

May 2, 1967

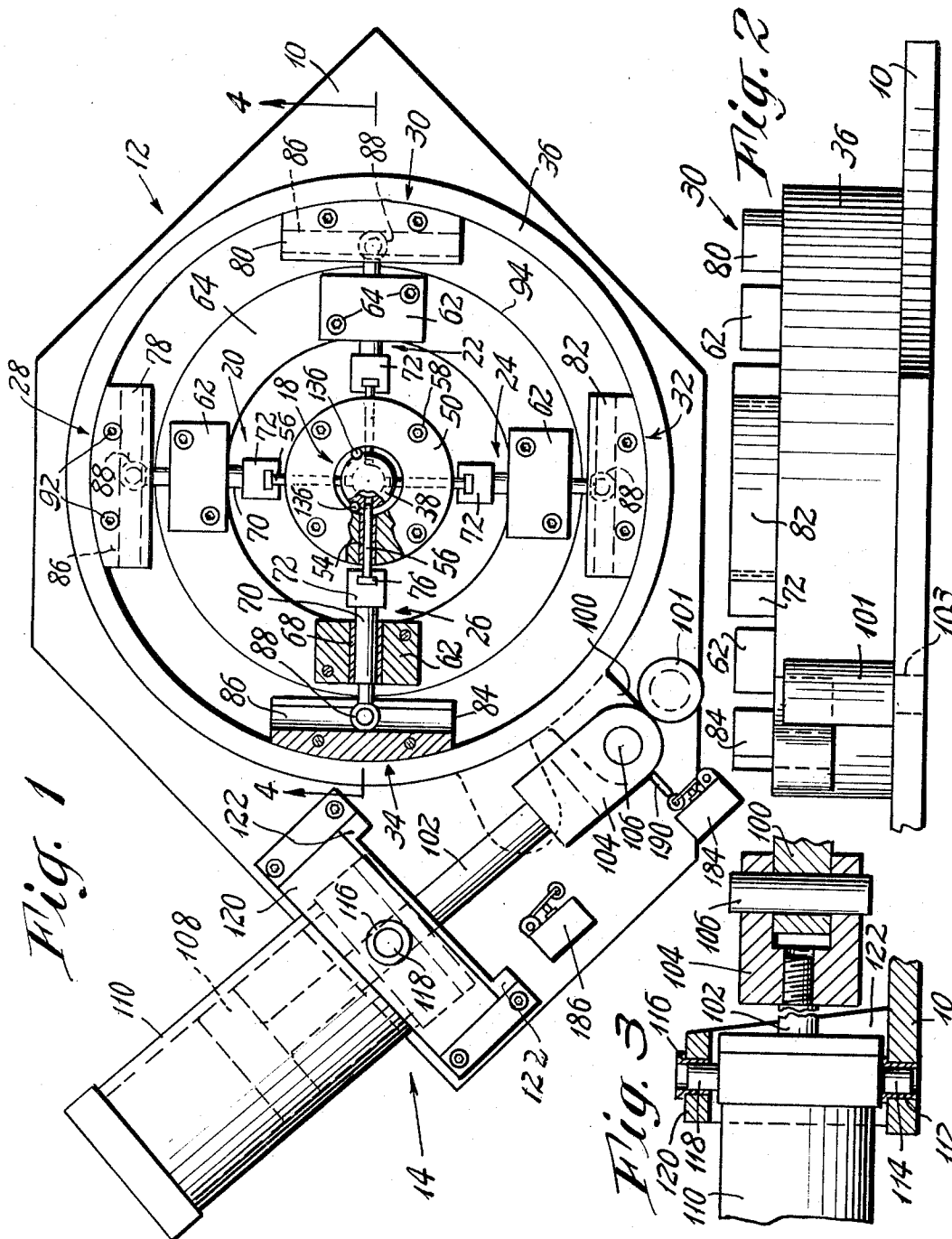
T. E. LAMBRO

3,316,787

MULTIPLE SIDE PUNCHING MACHINE

Filed Oct. 20, 1965

4 Sheets-Sheet 1



INVENTOR
Thomas E. Lambro
BY
Johnson and Kline
ATTORNEYS

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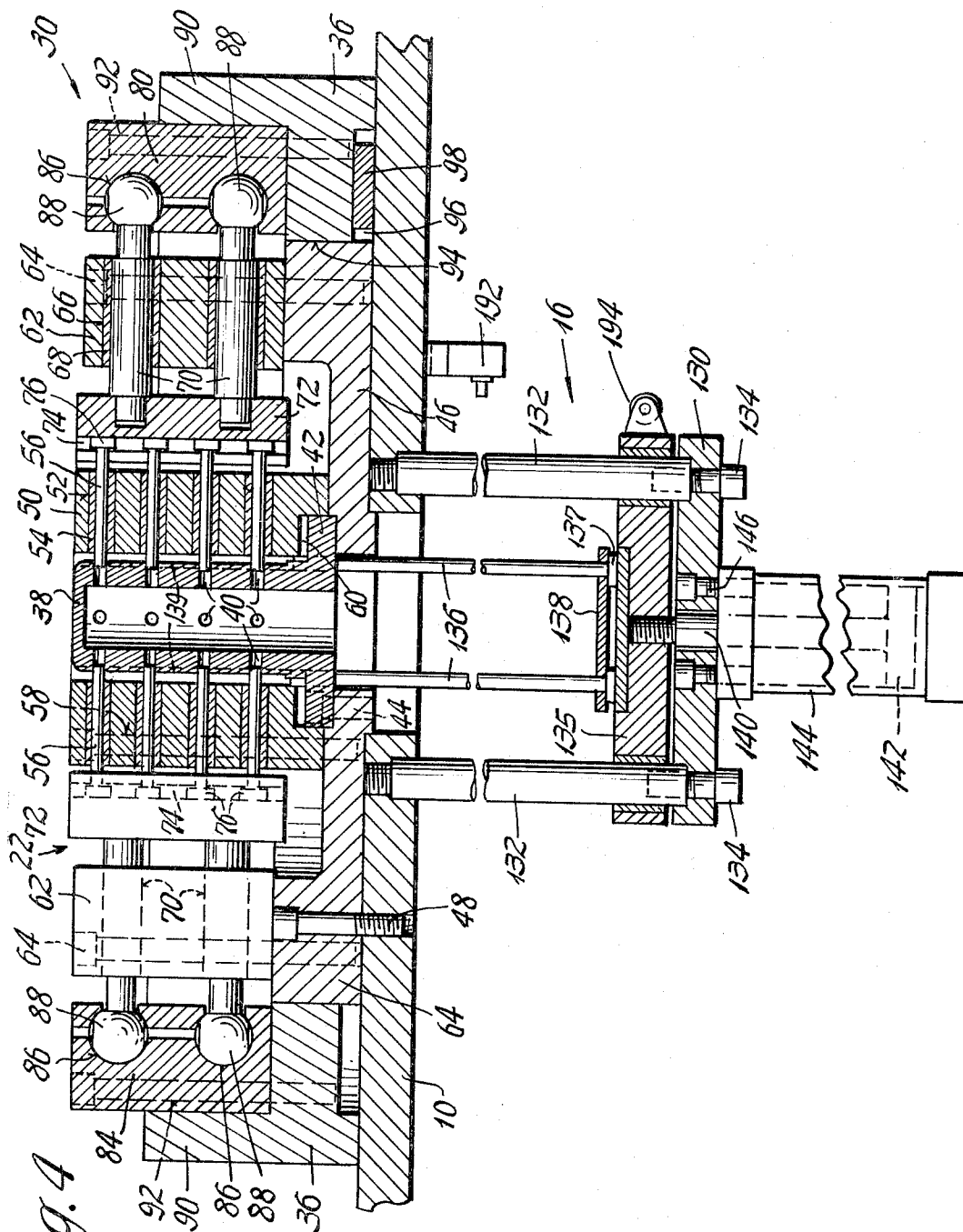
