April 25, 1944. H. E. NEVERDAL 2,347,575

BEAM BENDING MACHINE

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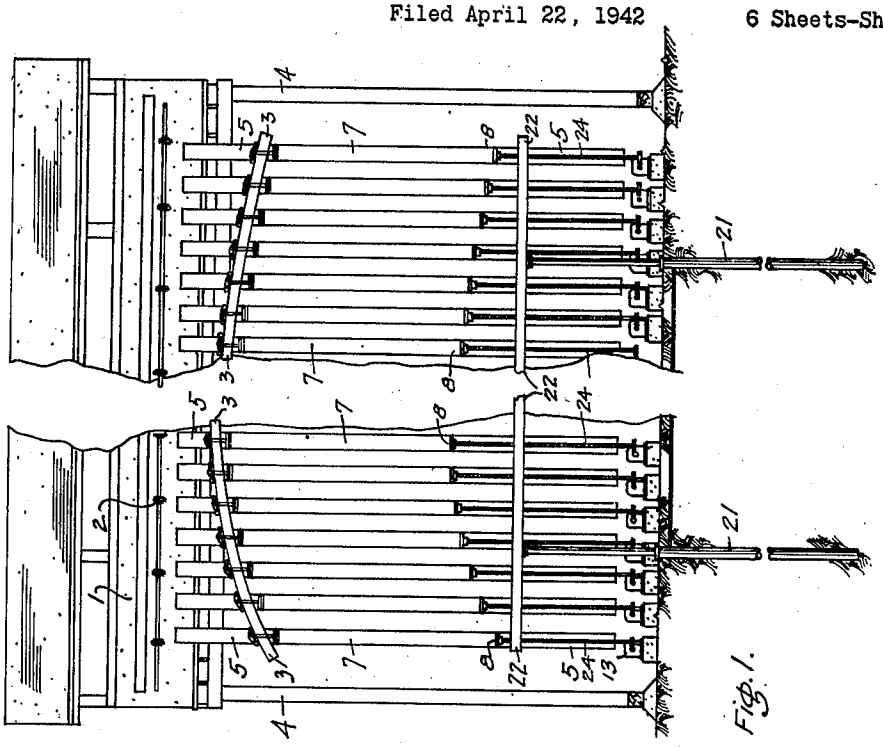


Fig. 1.

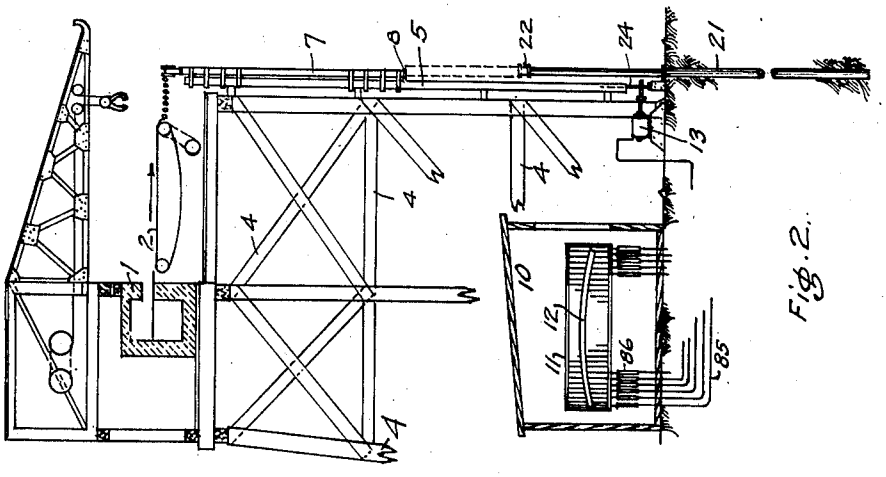


Fig. 2.

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BEAM BENDING MACHINE

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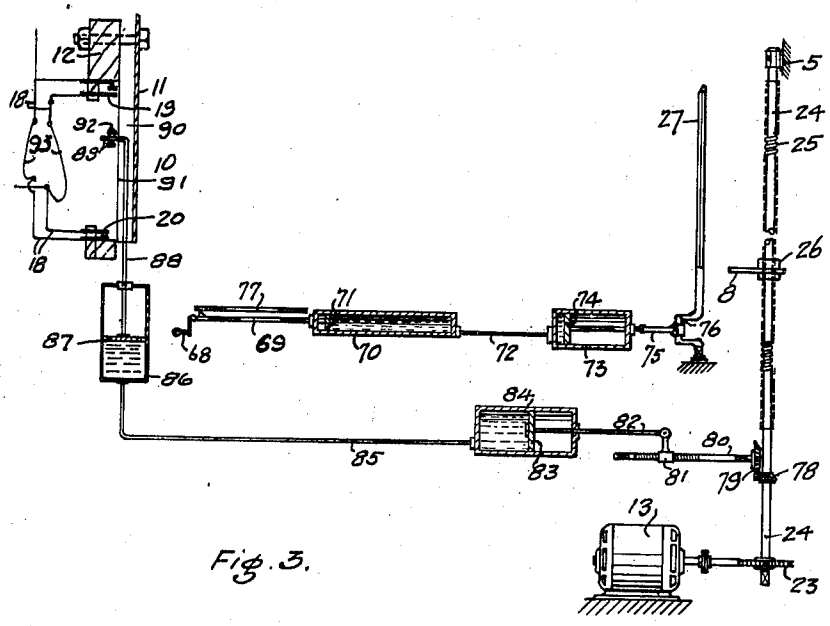


Fig. 3.

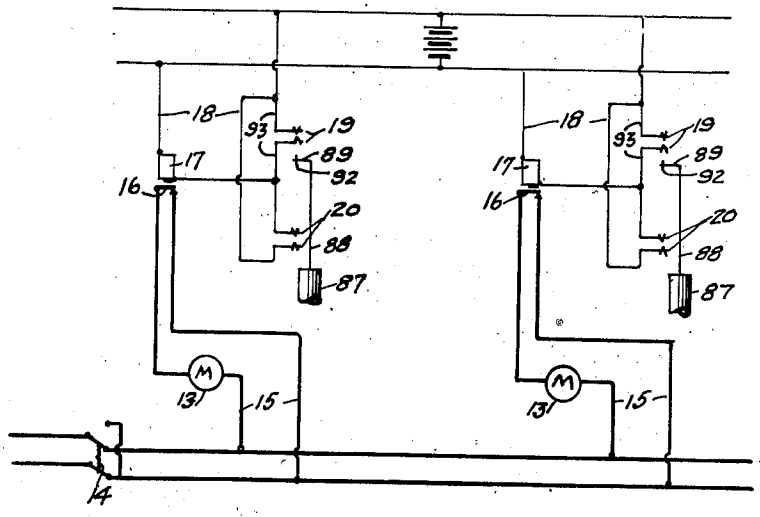


Fig. 4.

