection or conduit M^7 runs from the pump to a valve M^8 and a conduit M^9 runs from the pump. Another conduit M^{10} connects the accumulator cylinder with the conduit M^9.

Branch conduits N, N^1 and N^2 lead from the conduit or pipe M^9 and are provided, respectively, with valves N^3, N^4 and N^5. The conduit N, after leaving the valve N^3, runs to a two-way valve N^6 which is provided with a connecting conduit N^7 which, through branches N^8 N^8 may supply liquid to the cylinders D^{20}. A conduit N^9 leads from the opposite ends of the cylinders D^{20} back to the valve N^6. N^{10} is a fluid return conduit by means of which fluid which leaves the various hydraulic cylinders may be returned to the reservoir M. A branch N^{11} leads from the valve N^6 to the return conduit N^{10}. The conduit N^1, after passing through the valve N^4 leads to the two-way valve L^{13}. From this valve a conduit N^{12} leads to the cylinder C^{16}. The conduit N^{13} leads from the opposite end of the cylinder C^{16} back to the valve L^{13}, from which a connecting conduit N^{14} leads to the return pipe N^{10}. The conduit N^2, after passing through the valve N^5 leads to a two-way valve N^{15}. From this valve a conduit N^{16} having a branch N^{17} leads to the two hydraulic cylinders D^{13} from each of which return conduits N^{18} lead to the main return conduit N^{10}. N^{19} is a conduit connecting the pressure conduit M^9 with the main return conduit N^{10}. A valve N^{20} is positioned in it. N^{21} is a connecting conduit running from the

main return conduit N^{10} to the valve M^8 in the main pressure conduit M^9. The valve L^{13} is shown diagrammatically in Figure 15. It is indicated generally as the middle valve in Figures 6 and 7. The valve N^6 is the lowermost valve in Figures 6 and 7, while the valve N^{15} is the uppermost valve in Figures 6 and 7. In the form of the invention shown herewith, the valves N^6 and N^{15} are operated manually. The valve N^6 controls the operation of the main pull-down or hold-down cylinders D^{20}. It is manually controlled by a handle N^{22}. The valve N^{15} controls the operation of the cylinders D^{13}. In the form of the invention shown herewith, it also is manually controlled by a handle N^{23}. Thus the movement of the valve L^{13} is controlled automatically in response to a setting of the dial and so the amount of movement of the bending apron and, therefore, the amount of bend, is controlled automatically after the parts have been set for the desired bend. The operation and movement of the hold-down member, both as to raising and to lowering, is controlled manually. N^{24} is a conduit leading from the conduit N^{12} to the housing of the valve L^5.

While we have herewith shown and described a practical operative device, nevertheless many changes might be made in the size, shape, number and disposition of parts without departing from the spirit of our invention and we wish, therefore, that our showing be taken as in a sense diagrammatic.

The use and operation of this invention are as follows:

