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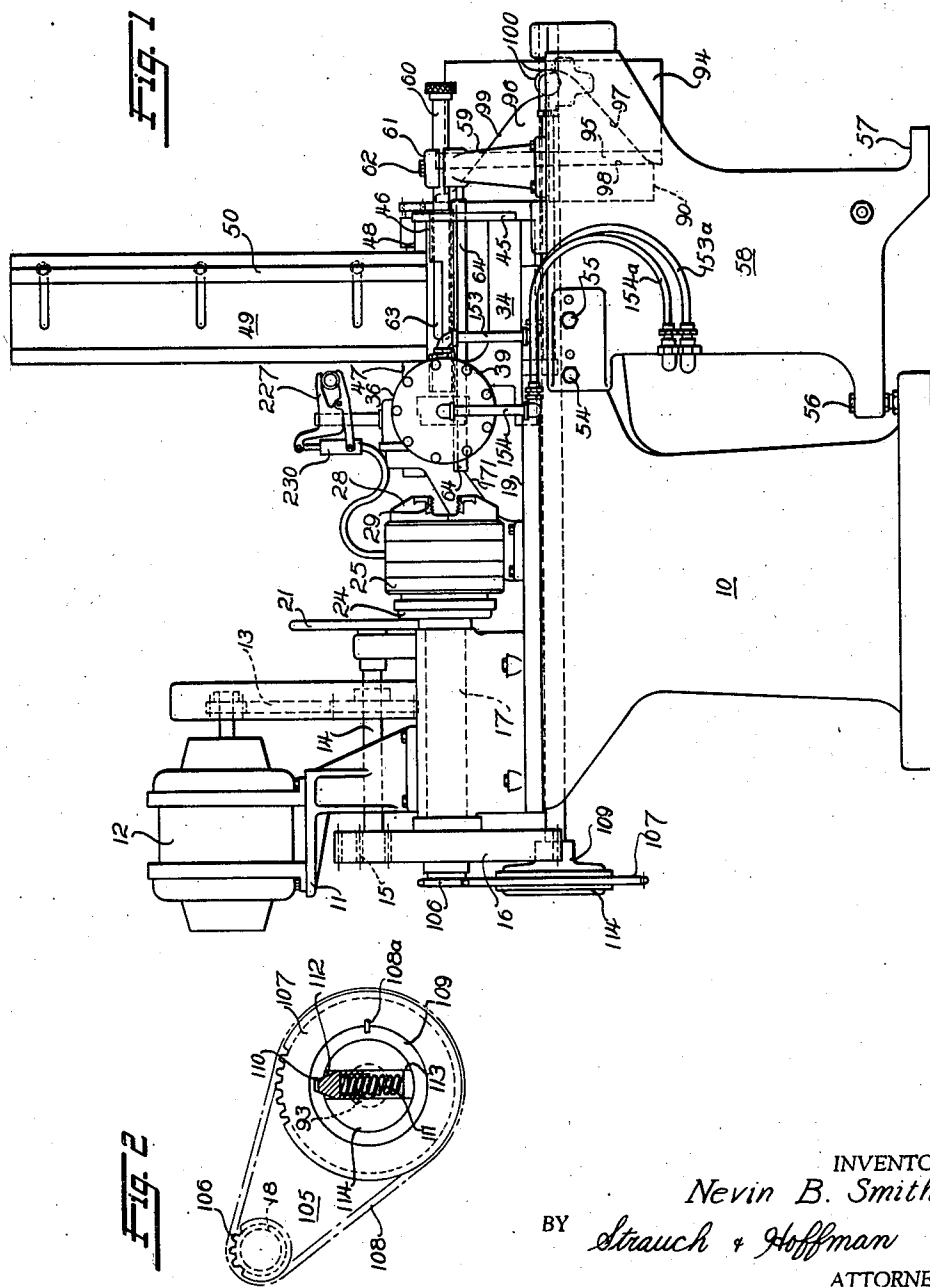
N. B. SMITH

2,360,906

AUTOMATIC METAL WORKING MACHINE

Filed Aug. 8, 1941

5 Sheets-Sheet 1



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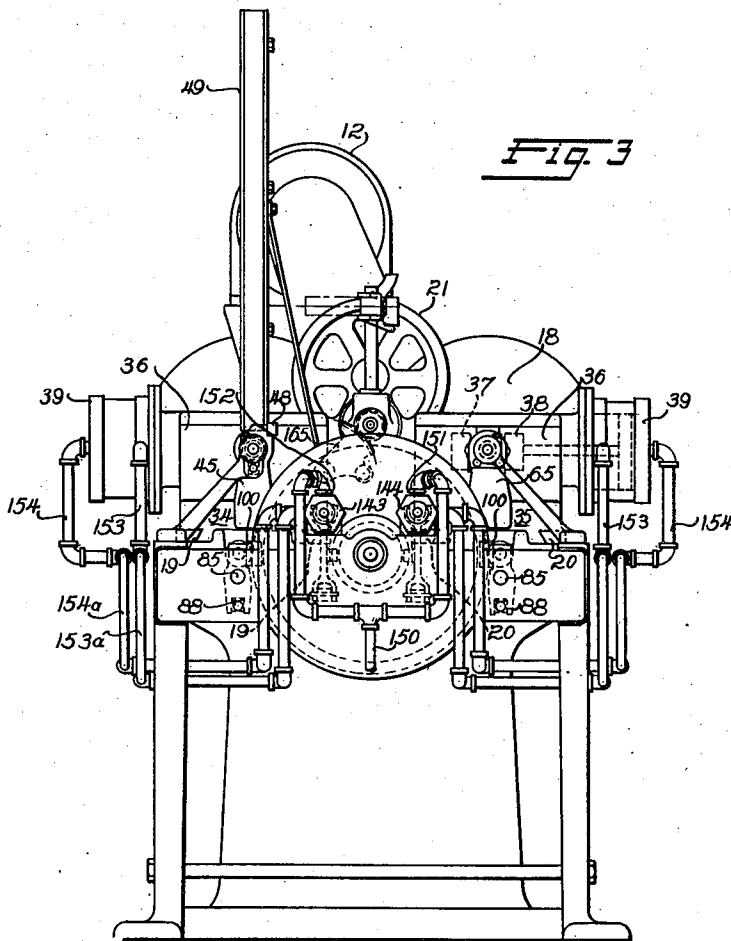
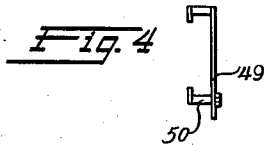
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AUTOMATIC METAL WORKING MACHINE