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Thomas E. Lambro

BY

Johnson and Kline
ATTORNEYS

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4 Sheets-Sheet 3

Fig. 5

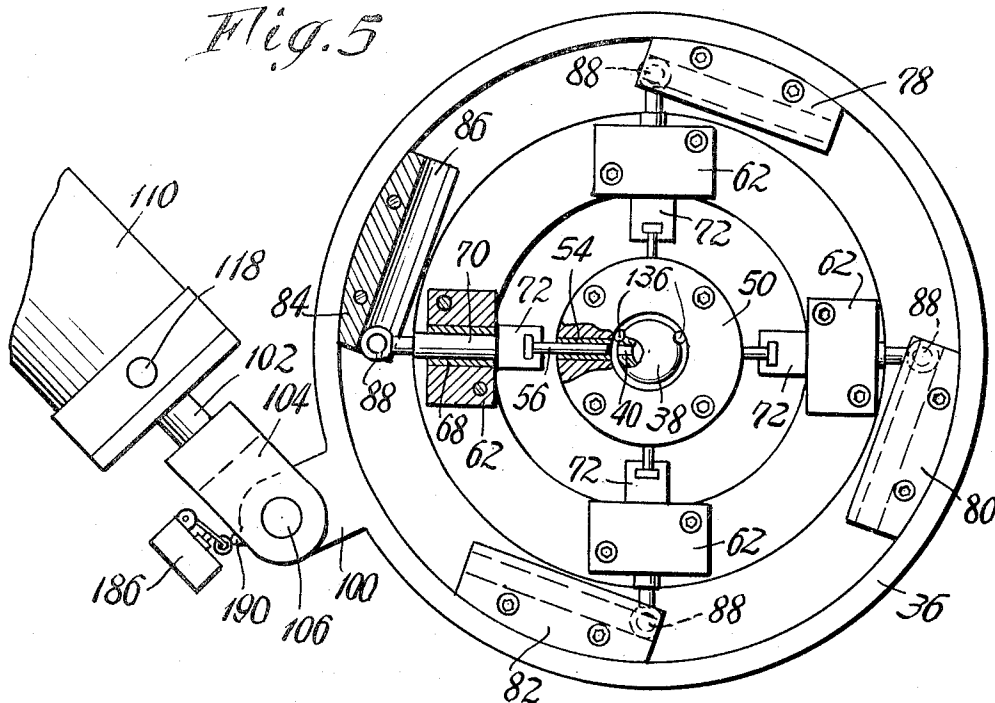
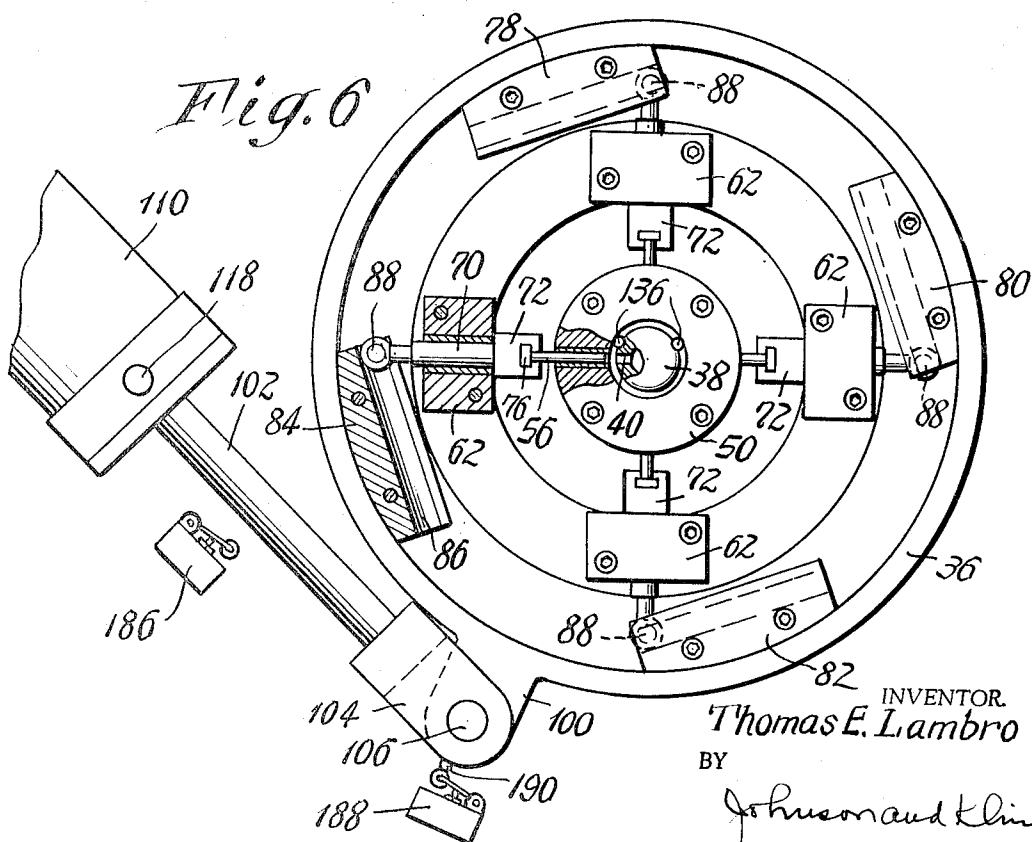


