

Nov. 10, 1970

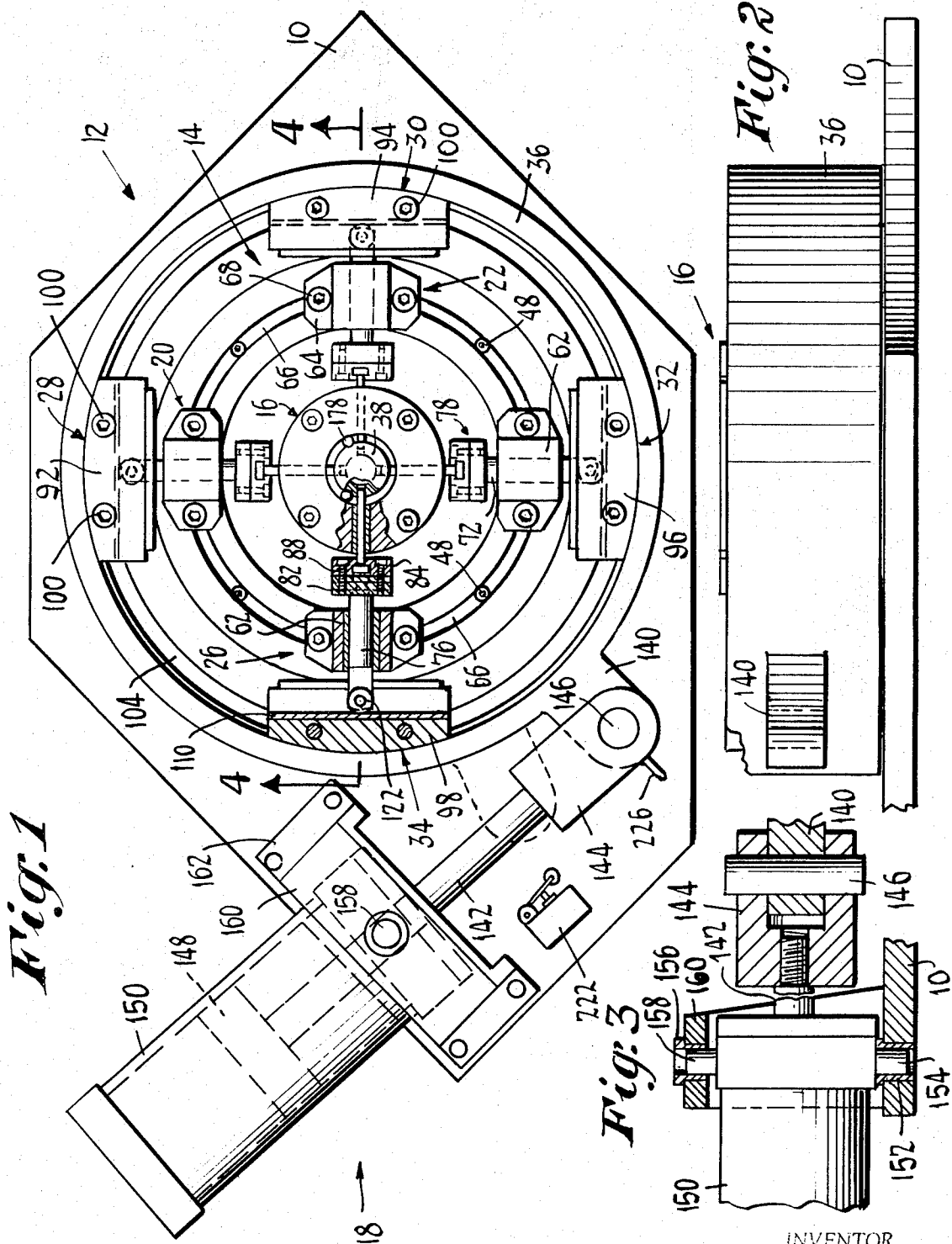
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3,538,735