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BEAM BENDING MACHINE

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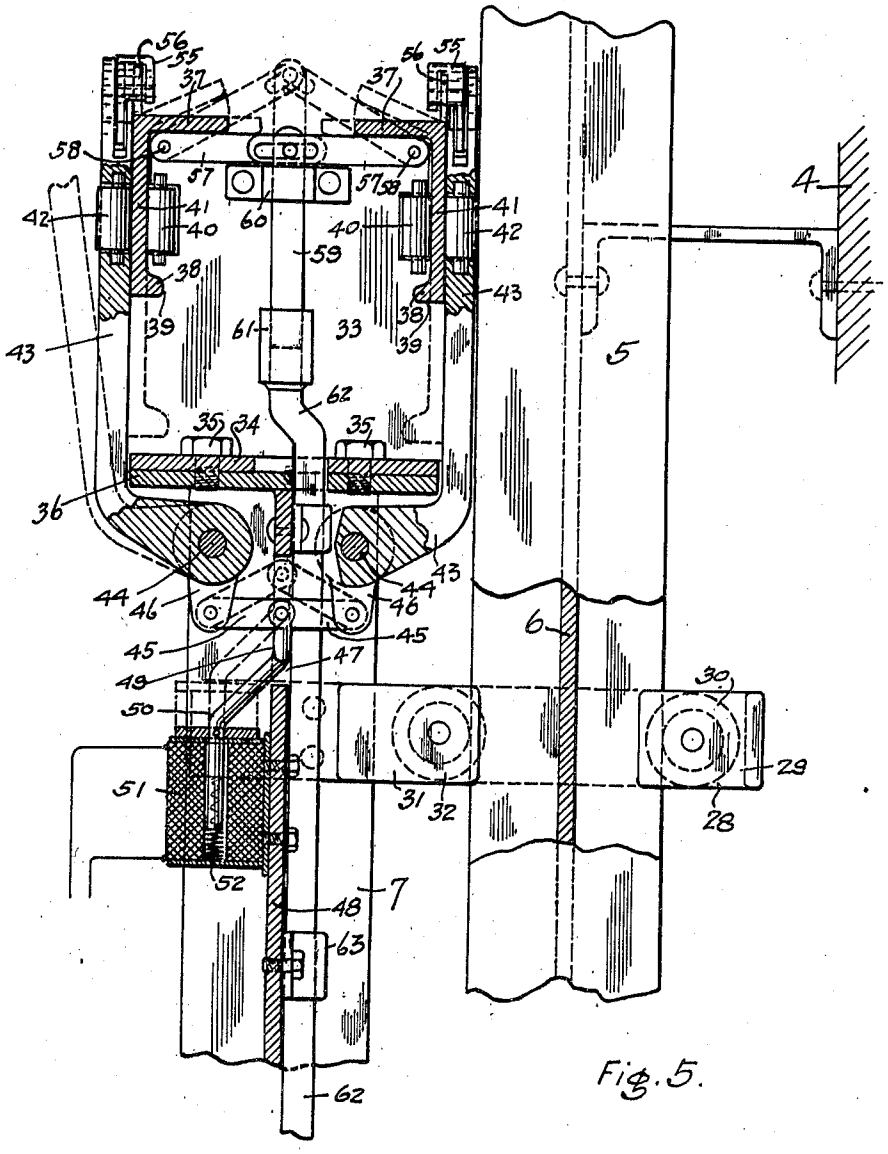


Fig. 5.

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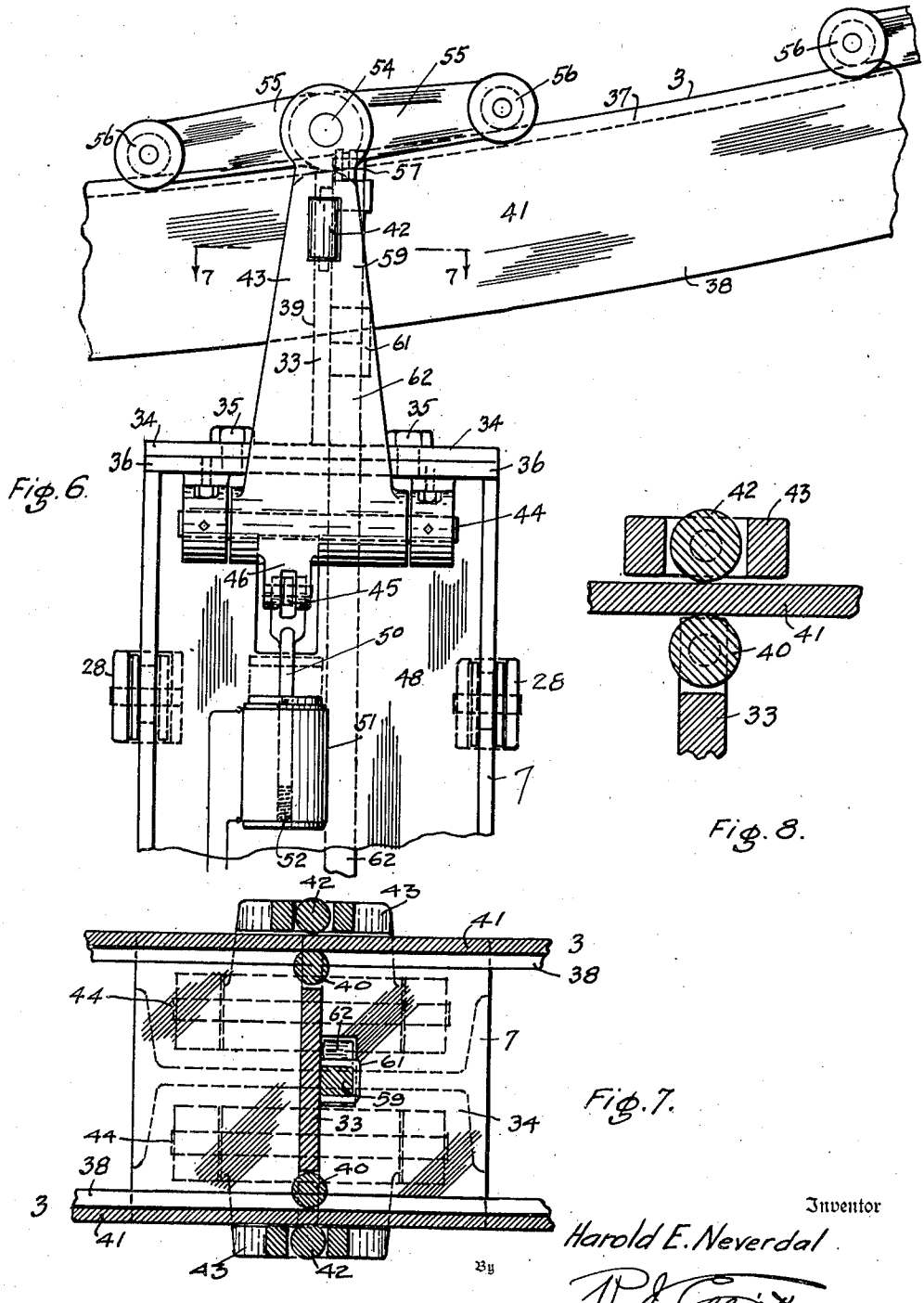


Fig. 6.

Fig. 8.

Fig. 7.

