

[54] STRUCTURAL STEEL PUNCH

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83/372; 408/46; 83/560; 83/639

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[58] Field of Search 83/211, 215, 368, 370,
83/372, 559, 560, 562, 639; 408/46, 211,
368, 405

[56] References Cited

UNITED STATES PATENTS

1,241,257	9/1917	Wurts et al.	83/562 X
3,391,593	7/1968	Jordan	83/560 X
3,667,333	6/1972	Flynn, Jr.	83/560 X
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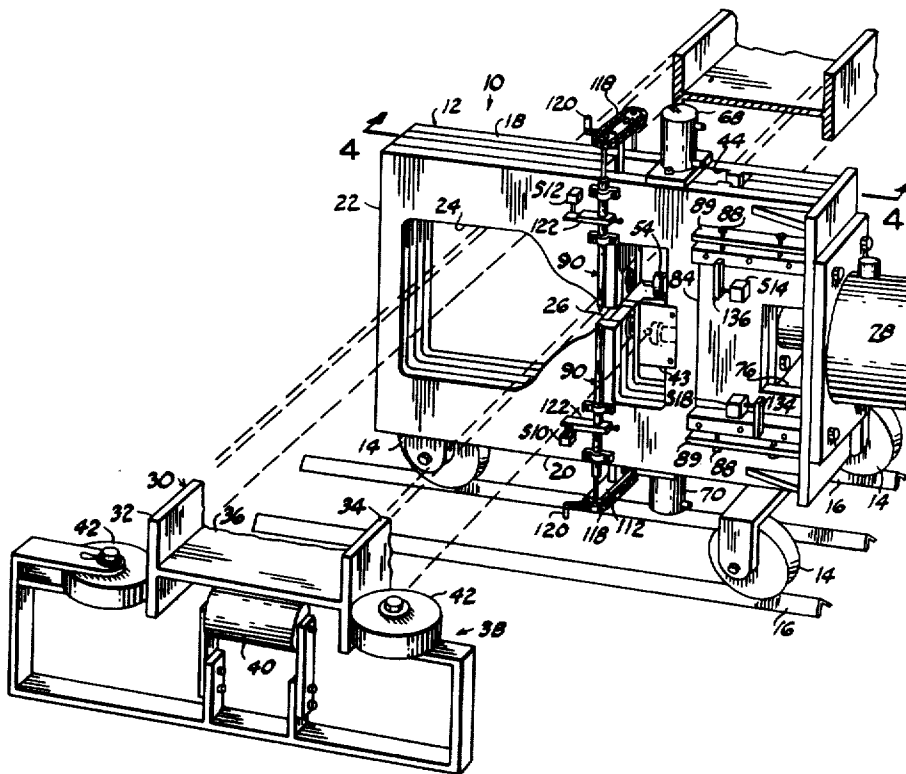
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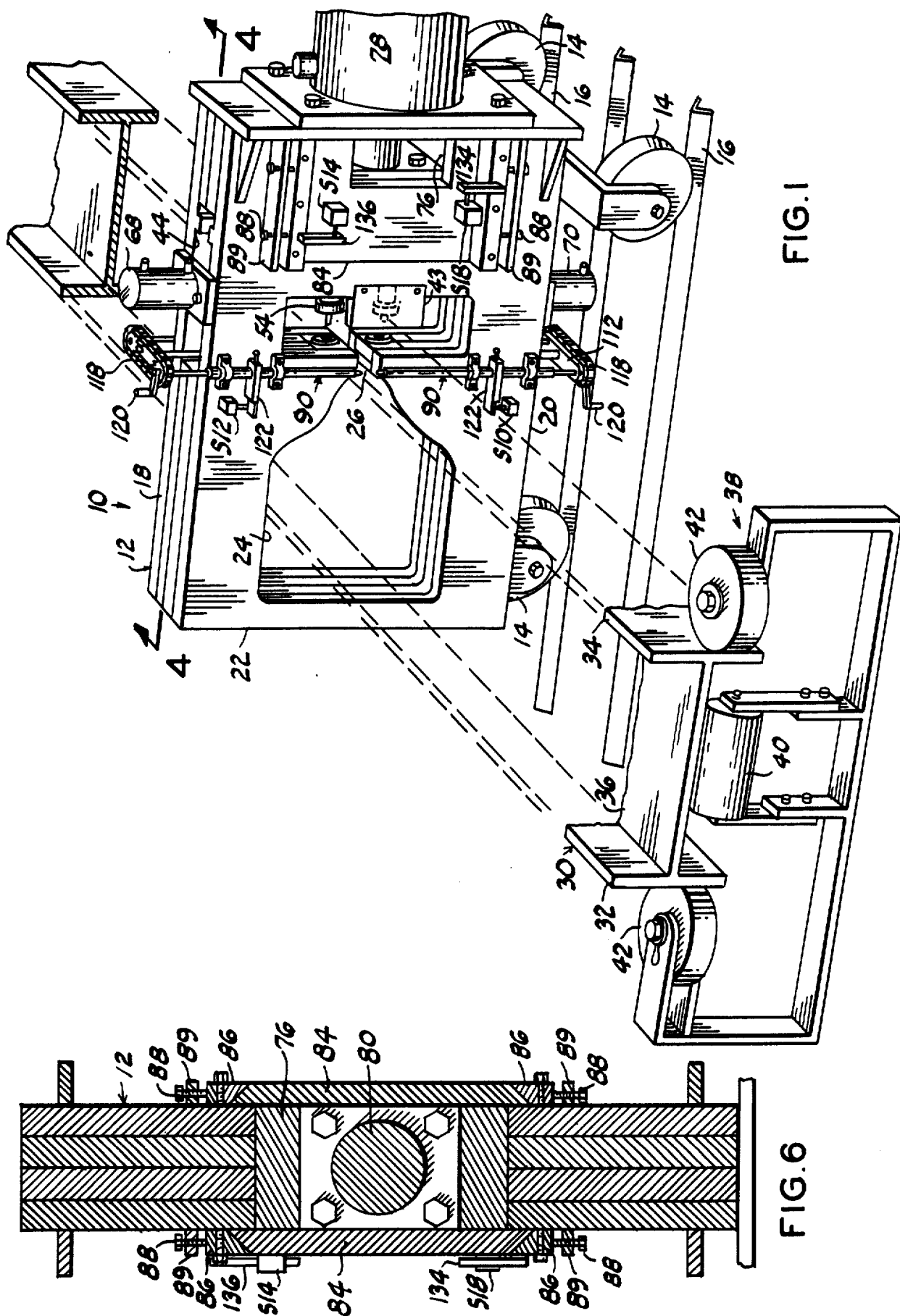
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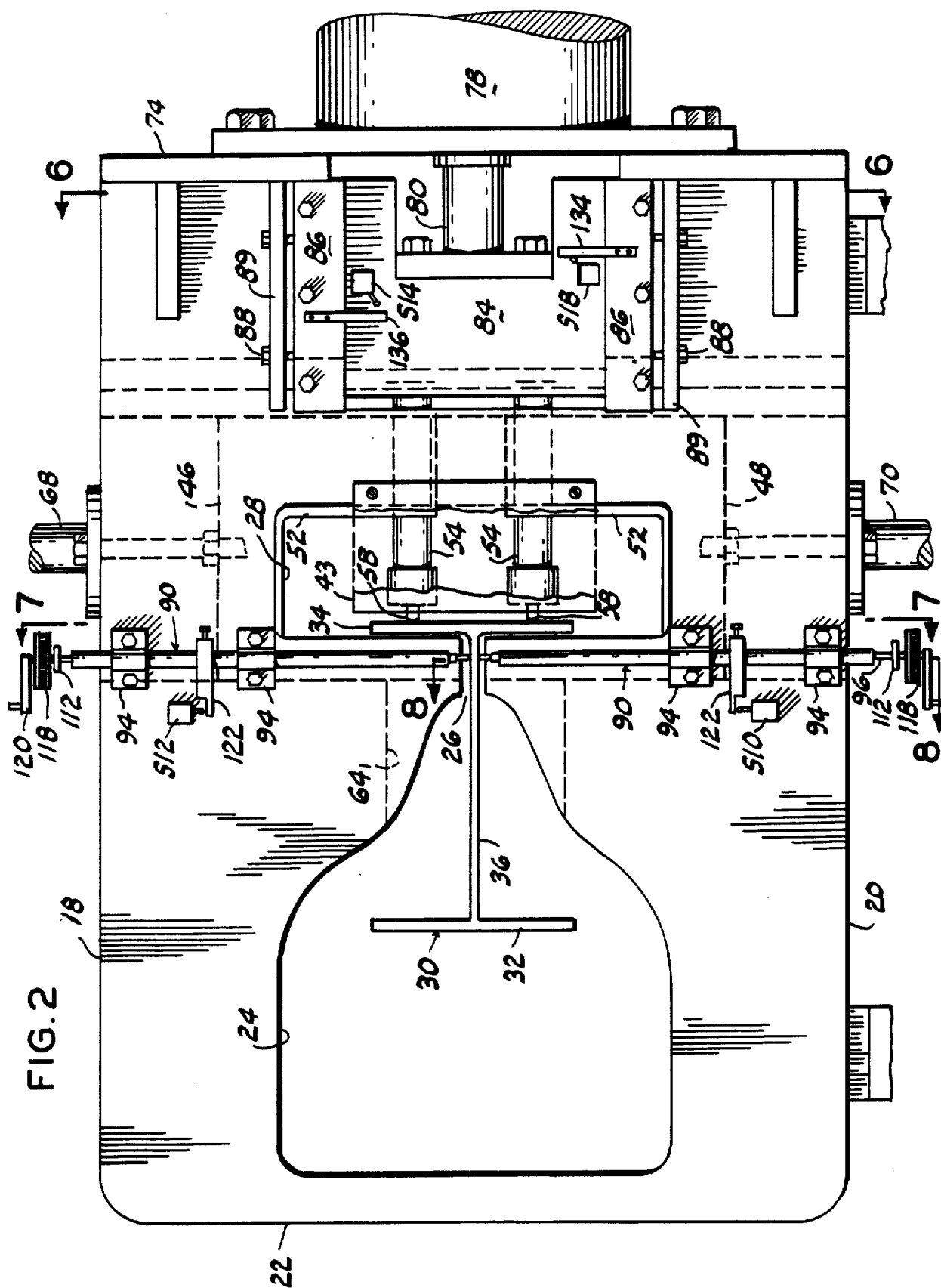
ABSTRACT