MULTIPLE SIDE PUNCHING MACHINE

Filed April 27, 1967

4 Sheets-Sheet 1



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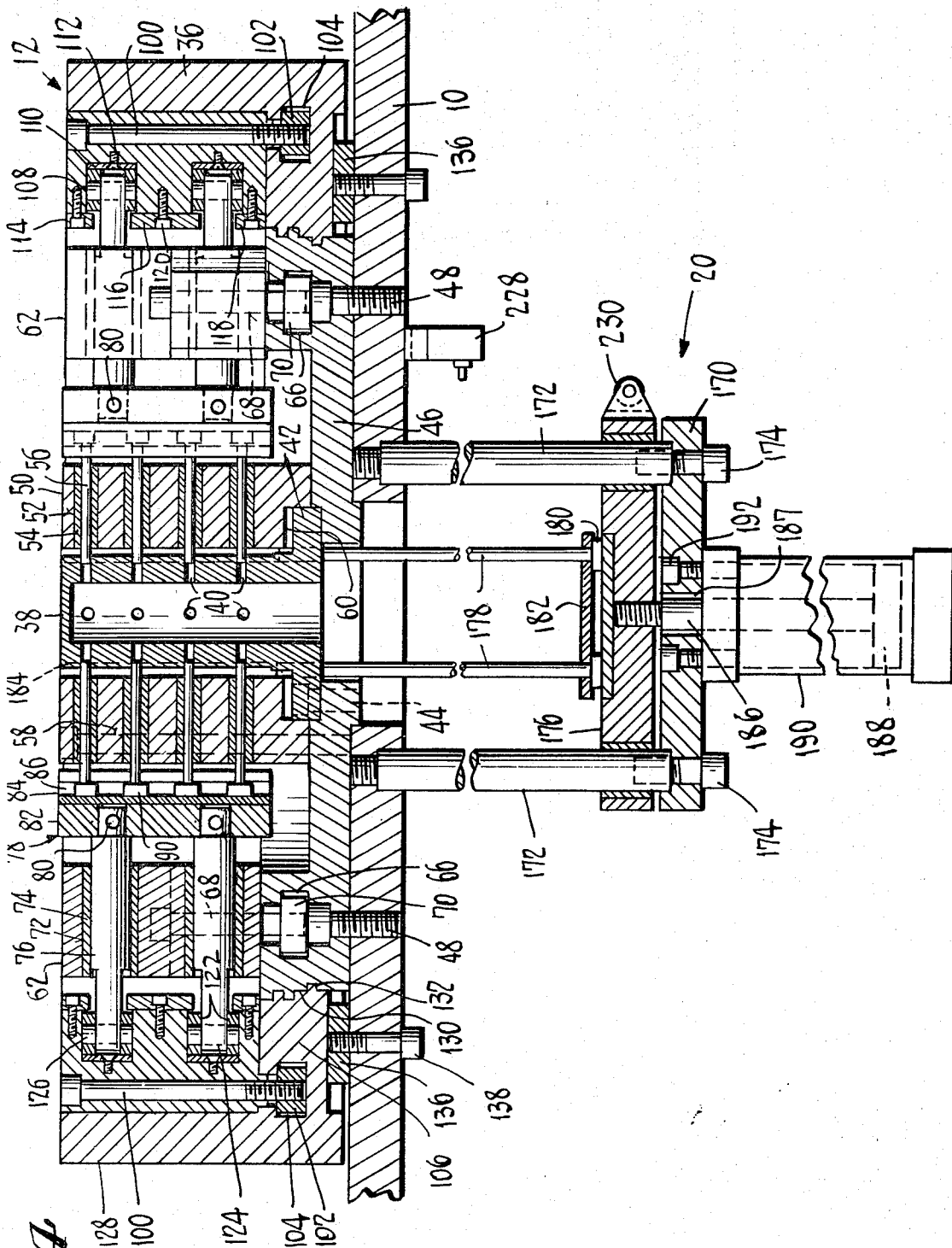
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4 Sheets-Sheet 2



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Fig. 5

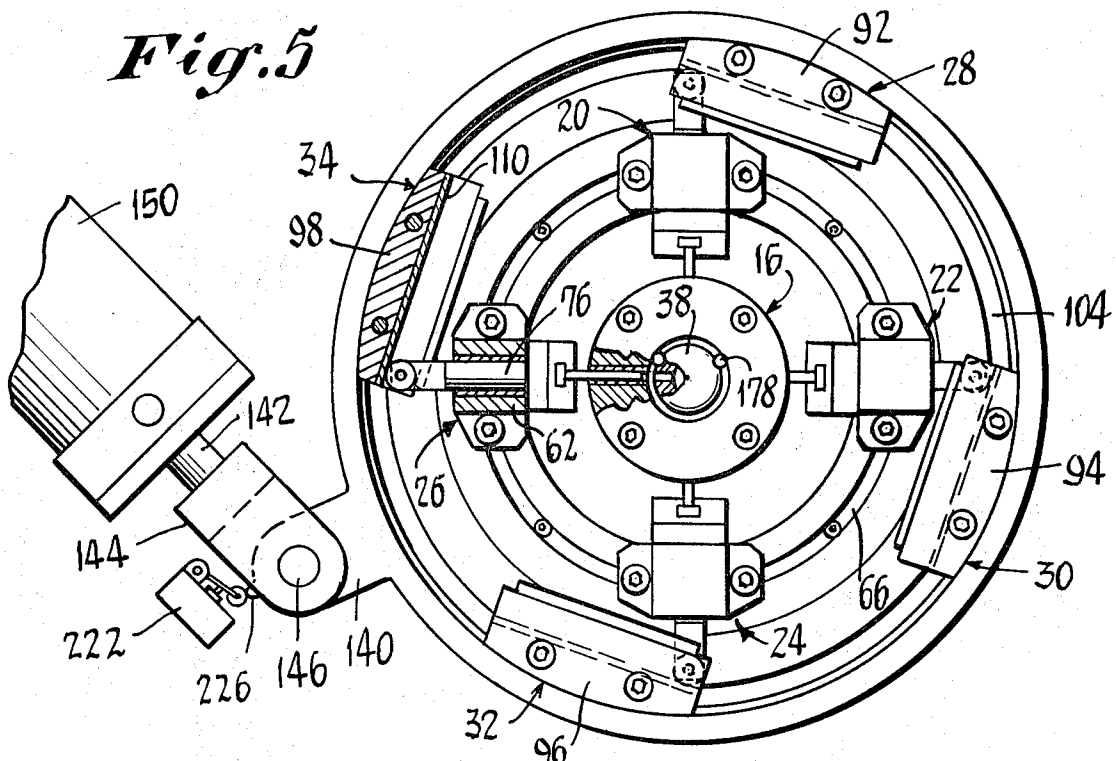
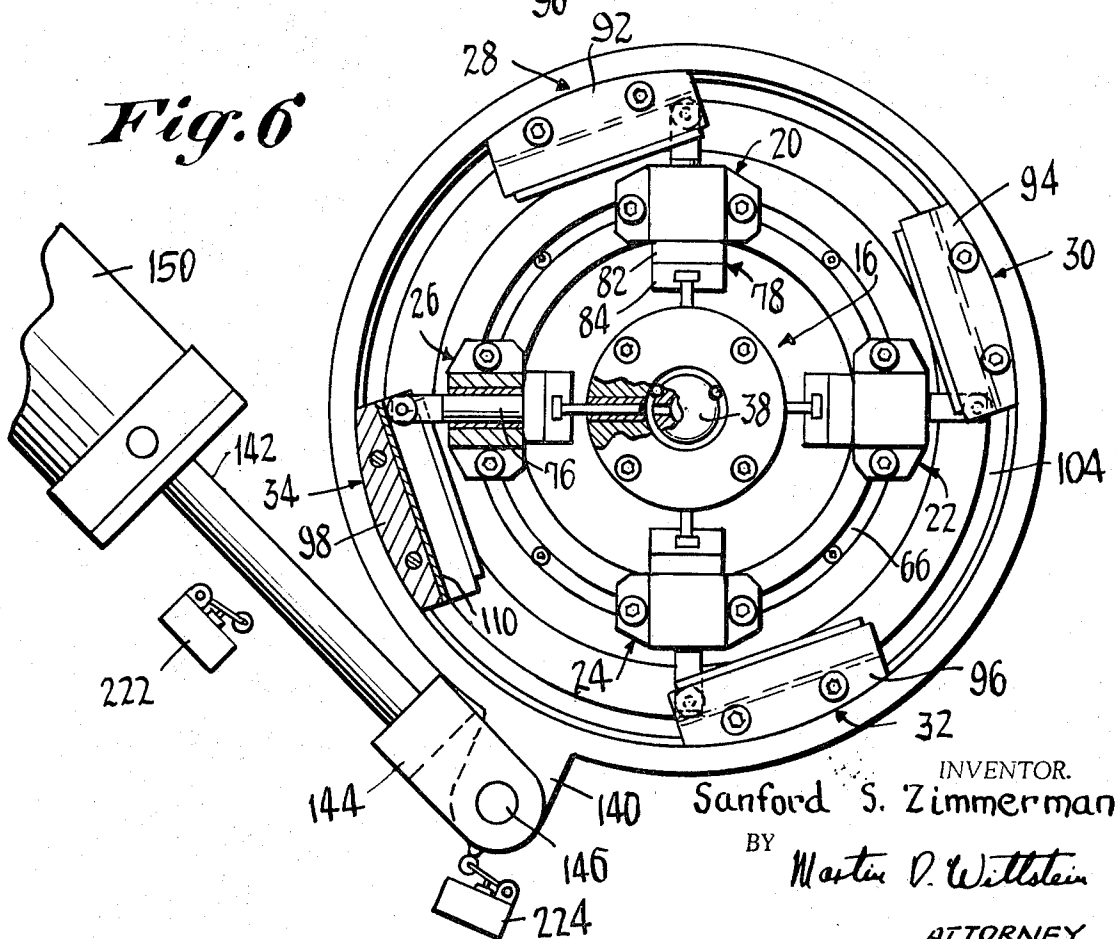