Fig. 6



INVENTOR.
Thomas E. Lambro

BY

Johnson and Kline
ATTORNEYS

May 2, 1967

T. E. LAMBRO

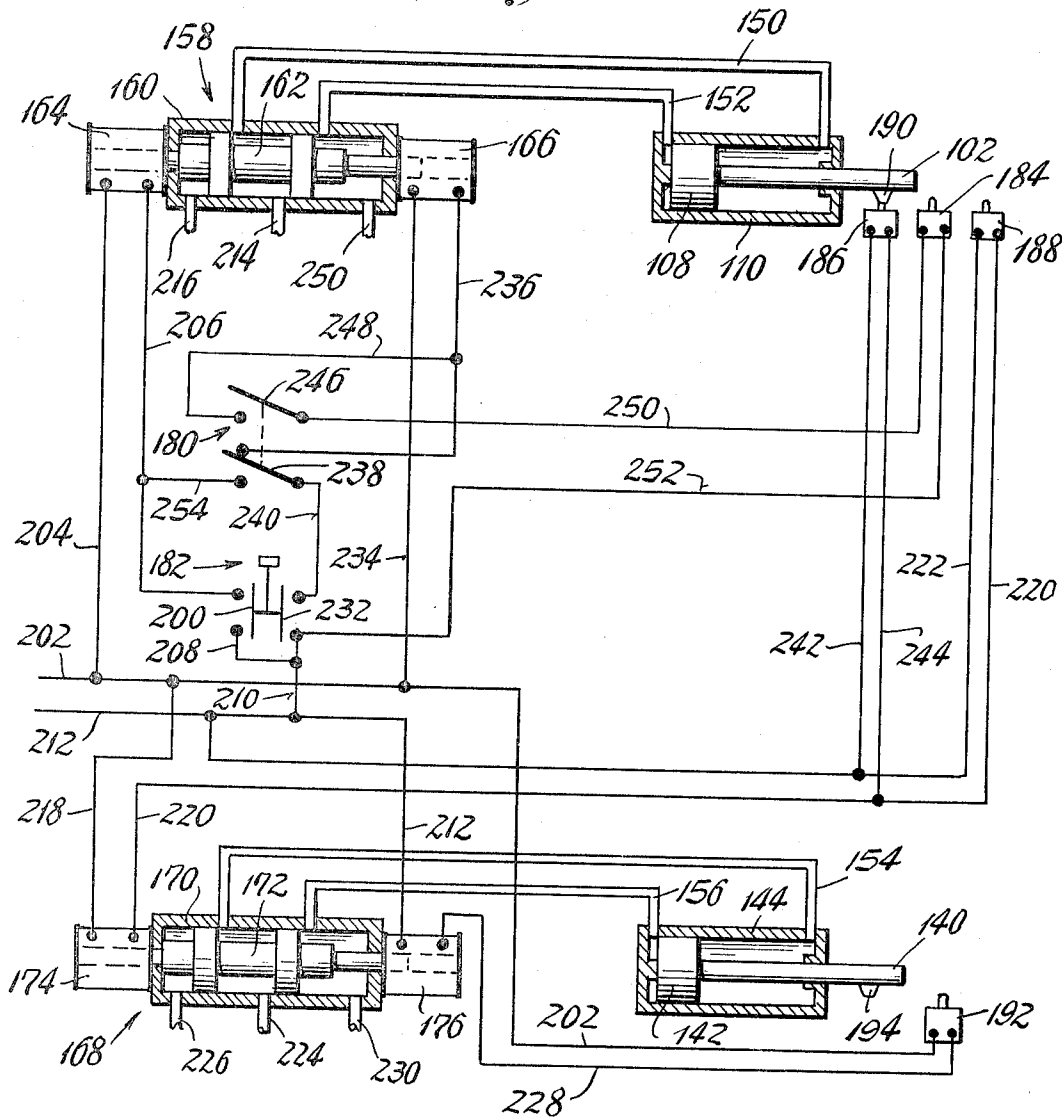
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4 Sheets-Sheet 4