A structural steel beam punching apparatus comprising a frame disposed in a generally vertical plane intersecting the horizontal travel path of a structural workpiece to be punched. An aperture in the frame surrounds the travel path. Oppositely disposed punch head means overlying opposing vertical surfaces of the workpiece are slidably supported by the frame for movement toward and away from each other in a plane normal to the workpiece travel path. A pressure head means is connected with punches guided by the punch heads and slidably supported by the frame for movement toward and away from punch heads for and punching holes in the workpiece.

6 Claims, 9 Drawing Figures







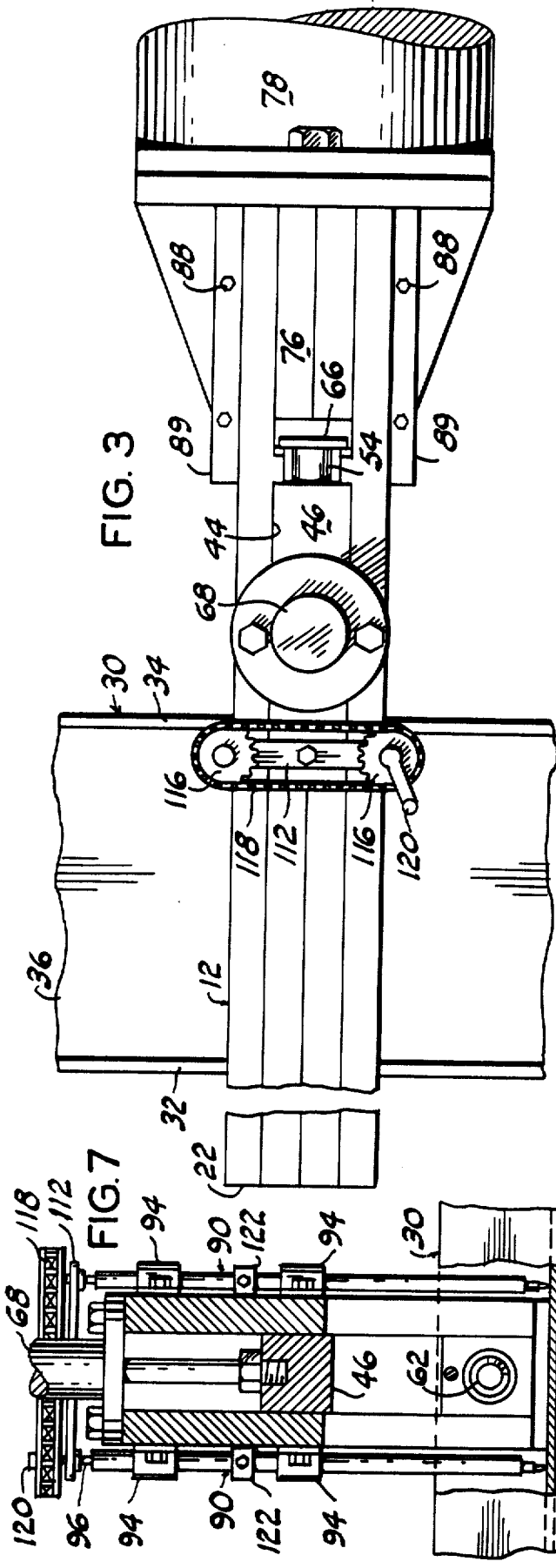
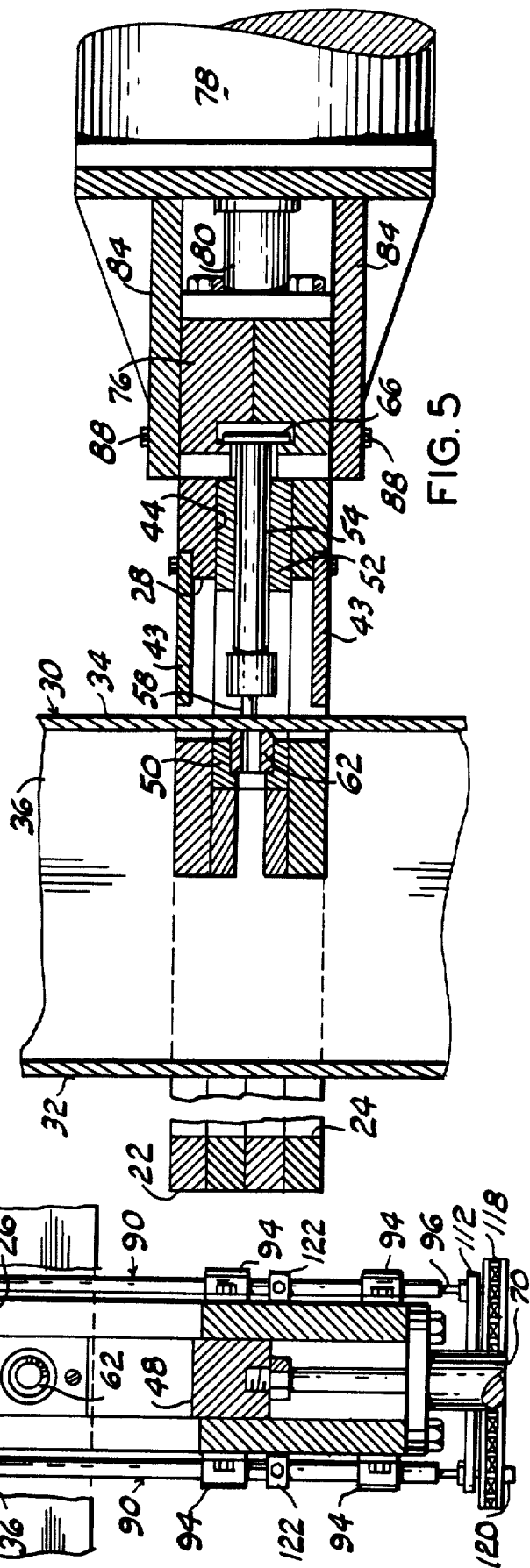