Fig. 6



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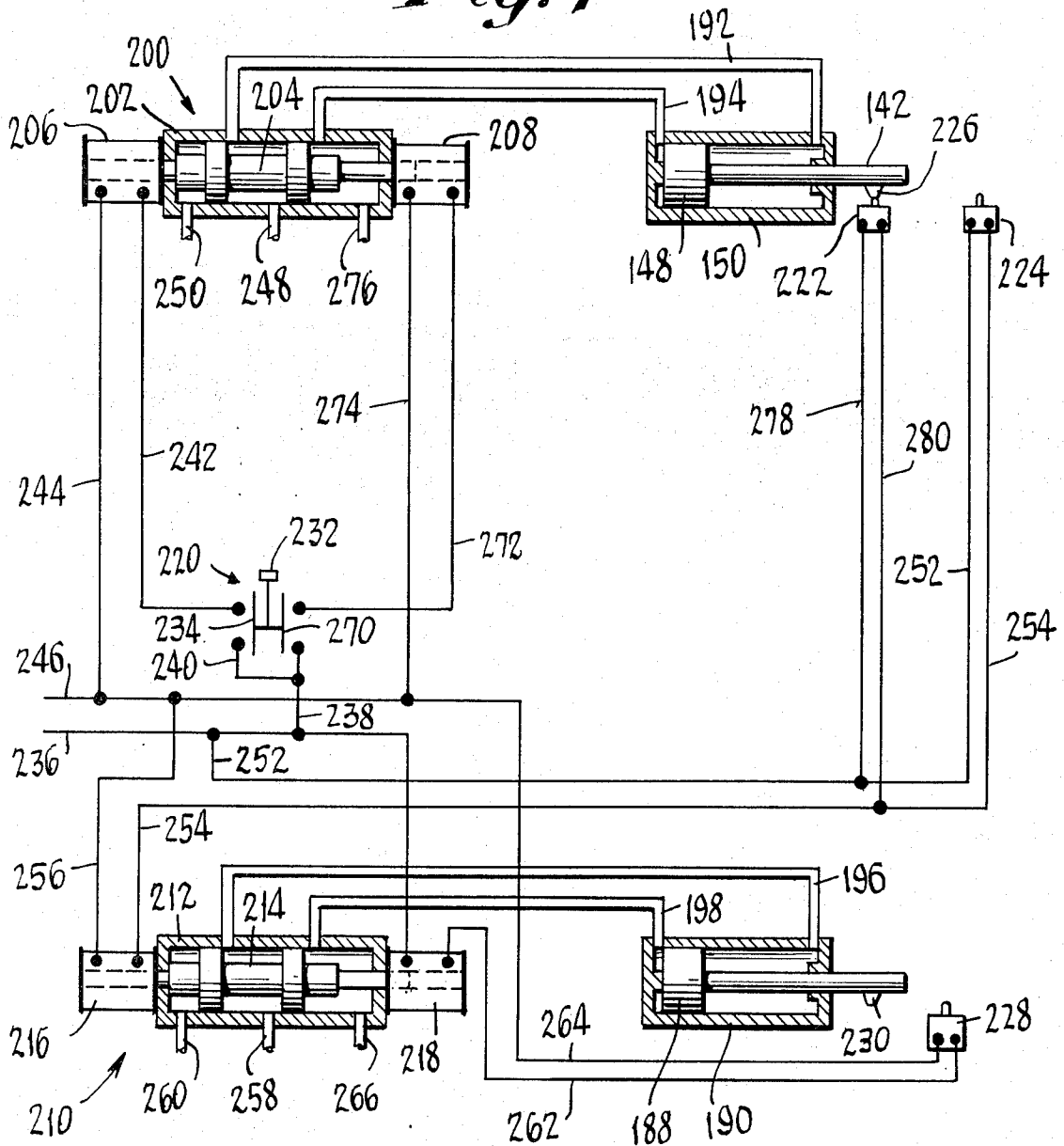
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Fig. 7