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5 Sheets-Sheet 2



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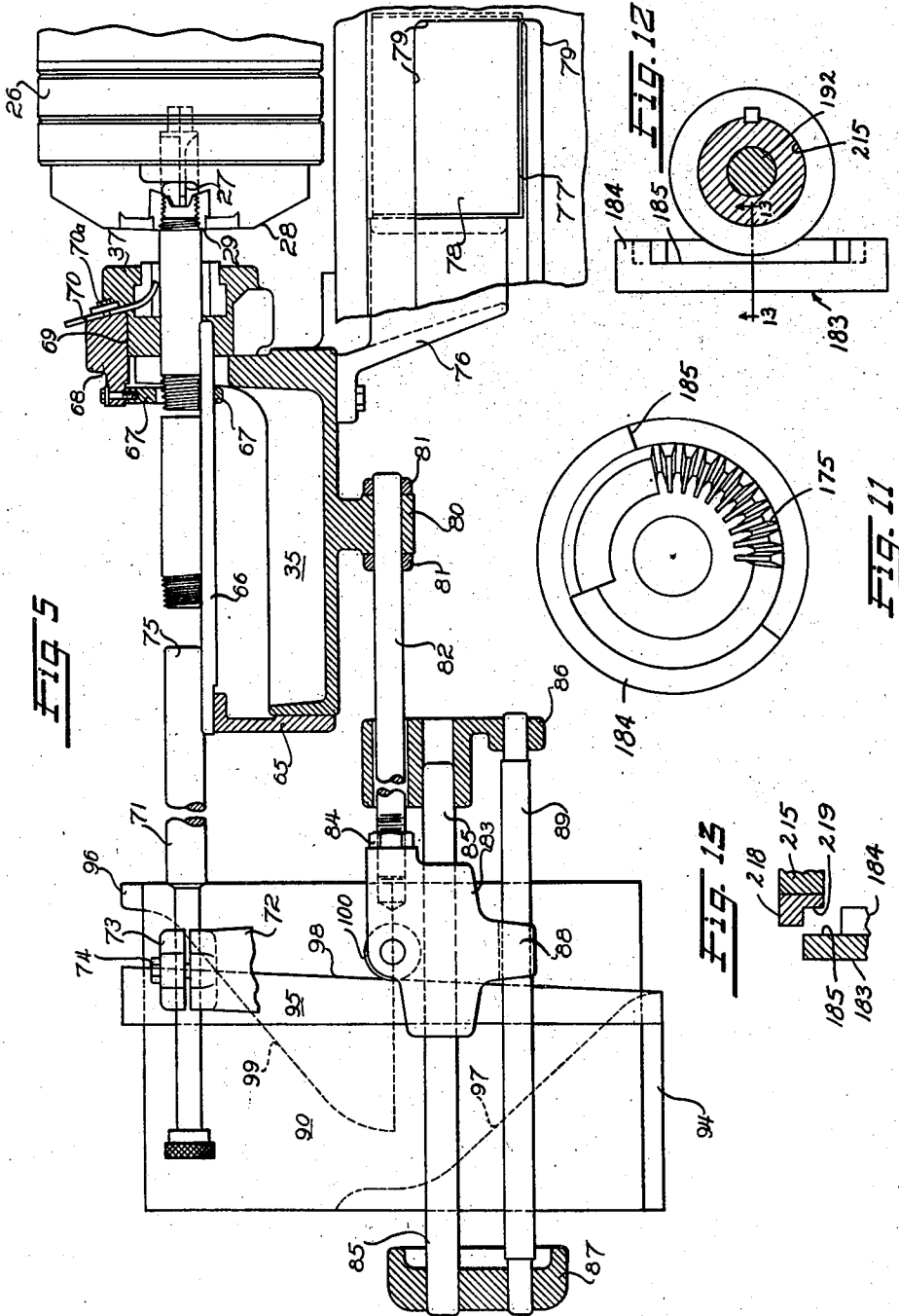
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AUTOMATIC METAL WORKING MACHINE

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5 Sheets-Sheet 3



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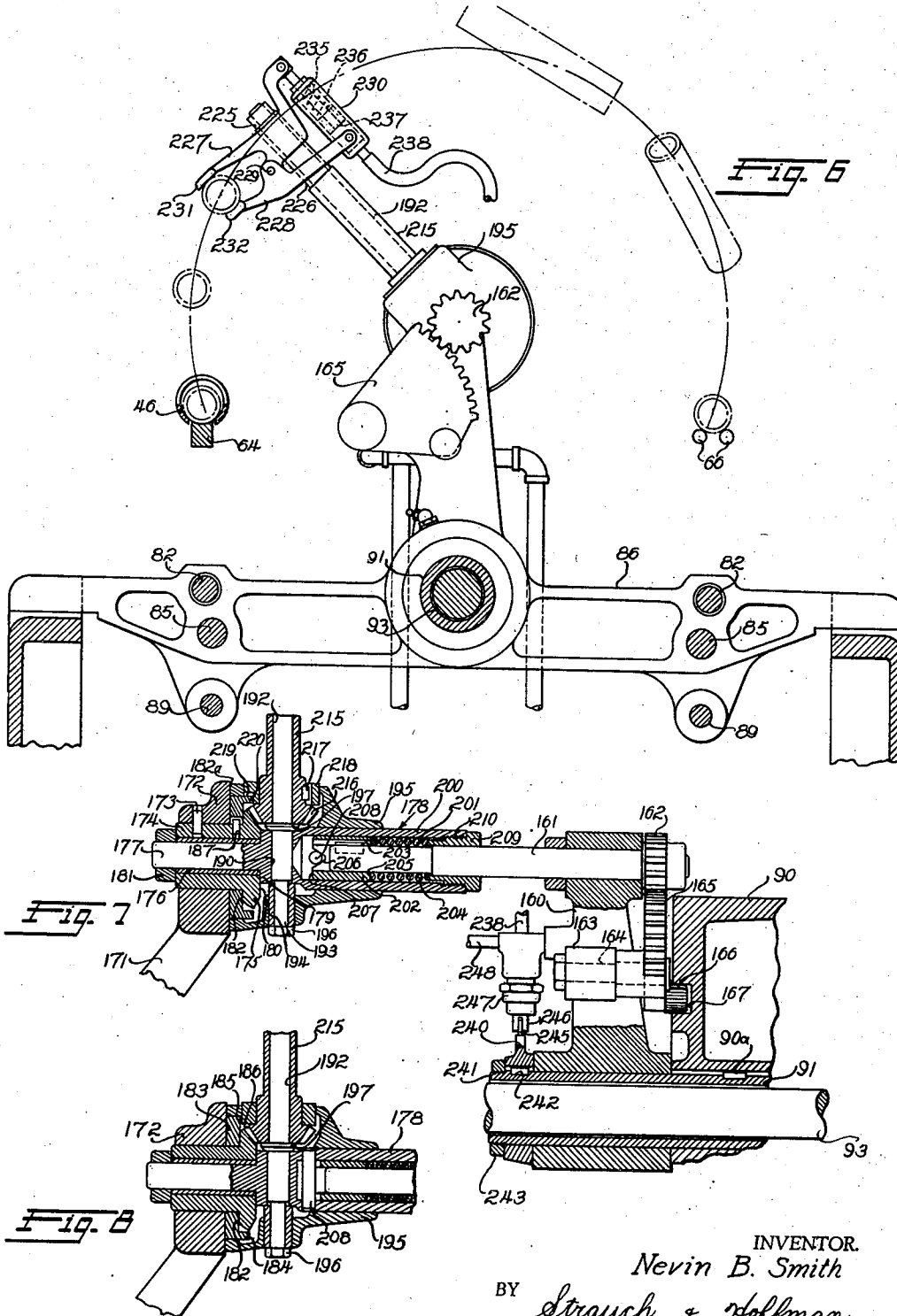
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AUTOMATIC METAL WORKING MACHINE