Fig. 7



INVENTOR
Thomas E. Lambro
BY
Johnson and Kline
ATTORNEYS

United States Patent Office

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MULTIPLE SIDE PUNCHING MACHINE
Thomas E. Lambro, Bridgeport, Conn., assignor to
Nathan Dolberge, Bridgeport, Conn.
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4 Claims. (Cl. 83-109)

The present invention relates to apparatus for punching the side walls of tubular stock material. More particularly it relates to a machine for radially punching a short piece of tubular material.

There is a great variety of applications, such as ladies' hair curlers, sound modulators or mufflers, small burners and torches, liquid dip tubes, friction sleeves, stop collars, and others too numerous to mention, where it is expedient or necessary to perforate a piece of tubular stock material of given length and diameter with a number of circumferentially spaced apertures. These apertures may be made either as a single peripheral band, or as a plurality of circumferentially spaced rows with a plurality of axially spaced apertures in each row. For example, wide variety of ladies' home permanent hair curlers typically comprise a short tube about which the hair is wound, with a retaining means, the tube having circumferentially spaced rows of axially aligned holes to facilitate the circulation of air through the formed curl to hasten drying and setting thereof.

It will at once be appreciated that articles as mentioned above, such as hair curler mandrels, must be produced in vast quantities and at the lowest possible cost. Accordingly, production efficiency is of the utmost importance in providing a satisfactory machine for making these articles.

Techniques presently used to pierce holes around the periphery of tubular articles or parts have not been highly successful for several reasons. Firstly, in one such technique, a vertical force is transferred through cams around the part. This causes a loss in the force applied to the punching tool, and also creates difficulty in properly placing an object in relation to the punching tool since the vertical head of the punch press blocks access to the tool.

Another technique is to use individual pneumatic or hydraulic cylinders for each punching tool around the periphery of the article being punched. This considerably increases the complexity and cost of the apparatus and creates a problem of synchronizing the operation of a number of power units.

Still another technique is to index the part over a die and pierce each hole or row of holes individually at a single piercing station, this technique involving a substantially reduced production rate coupled with the necessity of an indexing mechanism for the part.

Accordingly, there is need for, and it is a principal object of this invention to provide, a machine for punching a plurality of circumferentially spaced holes or rows thereof which obviates or eliminates the difficulties and disadvantages of the foregoing presently used techniques as well as others, and which achieves in a simple and efficient manner the following more specific objects.

Another object of the present invention is to provide a machine for punching a plurality of circumferentially spaced holes or rows thereof by the conversion of a single force applied as a torque to an element of the machine into a plurality of radial forces acting on punching tools with all of the forces acting in substantially the same plane.

A further object of the present invention is to provide a machine of the character described in which the magnitude of the force applied as a torque is multiplied in the conversion of the torque to the plurality of radial forces.

Still another object of the present invention is to provide a machine of the character described in which the

2

circumferentially spaced holes or rows thereof are formed simultaneously and in response to operation of a single source of power providing a driving force.

Another object of the present invention is to provide a machine of the character described in which the radial force acting on the punching tools increases as the latter approaches a punching position and is at a substantial maximum when the greatest resistance to the punching operation is encountered.

Yet another object of the present invention is to provide a machine of the character described in which a reciprocable action is imparted to the punching means to move the latter from a withdrawn position to a punching position and back to the withdrawn position in response to a single unidirectional arcuate movement over a predetermined arc of an element of the machine to which a torque is applied.

Still another object of the present invention is to provide a machine of the character described in which the aforesaid reciprocable action is imparted to the punching means in response to a bi-directional arcuate movement over half of the aforesaid predetermined arc in order to accommodate a large number of peripherally disposed punching means.

A further object of the invention is to provide a machine of the character described which operates at a high rate of speed, is economical to manufacture and maintain, and requires a minimum amount of manipulation and skill on the part of the operator.

A feature of the present invention is the provision of means for quickly and easily detaching and removing a plurality of punching tools and a mandrel and substituting different punching tools and a different mandrel therefor, so that parts of different shape or diameter can be accommodated in the machine and also that different numbers or pattern indentations or holes or rows thereof can be punched.

Another feature is the provision of control means associated with the actuating components of the machine for controlling the amount and direction of arcuate movement required of an element of the machine in accordance with the number and/or circumferential spacing of the holes or rows thereof with which a part is to be provided.

The principles of the present invention are embodied in a machine which comprises generally a plurality of punching units disposed in peripherally spaced relationship around a holding means, each punching unit having a ram and a ram guide, with at least one punching tool connected to the radially inner end of the ram. A corresponding plurality of actuating means are disposed radially outwardly of the punching units, the actuating means having means cooperating with the rams of the punching units for moving the latter radially by radial forces in response to an arcuate movement of the actuating means through a predetermined arc. A suitable carrier on which the several actuating means are mounted is oscillated through a predetermined angle of rotation by a torque applied from a single power unit so that the actuating means are oscillated over the predetermined arc.