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MULTIPLE SIDE PUNCHING MACHINE

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U.S. Cl. 72—324

8 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for simultaneously punching or forming apertures or shaped depressions in the side wall of tubular parts, the apertures or depressions being formed in a variety of patterns of circumferential and/or axial rows. A plurality of tool carrying, radially movable rams are driven inwardly and outwardly in response to unidirectional movement of actuating cams carried by an oscillating cam carrier, and automatic power means actuate both the carrier and an ejecting mechanism when an operating cycle is completed.

CROSS-REFERENCE

This application discloses and claims improvements in the invention claimed in copending application Ser. No. 498,508, filed Oct. 20, 1965, now Pat. 3,316,787 in the name of Thomas E. Lambro and assigned to the assignee of this application.

BRIEF SUMMARY

The present invention relates to improvements in a machine for simultaneously punching or forming a plurality of apertures or shaped depressions in the side wall of relatively short tubular blanks or semifinished articles of similar shape.

The machine consists generally of a frame having a substantially horizontal surface to which is secured a central die post around which the part to be worked is placed. A plurality of punching units are disposed in peripherally spaced relationship around the die post, each unit having a radially reciprocable ram and ram guide assembly, and a working tool and tool guide assembly. An annular carrier is rotatably mounted on the frame in concentric relationship with the punching units, and carries a plurality of actuating cams which are interconnected with the rams of the punching units for driving the latter radially inwardly and outwardly in response to oscillatory movement of the carrier and the cams. A pneumatic power unit is mounted on the frame and connected to the carrier for oscillating the latter. An ejecting mechanism is mounted on the frame beneath the die post and has means for ejecting a part from the die post when the working operation on the part is completed.

One of the significant aspects of the present invention resides in the cam construction and placement on the annular carrier. Specifically this is that the cams have radially spaced rectilinear camming surfaces for forcibly driving the rams both inwardly and outwardly, with both camming surfaces being of the same length and of sufficient length that the rams are moved through a complete cycle of inward and outward movement in response to a single unidirectional movement of the annular carrier and cams between spaced apart limit positions. Thus the power unit, the carrier and the cams need move only in one direction to effect both a punch and withdraw stroke of the working tools.

Also, the cams are located on the carrier in such manner that the rectilinear camming surfaces are perpendicular to the longitudinal axis of the rams and working

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tools when the latter are in their radially innermost position. Thus, the working force transmitted from the cams to the rams approaches a maximum as the working tool approaches and penetrates into the wall of the work part.

Another significant feature is the provision of means for applying only directly axial forces to the working tools regardless of the extent to which nonaxial forces are applied to the rams by the actuating cams, thus achieving an extremely high degree of accuracy in locating punch patterns, such accuracy being in the area of plus or minus .0005 of an inch.

Also, provision is made for adjustment of the working tools in the axial direction to compensate for wear so as to maintain the same degree of accuracy in working operations where the side wall of a part is not punched through, such as detenting or lancing.

Still further, provision is made for removably connecting both the working tools and a tool holder to the rams and frame of the machine respectively in a manner facilitating removal of the tools and tool holder as a unit without having to disassemble any portion of the machine.

Another significant aspect of this invention is the provision of means for mounting both the ram guide assembly on the frame and the cams on the carrier for angular adjustment to an infinite number of positions without any structural modification to the machine, thereby facilitating a wide variety of both symmetrical and nonsymmetrical punching patterns, and giving the machine greater versatility than was heretofore possible.

Having briefly described the nature and several important aspects of the present invention, it is a principal object thereof to provide a multiple side punching machine having improved working capabilities and production efficiency over other machines heretofore known.

Another object of the present invention is to provide a multiple side punching machine which reduces to a minimum the number of movements of working parts which are required to effect a working cycle of operation.

Still another object of the present invention is to provide a multiple side punching machine in which tool movement is rapid while approaching or moving clear of the work, but is retarded and is of maximum working force when the greatest resistance to penetration of the work part is obtained during the punching operation.

Another object is to provide a machine of the character described which will consistently perform to extremely close tolerances, and which has provision for rapid adjustment of the parts to compensate for wear and tear on the working tools.

Yet another object is to provide a multiple side punching machine which is flexible in permitting the selection of a wide variety of punching or working patterns.

These and other objects and features of the present invention will be apparent from an understanding of the following detailed description of a preferred embodiment of the invention when considered in conjunction with the accompanying drawings in which:

FIG. 1 is a plan view of a multiple side punching machine constructed in accordance with the principles of this invention, this view showing the parts in full working position;

FIGS. 2 and 3 are fragmentary side elevations of the machine illustrated in 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 machine parts in the two opposed withdrawn or non-working positions; and

FIG. 7 is a schematic diagram of the pneumatic and electric controls of the machine.

DETAILED DESCRIPTION

Referring now to the drawings, and particularly to FIGS 1 and 4 thereof, the general arrangement of the machine is seen to comprise a frame in the form of a substantially flat horizontal surface 10 which is supported by a plurality of legs (not shown). A punching component 12 is mounted on the frame 10 in position to vertically receive and eject parts to be punched, the punching component comprising the basic actuating parts 14 of the machine and a working assembly 16, hereinafter called the tooling which, in the manufacture of the machine, must be custom made for each different type of part being punched or for each different punch pattern employed. It will thus be appreciated that the machine of this invention is intended for use in very high production lots of identical parts.