FIG. 4

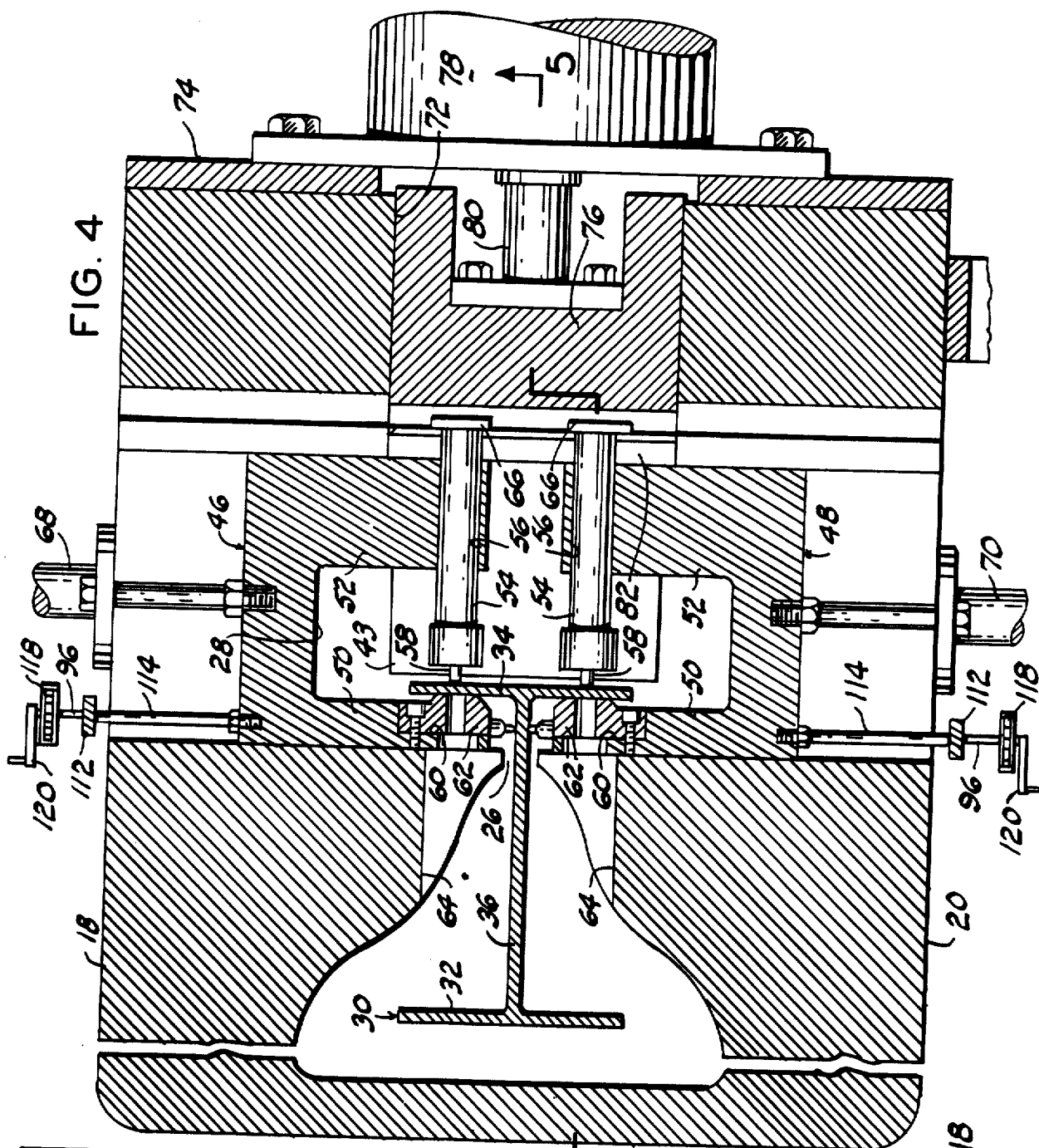


FIG. 8

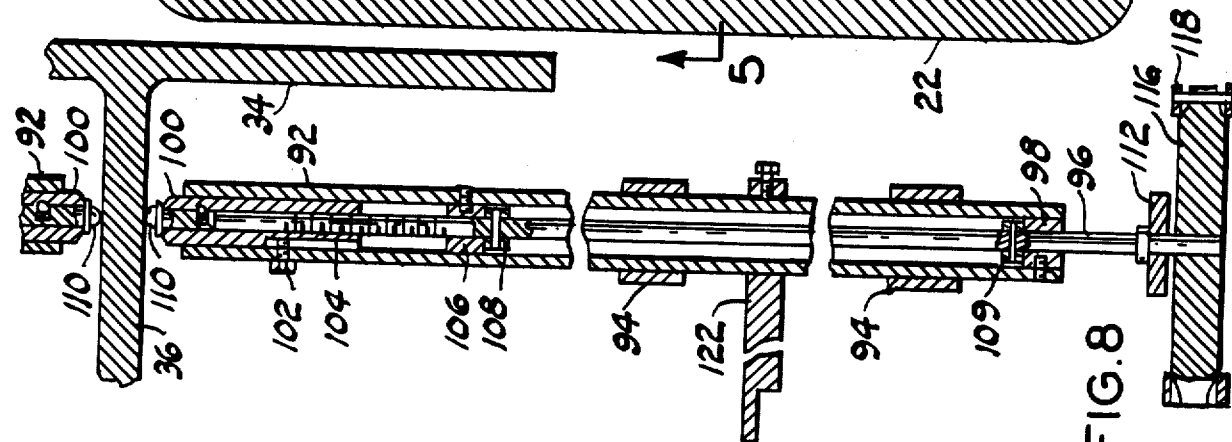
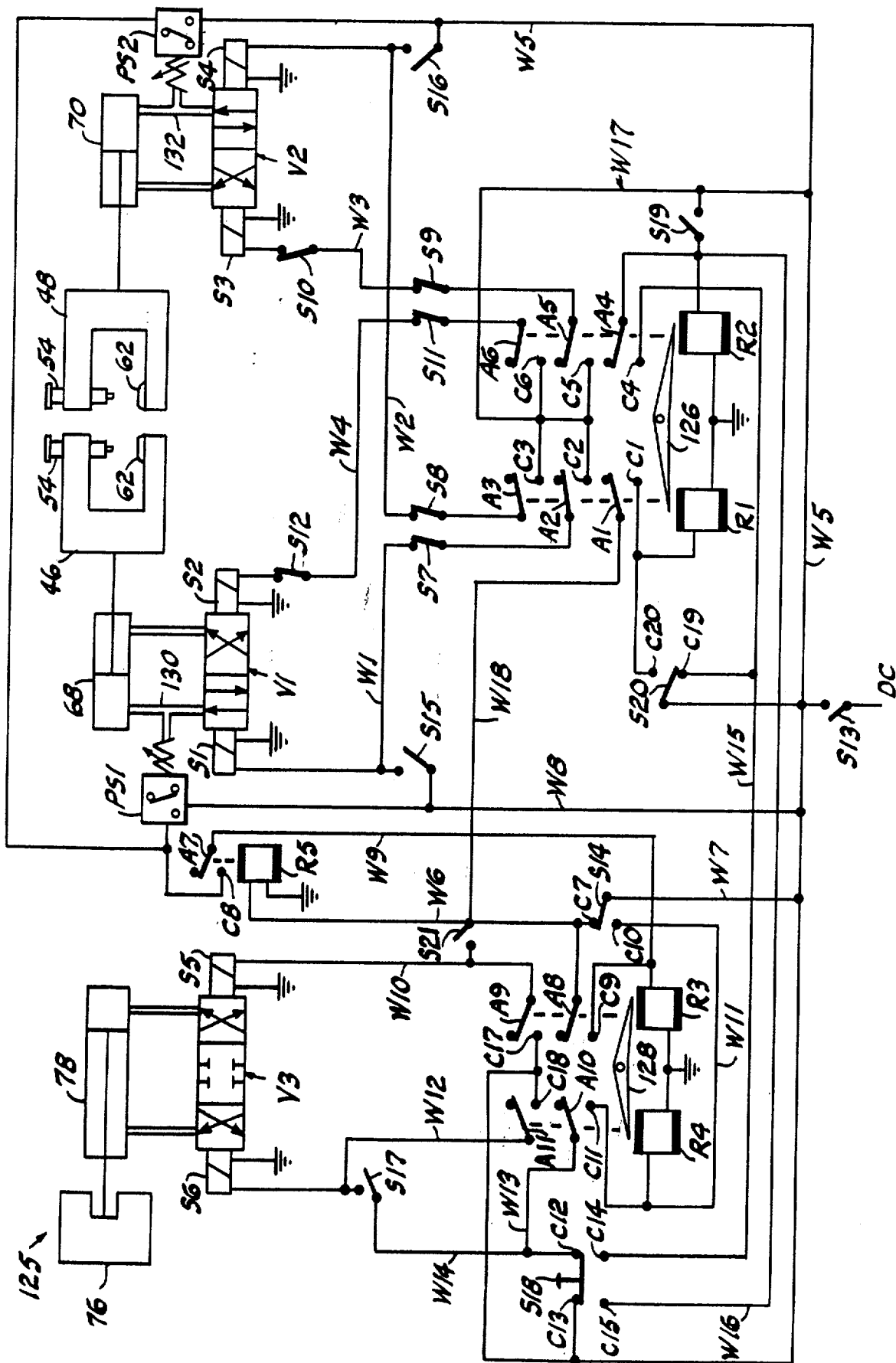