The brake is designed for the bending of material. In the form shown herewith it is particularly adapted for use as a machine for bending sheets or plates, which are given several successive bends, some in a reverse direction with respect to other bends. The hold-down plate is given a very considerable travel so that a plate having been put in from the rear and bent may be removed to the rear for adjustment of repositioning for subsequent bending. This is possible even where a quite a large piece has been bent up. Heretofore, in press brakes of the type now on the market, where a piece of considerable width is bent up, for example a piece eighteen inches or more in width, it has been necessary to withdraw the plate from the front of the machine. If subsequent bends are to be made, this necessitates carrying the piece bodily around the machine and re-inserting it in a reverse direction from the rear. With our invention, the plate having been bent up, the hold-down member is raised, the plate is withdrawn to the rear and then reversed, turned over and otherwise re-positioned for further bending. By reason of this, the supporting and holding mechanism to which the plate is attached can remain attached to it throughout the entire operation and once the plate has been put into the holding mechanism it need not be removed from it or detached from it until the entire bending operation is completed and this is true even although the bending operation includes several bends on one edge and several other bends on an opposite edge and such bends may involve considerable widths of material. This will be the case in bending a plate into the shape shown in Figure 3. In shaping that plate, the supporting equipment is attached approximately at the middle of the plate. Ordinarily, for the purpose of convenience, the carriage which is mounted to run along the frame members B^7 is put into the position shown in Figure 2, with the dog G^5 engaging one of the notches in the plate B^{10}. The plate is temporarily positioned in the trapeze mechanism, the latter is put in engagement with the carriage and the plate is then moved forward until it contacts spacing pins D^9. Usually the notches in the plate B^{10} are so positioned that for a given plate, when that plate is in contact with the spacing pins, the trapeze mechanism, if it is in position on the carriage as shown in Figure 2, will be at the center of the plate. The plate is then clamped to the trapeze mechanism, the hold-down member is raised, the plate is moved forward until the dog G^5 engages the next notch in the plate B^{10}, the hold-down member is then moved into position holding the plate, the apron C is raised by the hydraulic cylinder in a manner which will be described below. This raising is continued as far as necessary to give the desired bend and thus the bent portion E^1 is formed. When this bend is completed, the apron C is lowered, the hold-down member is raised, the carriage is moved forward until the dog engages the next notch, as for example, the notch shown in Figure 4, in which the dog lies. The hold-down member is then lowered, the apron C is raised to the position shown in Figure 5 to accomplish the second bending and to form the portion E^2. The degree of bending, that is to say, the angle through which bending is carried out, may be anything from one degree to a maximum of more than 90°. The hold down member D^7 is given the inclined front face D^8 to permit this amount of bend. Subsequent bends might be made by moving the carriage forward, but to form the plate shown in Figure 3, the carriage with the plate will be moved rearwardly until the plate is entirely out of contact with the machine. The plate will then be reversed and moved forward again between the bed and the hold-down member, the carriage will be moved to the suitable notch, which is the next to the last, as shown in Figure 4, from that occupied by the dog G^5 as shown in that figure, the hold-down member is moved into position and a subsequent bend is carried out. In this fashion the machine operates to give almost any suitable number of successive bends and, as has been said, these may be in a direction reversed, one with respect to the other.

The details of the operation of the mechanism itself will now be described. With the parts of the machine as shown in Figure 1, no bending is occurring and the hold-down member is in position. The details of the hold-down member are shown in Figure 13. As there shown, the plate D^4 is attached to the members D^1 which carry the lower member of the hold-down assembly D^{10} only at two points, namely, the bolts D^5. Thus, when the plate D^4 is pulled down, the hold-down effect is transmitted through the bolts D^5 to the members D^1 and thence to the members D^7 and D^{10}. By this construction, the danger of warping or bending of that portion of the hold-down assembly which contacts the work to be held down is reduced. With the parts as shown in Figure 1, the hold-down assembly is gripped and held down by the large cylinders D^{20}. The hooks D^{14}, which are pivotally attached to the plate D^4, are engaged with the member D^{22} of the piston rod D^{21}. A pull down on the piston to which this rod is attached pulls the hooks and the plate D^4 and the entire hold-down assembly and holds it in position. When it is desired to release the hold-down assembly and to raise it, the pistons to which the piston rods D^{21} are attached

are reversed, that is to say, moved upwardly. At first, the rod D^{21} contacts the bottom face of the plate D^4 and pushes the hold-down assembly up. If the movement is continued, the members D^{15} of the hooks D^{14} contact the cams D^{16} and the hooks are held, as indicated in dotted lines in Figure 12, out of engagement with the member D^{22}. If, for the purpose of the bend in question, it is necessary only to raise the hold-down assembly slightly, the heavy or large cylinder D^{20} will be used only. Where it is necessary to raise the hold-down assembly more, the cylinders D^{13} and their pistons and piston rods will be used, and in that case, pressure is applied to raise the pistons to which the piston rods D^{12} are attached, and the hold-down assembly is raised into the position shown in full lines in Figure 12. Equal movement of each side of the assembly is insured by the use of the shaft D^{19} which is journaled upon the plate D^4, and which carries the pinions D^{18} which mesh with the racks D on the side members B. By means, therefore, of movement of the pistons which lie within the cylinders D^{13} of D^{20} the hold-down assembly is raised or lowered.