Filed Aug. 8, 1941

5 Sheets-Sheet 4



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2,360,906

AUTOMATIC METAL WORKING MACHINE

Filed Aug. 8, 1941

5 Sheets-Sheet 5

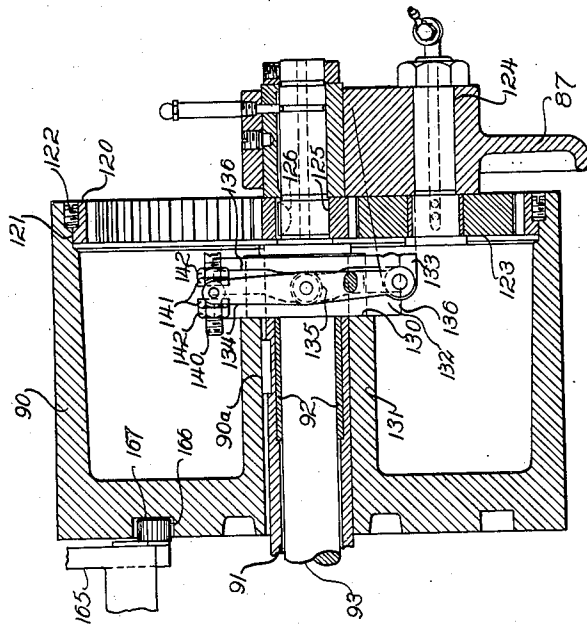


Fig. 9

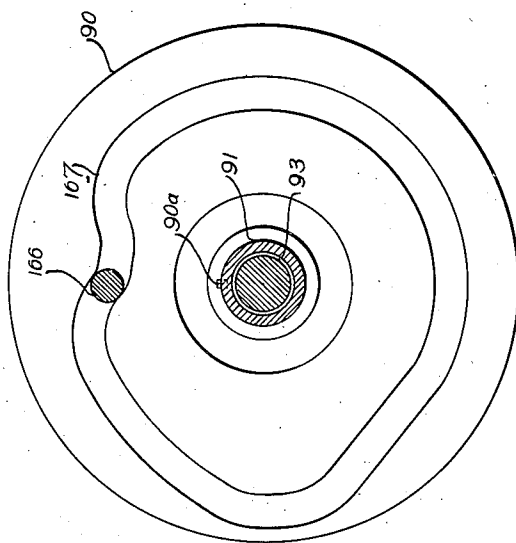


Fig. 10

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UNITED STATES PATENT OFFICE

2,360,906

AUTOMATIC METALWORKING MACHINE

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Application August 8, 1941, Serial No. 406,049

30 Claims. (Cl. 10—91)

This invention relates to a metal forming machine, in particular to a machine operable to perform two or more forming operations on a work piece, such as threading, turning, chamfering, etc. The invention relates further to a machine having, in combination with certain of its elements, a transfer mechanism adapted to control and effect the movement of work pieces from one forming stage of the machine to another.

As disclosed herein, the invention is applied to a metal forming machine having two parallel and horizontal work forming stages; more specifically, in the illustrated embodiment, it is applied to a double spindle threading machine of the type especially used to thread pipe nipples, studs, and other work requiring a thread on the opposite ends thereof.

In the production threading of pipe nipples, it always has been desired to minimize the labor and time required to produce the individual threads at the two ends thereof. While double spindle threading machines having a transfer device to automatically position the work in the second work forming stage are basically old, none of the prior developments has achieved any commercial success due to numerous shortcomings such as limited positiveness of operation, limited flexibility of application, and limited overall saving in labor and time with respect to older methods for producing nipples, such as threading each end thereof in an individual machine or in the separate spindles of a double spindle machine.

Accordingly, it is the primary object of my invention to provide an automatic machine especially adapted to thread pipe nipples and similar work pieces and so constructed as to be efficient and economical, positive and accurate, and flexible through a large range of applicability.

It is another object of my invention to provide for the application thereof to machines already in service by incorporating the novel features thereof into an attachment adapted for application to those machines.

It is another object of my invention to provide a metal working machine having a plurality of work forming stages and an improved transfer mechanism, of the general type shown in the United States Patent No. 1,904,493 to S. W. Mathias, combined with certain elements positively and accurately displacing any of a large variety of work pieces from one work forming

stage to another, in efficient and economical manner.

It is another object of my invention to provide an improved transfer mechanism which is applicable to a large variety of metal working machines having a plurality of work forming stages but which is especially adapted to such machines as have substantially parallel and horizontal work forming stages.

It is a further object of my invention to provide an automatic metal working machine having parallel work forming stages each comprising a rotatable element, a non-rotatable element, and means for effecting relative linear movement therebetween and actuating each stage according to a predetermined cycle and in spaced timing sequence to each other stage, with the force applied for effecting such relative linear movement of the rotatable and non-rotatable elements of each stage located in substantial opposing alignment with the force resisting such movement in order to reduce friction and wear.

It is a further object of my invention to provide means effecting the aforesaid relative movement of the rotatable and non-rotatable elements of each work forming stage, including an adjustment determining the minimum displacement between those elements when they are in closest proximity.

It is a further object of my invention to provide the non-rotatable element of one work forming stage with means for automatically gripping a work piece, for supporting the work piece prior to its being gripped, and for supporting the work piece after its being released from gripped position.

It is a further object of my invention to provide the non-rotatable element of another work forming stage with means for automatically gripping a work piece, for supporting and subsequently aligning the work piece prior to its being gripped, and for removing the work piece from the machine after its release from gripped position.

It is a further object of my invention to provide a machine having a plurality of work forming stages and a transfer mechanism for effecting movement of a work piece between two such stages, wherein the transfer mechanism displaces the work piece in two perpendicular circular paths and the movement thereof in one of those paths is effected by its motion in the other path.

It is a further object of my invention to pro-

vide a machine having a plurality of work forming stages and a transfer mechanism for effecting movement of a work piece between two such stages, wherein the transfer mechanism incorporates a fluid-operated work gripping member and automatic means controlling the operation thereof.

It is a further object of my invention to provide an improved transfer mechanism having a two piece oscillatory driving shaft and yieldable means disposed therebetween which permits the transmission of normal driving forces but not of abnormal ones such as would injure the mechanism.

It is a further object of my invention to provide an improved transfer mechanism having an oscillatory driving shaft and a grip carrying member rotatable therewith and also about an axis perpendicular thereto, wherein that member rotates about its axis through power supplied by the driving shaft.

It is a further object of my invention to provide an improved transfer mechanism as aforesaid, the grip carrying member having a beveled gear at the end thereof adjacent the drive shaft, which gear coacts with one mounted on a drive shaft support for effecting rotation of that member about its axis as it rotates with the drive shaft.

It is a further object of my invention to provide an improved transfer device as aforesaid, and further incorporating means whereby rotation of the grip carrying member about its axis is limited to only a portion of the time the drive shaft rotates.

Further objects will become apparent as the specification proceeds, in conjunction with the annexed drawings, and from the appended claims.

In the drawings:

Figure 1 is a view in elevation of the left hand side of the machine.

Figure 2 is a partial view showing the mechanism for driving the main shaft of the auxiliary machine frame.