In a preferred arrangement and manner of operation of the machine disclosed herein, the actuating means converts the torque to radial forces by means of cams having elongate cam surfaces which lie on chords of a circle defined by the arcuate movement of the ends of the cam surfaces in their oscillation over the predetermined arc. By this arrangement the ends of the cam surfaces are disposed radially farther outward from the article holding means than the midpoints of the cam surfaces. The rams of the punching units are provided with cam followers which are constrained to continuously cooperate with the cam surfaces so that the rams are moved radially

both inwardly and outwardly in response to a single unidirectional arcuate movement of the cam elements over the predetermined arc to move the cam surfaces from one end thereof to the other across the cam followers.

Other features and advantages of the present invention will be apparent from an understanding of the following detailed description thereof when considered in conjunction with the accompanying drawings in which:

FIGURE 1 is a plan view of the machine of this invention illustrating the parts in an intermediate or punching position;

FIGS. 2 and 3 are fragmentary side elevations of the machine of FIG. 1;

FIG. 4 is a sectional view taken on the line 4—4 of FIG. 1;

FIGS. 5 and 6 are fragmentary plan views illustrating the parts in either of two limit or non-punching positions; and

FIG. 7 is a schematic and electrical diagram of the control components for operating the machine of the present invention.

Referring to FIGURES 1 through 4, the general arrangement of the punching machine comprises a frame in the form of a flat surface 10 supported by a plurality of legs (not shown). A punching component 12 is horizontally mounted on the frame 10 in position to vertically receive and eject parts to be punched, and a power unit 14 is mounted on the frame 10 adjacent the punching component 12 for actuating the latter. As seen in FIGURE 4, an ejector mechanism 16 for the parts is mounted beneath the frame 10. As actually constructed, the machine also includes various control components which are also conveniently mounted under the frame 10, these components not being shown in detail since the specific construction thereof forms no part of the invention, but are operatively diagrammatically illustrated in FIGURE 7 and described hereinbelow.

The article punching component 12 is constructed and arranged to have the various operating parts thereof disposed radially with respect to a central article receiving and holding means 18. A plurality of punching units 20, 22, 24 and 26 are disposed around the holding means 18 in peripherally spaced relationship, and radially outwardly therefrom there is a corresponding number of actuating means 28, 30, 32 and 34. The actuating means 28, 30, 32 and 34 are fixedly mounted on a suitable carrier 36 which is oscillated over a predetermined arc by the power unit 14 in order to convert a torque applied to the carrier into a plurality of radial forces acting on each of the punching units 20, 22, 24 and 26 to effect radial movement of punching tools respectively connected thereto in a manner more fully explained below.

It is to be understood that the number and arrangement of punching units and actuating means disclosed herein is for illustrative purposes only, since it is within the scope of the invention to place as many punching units as may be desired around the holding means, and to peripherally space them in any desired manner whether equi-distant or otherwise. It is also within the scope of the invention to offset the path of movement of, and the direction of force to, the punching units so that the article is punched with a hole the axis of which is on a chord of the article rather than on the diameter thereof, assuming the article is other than rectangular in cross-section.

It should further be understood that the machine of this invention may be used with only a single punching unit to punch either one aperture in a blank or a single row of apertures extending axially of the blank.

Referring to FIGURE 4, the article holding means 18 comprises an elongate hollow mandrel 38 for supporting the article to be pierced, the mandrel having a plurality of apertures 40 through the wall thereof for cooperation with a plurality of punches, and a bottom outwardly projecting annular flange 42 through which the mandrel 38

is removably connected, as by screws 44, to a die set ring 46 which in turn is connected by bolts 48 to the frame 10 adjacent the outer edge of the die set ring 46. The mandrel 38 is shaped to be in accordance with the configuration of the article to be punched, and the location and arrangement of the holes 40 will be in accordance with the hole pattern which is to be provided on the article being punched.

Each of the punching units is identical in construction, and comprises an annular punch block 50 having a plurality of peripherally spaced rows of spaced apart stacked bores 52, each bore being provided with a bushing 54 in which a suitable punch 56 is adapted to move. The punch block 50 is removably secured to the die set ring 46 by bolts 58, and is provided with a counterbore 60 adapted to overlie the flange 42 of the mandrel 38.

Each punch unit further comprises a ram guide 62 secured adjacent the outer edge of the die set ring 46 by means of bolts 64. Each ram guide includes at least one, and preferably two, radially extending bores 66 provided with bushings 68 which slidably receive rams 70. The rams are connected at their inner ends to a ram head 72, the latter being provided with a vertically extending T-shaped slot 74 which is open toward the inner face of the ram head and also open at the top, and which receives in driving relationship a corresponding T-shaped head 76 provided on the outer end of each punch 56. Thus, as the rams 70 are radially reciprocated by means hereinafter described, the punches 56 are radially reciprocated through the T-slot connection. The T-slot connection also facilitates ready removal and replacement of the entire punch block 50 with a different set of punches 56.

The rams 70 are radially reciprocated by the actuating means 28, 30, 32 and 34 which, in one of the preferred embodiments of the invention, comprise ram actuators in the form of cams 78, 80, 82 and 84 which cooperate with the rams to impart radial movement to the latter in response to an arcuate movement over a predetermined arc of the ram actuators. As best seen in FIGURES 1 and 4, the cam 80, all the cams being identical, is constructed as a substantially rectangular block having at least one, and preferably two, elongate slots 86 which are substantially keyhole shape in cross section and which constitute cam surfaces, the slots being suitably contoured to receive a substantially spherically shaped element 88 formed on the outer end of each ram 70, the elements 88 constituting cam followers. The mating contours of the cam surfaces 86 and the cam followers 88 are not significant except to the extent that there must be a smooth sliding fit between the two and that the shape thereof is such that the rams 70 are moved both inwardly and outwardly in response to arcuate movement of the cam 80.