FIG. 9



STRUCTURAL STEEL PUNCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to structural steel processing machines and more particularly to a structural beam punch.

2. Description of the Prior Art

The prior art such as U.S. Pat. Nos. 1,241,254; 1,241,257 and 3,391,593 disclose punching holes in the webs of structural I-beams wherein the plane of the I-beam web is horizontally disposed in a travel path transversely intersected by the punching machine. The machines disclosed by the above patents do not disclose means for punching the vertically disposed flanges of the I-beam workpiece. In addition to punching holes in the I-beam web it is generally necessary that holes be punched or formed in the I-beam flanges. U.S. Pat. No. 3,572,204 discloses a hole forming apparatus for I-beams or H-beams which in addition to forming holes in the horizontally disposed web discloses drilling heads arranged on opposing sides of the vertically disposed beam flanges for drilling holes horizontally through the I-beam flanges. The principal objection to a machine of this type being the time element required for drilling holes in the vertical flanges as opposed to force punching holes in the flanges.

Beam punching machines presently in use for punching horizontally disposed flanges of a beam have usually comprised a frame having a C-shaped portion disposed in over and underlying relation of opposing upper and lower surfaces of the respective flange so that a punch may be forced from one tip portion of the C-frame toward the die block supported by the other tip of the C-frame. The workpiece beam must have its web vertically disposed when punching its flanges in this C-frame type punch. While this type of beam flange punching machine operates satisfactorily the principal objection to it is the necessary bulk or mass of the machine, in order to withstand necessary forces applied thereto during the punching action, precludes rotating this machine to perform a horizontal punching stroke on vertically disposed flanges of a beam.

The beam punching machine of this invention overcomes the above difficulties and objections by forming a beam punching frame which transversely intersects the travel path of a beam having its web horizontally disposed wherein punch head assembly means movable toward and away from each other on opposite sides of the plane of the beam web permit simultaneous punching of holes in a vertically disposed beam flange by a pressure head acting on punches supported by the punch head assembly.

SUMMARY OF THE INVENTION

A generally rectangular and planar frame is longitudinally disposed vertically edgewise and supported in wheel and track fashion for transverse intersecting movement of the frame with respect to the horizontal travel path of an I-beam workpiece having its web arranged in a horizontal plane supported and guided by rollers for movement through a beam admitting opening formed through the frame. Generally U-shaped punch head means is slidably supported vertically by the frame with the leg ends of the U-shapes arranged in confronting relation on opposing sides of the plane

of the I-beam web and on opposing sides of one of the I-beam flanges. Punch and die means is supported by each punch head means with the respective punch being forced toward the respective die in a beam flange punching action in response to a frame supported pressure head connected with the respective punches and horizontally movable toward and away from the I-beam flange. Control means including pressure operated cylinders and an electrical circuit initiates and completes the punching sequence.

The principle objects of this invention are to provide: a punching machine for acting on the vertically disposed flanges of a beam workpiece which will punch one or a plurality of holes with one punching stroke of the machine in accordance with a predetermined spacing between the axis of the holes being punched and the I-beam web; to punch both flanges of an I-beam workpiece and the web thereof with one pass of the beam through a horizontal travel path; semiautomatic control means initiating and completing a beam punching cycle in combination with punch positioning gauge rods contacting a preselected surface of the I-beam workpiece; and, retracting the gauge rods from contact with the I-beam surface following one punching cycle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary perspective view of the beam punching apparatus in operative position;

FIG. 2 is a fragmentary elevational view of the beam punching apparatus, to a larger scale;

FIG. 3 is a fragmentary top view of FIG. 2;

FIG. 4 is a fragmentary vertical cross-sectional view taken substantially along the line 4—4 of FIG. 1;

FIG. 5 is a fragmentary horizontal cross-sectional view taken substantially along the line 5—5 of FIG. 4;

FIG. 6 is a vertical cross-sectional view taken substantially along the line 6—6 of FIG. 2;

FIG. 7 is a fragmentary vertical cross-sectional view, partially in elevation, taken along the line 7—7 of FIG. 2;

FIG. 8 is a fragmentary vertical cross-sectional view, to a further enlarged scale, taken substantially along the line 8—8 of FIG. 2; and,

FIG. 9 is a schematic.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Like characters of reference designate like parts in those figures of the drawings in which they occur.

In the drawings:

Referring first to FIG. 1, the reference numeral 10 indicates the punching apparatus, as a whole, which is generally rectangular in overall configuration. The device 10 includes a frame 12 preferably formed from a plurality of plates assembled in laminated fashion for ease in preforming slots and apertures transversely of the frame. The frame 12 is vertically disposed edgewise and mounted by wheels or rollers 14 on tracks 16, either or both being provided with leveling screws, not shown, for horizontal movement of the frame transversely of the horizontal travel path of a workpiece to be described later.