Figure 3 is a view in elevation of the front end of the machine.

Figure 4 is a top view of the work magazine.

Figure 5 is a view in elevation of sections of the right-hand side of the machine;

Figure 6 is a view of the transfer mechanism and shows the path of travel of the transferred work blank;

Figure 7 is a cross-sectional view of the transfer mechanism;

Figure 8 is a similar cross-sectional view of a portion of the transfer mechanism but in different operating phase;

Figure 9 is a cross-sectional view of the main cam and associated mechanisms;

Figure 10 is a view of the cam outline of the transfer mechanism cam.

Figure 11 is a detail face view showing the assembled relation of certain of the parts.

Figure 12 is an enlarged detail view of the parts controlling operation of the work transfer gripper sleeve.

Figure 13 is a fragmentary sectional view taken on the line 13—13 of Figure 12.

Referring to Figure 1, the main machine frame 10 has mounted thereon a bracket 11 carrying a motor 12. A chain drive 13 transmits power from the motor to a drive shaft 14 supported on the frame 10. The drive shaft 14 has keyed thereto a pinion 15 which drives two spindle gears 16, one on each of two parallel spindles 17 and 18,

The axes of the spindles are in parallel alignment with the axes of a pair of carriage ways 19 and 20 as is best shown in Figure 3. A hand wheel 21 on shaft 14 may be used to rotate the aforescribed gears manually when it is desired to check the machine during various phases of its operation.

Each spindle has a flange 24 on which may be mounted a tool member; the disclosed embodiment shows left and right die heads 25 and 26, for threading operations, of the type disclosed in Patent 1,760,567, each provided with an internal trip, reaming and chamfering tool 27, as is best shown in Figure 5, of the type disclosed in Patent 1,699,994. Since such die heads long have been used for threading pipe nipples, they are well-known in the art and require no further description here. However, it may be mentioned that such die heads are provided with chaser holders 28 carrying threading chasers 29, the die heads being operable to disengage the chasers from the threaded work at the end of the threading operation, whereby the work may be withdrawn without "backing off" the die head. Further, the reaming and chamfering tool 27, in addition to serving as a trip plate to cause the die head to release the chasers from the threaded work, also serves to remove any burrs produced by the threading operation, by reaming the interior of the nipple and chamfering the exterior thereof to produce a smooth machined end.

Carriages 34 and 35 are slidably mounted on ways 19 and 20 for movement to and away from the respective die head 25 or 26. Each carriage, in the illustrated embodiment, is provided with a gripping mechanism 36 which includes a stationary jaw 37 and a movable jaw 38 that is actuated by a fluid motor 39 for clamping a work piece such as a nipple or stud, shown in Figures 5 and 6, in alignment with the axis of the spindle 17 or 18 and its respective die head 25 or 26 and subsequently releasing the same. The means for controlling the operation of the fluid motors 39 will later be described.

Referring to Figures 1, 3, and 6, the left-hand carriage 34 is provided with a bracket 45 attached to the rear end thereof. The bracket supports one end of a split tube 46, the other end of which is supported by the front section 47 of the carriage. The tube 46 is substantially aligned with the axis of die head 25 and serves to guide the work into position where it is gripped by the jaws of the gripping mechanism 36 during movement of the carriage. Bracket 45 also carries one end of a bar 48, the other end of which is carried by the front section 47 of the carriage. A vertical work magazine 49, formed of thin metal and whose cross-section is best shown in Figure 4, is supported by bar 48 and the front section 47 of the carriage. The front end 50 of work magazine 49 is adjustable to provide for different lengths of work blanks, which are retained in work magazine 49 one above the other and with their axes parallel to that of tube 46.

Securely fastened, as by bolts 54, 55, and 56, to the front end of main frame 10 and having legs 57, is an auxiliary machine frame 58. Mounted on the top of the frame 58 is a bracket 59 that adjustably positions a pusher rod 60 within the bore of tube 46 by means of a clamp 61 and bolt 62. The end 63 of rod 60 lying within the bore of tube 46 serves to push a work blank lying within that tube into position between jaws 37 and 38 of the left-hand gripping means 36 when the carriage 34 moves away from die head

25. At the same time, the semi-finished work blank formerly in the left-hand gripping mechanism 36 is ejected, by a new work blank entering, unto a concave upper surface of a cradle rod 64 (see Figures 6 and 1) supported by bracket 59 and slidably resting on the front section 47 of the carriage 34. There the work blank awaits transfer to the right-hand working stage of the machine.

It should be noted that the cradle rod 64 lies immediately below tube 46 with its upper concave surface disposed in the slotted portion thereof (see Figure 6) and that the upper section of tube 46 is cut away to permit a work blank to fall from the magazine 49 unto the bottom of the tube 46 when the carriage is sufficiently close to the die head 25 to have end 63 of pusher rod 60 in non-interfering position at the front end of tube 46. Thus, the return travel of carriage 34 away from die head 25 results in displacing the work blank in tube 46 into gripping position between the jaws 37 and 38 of gripping mechanism 36 and simultaneously ejecting the semi-finished blank from the gripping mechanism 36 unto cradle rod 64. Subsequently, the travel of the carriage 34 towards die head 25 permits a new work blank from magazine 49 to fall into position within tube 46. Further, since pusher rod 60 is adjustably positioned by clamp 61, different length blanks can be placed in proper position between the jaws of the gripping mechanism so as to extend the same distance forwardly of the jaws towards the die head 25.

Referring to Figures 3, 5, and 6, the right-hand carriage 35 has a bracket 65 on the rear end thereof on which are mounted two spaced rods 66, the front ends of which are supported by a bracket 67 attached to a spring clip carrying member 68 that is fastened to a section 69 of the right-hand gripping mechanism 36. A spring clip 70 is adjustably attached by stud 70a to member 68 and extends between the jaws 37 and 38 of the right-hand gripping mechanism 36 to contact the top of the work piece. The spaced rods 66 serve to support semi-finished work pieces transferred thereto from the left-hand work stage and together with spring clip 70 align the same for clamping in the gripping mechanism of carriage 35. Due to its resilient engagement with a work piece entering the grip jaws, clip 70 further absorbs the momentum developed by the impact of the work piece against the pusher rod 71 and thus precludes excessive forward movement thereof. A similar device, not shown, may be positioned above the cradle rod 64 to frictionally retard and engage a work piece as it is ejected from the tube 46 to clamping position in carriage 34.

A pusher rod 71 is adjustably mounted in bracket 72 by means of a clamp 73 and bolt 74 in the same manner as rod 60. The bracket 72 is mounted on the auxiliary machine frame 58 in the same manner as is aforementioned bracket 59 on the left side of the machine. Rod 71 moves the work piece along spaced rods 66 to proper position for gripping by the right-hand gripping mechanism 36. Thus, as carriage 35 moves away from die head 26, the forward end 75 of pusher rod 71 engages a semi-finished work blank and pushes it into position to be clamped in gripping mechanism 36. The entering semi-finished work piece displaces the finished work piece formerly gripped therein.

The carriage 35 has attached thereto a bracket 76 which carries a deflecting member 77 onto whose inclined surface 78 the finished work falls

and rolls out from the machine through a discharge opening 79 in main machine frame 10.