When the hold-down assembly returns to the hold down position after having been raised, the portions D^{15} of the hooks D^{14} pass below the cams D^{16} and the hooks then swing into the engaging position in which they engage the member D^{22} as shown in Figure 1. Pressure is then suitably applied in the cylinder D^{20} to pull down on the piston, the piston rod D^{21} and the hooks D^{14} and thus the hold down assembly is held in the holding position and the plate or other article which is to be bent or shaped is held against displacement and rests on the bed plate B^5 or the bed assembly generally.

With the parts held in this position, bending of the plate may commence. Pressure is suitably applied in the cylinder C^{16} to force out the rod C^{14} and this carries forward the carriage made of the shaft C^{12}, the side members C^{11} and the rear cross member C^8. The links C^7 which at their rear ends are pivoted on the cross member C^8, are moved forward as the carriage is moved forward. At their forward ends these links are pivoted upon the apron C and thus forward movement of the carriage, that is to say, movement from right to left, as shown in Figure 2, raises the apron C from the full line position of Figure 2 to the dotted line position of that figure. The apron carries the angular member C^1 which is in contact with the member to be bent and thus as the apron is swung or moved upwardly, the angular member C^1 contacts the material and effects the bend. As shown in Figure 5, the apron C is in a raised position and a bend has just been accomplished. When the apron has been moved sufficiently to accomplish the desired amount of bend, pressure is applied to the cylinder C^{16} to withdraw the piston C^{15} and thus the carriage and apron move again to the position shown in full lines in Figure 2, and shown also in Figure 4.

There is attached to one of the hinges which support the apron C, so as to rotate as the apron moves, a pinion H^2. The purpose of this pinion is to provide means for automatic control so that the amount of movement of the apron C and consequently the amount of bending accomplished by it may be automatically controlled. This automatic control will now be described.

The main function of the automatic control is to provide an adjustable automatic apparatus by means of which the operator can set the controlling mechanism so that the apron will move through a predetermined arc and will automatically stop at the end of that arc. Thus, the operator is not under the necessity of constantly watching the apron and the danger of allowing it to go too far or of stopping it too soon is removed. As a part of the automatic operating mechanism an hydraulic cylinder is used, which, at a predetermined adjustable point, is automatically actuated to move the lever which controls the pressure to cylinder C^{16} and thereby, of course, controls the movement of the apron C. This operating cylinder is the cylinder L^7. It is shown in plan in Figure 8. It appears in side elevation in Figure 6 and in end elevation in Figure 7. It is illustrated diagrammatically in Figure 15. As described above, the pinion H^2 which is moved with the apron C, is connected to the pinion H^7, carried upon the stub shaft H^6. Mounted to move with the pinion H^7 is a second pinion H^8. This pinion H^8 meshes with a pinion I^6 mounted to move with a shaft I which shaft also carries an arm I^7. By means of this gearing, movement of the apron C causes corresponding movement of the arm I^7. The thimble-like member J, which is movably mounted on the reduced extension I^1 of the shaft I, carries a plate J^8, provided with markings. Fixedly mounted on the member J is a member J^2, carrying a worm gear. A housing is movably mounted on the member J^2. It encloses a worm which meshes with the worm gear and the housing is also provided with a pointer J^6. A handle J^{12} is also provided for rotating the worm gear. The markings on the plate J^8 are arranged to indicate degrees of motion of the apron C. When it is desired to set the apparatus to carry out bending, the handle J^{12} is rotated so as to rotate the worm. Since the housing which carries the worm is held against movement by the contact of the stop J^7 with the stop K^2, the plate J^8, which is fastened to the member which carries the gear J^3, is rotated. This rotation is carried out until the desired adjustment has been made. If a plate or other piece of material to be acted upon is in position, the machine is now ready for bending movement. The operation of bending is normally manually initiated. The lever or handle L^{12} which controls the operation of the valve L^{13} is moved to the full line position of Figure 8. In that position pressure passes through the valve L^{13} to move the piston C^{15} outwardly or to the left. The apron is thus raised, the pinion H^2 is rotated with it. Through the gearing shown in detail in Figure 10, the rotation of the pinion H^2 causes rotation of the arm I^7. This arm moves clock-wise, as shown in Figure 10, or counter clock-wise, as shown in Figure 6. It moves until it strikes the stop J^{13} on the plate J^8. The position of this stop with respect to the initial position of the arm I^7 is adjusted by the adjusting movement of the plate or disc J^8, as above described. When the arm I^7 contacts the stop J^{13}, it moves the plate and since the worm gear and worm are locked together, it moves the parts which carry them, and the housing, in a counter clock-wise direction, as shown in Figure 6. In this movement the lever L is moved downwardly or counter clock-wise against the action of the spring L^1 which tends normally to hold it upward. This downward movement of the member L is transmitted by means of the link L^3 to the valve handle or lever L^4, thus putting pressure into the cylinder L^7 to move the piston to the right as shown in Figures 6 and 8, and