A power unit 18 is also mounted on the frame 10 adjacent the punching component 12 for actuating the latter, and an ejecting mechanism 20 (FIG. 4) is mounted on the underside of the frame 10 for ejecting parts after they have been punched. 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 present invention, but are operatively schematically illustrated in FIG. 7 and described hereinbelow.

The punching component 12 is constructed and arranged to have the actuating parts 14 thereof disposed radially with respect to the tooling 16. More specifically, a plurality of punching units 20, 22, 24 and 26 are disposed around the tooling 16 in peripherally spaced relationship, and radially outwardly therefrom there is a corresponding number of actuating cam assemblies 28, 30, 32 and 34. The cam assemblies are mounted on an annular carrier or ring 36 which is oscillated over a predetermined angle between spaced apart limit positions by the power unit 18 in order to convert a torque applied to the carrier into substantially radial forces acting on the punching units 20, 22, 24 and 26 to effect radial movement of punching tools respectively connected thereto in a manner more fully described below.

It is to be understood that the number and arrangement of punching units and cam assemblies 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 tooling, and to peripherally space them in any desired manner whether equidistant or otherwise. It is also within the scope of the invention to offset the path of movement of, and the direction of force applied 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 now to FIG. 4 for a more detailed description of the present machine, the tooling 16 comprises essentially a central elongate hollow mandrel or die post 38 which will have an exterior configuration conforming generally to the interior configuration of the part to be punched. The die post 38 has a plurality of apertures 40 extending radially through the wall thereof for cooperation with a plurality of punching tools described below, and is further provided with a bottom outwardly projecting annular flange 42 by means of which the die post 38 is removably secured, as by the screws 44, to the upper surface of a die set ring 46 which in turn is connected, as by the screws 48, to the frame 10. The location and arrangement of the apertures 40 in the die post will depend upon the nature of the punching pattern desired on the finished article.

The tooling 16 further comprises a punch block 50,

which may either be annular as shown in the drawings, or it may be segmental. The punch block 50 is provided with a plurality of peripherally spaced rows of vertically spaced apart bores 52, each bore being provided with a bushing 54 in which a working tool 56 is adapted to slide. The punch block is removably secured to the die set ring 46 by means of bolts 58 which extend axially through the punch block, the latter also being provided with a counter-bore 60 which overlies the annular flange 42 of the die post 38.

It will now be understood that the above described structure, with the exception of the die set ring 46, is not a permanent part of the machine, but rather is removable and is custom designed for each type of working operation to be performed on a particular article.

The punching units 20, 22, 24 and 26 are substantially identical, and comprise a ram guide 62 which is secured to the die set ring 46 adjacent the outer edge of the latter. Each ram guide 62 is provided with opposed laterally extending wings 64 (FIG. 1) which overlie a T-slot 66 formed in the die set ring 46. A headed bolt 68 passes through each wing 64 and is threadedly engaged with a nut 70 disposed in the T-slot 66 so that by tightening up on the nut 70 by the bolt 68, the ram guide 62 is secured to the die set ring. It will be observed that the ram guide may be securely locked in any desired angular position on the die set ring merely by loosening the bolts 68 for the particular ram guide, moving it angularly to the desired position and retightening the bolts. It will be noted that the headed bolts 48 which secure the die set ring 46 to the frame 10 are recessed into suitable counterbores in the bottom of the T-slot 66 so that the nuts 70 secured to the bolts 68 may pass over the tops of the bolts 48 while adjusting the position of the ram guide 62 to suite a desired punching pattern.

Each ram guide is further provided with a pair of radially extending bores 72, each bore being provided with a bushing 74 for receiving and guiding a pair of rams 76 for reciprocable movement in the ram guide 62. The rams are connected at their inner end to a tool carrier or ram head 78 by means of a pin connection 80 so that the rams support the tool carrier 78 for movement therewith. Thus as the rams are reciprocated by means hereinafter described, the ram head and the tools 56 carried thereby are reciprocated radially of the punch block 50 to perform the working operation.

Each ram head 78 comprises an elongate rectangular block 82 to which the rams 76 are connected, and another block 84 which has an open ended T-slot 86, or other suitable configuration, extending the length of the block 84, the block 82 being secured to the block 84 by means of the screws 88 as seen in FIG. 1. Each of the tools 56 is provided with a T-head 90 which is shaped to substantially fit within the T-slot 86 of the block 84, so that the tools are thus engaged with the ram head 78 in driving relationship in both directions of movement. The reason for the split ram head 78 is that, by loosening the screws 88 and inserting extremely thin shims at the interface between the blocks 82 and 84 and retightening the screws 88, the working end of the tools 56 can be maintained in precise relationship with the work even though some wear and tear may have slightly shortened the tools. This is quite critical in operations which do not require that a hole be punched through the tubular blank, such as with shaped depressions or detents, serrating or lancing to provide spring fingers, etc., in which the extent of indentation of a detent finger is critical.

Another advantage obtained by the construction of the ram head connection between the rams 76 and the tools 56 is that there is sufficient play in the T-slot connection between the ram head and the tools to assure that only absolutely axial forces are transmitted from the rams to the tools even though some non-axial driving forces are applied by the ram actuating means to be presently described to the rams. By thus assuring the axial alignment

of the driving forces applied to the tools, wear and tear on the tools and the tool bushings 54 is held to a minimum so that the machine maintains an extremely high degree of punching accuracy over a long period of time.