For the purpose of actuating each of the carriages 34 and 35 linearly, each carriage has a depending lug 80 (Figure 5) formed on the bottom thereof. A carriage driving rod 82 is journaled for rotation in the lug 80, and held against axial movement with respect to the lug by collars 81 fastened to the rod. The other end of the driving rod is threaded into a bore of sliding block 83 by which means it can be adjusted relative to the block. The rod is locked in adjusted position by a locknut 84 on its threaded portion.

Each sliding block 83 is slidably mounted on a cylindrical way 85 mounted between a front end section 86 and rear end section 87 of the auxiliary machine frame 58. Each sliding block has a bifurcated portion 88 extending over a guide rod 89 mounted between the aforementioned sections 86 and 87 and below the cylindrical way 85. Thus, the sliding blocks 83 are confined to linear movement, being prevented from rotating about guide ways 85 by the cooperating bifurcated sections 88 and guide rods 89.

In order to reciprocate these blocks and the carriages connected therewith, a main cam 90 is journaled about and keyed at 90a to a sleeve 91, which in turn is journaled about bearing liners 92 about a main cam driving shaft 93. Shaft 93 extends from the rear of the main machine frame 10 to the rear end section 87 of the auxiliary machine frame 58, as is best shown in Figures 1 and 9.

On the external periphery of the main cam 90 are located cam segments 94, 95, and 96, whose respective surfaces 97, 98, and 99 contact, in sequence, a contact roller 100, of which there is one journaled on each sliding block 83. The cams and rollers effect linear movement of the sliding blocks 83 as the main cam 90 is rotated (see Figures 1 and 5). It should be noted that clockwise rotation of the main cam 90 when looking toward the rear of the machine as in Figure 3, results in having cam segment 94 move each carriage to work threading position. Cam segment 95 imparts a lead screw motion to the carriage during the threading operation, and cam segment 96 returns the carriage for the start of a new cycle. Each phase of the movement of carriage 34 is 180° out of phase from the corresponding phase of carriage 35 with respect to rotation of the main cam 90.

Since the rise of the cam segment 95 and the rate of rotation of main cam 90 relative to that of the spindles 17 and 18 determines the lead of the thread being cut, it is obvious that different thread leads can be obtained by varying the rate of rotation of main cam 90 relative to that of spindles 17 and 18 as later will be described. Further, since the throw of cam segment 94 together with the additional rise of cam segment 95 determines the closest proximity between each carriage and its respective die head, it is obvious that minor adjustments thereof may be effected by adjusting each carriage driving rod 82 with respect to its sliding block 83 to avoid any interference.

It also should be noted that the centerline of main cam 90, that of each roller 100, and that of each carriage driving rod 82 are all parallel, which relationship assures transmitting the carriage driving forces smoothly to the carriages 34 and 35. By this arrangement the carriages can be driven with a minimum of misaligned forces which would tend to tilt the carriages. Also, the

opposing forces resisting movement of the carriages are substantially in the line of the actuating forces.

For driving the main cam shaft 93, a chain drive 105 is located at the rear of the machine. This drive includes a sprocket 106 mounted on the rear of the right-hand spindle 18. A sprocket 107 on the main cam shaft 93 is driven by sprocket 106 through chain 108. Sprocket 107 is keyed by key 108a to an end plate 109 rotatably mounted around shaft 93. This plate has a cam recess 110 into which is resiliently pressed, by a spring 111, a driving dog 112 located in a radial recess 113 of an end plate 114 which is mounted on and secured to the rear end of the shaft 93.

This assembly will transmit normal driving forces to shaft 93 but will not transmit abnormal forces. An abnormal force will cause spring 111 to be compressed to permit disengagement of driving dog 112 due to the camming contact of dog 112 with camming recess 110.

As has been mentioned, main cam 90 is not directly mounted on the main cam driving shaft 93, but is mounted about and keyed to sleeve 91 which, in turn, is mounted about bearing liners 92 that are rotatable around cam shaft 93. Since the rotation of cam shaft 93 is too rapid to permit main cam 90 to be directly mounted on and keyed to cam shaft 93, the above-described construction is used. For reducing the rate of rotation of main cam 90, that cam is provided with a large internal gear 120 which is inserted into an annular recess 121 thereof and fastened thereto by screws 122. The gear 120 is driven by an idler gear 123, mounted on a shaft 124 supported by the rear end section 87 of the auxiliary machine frame 58. Idler gear 123 is in turn driven by a small spur gear 125 keyed to the main cam shaft 93 by a key 126, as is shown in Figure 9.

Thus, the ratio of the gears 125 and 120 and that of the sprockets 106 and 107 establishes the rotation of the main cam 90 relative to that of spindles 17 and 18. By choosing different ratios of sprockets 106 and 107, it is possible to cut different leads of thread even though cam segment 95 be the same. Further, by adjusting the position of the internal trip, reaming, and chamfering tool 27 along the axis of the respective die head 25 or 26, it is possible to cut different thread lengths. The pusher rods 60 and 71 merely assure that the work protrudes beyond each gripping mechanism 36 by a sufficient yet not an excessive distance.

Referring to Figures 3 and 9, adjacent the end 130 of internal hub 131 of main cam 90 and mounted on and secured to sleeve 91 is a gripping mechanism control cam 132. On either side of cam 132 extend brackets 133 which are formed integral with the rear end section 87 of auxiliary machine frame 58. Each of these brackets has pivoted thereto a follower arm 134 which has a roller 135 engaged in a camming groove 136 of cam 132. Thus, as cam 132 rotates with sleeve 91, the follower arms 134 are oscillated in accordance with the configuration of the camming groove 136 of cam 132 which can best be seen in Figure 9.

The upper end of each follower arm 134 is adjustably connected to a valve stem 140 by adjusting nuts 141 and locknuts 142. One such valve stem is in each valve 143 and 144 to control the operation of the gripping mechanism 36 on carriages 34 and 35, respectively. Referring more particularly to Figures 1 and 3, a high pressure line 150 provides high pressure fluid to ports 151

and 152, respectively, of valves 143 and 144 and each valve has two lines 153 and 154 including flexible portions 153a and 154a to the respective fluid motor 39. By reciprocation of the stem 140 in each valve, high pressure fluid is delivered, alternately, to opposite ends of each fluid motor 39 to control the clamping and releasing of each gripping mechanism 36.

A transfer mechanism is used for the purpose of transferring the semi-finished work blanks from the cradle rod 64 of the left-hand working stage to rods 66 of the right-hand stage, as will now be described.

Referring to Figures 6, 7, 8, and 10, the front end section 86 of auxiliary machine frame 58 has an integral vertical bracket 160 in which is journaled a transfer drive shaft 161 that has a drive pinion 162 keyed to one end thereof. An integral offset boss 163 of bracket 160 has mounted therein a pin 164 carrying a gear segment 165 rotatably mounted thereon for oscillatory movement thereabout. Gear segment 165 has a cam roller 166 which is actuated in accordance with the configuration of cam groove 167 on the rear face of main cam 90. Thus, oscillations of gear segment 165 are transmitted to transfer drive shaft 161 by drive pinion 162.