thus to move the valve lever or handle L^{12} into the dotted line position of Figure 8. This movement reverses the direction of flow of pressure to the cylinder C^{16} so that the movement of the piston in that cylinder is reversed. Thus the apron C is stopped and reversed and moved again to the initial position shown in full lines for example in Figure 6. The valve handle or lever L^{12} will remain in the dotted line position of Figure 8. Reverse or downward movement of the apron C causes a corresponding movement of the pinion H^2 and the gearing which is attached to it. This frees the disc, the worm gear and housing for reverse or clock-wise movement as viewed in Figure 6, and these parts are then returned to their initial position by the spring L^1. The valve handle L^{12} will remain in the dotted line position of Figure 8 and the parts will remain stationary. When it is desired to effect another bending movement, the valve handle L^{12} is moved manually from the position shown in dotted lines in Figure 8 to the position shown in full lines in that figure. This movement moves the valve L^{13} into position to cause the piston C^{15} to move outwardly and thus to effect another bending operation.

The operation of the cylinders which move and control the movement of the hold-down assembly might be arranged automatically. In the particular form of the invention shown herewith the operation of these cylinders is controlled manually by the levers or handles N^{22} and N^{23}, which operate, respectively, valves N^6 and N^{15}.

We claim:

1. In combination in a forming machine, a bed, a hold-down member, means for moving said member, and a material bending means movably mounted means for moving the same, and automatic means for controlling the amount of bending movement, and for causing the bending means, upon the completion of a predetermined adjustable amount of movement in the bending direction, to return to its initial position.

2. In combination in a metal forming machine, a bed, a hold-down member, means for moving said member toward said bed and away from said bed, and a material bending means movably mounted with respect to said bed, means for moving the same, and automatic means for controlling the amount of bending movement and for causing the bending means, upon the completion of a predetermined adjustable amount of movement in the bending direction, to return to its initial position.

3. In combination in a metal forming machine, a bed, a hold-down member, hydraulic means for holding said member in the down position, a bending part mounted for bending movement, means for moving it, adjustable automatic means for controlling its movement to cause it to move through a predetermined distance.

4. In combination in a metal forming machine, a bed, a hold-down member, rapid hydraulic means for holding said member in the down position, a bending part mounted for bending movement, means for moving it, automatic means for controlling its movement to cause it to move through a predetermined adjustable distance, to stop, to reverse and to return to its initial position.

5. In combination in a metal forming machine, a bed, a hold-down member, rapid hydraulic means for holding said member in the down position, said means adapted to raise the member, a bending part mounted for bending movement and means for moving it.

6. In combination in a metal forming machine, a bed, a hold-down member, hydraulic means for holding said member in the down position, said means adapted to raise the member, an additional raising member for the hold-down member, a bending part mounted for bending movement and means for moving it.

7. In combination in a metal forming machine, a bed, a hold-down member, hydraulic means for holding said member in the down position, said means adapted to raise the member, an additional raising member for the hold-down member, of greater travel than the first mentioned member, a bending part mounted for bending movement and means for moving it.