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BEAM BENDING MACHINE

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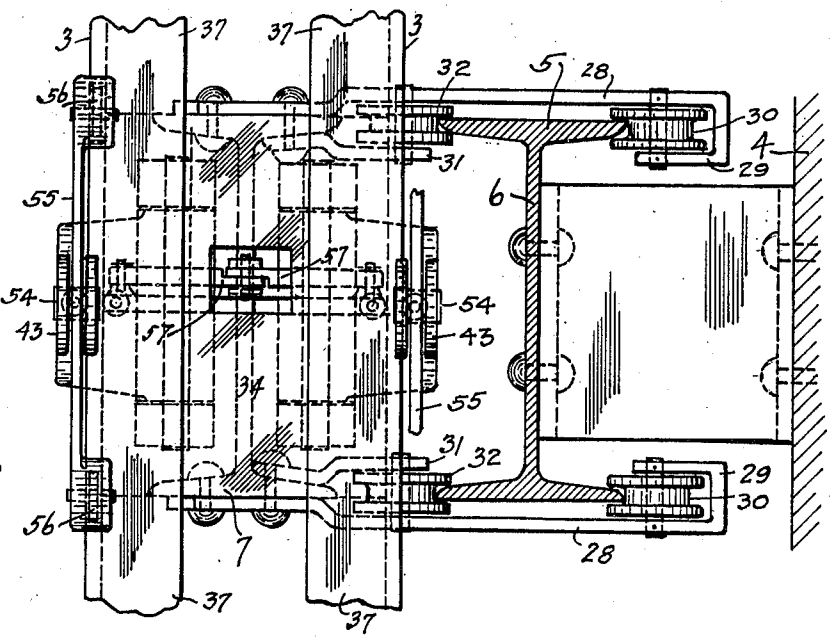


Fig. 9

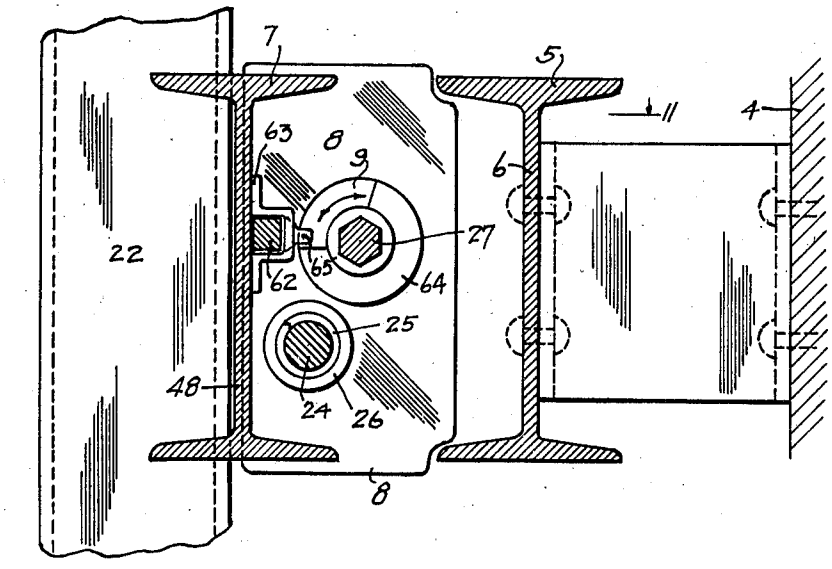


Fig. 10.

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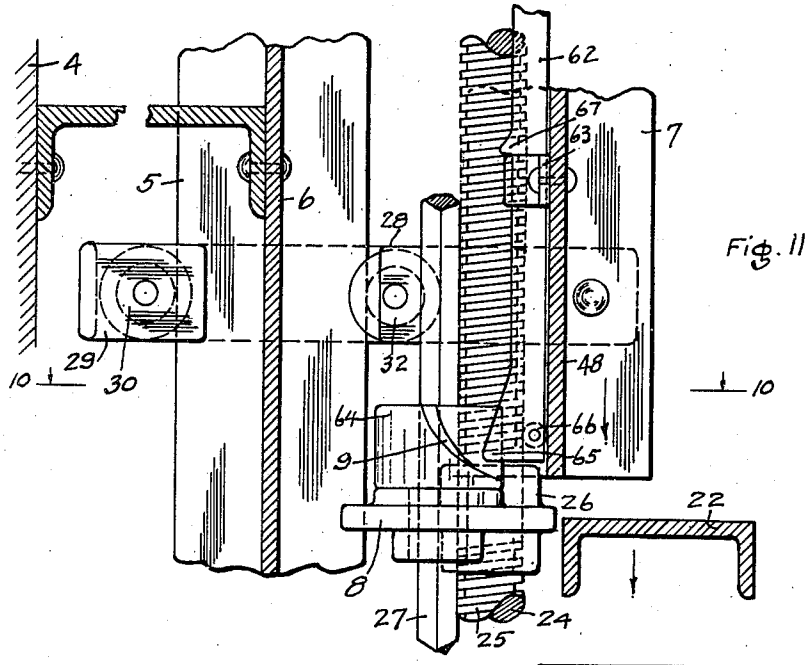
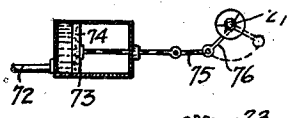


Fig. 11

Fig. 12.



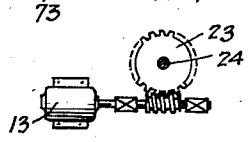
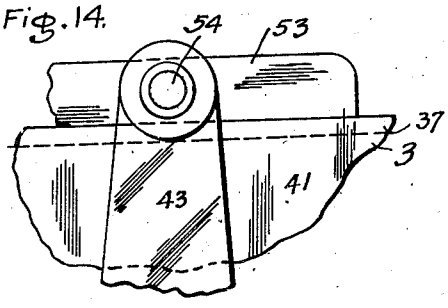


Fig. 13.

Fig. 14.



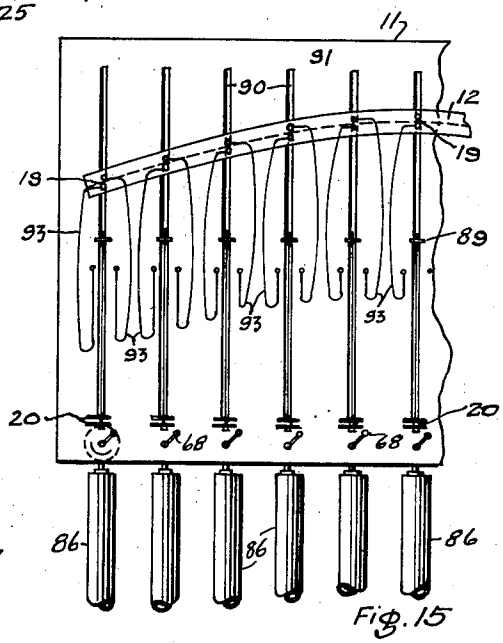


Fig. 15

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Patented Apr. 25, 1944 2,347,575

UNITED STATES PATENT OFFICE

2,347,575

BEAM BENDING MACHINE

Harold E. Neverdal, Tacoma, Wash.