An inverted Y-shaped bracket has its diverging legs 171 thereof fastened to opposite sides of the main machine frame 10, and its middle leg includes a large boss 172 in which is keyed, by pin 173, the shank 174 of an interrupted beveled gear 175.

A bushing 176 is disposed within the bore of interrupted beveled gear 175; and, in turn, reduced end 177 of transfer sleeve 178 is rotatably mounted therein. An annular surface 179 of the transfer sleeve 178 abuts the front face 180 of the interrupted beveled gear 175, while collar 181 on reduced end 177 of transfer sleeve 178 restricts axial movement of the transfer sleeve 178 in the opposite direction.

Disposed between the under face 182 of gear 175 and face 182a of boss 172 is a plate member 183 having a flanged edge 184 which is interrupted as at 185. It should be noted that the interrupted portion 185 of plate member 183 is in angular phase with the uninterrupted or tooth bearing portion 186 of gear 175 and that plate member 183 is keyed to gear 175 by a pin 187 to maintain that relationship by eliminating any possible relative rotation of these members.

Through bore 190 of the central section of transfer sleeve 178 extends a cylindrical transfer arm 192 whose reduced end 193 is journaled in a bushing 194 in a housing 195 and which extends up to the central section of transfer sleeve 178. The extreme lower end of reduced end 193 of transfer arm 192 has a threaded section on which is mounted a nut 196 to draw the flanged portion 197 of transfer arm 192 against the outer surface of the central section of transfer sleeve 178. In this manner, both the transfer arm 192 and the housing 195 are keyed to the transfer sleeve 178 for rotation therewith.

Section 200 of transfer sleeve 178 is made with large bore 201 in which is a rotatable dog 202 that is keyed to transfer drive shaft 161 by key 203 but which is axially movable with respect thereto. A spring 204 presses against end 205 of rotatable dog 202 to maintain camming notch 206 in end 207 of dog 202 in engagement with a drive pin 208 extending through the transfer sleeve 178, there being a stop nut 209 about transfer drive shaft 161 and engaging threaded por-

tion 210 of transfer sleeve 178 to resist the opposing action of spring 204. Thus, the oscillations of transfer drive shaft 161 are transmitted to the transfer sleeve 178, and any excessive oscillations thereof such as would injure the aforementioned parts or any interference with the rotation of transfer sleeve 178 is provided for by this safety device.

About transfer arm 192 is rotatably mounted a transfer grip sleeve 215 which has a beveled gear 216 formed integral therewith and adapted to engage and coast with the toothed section 186 of interrupted beveled gear 175. Transfer grip sleeve 215 has keyed thereto, by a key 217, a collar 218 having a recessed portion 219 on its periphery which, when the recessed portion 219 is in sliding contact with an end face 220 of flanged portion 184 of plate member 183, as is best shown in Figure 7, frictionally restrains rotation of the grip sleeve 215. Thus, transfer grip sleeve 215 is in non-rotatable phase when disposed as is shown in Figure 7, but in rotatable phase when the parts 184 and 219 are disposed as in Figures 8 and 12. It further should be noted that housing 195 surrounds these parts to prevent the ingress of foreign matter to the aforementioned working parts.

As is best shown in Figure 6, the transfer grip sleeve 215 is retained on the transfer arm 192 by a lock nut 225, and its reduced upper portion 226 carries a fluid-operated grip mechanism comprising a stationary jaw 227, a movable jaw 228, pivoted thereto at pivot point 229, and a fluid motor 230 disposed between the respective ends 231 and 232 of these jaws. Fluid motor 230 includes a spring 235 within its bore 236 and pressing against fixed piston 237 which is opposed to the inlet of high-pressure fluid from line 238. The means for controlling the flow of high pressure fluid in line 238 later will be described; however, it is obvious that the flow thereof to piston 237 results in clamping the jaws 227 and 228 by shifting the cylinder 230 and compressing spring 235 which serves to hold them open.

In the embodiment shown, the jaws 227 and 228 may clamp the work piece adjacent one end, as shown in Figure 3, so that at the end of the transfer movement it is deposited between the abutment 75 and the gripping mechanism on carriage 35. However, other ways of assuring that the transfer mechanism deposits the work piece in the proper place may be used, since the particular expedient used may vary according to the particular machine.

For controlling the flow of high-pressure fluid in line 238, a disk cam 240 is mounted on end 241 of sleeve 91 (see Figure 7) and is keyed thereto by key 242 to rotate therewith and is retained thereon by collar 243 which is threaded on end 241 of sleeve 91.

Disposed above the periphery of disk cam 240 is a camming roller 245 attached to stem 246 of valve 247 which controls the flow of high-pressure fluid from inlet 248 to line 238 and on to fluid motor 230.

Having described the operating parts of my novel machine, I now will describe the operating sequence thereof.

As carriage 34 finishes its forward threading movement, die head 25 opens so as to disengage chasers 29 from the completed thread. As carriage 34 starts its return movement, the gripping mechanism 36 thereon releases the semi-finished work blank, and further return movement of this carriage results in having the semi-finished work

blank displaced unto the concave upper surface of cradle rod 64 while a new work blank is aligned in gripping position as has been described. The return movement of carriage 34 is further utilized to close die head 25 for the next threading operation by actuating a yoke mechanism and trip rods (not shown) as is well-known in the art.

Transfer arm 192 now descends from its vertical dwell position. Sleeve 178 thereon rotates about the arm 192 until it assumes the position shown in Figure 6, after which no further rotation of sleeve 178 occurs because the transfer mechanism is disposed as in Figure 7. Transfer arm 192 continues its rotation toward the semi-finished work blank until the jaws 227 and 228 engage that piece and fluid motor 230 effects a clamping thereof therein.

Transfer arm 192 starts its travel to the second or right-hand work stage; and, after again assuming its position shown in Figure 6, sleeve 178 thereon starts to rotate the semi-finished work blank so that the unfinished end thereof is toward die head 26 by the time that jaws 227 and 228 are above the spaced rods 66 on carriage 35. The flow to fluid motor 230 then is interrupted to release the semi-finished work blank unto spaced rods 66.

Meanwhile, a work piece is being finished in the right-hand stage of the machine. As die head 26 opens and carriage 35 starts its return travel, this finished work piece is displaced by the newly transferred one and is removed from the machine as has previously been described. Further return movement of carriage 35 closes die head 26 in same manner as that of carriage 34 closes die head 25.

Transfer arm 192 has assumed its dwell position, shown in Figure 3, by this time and awaits the completion of the threading operation on the work blank in the left-hand stage which displaced the recently transferred one in the right-hand stage; the latter already being clamped in gripping mechanism 36 of carriage 35 and being advanced to threading position.

This cycle of operation repeats in efficient and economical manner and with positiveness and accuracy not heretofore known.