It will also be appreciated at this point that, because of the T-slot 86 and T-head 90 type of connection between the ram head 78 and the tools 56, by merely removing the screws 58 it is possible to remove the entire punch block 50 and all the tools carried thereby without any other disassembly of the machine. This is advantageous where, for example, it may be desired to run a subsequent batch of blanks with different tools where it is not necessary to rearrange the location of the punching units as a whole.

The rams 76 are reciprocated by the actuating cam assemblies 28, 30, 32 and 34 which, in the preferred form of the invention, comprise a plurality of elongate block like cam members 92, 94, 96 and 98. Each cam is secured to the carrier ring 36 for movement therewith by means of bolts 100 which pass through the cams and are threadedly engaged with nuts 102 which are disposed in a circular T-slot 104 formed in an inturned flange 106 which is an integral part of the carrier ring 36. The T-slot 104 in the carrier flange 106 provides the same advantage of infinite position adjustment of the cams on the carrier as does the T-slot 66 in the die set ring 46 with regard to similar adjustment of the angular position of the ram guides 62. It will be apparent that when setting up the actuating components 14 of the machine in conjunction with the tooling 16 for performing a particular working operation, the cams and the ram guides would be adjusted in the desired position simultaneously and all of the necessary bolts then tightened to secure the actuating parts in the desired position.

Each of the cams, as best seen in FIG. 4, is provided with a pair of elongated slots 108, in the bottom of which is secured a hardened wear plate 110 as by the screws 112. The radial inner face of each cam has secured thereto a plurality of similar wear plates 114, 116 and 118, all as by the screws 120. It will also be observed in FIG. 4 that the plates 114, 116 and 118 are made wide enough so as to overlap the opening leading into the slots 108 so that the radial outer surfaces of these plates define a bearing surface against which the cam followers mounted on the outer end of the rams 76 ride, the plates 114, 116 and 118 effectively capturing the cam followers within the slots 108. By this construction, the cams are effective so forcibly drive the rams 76 in both directions of movement, thereby providing a position means of withdrawal of the punches from the work after the working operation has been completed.

The cam followers comprise a pair of wheels 122 which are secured to the reduced outer end portion 124 of each ram by means of an axel 126 suitably pinned to each ram so that as the cams oscillate back and forth, there is a smooth, frictionless engagement between the cams and cam followers. This construction further assures maintaining a high degree of accuracy of the machine over a long period of time.

As already indicated, the cams are oscillated by means of the carrier 36, the latter having an upstanding flange portion 128 which provides additional support for the cams to relieve the high shearing forces imposed on the screws 100 by the resistance to deformation of the article being punched. The carrier has a shaped inner annular edge 130 on the flange portion 106 which cooperates with a correspondingly shaped outer edge portion 132 formed on the die set ring 46, which thereby guides the carrier for arcuate movement in a fixed circle. A plurality of hardened wear plates 136 are secured to the frame 10 as by the screws 138 on which the carrier rides.

As best seen in FIGS. 1 and 3, the carrier 36 is provided with a lug 140 to which a piston shaft 142 is pivotally connected by means of a clevis 144 and a pin 146. The

piston shaft 142 is fixedly connected to a piston head 148 which reciprocates in a cylinder 150, the latter being pivotally connected to the frame 10 by means of a bushing 152 in which a pin 154 connected to the cylinder rotates, and another bushing 156 within which another pin 158 connected to the cylinder rotates, the bushing 156 being fastened to the upper cross bar 160 of a U-shaped bracket 162 secured to the frame 10. From the foregoing it is seen that reciprocation of the piston head 148 within the cylinder 150, by means hereinafter described, imparts oscillatory movement to the carrier 36 and corresponding oscillatory movement to the cams 92-98 over a predetermined arc which is coordinated with the length of the cams.

The punching machine operates, in accordance with the principles of the present invention, in the manner now to be described. The carrier 36 and the actuating cams are driven by the piston rod 142 in a unidirectional movement to effect one complete cycle of operation of the punching tools 56 from a withdrawn position to a punching position and back to the withdrawn position. Thus movement of actuating parts is maintained at a minimum during the working cycle which not only reduces wear and tear on the moving parts but also substantially increases the production efficiency of the machine.

The radially spaced camming surfaces defined by the wear plates 110 and 114, 116 and 118, as seen in FIGS. 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 camming surfaces in their oscillation over a predetermined arc. They are also of sufficient length that they are in continuous engagement with the wheels 122 throughout the extent of movement of the cams. Therefore, the camming surfaces are disposed gradually closer to the longitudinal axis of the die post 38 from either outer end of the camming surfaces toward the midpoints thereof. Thus, as the carrier rotates from one end position as shown in FIG. 5 toward the intermediate position shown in FIG. 1, the cam follower wheels 122 and all of the actuating parts connected thereto 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 of a nonradial force to a completely radial force acting on the rams. This force reaches a maximum when the cam surfaces are perpendicular to the axes of the rams. This construction has the advantage of applying the greatest speed of movement of the rams as the tools approach a punching position, and gradually diminishing the speed of the rams but increasing the working force applied thereto as the midpoint of the cam surfaces approaches the cam follower wheels, that is, when the straight line cam surface is substantially perpendicular to the axes of the rams.

It will now be understood that the extent of radial movement of the rams and working tools is determined by the difference in radial distance from the axis of the die post 38 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 76 are moved radially outwardly to withdraw the working tools by the action of the cam surfaces defined by the wear plates 114, 116 and 118. The rams and working tools are fully withdrawn when the cams are moved sufficiently far to dispose the other ends there-

of in engagement with the rollers 122. It is now apparent that the rams are formed to have a length sufficient to be in continuous and bidirectional driving relationship with the cam followers throughout the extent of movement of the carrier 36 in one direction between its limit positions so that the rams and working tools 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.