The several cams 78 through 84 are oscillated by means of the aforementioned carrier 36, and are secured thereto by the screws 92. The carrier has an annular upstanding flange 90 which provide additional support for the cams to relieve the high shearing or bending force imposed on the screws by the resistance to deformation of the article being punched. The carrier 36 has an inner annular edge 94 which cooperates in sliding engagement with the outer annular edge 96 of the die set ring 46, and a plurality of bearing blocks 98 are provided upon which the carrier 36 rests and slides.

As best seen in FIGURES 1 and 3, the carrier 36 is provided with a lug 100 to which a piston shaft 102 is pivotally connected by means of a clevis 104 and pin 106. Piston shaft 102 is fixedly connected to a piston head 108 which reciprocates in a cylinder 110, the latter being pivotally connected to the frame 10 by means of a bushing 112 in which a pin 114 connected to the cylinder rotates, and another bushing 116 within which another pin 118 connected to the cylinder rotates, the bushing 116 being fastened to the upper cross bar 120 of a U-shaped bracket 122 secured to the frame 10. From the foregoing it is seen that reciprocation of the piston head 108

within the cylinder 110, by means hereinafter described, imparts oscillatory movement to the carrier 36 and corresponding oscillatory movement of the several cams 78 through 84 over a predetermined arc which is coordinated with the length of the cams in a manner now to be described.

The machine of the present invention is readily adaptable to operation in two different manners in accordance with the pattern of punching or piercing being performed. In a preferred manner of operation, and the arrangement of certain components in accordance therewith, the carrier 36 and the actuating cams are driven by the piston 108 in a unidirectional movement to effect one complete reciprocation of the punches 56 from a withdrawn position to a punching position and back to the withdrawn position.

The cam surfaces 86, as seen in FIGURES 1, 5 and 6, are formed to be rectilinear and are disposed in alignment with chords of a circle defined by the arcuate movement of the ends of the cam surfaces in their oscillation over a predetermined arc. Therefore, the cam surfaces 86 are disposed gradually closer to the axis of the mandrel 38 from either outer end of the cam surfaces toward the midpoints thereof. Thus, as the carrier 36 rotates from one end position shown in FIG. 5 toward the intermediate position shown in FIG. 1, the cam followers 88 and rams 70 are moved radially inwardly to effect a punching operation.

The cams are disposed on the carrier in such position that the cam surfaces are perpendicular to the axes of the rams, when the cam surfaces are bisected by the axes of the rams, and this occurs when the rams are in their radially innermost position. Thus the arrangement is such that the force transmitted from the cams to the cam followers is increased as the rams and punches approach punching position, since the force acting on the rams is gradually shifted from a radially acting component to a total force acting axially on the rams. This force reaches a maximum when the cam surfaces are perpendicular to the axes of the rams.

It will now be understood that the extent of radial movement of the rams and punches is determined by the difference in radial distance from the axis of the mandrel to the midpoints of the cam surfaces and the ends thereof respectively.

As the carrier 36 continues to rotate in the same direction and moves the cams from the punching position of FIG. 1 toward the other end position shown in FIG. 6, the rams 70 are moved radially outwardly to withdraw the punches by the action of the keyhole slot cam surfaces 86 on the opposite surfaces of the spherical cam followers 88. The rams and punches are fully withdrawn when the cams are moved sufficiently far to dispose the other ends thereof in engagement with the followers 88. It is now apparent that the rams and punches are moved both radially inwardly and outwardly to punch and withdraw in response to a single, uninterrupted unidirectional movement of the carrier 36. A reverse movement of the carrier 36 from the position shown in FIG. 6 to that of FIG. 5 will effect another complete punching operation.

The foregoing arrangement of the cams and mode of operation thereof has the advantage of high speed because of the unidirectional movement of the carrier 36 to effect a complete punching operation. There may be occasions, however, where it is desired to punch or pierce a greater number of rows of indentations or holes than is possible with the foregoing construction.

To accomplish this result, the cams 78-84 are replaced with similar cams which constitute only one-half the length of the cams shown in the drawings. These half length cams are disposed on the carrier 36 in a position corresponding to that now occupied by either half of the cams shown, that is, from either end to the midpoint thereof. Thus, the short cam surfaces would lie on the same chords as now defined by the cam surfaces 86 of

cams 78-84, but they would extend only from one of the radial outer ends of the cam surfaces 86 to the midpoints thereof, which would be the radial inner end of the short cam surfaces. This end of the short cam, and surfaces 5 intersects with the axis of the rams when the cams are positioned to cause the rams and punches to be in their radially innermost position. Also, as was the case with the full length cams 78-84, the short cams are positioned so that the cam surfaces are perpendicular to the axis 10 of the rams where the rams and punches are in their full punching position. It is now apparent that with cams of this nature, more punching units may be disposed peripherally around the mandrel. This is possible with the long cams shown in the drawings.

In order to effect a complete punching operation with the short cam construction, it is necessary to move the carrier 36 in opposite directions and only one-half the distance in each direction than was necessary with the long cams 78-84. Although it makes no difference 20 functionally from which end position the carrier 36 commences its movement for the punching stroke and to which it returns for the withdrawing stroke, the operating and control components hereinafter described are arranged to cause the carrier to commence movement 25 from the FIG. 5 position and to return to that position to effect a complete punching cycle.