Application April 22, 1942, Serial No. 439,988

23 Claims. (Cl. 153—51)

This invention relates to machines for bending rolled steel beams and has special reference to such beams as are intended for use in ship building, such as ribs and deck beams.

The objects of the invention are to provide a means for simultaneously and complementarily giving the right and left ribs, or other beams, the same longitudinal curvature, and also the same angular bend of the short legs thereof; means for holding said ribs or beams in the machine; means for applying the bending force at spaced intervals therealong; means for permitting the rib or beams to slide longitudinally in said bending means to compensate for the bending thereof; means for controlling the extent of the bending at all points therein; means for operating each controlling means; and means for automatically controlling all said operating means from a single control matrix. Further objects are to save time, labor, and floor space usually required in obtaining the several shaped ribs, or other beams, of a ship, and thereby to reduce the cost of ship construction.

I attain these and other objects, as will appear to those skilled in the art as the description of my machine proceeds, by the devices, mechanisms, and arrangements illustrated in the accompanying drawings, in which—

Fig. 1 is a fractional diagrammatic front elevation of my improved bending machine having completed the bending of a pair of bulb beams; Fig. 2 is a similar side elevation thereof; Fig. 3 is a diagrammatic view showing the connections between the bending machine and the control panel; Fig. 4 is a diagrammatic view showing the wiring of the automatic control of the bending machine from the control panel; Fig. 5 is a cross-section of the upper end of one of the bending elements of my machine; Fig. 6 is a front elevation thereof; Fig. 7 is a section thereof, taken on the line 7—7 in Fig. 6; Fig. 8 is an enlargement of a portion of Fig. 7; Fig. 9 is a plan view of the upper end of one of the bending elements; Fig. 10 is a section of one of said elements, taken on the line 10—10 in Fig. 11 and showing the adjustable stop in plan view; Fig. 11 is a section taken on the line 11—11 in Fig. 10, of a portion of the fixed guide beam and of the adjustable stop thereon, showing the sliding beam approaching the said stop; Fig. 12 is a diagrammatic representation of the cam adjusting means; Fig. 13 is a similar view of the stop-screw operating means; Fig. 14 is a side view of the means for clamping the bulb means against longitudinal motion at one station in the bending machine; and Fig. 15 is a front view of a portion of the control panel in the office, during the time that the several motors are raising or lowering all the adjustable stops in the bending machine.

Similar numerals of reference refer to similar parts throughout the several views.

It is evident that the skin of a ship, at substantially every point in its area, lies in constantly changing planes and that corresponding points on opposite sides of the vessel lie in complementary planes, that is to say, in planes having equal but reversed angles in respect to the longitudinal and horizontal axes of the ship. The ribs lie in planes at right-angles to the longitudinal axis of the ship and of the keel to which they are attached. The side of the ship, at any plane in which a rib lies, will make varying angles to the plane of the rib, from point to point in the rib, except at such midship stations where the sides are parallel and the bottom horizontal, at which places the planes of the ribs lie at right-angles to the planes of the sides and bottom, but if the sides are converging while the bottom may still remain flat, the angle between the side and the plane of the rib will change from point to point in accordance with the design of the ship. It is also evident that the cross-sectional outline of the ship will, in general, vary with the design of the ship, but that the right and left ribs, at any such station, will be similar but complementary, the one to the other, and also that the short leg of each such rib will be bent from its normal position at right angles to the web of the rib, to lie flat on the skin at every part thereof, in accordance with the change of angle which the skin of the ship makes with the cross-sectional plane of the ship in which the particular rib lies.

Therefore, in fashioning the ribs of a ship, it is necessary to bend them so that the outline or form of the rib, as viewed in the direction of the axis of the ship, will correspond with the cross-section of the ship at that station, and further, that the angle between the plane of the rib web and the outer side of the short leg shall vary in accordance with the designed angle which the skin makes, from point to point, with the plane of the rib. This angle is always either a right angle or an obtuse angle.

The problem, then, of providing a machine for preparing a pair of complementary ribs for a ship, is to so bend the ribs that they form the same and the correct shape for that particular pair and that the short legs of said ribs be bent

equally at all corresponding points in said outline, but differently from point to point in said outline, in accordance with the ship design. Furthermore, it is an expensive matter to make full size templates for each pair of ribs and to lay out the change of angle of the short legs thereof from point to point.

In order to simplify the work and reduce the expense of preparing the ribs for a ship I have devised the hereinafter described bending machine in which the force of gravity is utilized, and an automatic means by which the shape of the ribs may be controlled from a central point by means of a small matrix or pattern, and a manually controlled means, in the central office, whereby the bending of the short legs of the two beams may be controlled.

It is to be understood that a suitable heating furnace, together with suitable means for handling the hot beams therefrom, are supplied and that said handling means includes suitable apparatus for placing the beams in the bending machine and for handling them and removing them after they have been bent by the machine, but these parts are illustrated without detail herein as they form no part of the present invention.

Referring, now, to the drawings, it will be seen that an elevated furnace 1 (Fig. 2) is provided to heat the beams which it is desired to bend, and that said furnace is conveniently made somewhat longer than the longest beam to be treated therein. This furnace 1 opens on a conveyer chain 2 leading therefrom and adapted to deliver two of the said beams 3, in reversed positions, to the top of the bending machine. I prefer to mount the furnace 1 and the chain 2 at the top of a suitable structure whose vertical side at the end of the conveyer 2 forms the supporting structure 4 for the main part of this improved bending machine.

At suitable spacing along the entire front of the supporting structure 4 I mount a series of vertical I-beams 5 (Fig. 1), having their webs 6 (Fig. 10) parallel with the face of said supporting structure 4 and permanently secured thereto. The spacing of these I-beams 5 may conveniently be at about two-foot centers. Each of these fixed beams 5 forms a guide for the bending machine mechanism at such station.

In general this bending mechanism comprises, at each station, a vertically sliding I-beam 7, guided in its vertical movement by the said fixed beam 5 with which it is associated, and the head of which grips the two heated bulb beams 3 by hereinafter described mechanism so that the weight of said beam 7 is supported, during the bending operation, by the said beams 3. The vertically sliding beams 7 are each permitted to pass downward, under the action of gravity, dragging the beams 3 with them, until the lower ends of each successively rest on the respective stop plates 8, whose positions have been automatically adjusted to suit the amount of bend which is to be given to the bulb beams 3 at that station (Fig. 1). Also the head of the vertically sliding beam 7 is provided with means to bend the short legs of the said beams 3, in complementary manner and in equal degree, said mechanism, which is also operated by the weight of the moving parts, is controlled by the position of an inclined plane surface 9 (Figs. 10, 11) mounted on the said stop plate 8. The said angle bending means engages the adjusted cam 9 a controlled distance before the motion of the said vertically sliding beam 7 is stopped by its engagement with the said stop plate 8, so that the full weight of the moving parts is applied to the bending of the beams 3 and to their short legs, just before such bending ceases.

An operating office 10 (Fig. 2) may be constructed at any convenient place, and a control panel 11 is set up therein, said control panel having a removable designed pattern or matrix 12 secured thereto.