At the end of each punching operation, i.e., when the cams are moved by the carrier to the FIG. 5 or FIG. 6 position of the parts, the ejector mechanism 20 mounted on the underside of the frame 10 is actuated by means to be hereinafter described to eject the part from the die post 38 in an upward direction. As best seen in FIG. 4, the ejecting mechanism comprises a supporting plate 170 mounted under the frame 10 by means of bolts 172 which are threadably engaged with the frame 10 and to which the plate 170 is secured by screws 174. The bolts 172 form guide rods for guiding a ram plate 176 for vertical reciprocatory movement, the ram plate removably carrying a plurality of spaced ejector pins 178 having heads 180 captured between a plate 182 which is screwed to the ram plate 176. The ejector pins pass through elongate slots 184 so that the ejector pins 178 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 176 is driven by a piston rod 186 which passes through a hole 187 formed in the plate 170 and is threadably engaged with the ram plate, the piston rod being connected at its other end to a piston 188 reciprocally mounted within an air cylinder 190. The cylinder 190 is connected to the support plate 170 by screws 192. The part is ejected from the die post 38 by operation of the piston 188 to raise the ejector pins 178, the piston being operated in both directions in timed relationship with operation of the carrier 36 when the latter reaches a terminal position by control means hereinafter described.

A more thorough understanding of the control components of the machine and its mode of operation will be obtained by reference to FIG. 7, wherein the carrier actuating piston 148 and cylinder 150, and the ejector mechanism piston 188 and cylinder 190 are all shown schematically, together with other control components. The piston 148 is reciprocated by air from lines 192 and 194 by alternately delivering air to one side of the cylinder 150 through one line and simultaneously venting the other side of the cylinder through the other line. The piston 188 for the ejector mechanism is reciprocated in the cylinder 190 in the same manner by means of air lines 196 and 198.

The flow of air in lines 192 and 194 is controlled preferably by a four-way spool valve 200 having a cylinder 202 in which a spool 204 is reciprocated by solenoids 206 and 208, the spool selectively controlling the flow of air in the lines 192 and 194.

The flow of air in lines 196 and 198 is controlled by another spool valve 210 which is substantially identical to the valve 200, having a cylinder 212, a spool 214, and solenoids 216 and 218 for reciprocating the spool.

An impulse type start switch 220 of known construction is provided for actuating the solenoids 206 and 208 alternately. A pair of normally open impulse type limit switches 222 and 224 are provided at the limit positions of the stroke of the carrier 36 (see FIG. 6) and are actuated by any suitable actuator 226 carried by the clevis 144 on the outer end of the piston rod 142, the switches 222 and 224 serving to control the solenoid 216 on the ejector spool valve 210. The other solenoid 218 on the ejector spool valve is controlled by a similar impulse type limit switch 228 which is secured to the underside of the frame 10 (see FIG. 4) in position to be contacted by an

actuator 230 suitably carried by the ram plate 176 when the latter reaches the end of its ejecting stroke.

The remaining elements of the control mechanism described above will be explained in connection with a description of a complete cycle of operation of the machine, which is as follows: Commencing with the carrier 36 and the associated parts in the position illustrated in FIG. 5, depression of the start switch 220, either by a finger or foot operated pushbutton 232, momentarily moves the switch blade 234 to the left as viewed in FIG. 7, thereby completing a circuit from the main lead 236 through a lead 238, a lead 240, the switch blade 234, a lead 242, through the winding of the solenoid 206 and a lead 244 back to the other supply lead 246. Energization of the solenoid 206 forces the spool 204 toward the right, whereupon air enters through the inlet port 248 and thence through the line 194 into the left side of the cylinder 150 to drive the piston 148 toward the right. Simultaneously, air in the right side of the cylinder 150 is vented through the line 192 and the exhaust port 250 of the control valve 200. This action rotates the carrier 36 in a counterclockwise direction from the position shown in FIG. 5 to that shown in FIG. 6 thereby causing a complete punching and withdrawal operation of the working parts of the punching units as described above.

When the carrier 36 reaches the end of its stroke, the actuator 226 closes the impulse switch 224 to effect a momentary closing of a circuit from the supply lead 236 through a lead 252, the switch 224, a lead 254, the winding of the solenoid 216, and a lead 256 to the other supply lead 246. Energization of the solenoid 216 causes the spool 214 to be moved toward the right, whereupon air enters through the inlet port 258 and flows through the line 198 to the left side of the cylinder 190. Simultaneously, air in the right side of the cylinder 190 is vented through the line 196 and the exhaust port 260 of the valve 210. This action causes the piston 188 to be driven toward the right, whereby the ejector pins 178 connected to the piston forcibly eject the part from the die post 38.

When the ejector piston 188 reaches the end of its stroke, the actuator 230 carried by the ejector ram plate 176 closes the impulse switch 228 which causes a momentary closing of a circuit from the supply lead 236, the winding of the solenoid 218, a lead 262, the switch 228, and a lead 264 back to the other supply lead 246, which energizes the solenoid 218 to cause the spool 214 to move toward the left. This movement permits air to enter through the inlet port 258 and through the line 196 to the right side of the cylinder 190, whereupon the piston 188 is returned to the position shown in FIG. 7, the air on the left side of the cylinder 190 now being vented through the line 198 and the exhaust port 266. Thus the ejector mechanism is instantly returned to its normal position and another part may be placed on the die post 38 preparatory for the next cycle of operation.

When the start switch 220 is again actuated after the next blank is placed on the die post 38, the switch blade 270 momentarily moves toward the right to complete a circuit from the supply lead 236 through the lead 238, the switch blade 270, a lead 272, through the winding of the solenoid 208, and a lead 274 back to the other supply lead 246. Energization of the solenoid 208 moves the spool 204 toward the left back to the position shown in FIG. 7, whereupon air enters through the inlet port 248 and flows through line 192 to the right side of the cylinder 150, whereupon the piston 148 is moved toward the left, the air in the left side of the cylinder 150 being vented through line 194 and the exhaust port 276 of the valve 200. Movement of the piston 148 toward the left drives the carrier 36 in a clockwise direction to perform another punching and withdrawal operation as above described.