At the end of each punching cycle, regardless of which of the above described modes of operation is utilized, the ejector mechanism 16 is operated by means hereinafter described to eject the part from the mandrel 38 and the punching units. Referring to FIG. 4, the ejector 16 comprises a support plate 130 mounted under the table 10 by means of bolts 132 which are threadedly engaged with the table 10 and to which the plate 130 is secured 35 by screw 134. The bolts 132 form guide rods for guiding a ram plate 135 for vertical reciprocatory movement, the ram plate 135 removably carrying a plurality of spaced ejector pins 136 having heads 137 captured between a plate 138 which is screwed to the ram plate 40 135. The pins 136 pass through elongate slots 139 formed in the side wall of the mandrel so that the pins 136 underlie the bottom of the part being punched, thereby eliminating any tendency for the pins to slip over the outer wall of a thin part and fail to eject it.

The ram plate 135 is driven by a piston rod 140 45 threadedly engaged with the ram plate, the piston rod being connected to a piston 142 reciprocably mounted within an air cylinder 144. The cylinder is connected to the support plate 130 by screws 146. The part is 50 ejected from the mandrel by operation of the piston 142 to raise the ejector pins 136, the piston being operated in both directions in timed sequence with operation of the carrier 36 by control components hereinafter described.

An understanding of the control components and the modes of operation of the machine above described will be obtained from a consideration of FIG. 7. The carrier drive piston 108 and its cylinder 110, and the ejector mechanism piston 142 and its cylinder 144 are both shown schematically. The piston 108 is reciprocated by air from lines 150 and 152 by alternately delivering air to one side of the cylinder 110 through one line and simultaneously venting the other side of the cylinder through the other line. The piston 142 is reciprocated 65 in the cylinder 144 in the same manner by means of air lines 154 and 156.

The flow of air in lines 150 and 152 is controlled preferably by a four-way spool valve 158 having a cylinder 160 in which a spool 162 is reciprocated by solenoids 164 and 166, the spool selectively controlling the flow of air in the lines 150 and 152 in known manner.

The flow of air in lines 154 and 156 is controlled by another spool valve 168 which is substantially identical to the valve 158, having a cylinder 170, spool 172 and solenoids 174 and 176 for operating the spool.

A manual control switch 180 is operative to control the electrical circuits and components for operation of the carrier 36 either in unidirectional full stroke manner or in bidirectional half-stroke manner to effect a complete punching operation. An impulse type start switch 182 of known construction is provided for actuating the solenoids 164 and 166, and an impulse type normally open limit switch 184 (FIGS. 1 and 7) also controls the solenoid 166 when the control switch 180 is set for bidirectional half-stroke operation of the carrier.

A pair of normally open impulse type limit switches 186 and 188 are provided at the limits of the stroke of the piston rod 102 (FIGS. 6 and 7) and are actuated by a suitable actuator 190 to control the solenoid 174 on the ejector spool valve 168. The other solenoid 176 is controlled by a normally open limit switch 192 disposed under the table 10 as seen in FIG. 4 in the path of movement of an actuator 194 carried by a part of the ejector mechanism.

A complete cycle of operation of the machine is as follows: Commencing with the carrier 36 and cams as shown in FIG. 5, depression of the start switch 182 momentarily moves blade 200 to the left to complete a circuit to the solenoid 164 through supply lead 202, lead 204, through the solenoid winding, lead 206, blade 200, lead 208 and lead 210 to the other supply lead 212. Energization of the solenoid 164 shifts the spool 162 to the right, whereupon air enters through inlet port 214 and flows through line 152 and into the left side of the cylinder 110 to drive the piston 108 toward the right, while simultaneously venting the right side of the cylinder 110 through line 150 and exhaust port 216 of the valve 158. This rotates the carrier 36 in a counter-clockwise direction from the position shown in FIG. 5 to that of FIG. 6, thereby effecting a complete punching and withdrawing operation of the punching units as above described.

At the end of the stroke of piston 108 and shaft 102, the actuator 190 momentarily closes the impulse switch 188 to complete a circuit to the solenoid 174 of the ejector valve 168 through supply lead 202, lead 218, through the solenoid winding, lead 220, switch 188, and lead 222 back to the other supply lead 212. Energization of the solenoid 174 shifts the spool 172 toward the right permitting air to flow through the inlet port 224, and line 156 into the left side of the cylinder 144, simultaneously venting the other side of the cylinder through line 154 and exhaust port 226 of the cylinder 170. This drives the ejector pins 136 upwardly and forces the punched article off of the mandrel 38.

When the ejector piston 140 reaches the end of its stroke, the actuator 194 momentarily closes the switch 192, which need not be of the impulse type, to complete a circuit to the solenoid 176 through supply lead 212, the solenoid winding, lead 228, switch 192 and supply lead 202. Energization of the solenoid 176 shifts the spool 172 toward the left whereupon air flows from the inlet port 224 through line 154 to the right side of the cylinder 144, the other side of the cylinder now being vented through line 156 and exhaust port 230. Thus the ejector mechanism is returned to its original position and another part may be placed upon the mandrel for punching.

When the start switch is again actuated, the blade 232 momentarily moves to the right to complete a circuit to the solenoid 166 through supply lead 202, lead 234, the solenoid winding, lead 236, blade 238 of control switch 180, lead 240, blade 232 and lead 210 to the other supply lead 212. Energization of the solenoid 166 shifts the spool 162 back to the left whereupon air flows through line 150 into the right side of the cylinder 110, the other side of the cylinder being vented through line 152 and exhaust port 250. This drives the carrier 36 in a clockwise direction from the FIG. 6 position back to the FIG. 5 position to effect another complete

punching and withdrawing operation of the punching units.