The control panel 11 is provided with a series of indicating means, one for each station of the bending machine, and each adapted to show the relative position of the corresponding stop plate 8 of the bending machine, at all times, the motion of the said indicating means being in exact proportion to the motion of the stop plate 8 in the guide beam 5, as hereinafter described.

The motion of the stop plate 8 is caused by the running of a motor 13 (Figs. 3, 4, 13). The main electric circuit supplying the power for the motors 13 passes through a reversible switch 14, in the office 10, and is provided with branch circuits 15 each of which connects it to the respective motor 13 through a magnetically broken relay switch 16. The relay magnet 17 is energized to open the switch 16 when the suitably energized relay circuit 18 is closed by contact of the indicating means with either of the two plug terminals 19 and 20, mounted on the matrix 12 and at the bottom of the panel, respectively. Thus it will be seen that when the indicating means of any station engages the matrix-held terminals 19 to close the circuit 18, the magnet 17 will open the switch 16 and thus break the branch circuit 15 and stop the motor 13 and the motion of the stop plate 8. And this stop plate 8 is held in such position until the motor 13 is reversed by the switch 14 and the switch 16 is closed, when it will descend and the indicating means in the office panel 11 will also proportionately descend. When the indicating means reaches the lower end of its travel in the panel, it contacts the terminals 20, thus similarly breaking the circuit 15 and stopping the corresponding motor when the stop plate 8 is at the lower end of its permitted travel.

Similarly the said panel 11 is provided with suitable indicating means at each station thereon, which may be manually set and which are each connected to the corresponding above mentioned inclined cam surfaces 9 (Figs. 3, 11, 12) so that each such surface 9 may be properly and individually adjusted to cause the short legs of both of the beams 3 in the machine to be bent to the desired angle at each such station when the bending of said beam 3 has been completed.

The upward motion of all the sliding beams 7 in this machine, is caused by a hydraulic lift (Figs. 1, 2, 10, 11) comprising suitable cylinders 21, raising or lowering a cross beam 22 which is positioned vertically under the outer portions of all of the vertically sliding beams 7 so as to engage them all and yet so as to miss engagement with the outer edges of the several stop plates 8. This hydraulic lift is not illustrated in detail herein but is adapted to raise all the beams 7 simultaneously until their heads lie in the position adapted to receive the hot bulb beams 3 to be bent. Then, after the beams 3 have been properly placed in the said heads, the hold-down trolley wheels 56 on each head are applied thereto in such manner that the said beams 7 hang from the upper angles of the right and left bulb beams 3. When the placing of the beams 3 in all the heads has been completed, the hydraulic lift beam 22 is lowered until the highest stop

plate 8 is engaged by the corresponding sliding beam 7.

As the hydraulic lift beam 22 is continued to be lowered the hanging beams 7 bend the beams 3 at their several stations until each successively reaches its stop plate 8, and since the positions of these stop plates 8 are each controlled by the designed shape of the pattern 12, it follows that the two beams 3 will have been equally bent to the designed shape. And furthermore, just before each of the hanging beams 7 reaches its stop plate 8, the short leg bending apparatus comes into action by engagement with the adjusted cam surface 9 on the said stop plate 8, thus applying the weight of the beam 7 thereto to bend the said short legs to the desired obtuse angles.

The motor 13 is provided with a worm (Fig. 13) on its shaft, said worm rotating a worm wheel 23. This worm wheel 23 is mounted on the lower end of a long vertical screw-threaded shaft 24 which is mounted in suitable bearings supported by the fixed beam 5. The screw thread 25 of each shaft 24 is preferably square in form. The stop plate 8 (Figs. 10, 11) is carried by a long nut 26, integral therewith, through which the screw 25 is threaded. The stop plate 8 cannot turn with the turning of the shaft 24, being held from turning by the hereinafter described cam control shaft 27, and therefore the nut 26, with the plate 8, travels up or down in the fixed beam 5 with the turning of the shaft 24. The stop plate 8 extends out from the said fixed beam 5 a distance sufficient to engage under about one-half of the sliding beam 7.

The sliding beam 7 is preferably of the same size as is the fixed beam 5. The length of the beam 7 is such that, if it travels down to its lowest position on the beam 5, its head will then be positioned below its uppermost position a distance greater than the maximum bend required for the ship's ribs, and the length of the fixed beam 5 exceeds that of the sliding beam 7 by such maximum travel distance. The sliding beam 7 is guided in its vertical travel by wheeled yokes secured thereto and engaging the flange edges of the fixed beam 5. The yokes 28 (Figs. 5, 9–11) are secured to the outer surfaces of the flanges of the sliding beam 7 and extend horizontally out therefrom towards the fixed beam 5, being bent at their outer ends to form hooks 29 in which the outer flanged guide wheels 30 are mounted. Short pieces 31 are fastened to the inner sides of the flanges of the beams 7 to form, with the yokes 28, the mounting for the inner flanged wheels 32. These wheels 30 and 32 engage the outer and inner edges of the flanges of the fixed beam 5 on each side and thus guide the movement of the sliding beam 7 vertically and hold it from any other movement. These yokes are preferably mounted near the top and bottom ends of the sliding beam 7.

Referring, now, particularly to Figs. 5–9 showing the upper end of one of the sliding beams 7, it will be seen that the head of each sliding beam 7 comprises a vertical plate 33 welded to a head plate 34, which is removably secured by means of bolts 35 to a plate 36 which is welded to the top of the beam 7. The head 33 is adapted to receive the two beams 3 to be bent, said beams 3 being in reversed or right-left positions, with their short legs 37 lying above the head 33 and pointing towards each other, and with their webs lying along the vertical edges of the head 33 and with the bulbs 38 lying in prepared recesses 39 in the edges of the head 33. A set of heads 33 are made for each section or shape of the beams 3, and these heads are changed for each change in size of the said bulb beams 3 by unscrewing the bolts 35 and substituting a new head on each beam 7. A pair of vertical rollers 40 are mounted in the edges of each of the heads 33 and are adapted to engage the inner surfaces of the webs 41 of the two beams 3.

The beams 3 are locked in place on each of the heads 33 by means of rollers 42 carried by two large lever arms 43, cooperating with the above described rollers 40. The levers 43 are clamped in such position as to hold the webs 41 of the beams 3 firmly between the two pairs of rollers 40 and 42. These levers 43 are bent in under the plate 36 of the beam 7, and are secured thereto by means of pivot pins 44 whereby they are permitted to swing outward from such clamping position in order to permit the two beams 3 to be lowered into position in the head 33.