From the foregoing description of the construction and operation of my machine, it is obvious that I have fulfilled my objectives. It should be especially noted that existing manually-operated double spindle machines can be converted into an automatically operated one by incorporating my invention in an attachment for application thereto, as is shown in the drawings. It should further be noted that power is supplied smoothly to the carriages; that the machine incorporates several safety devices to protect the parts thereof against injury; that the transfer mechanism is of simple construction being actuated only by power from one shaft instead of having individual power sources for the transfer arm and the transfer sleeve; that the use of such a transfer mechanism is not limited only to a machine having two stages; that the semi-finished work blanks are removed from a stage without tilting thereof until they are clear of all obstructions of that stage; and that different types of tools can be carried by the spindles to perform many operations other than threading.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the

scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A metal working machine comprising a frame having mounted thereon at least two work forming devices rotatable about substantially parallel axes; work holding means reciprocable relative to each of said forming devices along paths in alignment with the axes of said work forming devices; guide ways on said frame for said holding means; an extension on said frame and a drive means journaled therein; reciprocable slide means and means on said extension guiding them for movement parallel to the movement of said holding means; means connecting said slide means and said holding means; means connecting said drive and slide means in substantial alignment with the path of movement of said slide means in order to reduce friction and wear; a transfer member operable to grip a work piece after release by a first of said work holding means and to transfer it to a position where it is engaged by a second of said work holding means; and means operable by said drive means for actuating said transfer member and alternately reciprocating said first and second work holding means in automatic timed phase relationship with each other and with said transfer member.

2. A metal working machine comprising a frame having mounted thereon at least two spindles rotatable about substantially parallel axes; work forming devices on said spindles; work holding means reciprocable relative to each of said forming devices along paths in alignment with the axes of said spindles; guide means on said frame for said holding means; an extension on said frame and a drive means journaled therein; reciprocable slide means and rods on said extension guiding them for movement parallel to the movement of said holding means; connecting means between said slide means and said holding means; connecting means between said slide means and drive means in substantial alignment with said guide means and said rods; said drive means being operable to reciprocate each of said work holding means through cycles having similar phases occurring at different predetermined relative periods; and transfer means driven by said drive means in proper phase relationship with said work holding means and operable to pick up a work piece after release by a first of said work holding means, to reverse it end for end, and transfer it to a parallel position for engagement by a second of said work holding means.

3. In a machine, means forming a plurality of parallel work forming stages, each stage comprising a pair of spaced members movable toward each other to clamp a work piece therebetween; means for reciprocating said members from a loading position to a work forming position in a direction perpendicular to their relative movement; means operable to form said work piece when said members are in work forming position; support means extending between said spaced members in the direction of their reciprocal movement and in position to locate the work piece for clamping by said members, one of said supports being operable to receive it after release

thereby; and transfer means automatically operated in timed relationship with the movement of said spaced members with respect to each other and to said work forming means, to transfer a work piece from said one support to another of said supports while reversing it end for end, whereby one end of the work piece is presented to the work forming means of one stage and the other end is subsequently presented to the work forming means of another stage, said transfer means comprising an arm mounted for oscillation about a substantially horizontal axis intermediate said supports and carrying jaws adapted to grip the work piece and lift it from one of said supports and swing it through a curved path to the other of said supports.

4. A machine having at least two spaced work forming means operable to perform successive forming operations on a work piece in automatic timed sequence at two work stations adjacent said work forming means; support means at each station upon which the work is adapted to rest; and mechanism operable to pick up a work piece from one of said support means and transfer it to the other support means while simultaneously reversing it end for end; wherein said mechanism includes a first element rotatable about a first axis, and a second element rotatable about said first axis and about an intersecting axis, means operable to rotate said first element about the first axis, and means operable to cause the movement of said second element about the intersecting axis to be affected by the rotation of said first element.

5. The apparatus described in claim 4, including an element operable to cooperate with said second element to limit the rotation of said second element about the said second axis to only a portion of its period of rotation about said first axis.

6. The apparatus described in claim 4, wherein the last-mentioned means includes a stationary third element having rotating means cooperating with said second element during only a portion of the period of its rotation about said first axis, whereby it is effective to rotate the second element about the said second axis only during the period that said rotating means is in cooperative relationship therewith.

7. The apparatus described in claim 4, wherein the last-mentioned means includes a stationary third element having rotating means cooperating with said second element during only a portion of its rotation about said first axis, and means operating to prevent rotation of said second element about said second axis except during the period said rotating means cooperates therewith.

8. A machine having at least two spaced work forming means operable to perform successive forming operations on a work piece in automatic timed sequence; positive reciprocating means operable to advance work pieces into each work forming means; and a transfer mechanism including a fluid-operated member, operable to clamp a work piece released by one reciprocating means, and to transfer it to another reciprocating means; and means controlling the supply of fluid to said member automatically in timed sequence with operation of said reciprocating means.

9. A machine having at least two spaced work forming means operable to perform successive forming operations on a work piece in automatic timed sequence; reciprocating means including fluid-operated gripping means operable to ad-

vance work pieces to each work forming means; a transfer mechanism, including a fluid-operated transfer member, operable to clamp a work piece released by the gripping means of one of said reciprocating means and to transfer it to another of said reciprocating means; and means operable to control automatically the timed sequence of the movement of said reciprocating means and the respective supplies of fluid to said gripping means and said transfer member.

10. In a power driven machine having a plurality of work forming means operable to perform successive forming operations on a work piece in timed sequence, a work supporting and gripping device associated with each of said work forming means; a transfer means operable in timed relation to the working phase of said forming means to transfer a partially formed work piece from one to another of said work supporting and gripping devices; a work gripping device on said transfer means; and automatic fluid-operated means to render said last-named gripping device effective in timed relation to the operation of said transfer means.

11. A machine having a plurality of movable work carriers; a plurality of forming devices; power means operating said carriers to move work pieces into engagement with said forming devices and including a positive drive connected to said power means operable to disengage upon overload; transfer mechanism operable to move a work piece from one to another of said carriers; and positive drive means for said mechanism connected to said power means and operable to disengage upon overload.

12. The apparatus described in claim 11 wherein said last-mentioned positive drive means includes a two-piece shaft and a connection therebetween disengageable upon overload.

13. A metal working machine comprising a frame having at least two work forming stages each including relatively rotatable and linearly movable elements mounted on said frame; drive means on said frame operable to move elements of said two stages through cycles of linear movement in automatic timed sequence; said drive means including means operable to actuate said elements in their linear travel by forces substantially in line with the forces opposing linear travel thereof; said work forming stages each including a mechanism for automatically gripping and releasing a work piece, means for supporting a work piece in position to be gripped by said mechanism and for receiving said work piece after release thereby; a transfer member operable to grip and transfer a work piece, by bodily lifting it, from one said supporting means to another; said drive means also being operable to operate said transfer member in timed relationship with respect to the movements of said linearly movable elements.

14. The device described in claim 2 wherein said first-mentioned connecting means is provided with means for adjusting its length, whereby the relative positions of said relatively rotating elements at the ends of their relatively linear movements can be determined.

15. A machine having a plurality of movable work carriers, a plurality of forming devices; power means operating said carriers to move work pieces into engagement with said forming devices; transfer mechanism operable to move a work piece from one to another of said carriers; and positive drive means for said mechanism connected to said power means and embody-

ing interengaging means operable to disengage upon overload, said positive drive means including a pair of elements mounted for relative axial sliding movement; a recess in one element, a projection on the other element fitting into said recess; and spring means urging said projection into said recess.