At the end of the return stroke of the piston rod 102, the actuator 190 momentarily closes the impulse switch 186 to complete a circuit to the solenoid 174 of the ejector mechanism since the switch 186 is connected in parallel with the switch 188 through leads 242 and 244. Energization of the solenoid 174 causes another cycle of operation of the ejector mechanism as above described.

When it is desired to operate the machine in the bidirectional half-stroke manner with short cams, the control switch 180 is set so that the double throw blade 238 and a single throw blade 246 are in a horizontal position. In this position, the start switch 182 actuates only the left solenoid 164 of the valve 158 regardless of which way the switch 182 moves, the right solenoid 166 now being actuated by the limit switch 184 which has been brought into circuit by the control switch 180.

Thus, when the blade 200 of the start switch 182 makes contact, the solenoid 164 is energized through the same circuit traced above, and the spool 162 shifts and the piston rod 102 move toward the right. Now, however, when the actuator 190 closes the switch 184, a circuit is completed to the solenoid 166 through supply lead 202, lead 234, the solenoid winding, lead 236, lead 248, blade 246 of the control switch 180, lead 250, switch 184, lead 252 and lead 210 to the other supply lead 212. Energization of the solenoid 166 shifts the spool back to the left which immediately reverses the flow of air to return the piston 108 and the carrier 36 to its starting position. At that moment the switch 186 is momentarily closed to energize the solenoid 174 of the ejector valve 168 to actuate a cycle of the ejector mechanism as described above.

It will be noted from FIG. 1 that a stop 101 is removably mounted on the frame 10, the stop shown being a large headed bolt which is received in an aperture 103 in the frame 10 and preferably threaded therein. The stop 101 abruptly arrests movement of the carrier 36 in the desired position when short length cams are being utilized, it being understood for this description that the stop 101 is removed when the long cams shown in FIG. 1 are being utilized for punching.

When the start switch is again operated to effect another punching cycle, the blade 232 momentarily closes a circuit to the left solenoid 164 of the valve 158 through supply lead 202, lead 204, the solenoid winding, lead 206, lead 254, blade 238 of the control switch 180, lead 240, blade 232 and lead 210 to the other supply lead 212. The solenoid 164 is again energized to commence another bi-directional cycle of operation of the carrier 36.

It is apparent from the foregoing that there is provided a multiple side punching machine which achieves the foregoing objects and avoids the disadvantages of prior art machines. It is to be understood that the invention is not to be considered as limited to the specific construction and modes of operation described hereinabove and shown in the accompanying drawings, which are merely illustrative of the principles of the invention and which are susceptible to variation of form, size, detail and arrangement of parts, the invention being intended to cover all such variations and modifications thereof as may be deemed to be within the scope of the appended claims.

What I claim is:

1. A machine for multiple side punching of tubular blanks comprising:

- (A) a frame,
- (B) means on said frame for supporting tubular blanks,
- (C) a plurality of angularly spaced punching units disposed around said supporting means, each punching unit comprising

- (1) radially acting punching means disposed adjacent said blank supporting means,
- (2) a ram disposed radially with respect to said

supporting means for actuating said punching means, and

- (3) a ram guide secured to said frame for supporting and guiding said ram for reciprocable movement,

(D) an annular carrier rotatably supported on said frame,

(E) means for oscillating said carrier through a predetermined angle of rotation between spaced apart limit positions,

(F) cam means interconnecting said carrier and said plurality of rams in continuous driving relationship throughout the extent of movement of said carrier between said limit positions for simultaneously forcibly driving said rams both inwardly and outwardly in response to oscillatory movement of said carrier between said limit positions,

(G) ejecting means mounted on said frame adjacent said supporting means for ejecting a blank therefrom, and

(H) means responsive to the arrival of said carrier in one of said limit positions for actuating said ejecting means upon completion of a radially outward movement of said rams.

2. A machine as set forth in claim 1 wherein said cam means comprises cam follower means carried by the outer end of each ram, and a corresponding plurality of substantially elongate block-like cam members each having radially spaced inner and outer rectilinear cam surfaces which cooperate with opposed surfaces of said cam follower means on said rams.

3. A machine for multiple side punching of tubular blanks comprising:

(A) a frame,

(B) means on said frame for supporting tubular blanks,

(C) a plurality of angularly spaced punching units disposed around said supporting means, each punching unit comprising

(1) radially acting punching means disposed adjacent said blank supporting means,

(2) a ram disposed radially with respect to said supporting means for actuating said punching means, and

(3) a ram guide secured to said frame for supporting and guiding said ram for reciprocable movement,

(D) an annular carrier rotatably supported on said frame,

(E) means for oscillating said carrier through a predetermined angle of rotation between spaced apart limit positions, and

(F) cam means interconnecting said carrier and said plurality of rams in driving relationship for simultaneously reciprocating said rams in response to oscillatory movement of said carrier between said limit positions, said cam means including

(1) cam follower means on the outer end of each ram,

(2) a plurality of substantially identical elongate block-like cam members each having a rectilinear cam surface of sufficient length so as to be in engagement with said cam follower means throughout the extent of movement of said carrier, and

(3) means for removably and rigidly securing said cam members to said carrier in a plurality of angularly spaced positions thereon whereby said cam members are interchangeable with each other and may be positioned on said carrier in accordance with a plurality of punching patterns.

4. A machine as set forth in claim 3 wherein said cam members have radially spaced inner and outer rectilinear cam surfaces which cooperate with opposed surfaces of the cam follower means on said rams to forcibly drive the latter inwardly and outwardly as said cam members are moved by said carrier.

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WILLIAM W. DYER, JR., *Primary Examiner.*

J. M. MEISTER, *Assistant Examiner.*