The locking of the arms or clamping levers 43 is accomplished by means of toggle links 45 (Fig. 5) connected to each other and to the short arms 46 of the said clamping levers 43, in such manner that, when the levers 43 are in clamping position, the toggle links 45 connecting the arms 46 are at or slightly below dead center. A slot 47 is made in the web 48 of the beam 7, through which the said links 45 freely pass. An operating rod 49 is connected to the two links 45 at their knuckle joint and passes downward therefrom. When the links 45 are at or slightly below dead center the rod 49 rests on the bottom of the slot 47 and prevent further downward movement of the links 45, thus locking the levers 43 in their closed position. This operating rod 49 is offset at 50 and passes into the solenoid 51, secured to the side of the web 48, and forms the core thereof. The lower end of the rod 49 is engaged by a spring 52, which may be mounted within the solenoid 51, and which presses said rod 49 upward as soon as the electro-magnetic action of the solenoid 51 is released, thereby pushing the knuckle of the toggle links 45 upward and releasing their locking action on the levers 43, which promptly fall outward under the action of gravity, since the pivots 44 are placed inward from the centers of gravity of the released levers 43. The knuckle joint of the toggle links 45 engages the upper end of the slot 47 to limit the opening motion of the levers 43. The operation of all the solenoids 51 is controlled by suitable electric circuits, not shown herein, and preferably operated from the office 10.

Thus it will be seen that as soon as the beams 3 are both in place in the several beam heads 33, the solenoids 51 are energized, thus drawing the rods 49 downward, compressing the springs 52 and forcing the short arms 46 outward and clamping the levers 43 inward.

One of the sliding beams 7 is provided with a head which does not permit the beams 3 to slide therein, but clamps them in fixed longitudinal position. This head may usually be on the sliding beam 7 which first engages the stop plate 8, as above described. The purpose of this clamping the beams 3 is to provide a reference point from which definite measurements may be made. The extent of the sliding of the beams 3 in the other heads will, in general, vary somewhat with the distance from such anchored point. In this case it will be seen that the rollers 40 and 42

have been omitted (Fig. 14). A pair of clamping trolley plates 53 are mounted on pivots 54 which extend inward from the upper ends of the above described levers 43. These trolleys 53 engage the upper edges of the beams 3. When the beam 7 is not supported either by the lift beam 21 or by the stop plate 8, it hangs on the two beams 3 by means of said trolley clamping plates 53.

Each of the other sliding beams 7 is provided with the above described clamping rollers 40 and 42 which permit a longitudinal sliding of the beams 3 in the respective heads 33. Also the pivots 54, at the upper ends of the levers 43, are provided with trolley plates 55 on the ends of which are mounted two wheels 56 which ride on the upper edges of the beams 3 and which permit the said beams 3 to slide longitudinally thereunder.

The length of the trolleys 55 is such as to evenly divide the spaces between the wheels 56, which may well be about twelve inches apart. When the several beams 7 are not supported either by the lift beam 22 or by the respective stop plates 8, they are supported by the hot beams 3 through the wheels 56, trolleys 55 and pivots 54, thus causing the hot beams 3 to bend under the weight of the sliding beams 7.

When the lift beam 22 begins to be lowered, all the beams 7, together with the hot beams 3 secured therein, are lowered until one such beam 7 is stopped in its downward travel by its engagement with the highest stop plate 8. Then the weight of all the other beams 7, and 3, is carried by said stop plate 8 so that the beams 3 are bent at such station. As the second such beam 7 reaches its stop plate 8 the bending of the beams 3 ceases at the first stopped station but continues at the second station until the next or third succeeding beam has reached its stop plate. And so forth until the entire length of the hot beams 3 has been bent to the desired shape. It will be noted that the trolleys 55 turn on the pivots 54 to adjust themselves to the angle of the bent beams 3, and that the beams 3 slide under the wheels 56, 40 and 42 to compensate for the increased length between the stations as they are bent.

Referring now to the mechanism for bending the short legs 37 to the required obtuse angles. As seen in Fig. 5 each head 33 is provided with a pair of levers 57 pivoted thereto at 58 close under the inside corners of the two bulb beams 3. These levers 57 lie under the short legs 37 and extend past the central line of the head 33. Each said lever 57 is engaged by and adapted to be forced upward at the central line by means of a short compression bar 59, mounted in suitable straps 60 secured to the head 33.

The lower end of this bar 59 rests in a socket 61 formed on the upper end of a long compression bar 62. The purpose of so mounting the bar 59 in the socket 61 is to enable the head 33 to be removed from the beam 7 without having to disengage the bar 59 from the above described levers 57 at each head. The bar 62 is mounted in suitable straps 63 secured to the web 48 of the beam 7.

Referring, now, to Fig. 11, in which the bar operating means is illustrated, it will be seen that the circular cam block 64 is slidably mounted on the hexagonal shaft 27 and rotatably mounted on the stop plate 8. The upper surface 9 of the cam block 64 is inclined upward from its lowest point and is adapted to be engaged by the foot 65 of the bar 62. An antifriction wheel 66 may be mounted on the end of the bar 62 to bear against the web 48 of the beam 7. The bar 62 is prevented from excess downward movement in the straps 63 by means of a stop lug 67 engaging one of the said straps. The distance that the foot 65 is above the lowest line of the beam 7 is equal to the distance that the lowest point in the cam surface 9 is above the upper surface of the stop plate 8, so that when the beam 7 is brought to rest on the plate 8, the foot 65 will not raise the bar 62 if the cam block 64 has been turned to bring the lowest point in the inclined surface 9 in line for engagement by the foot 65, with the result that no movement of the bar 62 is made and therefore there is no movement of the bar 59 or of the levers 57, and the short legs 37 of the beams 3 remain in their original positions at right angles to the webs 41 thereof.

But if the shaft 27 has been turned, as hereinafter described, to bring a higher part of the inclined surface 9 into position to be engaged by the foot 65 of the descending bar 62, such engagement will occur before the beam 7 has reached the stop plate 8, and therefore there will be a relative movement of the bar 62 upward on the web 48 of the beam 7, resulting in an upward movement of the bar 59 and of the inner ends of the levers 57, turning them on their pivots 58, and forcing the short legs 37 upward at a determined obtuse angle, said angle being dependent on the point of engagement of the foot 65 on the inclined surface 9.

The positions of all the cam blocks 64 are controlled from the control panel 11, in the office 10, as follows: Referring to Figs. 3, 12 and 15, it will be seen that each station on the control panel is provided with a rotatable handle 68 adapted to turn the screw 69. The screw 69 passes into a cylinder 70 and forces a piston 71 along the said cylinder. The far end of the cylinder 70 is filled with oil, or other suitable liquid, and is open to a pipe 72 leading to a larger cylinder 73 at the bending machine. This cylinder 73 has a piston 74 therein. The pipe 72 and the near end of the cylinder 73 are filled with oil and are in free communication with the oil-filled end of the cylinder 70. The piston 74 is connected by a suitable connecting rod 75 with a crank 76 in the above-described hexagonal vertical shaft 27 on which the cam block 64 is slidably mounted. A suitable indicating scale 77 may be mounted adjacent the screw 69 and is adapted to show the angle which the short legs 37 of the beams 3 will be given by the engagement of the foot 65 with the surface 9 as thus adjusted.

The control of the positions of the several stop plates 8 from the control panel 11 is accomplished in the following manner. The motor 13 turns the screw shaft 24 by means of the worm and worm wheel 23 (Figs. 3, 13). A bevel gear 78 is mounted on the shaft 24 and meshes with a bevel gear 79 on the horizontal shaft 80. This shaft 80 is screw-threaded and moves a nut 81 therealong. This nut 81 is connected by a rod 82 with a piston 83 in a cylinder 84. The cylinder 84 is connected by a pipe 85 with a vertical cylinder 86 which is positioned as a part of the panel 11 and in proper relation to its corresponding cylinders 86 of the other stations of the bending machine. Oil, or other suitable liquid fills the pipe 85 and the adjacent parts of the cylinders 84 and 86. A piston 87 is mounted in the cylinder 86 and moves freely therein. An indicator rod 88 passes upward from the piston 87 and car-

ries a head 89 thereon, said head 89 traveling up or down in the slot 90 in the panel 11.