Between its top and bottom edge surfaces 18 and 20 and toward its end surface 22, the frame 12 is provided with a generally horizontal opening 24 which communicates through a narrow portion of throat area 26 with a vertically elongated opening 28 formed intermediate

the length of the frame. The purpose of the openings 24 and 28, which are vertically substantially equal, and the throat opening 26 is to cooperatively receive loosely a range of sizes of a structural workpiece, such as an I-beam 30, with the flanges 32 and 34 of the beam being vertically disposed and extending through the frame openings 24 and 28 with the web 36 of the beam horizontally disposed and projecting through the throat opening 26. Another purpose of the throat opening 26 is to provide frame support for punch heads during a punching operation when disposed on opposing sides of and adjacent the beam web 36 as will be presently explained.

The beam 30 is normally supported in a horizontal plane forming a workpiece travel path by a beam supporting and guiding apparatus 38 having vertically adjustable rollers 40 contacting the depending surfaces of the beam web 36 with laterally disposed rollers 42 guidingly contacting the vertical face surface of the beam flanges 32 and 34 opposite the web in a substantially conventional manner. The rollers 42 are preferably spring loaded to permit a lateral movement, of the beam 30, a preselected distance during the punching action as hereinafter described. Stripper plates 43, secured to opposing sides of the frame medial the vertical length of the opening 28, project toward the beam flange 34 to prevent lateral movement of the beam beyond a predetermined limit following each flange punching action as later described.

An opening or slot 44, substantially T-shaped when viewed from the top surface 18 of the frame, extends through the frame between its top and bottom surfaces 18 and 20 and within its opposing vertical side surfaces in intersecting communicating relation with respect to the frame opening 28. A pair of punch heads 46 and 48, each U-shaped in general configuration (FIGS. 2 and 4), are slidably received for vertical movement by that portion of the slot 44 forming the stem of the T-shape with the leg members 50 and 52 of each punch head projecting toward each other in confronting relation for movement toward and away from each other. The length of the opening, formed between the surfaces of the bight portion of the U-shape of the punch heads, when the legs thereof are disposed adjacent each other in abutting relation, being such that it is not less than the vertical length of the frame opening 28 for cooperative accommodation of the beam flange 34.

Punch means comprising a punch stem 54 is slidably supported by an opening 56 formed in each punch head leg 52 for movement of each punch stem toward and away from the other leg 50 of the punch head. Each punch stem is provided with a punching mandrel 58 of a size equal to the diameter of a hole it is desired to punch in the beam flange. Each punch head leg 50 is provided with a recess 60 within which a punch die 62 is secured.

As shown more clearly in FIG. 4, between its outer surfaces, the frame 12 is provided with a slot or opening 64, at opposing upper and lower limits of the throat 26, for passage of portions or plugs punched out of the flange by the punch mandrels 58. Each of the punch stems 54 includes a substantially rectangular head or end portion 66 opposite the mandrel 58 which is slidably supported in guiding relation by the T-shaped slot 44 when the punch heads 46 and 48 are moved toward and away from each other. Punch head movement is accomplished by a pair of pressure operated cylinders

68 and 70 having their respective piston rods connected with the respective punch head 46 and 48 for positioning the punch heads and punch means at a predetermined location with respect to the beam flange 34 in the manner explained hereinbelow.

The frame is further provided with a transverse slot 72 between its top and bottom edge surfaces 18 and 20 open to its respective sides and end surface 74 opposite its end 22 and intersecting the T-shaped slot 44. The slot 72 slidably receives a hammer block or pressure head 76 for horizontal movement toward and away from the punch heads 46 and 48 by a main cylinder 78 having its piston rod 80 connected with the pressure head. The end of the pressure head 76, opposite the piston rod 80, is provided with a slot 82 cooperating with and forming a continuation of the T-shaped slot 44 bisected by the slot 72. The purpose of the T-shaped pressure head slot 82 is to cooperatively support slidably the punch stem heads 66 and move the punch stems 54 axially toward and away from the beam flange 34 in response to reciprocating movement of the pressure head in the punching action presently described.

The pressure head is drivably supported within the slot 72 by a pair of pressure head plate 84 (FIGS. 1 and 6) secured to the pressure head 76 and overlapping marginal edge surfaces defining upper and lower limits of the pressure head slot 72, as viewed in the drawings. Pressure head guides 86, having angular surfaces cooperatively contacting the plates 84, are secured to the respective opposing surfaces of the frame marginal edge portions surrounding the pressure head plates 84 and may be adjusted by screws 88 supported by back-up strips 89 for maintaining the pressure head 76 properly aligned within its slot 72 to reduce sliding friction to a minimum. Movement of the pressure head 76 toward and away from the beam 30 is controlled by limit switches S14 and S18 in the manner presently explained.

Referring also to FIGS. 7 and 8, the predetermined position of the holes to be punched in the beam flange 34 is obtained by guide rods 90 arranged in pairs on respective opposing sides of the frame for movement toward and away from the beam web 36 in response to movement of the punch heads 46 and 48. Each of the guides 90 comprises an elongated casing 92 longitudinally supported slidably by one or more bearings 94 secured to outer side surfaces of the frame. An elongated rod 96 extends into the casing 92 through a bushing 98, fixed to the casing at one end and is threadedly engaged with a spacer block 100 at its other end. The spacer block 100 is maintained longitudinally slidable within the casing 92 by a set screw 102 extending through the casing wall and entering a groove 104. A bushing 106, fixed to the inner wall of the casing, and stop 108, secured to the rod 96, insures longitudinal movement of the spacer block 100 in response to angular rotation of the rod 96. Similarly, a stop 109, secured to the rod 96 inwardly of the bearing 98, prevents removal of the rod 96 from the casing 92 in a direction opposite the web 36. The spacer block removably receives axially a finger 110 held in place by a spring urged pin and having a rounded end surface contacting the adjacent surface of the beam web 36. The rods 96 are connected together at the respective top and bottom edge surface of the frame by cross bars 112 in turn connected to the respective punch heads 46 and 48 by a shaft 114. The end of each rod 96, at its end opposite the web 36, is coaxial

ally connected with a sprocket 116 forming a pair of sprockets at the top and bottom edge surfaces of the frame having a chain 118 entrained therearound for rotating the rods 96 of the respective pairs in unison. The rods 96 are longitudinally adjusted within their respective pairs of casings 92 to extend or retract the spacer block 100 by a manually operated hand crank 120, or the like, secured to one of the sprockets 116 at respective upper and lower surfaces of the frame.