8. In combination in a metal forming machine, a bed, a hold-down member, rapid hydraulic means for holding said member in the down position, said means adapted to raise the member, a bending part mounted for bending movement, means for moving it, adjustable automatic means for controlling its movement to cause it to move through a predetermined distance.

9. In combination in a metal forming machine, a bed, a hold-down member, hydraulic means for holding said member in the down position, said means adapted to raise the member, an additional raising member for the hold-down member, a bending part mounted for bending movement, means for moving it, adjustable automatic means for controlling its movement to cause it to move through a predetermined distance, to stop, to reverse and to return to its initial position.

10. In combination in a metal forming machine, a bed, a hold-down member, hydraulic means for holding said member in the down position, said means adapted to raise the member, an additional raising member for the hold-down member, of greater travel than the first mentioned member, a bending part mounted for bending movement with respect to the bed, means for moving it, adjustable automatic means for controlling its movement to cause it to move through a predetermined distance, to stop, to reverse and to return to its initial position.

11. In combination in a material handling means, a bed, frame members extending above said bed, a hold-down member positioned to move along said frame members, means to equalize the movement of said hold-down member along said frame members, a bending member and means for moving it.

12. In combination in a material handling means, a bed, frame members extending above said bed, a hold-down member positioned to move along said frame members, means on said hold-down member and engaging portions of said frame members, to equalize the movement of said hold-down member along said frame members, a bending member and means for moving it.

13. In combination in a material handling means, a bed, frame members extending above said bed, a hold-down member positioned to move along said frame members, means on said hold-down member and engaging portions of said frame members, to equalize the movement of said hold-down member along said frame members, a plurality of means for raising said hold-down member, one adapted for use in holding down the hold-down means, a bending member and means for moving it.

14. In combination in a metal forming ma-

chine, means for holding a piece of metal immovable, and means for bending a portion of said metal, said bending means including a bending member movably mounted and means for moving it, and an additional means for adjustably and automatically controlling the movement of said bending means to cause it to accomplish a predetermined movement, said automatic means including a member mounted to move with the bending means, a stop, said movably mounted member adapted to move to contact said stop, and thereby cause movement of the controlling means to stop the bending means.

15. In combination in a metal forming machine, means for holding a piece of metal immovable, and means for bending a portion of said metal, said bending means including a bending member movably mounted and means for moving it, and an additional means for adjustably and automatically controlling the movement of said bending means to cause it to accomplish a predetermined movement, to stop at the completion of said movement and to reverse its direction of movement, said automatic means including a member mounted to move with the bending means, a stop, said movably mounted member adapted to move to contact said stop, and thereby to cause movement of the controlling means to stop and to reverse the bending means.

16. In combination in a metal forming machine, means for holding a piece of metal immovable, and means for bending a portion of said metal, said bending means including a bending member movably mounted and means for moving it, and an additional means for adjustably and automatically controlling the movement of said bending means to cause it to accomplish a predetermined movement, said automatic means including a member mounted to move with the bending means, an adjustable stop, said movably mounted member adapted to move to contact said stop, and thereby to cause movement of the controlling means to stop the bending means.

17. In combination in a metal forming machine, means for holding a piece of metal immovable, and means for bending a portion of said metal, said bending means including a bending member movably mounted and means for moving it, and an additional means for adjustably and automatically controlling the movement of said bending means to cause it to accomplish a predetermined movement, said automatic means including a member mounted to move with the bending means, an adjustable stop, a second member moved by said first mentioned member, adapted thereby to move to contact said stop, and thereby to cause movement of the controlling means to stop the bending means.

18. In combination in a metal forming machine, means for holding a piece of metal immovable, and means for bending a portion of said metal, said bending means including a bending member movably mounted and means for moving it, and an additional means for adjustably and automatically controlling the movement of said bending means to cause it to accomplish a predetermined movement, to stop at the completion of said movement, to reverse its direction of movement and to return to its original position, said automatic means including a member mounted to move with the bending means, an adjustable stop, a second member moved by said first mentioned member, adapted thereby to move to contact said stop, a third movable member adapted to be moved when the second member has contacted the stop and thereby to cause movement of the controlling means to stop and to reverse the bending means.

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