When the carrier reaches its clockwise terminal position, the actuator 226 closes the momentary switch 222 which completes a circuit from the supply lead 236

through the lead 252, a lead 278, the switch 222, a lead 280, the lead 254, the solenoid 216 and the lead 256 back to the other supply lead 246, whereupon energization of the solenoid 216 initiates a complete cycle of operation of the ejector mechanism as described above.

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 mode of operation described hereinabove and shown in the accompanying drawings, which is merely illustrative of the principles of the invention and which is 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 a tubular blank,
- (C) a plurality of angularly spaced punching units disposed around said supporting means, each punching unit comprising
 - (1) a ram guide having means for supporting and guiding a ram for reciprocable movement radially with respect to said blank supporting means,
 - (2) a ram disposed in said guiding means, and
 - (3) means carried by the radial inner end of said ram for connecting a working tool thereto,
- (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 mounted on said carrier in driving engagement with the radial outer end of said rams, said cam means including means formed to be in continuous and bidirectional driving relationship with said rams throughout the extent of movement of said carrier in one direction so as to drivingly interconnect said carrier and said plurality of rams to simultaneously forcibly drive said rams both inwardly and outwardly in response to a single unidirectional movement of said carrier between said limit positions,
- (G) ejecting means mounted on said frame adjacent said blank supporting means for ejecting a blank therefrom, and
- (H) means responsive to the arrival of said carrier in both said limit positions for actuating said ejecting means upon completion of each single unidirectional movement of said carrier.

2. A machine as set forth in claim 1 wherein said cam means comprises a roller carried by the radial outer end of each ram, and corresponding plurality of substantially elongate blocklike cam members each having an elongate slot formed therein with an elongate hardened wear plate disposed in the bottom of said slot and a plurality of correspondingly elongate hardened wear plates disposed at, and partially blocking, the entrance to said slot and effectively capturing said roller within said slot, said wear plates defining a pair of radially spaced inner and outer cam surfaces to drive in response to the forces on said rollers by said wear plates said rams both inwardly and outwardly.

3. A machine as set forth in claim 2 wherein said cam members are disposed on said carrier in position to have said cam surfaces substantially perpendicular to the axes of said rams when the latter are aligned with the midpoints of said cam surfaces whereby the camming force approaches a maximum as the rams reach their radially innermost working position.

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

- (A) a frame,
- (B) means on said frame for supporting a tubular blank,
- (C) a plurality of angularly spaced punching units disposed around said supporting means, each punching unit comprising
 - (1) a ram guide having means for supporting and guiding a ram for reciprocable movement radially with respect to said blank supporting means,
 - (2) a ram disposed in said guiding means,
 - (3) means carried by the radial inner end of said ram for connecting a working tool thereto,
- (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 for simultaneously forcibly driving said rams both inwardly and outwardly in response to a single unidirectional movement of said carrier between said limit positions, and
- (G) means for adjustably securing said ram guides to said frame and said cam means to said carrier at any peripherally spaced location around said blank supporting means, said means including a pair of concentric substantially T-shaped recesses formed in said frame and said carrier respectively, and means on said ram guides and said cam means cooperating with said recesses and slidable therein to a desired angular location for securing both the rams guides and cam means in said desired locations.

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

- (A) a frame,
- (B) means on said frame for supporting a tubular blank,
- (C) a plurality of angularly spaced punching units disposed around said supporting means, each punching unit comprising
 - (1) a ram guide having means for supporting and guiding a ram for reciprocable movement radially with respect to said blank supporting means,
 - (2) a ram disposed in said guiding means,
 - (3) a punch block secured to said frame and having means for supporting and guiding a punching tool for reciprocable movement radially with respect to said supporting means, and
 - (4) a punching tool slidably received in said punch block supporting means,
- (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 for simultaneously forcibly driving said rams both inwardly and outwardly in response to a single unidirectional movement of said carrier between said limit positions, and
- (G) means carried by the radial inner end of each ram between said punch block and said ram guide for connecting said punching tools to said rams, said connecting means including means for transmitting only an axial driving force from said rams to said punching tools while a nonaxial driving force is being imparted to said rams by said cam means so that such nonaxial driving force is not transmitted to said punching tools.

6. A machine as set forth in claim 5 wherein said punch block includes means for removably securing said punch block to said frame, and said connecting means includes means for removably connecting said punching tools to

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said rams by movement of said punching tools axially of said blank supporting means whereby said punch block, together with said punching tools therein, can be withdrawn from the machine by movement axially of said blank supporting means and thus disconnected from said rams.

7. A machine as set forth in claim 6 wherein said means for removably connecting said punching tools to said rams comprises a ram head carried by the radial inner end of each ram, an elongate hollow substantially T-shaped recess formed in said ram head and opening radially inwardly, said punching tool having an enlarged substantially T-shaped head formed on its radial outer end which substantially corresponds to the shape of said recess whereby said tool head may be inserted into said recess and removed therefrom through the open end of the recess.

8. A machine as set forth in claim 5 wherein each of said connecting means comprises a ram head formed of two separable body members, one of said body members being carried by said ram, the other of said body members having means for securing said working tool thereto,

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and means removably securing said body members together whereby a shim can be inserted between the adjacent faces of said body members to compensate for wear on said tool to maintain a desired radially innermost position of the working end of said tool.

References Cited

UNITED STATES PATENTS

2,374,301	4/1945	Olney	83—194
2,419,534	4/1947	Burleson	83—194
2,513,710	7/1950	Brauchler	72—402
2,514,507	7/1950	Mueller	72—402
3,316,787	5/1967	Lambro	83—109

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