A stop 122, adjustably secured to at least two of the casings 92 on opposing sides of the beam web 36, respectively, engage limit switches S10 and S12 to stop movement of the pressure heads 46 and 48 away from each other in the manner presently described.

Referring more particularly to FIG. 9, control means for the apparatus 10 is indicated generally at 125 comprising fluid pressure control valves and an electrical circuit including relays and solenoids. A two-way two-position valve V1, connected with a source of fluid under pressure, not shown, is connected to the respective ends of the punch head operating cylinder 68. Solenoids S1 and S2 are connected with the respective ends of the valve V1 for shifting the latter. An identical valve V2, similarly connects the ends of the cylinder 70 with a source of fluid under pressure. The valve V2 is operated by solenoids S3 and S4. A two-way three-position valve V3 similarly connects a source of fluid under pressure to the main cylinder 78 and is operated by solenoids S5 and S6. A pair of three-pole relays R1 and R2 are interconnected in a conventional manner by a bar interlock 126 for initiating the punch cycle of the apparatus 10 and actuation of the cylinders 68 and 70 to move the punch head means 46 and 48. A second pair of two-pole relays R3 and R4 are similarly interconnected by a bar interlock 128 for actuating the main cylinder 78 and moving the pressure head 72 to effect the punching stroke in the manner presently explained. The interlock bar 126 permits only one of the relays R1 or R2 to be energized at a given time.

When relay R1 is energized its armature A1 completes a holding circuit to ground with its contact C1 as presently described.

Relay R1 armature A2 is connected by a wire W1 through a normally closed switch S7 to the solenoid S1 of the valve V1. Relay R1 armature A3 is connected by a wire W2 through a normally closed switch S8 to the solenoid S4 of the valve V2. Relay R2 armature A4, when closed with its contact C4, completes a holding circuit to ground for this relay as presently described.

Relay R2 armature A5 is connected by a wire W3 through series connected normally closed switches S9 and S10 to the solenoid S3 of the valve V2. Armature A6 of relay R2 is similarly connected by a wire W4 through series connected normally closed switches S11 and S12 to the solenoid S2 of the valve V1.

A source of direct current DC is connected to the circuit source wire W5 through an "off-on" switch S13. Another relay R5 has one end of its coil connected by a wire W6 to a contact C7 normally closed with a limit switch arm S14, with the other end of the switch arm S14 being connected to the source wire W5 by a wire W7. The other end of the coil of relay R5 is grounded so that when the "on-off" switch S13 is closed the coil of relay R5 is normally energized and its armature A7 is closed with its contact C8. Contact C8 of relay R5 is connected in series with one contact each of a pair of pressure switches PS1 and PS2, respectively, opera-

tively connected with and activated by fluid pressure in the tubing 130 and 132 connecting the valves V1 and V2 to the punch head operating cylinders 68 and 70. The other contact of the pressure switch PS1 is connected to the source wire W5 by a wire W8 while the other contact of the pressure switch PS2 is connected to the source wire W5. Normally open punch head moving jog switches S15 and S16 respectively connect the wires W1 and W2 to the current source.

Armature A7 of relay R5 is connected by a wire W9 to one end of the coil of relay R3 and also to relay R3 contact C9. Relay R3 armature A8 is connected to the wire W6 between relay R5 and switch S14. Armature A9 of relay R3 is connected by a wire W10 to solenoid S5 of the valve V3. Contact C10 of limit switch S14 is connected by a wire W11 to one end of the coil of relay R4 and to its contact C11. Relay R4 armature A10 completes a holding circuit to ground when closed with contact C11 for relay R4 as presently described. Relay R4 armature A11 is connected by a wire W12 to the solenoid S6 of the valve V3. The armature A10 is connected by wires W13 and W14 to a normally open pressure head jog switch S17 connected to the wire W12.

The wire W14 is also connected with a contact C12 of a limit switch S18 having other contacts C13, C14 and C15. The limit switch S18 is a four-point-two-position make and break push-button type and is normally closed with its contacts C12 and C13. The source wire W5 is connected to the Switch S18, contact C13 and to the contacts C17 and C18 of relay R4 armatures A9 and A11, respectively. The limit switch S18 contact C14 is connected with the contact C4 of relay R2 by a wire W15. The limit switch S18 contact C15 is connected to one end of the coil of relay R2 and its armature A4 by a wire W16.

The source wire W5 is connected to the relays R1 and R2 contacts C2, C3, C5 and C6 by a wire W17. A normally open switch S19 is connected between the wire W16 and wire W17 for the purposes presently explained. The source wire W5 is connected with the armature of a start switch S20 normally closed with its contact C19 connected with the wire W15. Switch S20 contact C20 is connected with contact C1 of relay R1 and with one end of the coil of relay R1. Relay R1 armature A1 is connected to the wire W6 by a wire W18 and a normally open jog pressure head switch S21 is connected between the wires W6 and W10.

OPERATION

In operation the punching apparatus 10 and beam 30 are arranged, as shown in FIG. 1. Obviously a second identical punching apparatus may be disposed in cooperative opposition on the opposite side of the beam for punching both flanges of the beam. The coil of relay R5 is energized through the switch S14, closing its armature A7 with its contact C8, in response to the manual closing of the "off-on" switch S13. Assuming the beam 30 is disposed in a predetermined position with respect to the punch assemblies, the starting switch S20 is manually closed momentarily with its contact C20 energizing the coil of relay R1. Relay R1 armature A1 then maintains a holding circuit until switch S14 is opened as presently explained. When relay R1 is energized, current is applied from its armatures A2 and A3 to the solenoids S1 and S4 of the punch head operating valves V1 and V2 thus operating the cylinders 68 and 70 and moving the punch heads 46 and 48 toward each other