The panel 11, in the office 10, comprises a front board 91 (Fig. 15) in which a series of vertical slots 90 are provided, one for each station or bending element 7 of the bending machine. The indicator heads 89 extend through said slots 90. Each head 89 is provided with a contact point 92 which is adapted to engage and make contact between either of the pairs of terminals 19 and 20 in the relay circuit 18. The contact point 92 is preferably screw-threaded in the head 89 whereby it may be adjusted vertically.

The panel 11 has a pattern or matrix 12 removably secured thereto, said matrix being of designed shape corresponding with the desired amount of bending of the ribs 3 at each particular station. The matrix 12 is provided at each station therein with a pair of plug terminals 19, normally out of contact with each other but adapted to make contact when engaged by the above described adjustable point 92. The wires 93 forming a part of the respective relay circuits 18, lead from the plug terminals 19 to the respective relay magnets 17 and the battery, or other source of electric energy, respectively, which said parts may be mounted in the panel 11 or at any other suitable point.

The terminals 20 at the lower end of the several slots 90 are permanently fixed in position and are adapted to stop the downward or return motion of the stops 8 and the heads 89, when they are engaged by the said heads.

Thus it will be seen that I have invented a machine for bending beams and their short legs, in complementary pairs, by gravity, together with means for automatically controlling the outline of said bent beams together with means for manually controlling the extent or angle of bend in the short legs of said bent beams. Also it will be seen that such a machine is of simple construction and operation and that it will perform its work quickly and accurately.

It is to be understood that, while I have illustrated and described what I conceive to be the best and most practical embodiment of my invention, it is obvious that many changes and variations may be made in the details of construction thereof without departing from my invention as expressed in the appended claims. As instances of a few of such possible variations I might state that the hydraulic lift may be replaced by a mechanically operated lift; that the hydraulic connection between the individual stop plates and the corresponding indicator heads in the office may be replaced by a mechanical connection; that the rotary adjustment of the inclined planes may be replaced by a longitudinal adjustment thereof, and so forth, as may be desired by the firm building or operating the said bending machine; and I wish it to be understood that my invention is not to be limited to the specific form or arrangement of parts herein described and illustrated or specifically covered by my appended claims.

Having, therefore, described my invention, what I claim and desire to secure by Letters Patent is:

1. In a bending machine for hot beams, the combination of a plurality of fixed vertical guide beams; stop plates adjustably supported thereon; a plurality of vertically sliding beams, each guided in vertical movement by its corresponding fixed beam, and adapted to be stopped by contact with said stop plate; and suspending means mounted on the head of each of said sliding beams and adapted to connect said head to the hot beams to be bent whereby, as said sliding beams pass downward on said guide beams and successively engage said stop plates, said hot beams are bent to the form determined by the adjusted positions of said stop plates.

2. A bending machine as set forth in claim 1, wherein said suspending means, on one said sliding beam head, secures said hot beams against longitudinal motion therein; and wherein the suspending means, on each of the other sliding beams, permits a longitudinal motion of the hot beams therein, whereby compensation for the bending of the hot beams is provided without permitting lateral motion of the sliding beams.

3. A bending machine as set forth in claim 1, wherein said suspending means is pivotally mounted on the head of each said sliding beam, and is adapted to swing on its pivot to adjust itself relatively to the sliding beam in accordance with the angle of the sliding beam to the hot bent beams at each station.

4. A bending machine as set forth in claim 1, wherein said suspending means comprises a pair of trolley plates pivotally mounted on the head of each of said sliding beams, and each adapted to swing on its pivot to adjust itself to the angle of bend of the hot beam, and wherein each said trolley plate is provided with wheels whereby said hot beams may slide under said suspending means to compensate for the change in length between stations by the bending of said hot beams.

5. In a hot beam bending machine, the combination with a guided sliding beam; of a head thereto operatively engaging the hot beam to be bent; a clamping lever mounted on said sliding beam adjacent the side of the hot beam to be bent; and rollers mounted in the head and in the clamping lever and respectively engaging the two sides of the hot beam, whereby longitudinal motion of the hot beam is permitted past said head and said clamping lever.

6. In a hot beam bending machine, the combination with a guided sliding beam; of a head thereto operatively engaging the hot beam to be bent; a clamping lever mounted on the sliding beam adjacent the side of the hot beam and extending above the hot beam; rollers mounted in the head and in the clamping lever and respectively engaging the two sides of the hot beam; a trolley plate pivotally secured to the upper end of the clamping lever and extending over the hot beam; and wheels mounted on the ends of said trolley plate and engaging the upper surface of said hot beam.

7. In a hot beam bending machine, the combination of a guided sliding beam; of a head thereto operatively engaging the hot beam to be bent; a clamping lever pivotally mounted on said sliding beam and lying adjacent the side of the hot beam and adapted to clamp the hot beam to the head; a toggle link mechanism adapted to lock said clamp lever in clamping position; and electro-magnetic means adapted to move said toggle mechanism into locking position.

8. In a hot beam bending machine, the combination of a guided sliding beam; of a head thereto operatively engaging the hot beam to be bent; a clamping lever pivotally mounted on said sliding beam and lying adjacent the side of the hot beam and adapted to clamp the hot beam to the head; a toggle link mechanism adapted to lock said clamp lever in clamping position; electro-magnetic means adapted to move said toggle mechanism into locking position; and spring

means adapted to throw said toggle mechanism out of locking position upon the release of said electro-magnetic means.

9. In a hot beam bending machine, the combination of a plurality of fixed vertical guide beams; stop plates supported thereon; screws for independently adjusting the positions of each of said stop plates on said fixed beams; separate electric motors with mechanism driven thereby for operating each said screw; and automatic means operated by said motor-driven mechanism, whereby said electric motor is stopped when said stop plate has been moved to the desired adjusted position.

10. In a hot beam bending machine, the combination of a plurality of fixed vertical guide beams; stop plates supported thereon; screws for independently adjusting the positions of each of said stop plates on said fixed beams; separate electric motors with mechanism driven thereby for operating each said screw; a control panel; a plurality of indicating means on said control panel, each corresponding with one of said stop plates; means connecting each of said stop-plate-adjusting screws with its corresponding indicating means on the panel, whereby said indicating means is moved in proportion as said stop plate is moved; a matrix mounted on said control panel and crossing the paths of said separate indicating means; and separate energized electric control circuits, each adapted to be closed by each said indicating means when the indicating means engages the matrix, whereby the corresponding electric motor is stopped.