within the frame. Simultaneously, the gauge rods 90 are being moved toward the I-beam web 36. When the gauge rod tips 110 contact the I-beam web the punch mandrels 58 are at a predetermined location for punching holes in the beam flange 34 and the pressure switches PS1 and PS2 close in response to a predetermined fluid pressure build-up in the cylinder supply lines 130 and 132 thus applying current from the supply wire W5 through the armature A7 of relay R5 to energize the coil of relay R3 and close its armatures. Armature A8 of relay R3 forms a holding circuit for this relay from the source to ground through the switch S14 while it remains closed with its contact C7. Closing relay R3 armature A9 with its contact C17 applies current from the source wire W5 to the solenoid S5 of the pressure head valve V3 advancing the pressure head 76 toward the I-beam so that the punch mandrels 58 penetrate the I-beam flange 34. Movement of the pressure head toward the I-beam is stopped by the opening of the punch limit switch S14 from its contact C7. Actuation of switch arm S14 is accomplished by a stop 134 (FIGS. 1 and 2) secured to the plate guide 86, which moves the switch arm S14 in response to a predetermined setting or location of the stop 134 with respect to the switch. Breaking switch S14 from its contact C7 and closing with its contact C10 de-energizes relays R1, R3 and R5 and energizes relay R4 and closes its armatures with their respective contacts with its armature A10 forming a holding circuit for maintaining relay R4 energized. Current is then supplied to solenoid S6 of the pressure head valve V3 by relay R4 armature A11 which returns, i.e., moves the pressure head outward, from the beam 30 withdrawing the punch mandrels from holes formed in the beam flange 34. Simultaneously, the arm of switch S14 makes with its contact C7 energizing relay R5 as before.

The stripper plates 43 prevent lateral movement of the beam flange 34 toward the pressure head as the punch mandrels are withdrawn. Movement of the pressure head away from the beam is interrupted by a stop 136, secured to one of the pressure plate guides 86, (FIGS. 1 and 2) contacting and opening the limit switch S18, contacts C12 and C13 and bridging its contacts C14 and C15. Opening contacts C12 and C13 interrupts current to relay R4 which, when de-energized, stops the return or withdrawal travel of the pressure head. Pressure head valve V3, then shifts to its neutral position. Switch S18, bridging its contacts C14 and C15, completes a circuit from the source wire W5 through the start switch S20 closed with its contact C19 by wires W15 and W16 to energize relay R2 which is then maintained energized by its armature A4 closed with its contact C4. Relay R2 armatures A5 and A6 energize solenoids S2 and S3 of punch head valves V1 and V2 which shifts the respective valves and moves the respective punch heads 46 and 48 outward of the frame in opposite directions until the stop 122 (FIG. 2) on the respective gauge rod 90 opens punch head out-travel limit switches S10 and S12 which deenergizes solenoids S2 and S3. Relays R2 and R5 remain energized while the beam 30 is advanced to another setting. When the arm of start switch S20 is again moved from its contact C19 to its contact C20 current to relay R2 is interrupted. This completes one cycle of operation.

In arranging the location of the apparatus 10 and beam 30 and for testing purposes the jog switches S15 and S16 may be manually closed temporarily for mov-

ing the punch heads toward each other, either simultaneously or singly. Closing switch S19, connecting wire W15 with wire W17 energizes relay R2 for moving the punch heads away from each other in a testing sequence unless the punch heads have been previously moved outwardly and opened limit switches S10 and S12. Similarly, the pressure head normally open jog switches S17 and S21 may be closed individually for moving the pressure head 76 away from or toward the I-beam, respectively.

Obviously the invention is susceptible to changes or alterations without defeating its practicability, therefore, I do not wish to be confined to the preferred embodiment shown in the drawings and described herein.

I claim:

1. An apparatus for punching the flanges of an elongated structural I-beam having its web horizontally disposed and being arranged for movement lengthwise in a horizontal travel path, comprising:

means defining a punching station including a main frame having side wall surfaces normal to the travel path and having a top and a bottom edge surface, said frame extending transversely of the travel path and having a transverse aperture characterized by an intermediate throat portion partially describing and surrounding an intermediate portion of an I-beam workpiece,

said frame having a through slot extending between its top and bottom edge surfaces and between its side wall surfaces in intersecting relation with respect to one end portion of the transverse aperture and an adjacent portion of the aperture throat;

first and second punch head means slidably supported by said frame within the through slot for vertical movement toward and away from each other in a plane normal to the travel path, said first and second punch head means comprising,

a U-shaped punch head body with the legs defining the respective U-shape projecting toward each other on opposite sides of the horizontal plane of the I-beam web and being respectively disposed on opposite sides of the I-beam flange to be punched,

one leg of each U-shaped punch head being slidably supported, against movement in the same plane in a direction away from the other leg of the respective U-shape, by that portion of the through slot intersecting the aperture throat forming portion of said frame, and a gauge rod adjustably connected to and movable with each said punch head body;

punch assembly means including a punch die supported by the end portion of the leg of each said first and second punch head means disposed adjacent the web of an I-beam workpiece,

one end of said gauge rod projecting toward the adjacent surface of an I-beam web disposed in the travel path for disposing the respective punch die a predetermined distance from a plane defining the web center of an I-beam workpiece,

said frame having a transverse slot in one end intersecting the through slot;

pressure head means slidably supported by said frame within the transverse slot for horizontal movement in a direction transverse to the travel

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path toward and away from said punch head means;
means for vertically moving said first and second punch head means toward and away from each other; and,
means for horizontally moving said pressure head means.
2. The apparatus according to claim 1 in which said punch assembly means further includes:
a punch slidably supported by said other leg of each said punch head body coaxial with respect to the respective punch die for movement toward and away from the respective said punch die in response to movement of said pressure head toward and away from the travel path.
3. The apparatus according to claim 2 in which said pressure head is provided with a T-shaped slot in its end portion facing the travel path for slidably receiving the adjacent end portion of the respective said punch and permitting movement of said punches into and out of the T-shaped slot in response to movement of said first and second punch head means toward and away from the travel path.
4. The apparatus according to claim 3 in which said vertically moving means includes:

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a pair of fluid operated cylinders respectively connected with said frame,
said pair of cylinders each having a piston respectively connected with each said punch head body.
5. The apparatus according to claim 4 in which said horizontally moving means includes:
a fluid operated main cylinder connected with said frame and having a piston connected with said pressure head opposite its T-shaped slot.
6. The apparatus according to claim 5 and further including:
control means for operating said pair of cylinders and said main cylinder in a predetermined sequence,
said control means including a plurality of solenoid operated valves individually connecting a source of fluid under pressure with each said cylinder;
an electrical circuit connecting a source of electrical energy with the solenoids of said valves; and,
a plurality of limit switches interposed in said circuit and being opened and closed by the respective direction of movement of said first and second punch head means and said pressure head means.

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