11. In a hot beam bending machine, the combination of a plurality of fixed vertical guide beams; stop plates supported thereon; separate screws for independently adjusting the positions of each of said stop plates on said fixed beams; separate electric motors with mechanism driven thereby for operating each said screw; a control panel; a plurality of indicating means on said control panel, each corresponding with one of said stop plates; means connecting each of said stop-plate-adjusting screws with its corresponding indicating means on the panel, whereby said indicating means is moved in proportion as said stop plate is moved; a matrix mounted on said control panel and crossing the paths of said separate indicating means; an energized electric relay circuit for each of said indicating means; terminals in each said relay circuit, normally breaking said circuit, and adapted to be engaged by said indicating means to close said relay circuit when the indicating means engages said terminals; and a relay magnetic switch in each said relay circuit and controlling each said electric motor and adapted to open said switch when said relay circuit is closed.

12. In a hot beam bending machine, the combination of a plurality of fixed vertical guide beams; stop plates supported thereon; separate screws for adjusting the positions of each of said stop plates on said fixed beams; a plurality of vertically sliding beams, each guided in its vertical movement by its corresponding fixed beam, and adapted to engage and be stopped by its corresponding stop plate; means to secure the hot beams in the heads of the several sliding beams, whereby as said sliding beams pass downward and successively engage said adjusted stop plates, said hot beams are bent to the form determined by the adjusted positions of the several said stop plates; separate motors, with mechanism driven thereby, for operating each said screw; and automatic means, operated by said motor-driven mechanism, whereby each of said motors is stopped when said stop plate has been moved to the desired adjusted position.

13. In a hot beam bending machine, the combination with a series of separate means adapted for gripping the beams to be bent and each adapted to move in parallel lines; separate stop plates mounted in the paths of each of said moving gripping means and adapted to stop its motion; screws for adjusting the positions of each of said stop plates; separate energized electric motors adapted to operate each said screw; a control panel; a series of indicating means on said control panel, each corresponding with one of said stop plates; means connecting each of said stop plate adjusting screws with its corresponding indicating means, whereby said indicating means is moved in proportion as said stop plates are moved; a matrix mounted on said control panel and crossing the paths of each of said indicating means; an energized electric relay circuit for each of said indicating means; terminals in each of said relay circuits, normally breaking said circuits, and adapted to be engaged by the corresponding indicating means to close said relay circuit when said indicating means engages said terminals; and a relay magnetic switch in each said relay circuit and controlling each said electric motor and operated to open said switch to stop its motor when said relay circuit is closed.

14. In a bending machine for the short legs of hot beams, the combination of a plurality of fixed vertical guide beams; stop plates adjustably supported thereon; an inclined plane supported on each said stop plate; a plurality of vertically sliding beams, each guided in its vertical movement by its corresponding fixed beam and adapted to be stopped by engagement with said stop plate thereon; a head at the upper end of each said sliding beam and adapted to secure the hot beam therein; a lever pivoted to the upper part of each said head and lying under the short leg to be bent; and a bar mounted on said sliding beam and engaging said lever, and extending to the lower end of said sliding beam, and adapted to engage said inclined plane before the sliding beam engages the stop plate, whereby the bar is forced relatively upward to raise the lever and to bend the short leg of the hot beam as the sliding beam passes downward to said stop plate.

15. In a bending machine for the short legs of hot beams, the combination of a plurality of fixed vertical guide beams; stop plates adjustably supported thereon; an inclined plane supported on each stop plate; a plurality of vertically sliding beams, each guided in its vertical movement by its corresponding fixed beam and adapted to be stopped by engagement with said stop plate thereon; a head at the upper end of each said sliding beam and adapted to secure the hot beam therein; a lever pivoted to the upper part of each said head and lying under the short leg to be bent; a bar mounted on said sliding beam and engaging said lever, and extending to the lower end of said sliding beam, and adapted to engage the inclined plane before the sliding beam engages the stop plate, whereby the bar is forced relatively upward to raise the lever and to bend the short leg of the hot beam as the sliding beam passes downward to said stop plate; and separate means adapted to adjust each said inclined plane, whereby the extent of bending of said short leg, at each station, is controlled.

16. A bending machine as set forth in claim 15, wherein the head of said sliding beam is removable; and wherein said bar is composed of two separate lengths connected together by a socket, the joint between said lengths being substantially near the joint between the sliding beam and its head.

17. A bending machine as set forth in claim 15, wherein each said inclined plane is composed of a block rotatably mounted on the stop plate and having its upper surface inclined; and wherein each said adjusting means comprises a rotatable shaft, whereon said block has a sliding connection but rotates therewith and may be adjusted by turning the said shaft.

18. In a bending machine for the short legs of hot beams, the combination of a plurality of separate sliding beams adapted to move in parallel lines; stop plates mounted in the paths of each said sliding beam and adapted to stop its movement; an inclined plane supported on each stop plate; a head at the end of each said sliding beam and adapted to secure two hot beams in reversed positions therein; a pair of levers pivoted to the upper part of each said head and respectively lying under the two short legs to be bent; and a bar mounted on each said sliding beam and engaging both said levers to move their free ends equally upward, and extending to the lower end of said sliding beam, and adapted to engage the inclined plane before the sliding beam engages the stop plate, whereby the bar is forced relatively upward to raise both said levers equally and to bend the short legs of both said hot beams as the sliding beam passes downward to engage said stop plate.

19. In a bending machine for the short legs of hot beams, the combination of a plurality of separate sliding beams, each adapted to move in parallel lines; stop plates mounted in the path of each of said sliding beams and adapted to stop its movement; a cam block rotatably mounted on each said stop plate, and having an inclined upper surface; a head at the upper end of each said sliding beam and adapted to secure the hot beam therein; a lever pivoted to the upper part of each said head and lying under the short leg to be bent; a bar mounted on each said sliding beam and engaging said lever, and extending to the lower end of said sliding beam, and adapted to engage the inclined surface of said cam block before the sliding beam engages the stop plate, to force said bar relatively upward and raise said lever and bend the short leg; and means to rotate said cam block thereby to adjust the point of contact therewith of said bar, to control the extent of bending of said short leg.

20. A bending machine as set forth in claim 19, wherein said means to adjust the cam block comprises a shaft whereon said cam block freely slides without relative rotary motion; a crank in said shaft; and means for adjusting the position of said crank.

21. A bending machine as set forth in claim 19, wherein said means to adjust the cam block comprises a shaft whereon said cam block freely slides without relative rotary motion; a crank in said shaft; a longitudinally adjustable rod; and a connecting rod joining the crank to said adjustable rod.

22. A bending machine as set forth in claim 19, wherein said means to adjust the cam block comprises a shaft whereon said cam block freely slides without relative rotary motion; a crank in said shaft; a cylinder; a piston mounted therein; a connecting mechanism joining said piston to said crank; and means to operate said piston.

23. A bending machine as set forth in claim 19, wherein said means to adjust the cam block comprises a shaft whereon said cam shaft freely slides without relative rotary motion; a crank in said shaft; a hydraulic cylinder; a fluid operated piston mounted therein; a connecting mechanism joining said piston to said crank; a remote hydraulic cylinder; a manually adjusted piston therein; and confined fluid between said adjusted piston and said fluid operated piston, whereby the fluid operated piston is moved in proportion to the manually adjusted piston whereby said cam block is turned.

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