16. In a machine for threading both ends of elongated work pieces, a primary threading device and a secondary threading device disposed in side-by-side relationship; a primary and a secondary carriage aligned respectively with said threading devices and mounted for reciprocation toward and away therefrom; means for alternately reciprocating said carriages; a primary and a secondary work gripping device supported by said carriages and adapted to hold the work pieces during threading; a stationary support mounted in front of said primary threading device; means for feeding work pieces to said support and advancing them endwise in succession toward said primary threading device as said primary carriage is reciprocated; a secondary work support aligned with said secondary threading device; means for advancing work pieces on said secondary support endwise in succession toward said secondary threading device as said secondary carriage is reciprocated; means for releasing said primary work gripping device at the conclusion of the primary threading operation and for moving the same away from said primary threading device a sufficient distance to leave the threaded work piece in exposed position on said stationary support between said primary threading device and said primary work gripping device, said transfer mechanism operating in automatic timed relationship with reciprocation of said carriages, for gripping the exposed work piece intermediate its ends and transferring it bodily to said secondary support and simultaneously reversing it end-for-end, so as to present its unthreaded end to said secondary threading device, and means for causing said secondary work gripping device to then grip the transferred work piece and feed it into said secondary threading device, said secondary support being mounted on said carriage and cooperating with a stationary pusher for causing the work piece to be discharged from said support upon reciprocation of said carriage at the conclusion of the threading operation in said secondary threading device.

17. In a machine for threading both ends of elongated work pieces, a primary threading device and a secondary threading device disposed in side-by-side relationship; a primary and a secondary carriage respectively aligned with said threading devices and mounted for reciprocation toward and away therefrom; means for alternately reciprocating said carriages; a primary and a secondary work gripping device respectively supported by said carriages and adapted to hold the work pieces during threading; a stationary support mounted in front of said primary threading device; means for feeding work pieces to said support and advancing them endwise in succession toward said primary threading device as said primary carriage is reciprocated; a secondary work support aligned with said secondary threading device; means for advancing work pieces on said secondary support endwise in succession toward said secondary threading device as said secondary carriage is reciprocated; means for releasing said primary work gripping device at the conclusion of the primary threading oper-

ation and for moving the same away from said primary threading device a sufficient distance to leave the threaded work piece in exposed position on said stationary support between said primary threading device and said primary work gripping device, and a transfer mechanism, comprising an arm mounted for swinging movement in a substantially vertical plane and also for rotation about its longitudinal axis, a gripping device carried by the free end of said arm; means for causing said arm to swing and also rotate about its axis and bring said gripping device over the exposed threaded work piece on said stationary support, means for causing the gripping device to grip the work piece; means for causing said arm to swing and simultaneously rotate and bring said gripping device and the gripped work adjacent said secondary support in reversed end-for-end relationship; and means for causing the gripping device to release the work and deposit it upon said secondary support, and thereby present its unthreaded end to said secondary threading device.

18. A machine having at least two spaced work forming means operable to perform successive forming operations on a work piece in automatic timed sequence; a work supporting and gripping device associated with each of said work forming means and mechanism operable to transfer a work piece from one of said devices to the other, for successive operation thereupon by said two work forming means, said mechanism including an oscillatory rotatable shaft driven by a positive drive means, a support for said shaft, a grip carrying member rotatable with said shaft and also about an axis at an angle thereto, gripping means on said member a gear fixed to said member and meshing with a cooperating gear on said support; said gears being effective to rotate said member about said axis as the result of rotation of said shaft; means for automatically actuating said gripping devices in timed sequence with respect to rocking movement of said shaft, means for causing said gripping means to grip a work piece when it is released from one of said gripping devices and to release said work piece automatically upon delivery thereof to the other of said supporting and gripping devices.

19. The apparatus described in claim 18 whereby in one of said gears includes a discontinuity whereby the gears are effective to rotate said member about said axis during only a portion of the rotation of said shaft.

20. A machine having at least two spaced work forming means operable to perform successive forming operations on a work piece in automatic timed sequence; and mechanism operable to transfer a work piece from a first to a second forming means, said mechanism comprising an oscillatory rotatable shaft driven by a positive drive means, a support for said shaft, a grip carrying member rotatable with said shaft and also about an axis at an angle thereto, a first gear fixed to said member and a second gear on said support, said gears having tooth means coacting to effect rotation of said first gear during a portion only of the period of oscillation of said shaft and thereby rotate said member about said axis; and means operable to prevent rotation of said member about said axis except when said gears are in cooperative relationship.

21. The apparatus described in claim 20 whereby in said last-mentioned means includes an element fixed to said second gear and having a discontinuous surface, and an element fixed to said

first gear and having a recess arranged for camming contact with said discontinuous surface.

22. In a machine for threading both ends of elongated work pieces, a primary threading device and a secondary threading device disposed in side-by-side relationship; a carriage aligned with each of said threading devices and mounted for reciprocation toward and away therefrom; means for alternately reciprocating said carriages; a primary and a secondary work gripping device respectively supported by said carriages and adapted to hold the work pieces during threading; a stationary work support mounted in front of said primary threading device; means for feeding work pieces to said support and advancing them endwise in succession toward said primary threading device as said primary carriage is reciprocated; a secondary work support aligned with said secondary threading device; means for advancing work pieces on said secondary support endwise in succession toward said secondary threading device as said secondary carriage is reciprocated; means for releasing said primary work gripping device at the conclusion of the primary threading operation and for moving the same away from said primary threading device a sufficient distance to leave the threaded work piece in exposed position on said stationary support between said primary threading device and said primary work gripping device; and a transfer mechanism, operating in automatic timed relationship with reciprocation of said carriages, for gripping the exposed work piece intermediate its ends and transferring it bodily to said secondary support and simultaneously reversing it end-for-end, so as to present its unthreaded end to said secondary threading device.

23. In a machine for threading both ends of elongated work pieces, a primary threading device and a secondary threading device disposed in side-by-side relationship; a primary and a secondary carriage aligned respectively with said threading devices and mounted for reciprocation toward and away therefrom; means for alternately reciprocating said carriages; a primary and a secondary work gripping device supported by said carriages and adapted to hold the work pieces during threading; a stationary support mounted in front of said primary threading device; and having a portion extending between the latter and said primary work gripping device; means for feeding work pieces to said support and advancing them endwise in succession toward said primary threading device as said primary carriage is reciprocated; a secondary work support aligned with said secondary threading device; means for advancing work pieces on said secondary support endwise in succession toward said secondary threading device as said secondary carriage is reciprocated; means for releasing said primary work gripping device at the conclusion of the primary threading operation and for moving the same away from said primary threading device a sufficient distance to leave the threaded work piece in exposed position on said stationary support between said primary threading device and said primary work gripping device; a transfer mechanism, operating in automatic timed relationship with reciprocation of said carriages, comprising a clamp device for gripping the exposed work piece intermediate its ends and means for swinging the gripping device so as to transfer the work piece bodily to said secondary support and simultaneously re-

verse it end-for-end, so as to present its unthreaded end to said secondary threading device; and means for causing the secondary work gripping device to grip and feed the transferred work piece to said secondary threading device.

24. The machine defined in claim 23, wherein said clamp device comprises a pair of relatively movable clamp jaws; a fluid motor for actuating said jaws; a valve on a stationary part of the machine; a flexible conduit placing said valve in communication with said motor; a source of fluid energy connected to said valve; and means for automatically actuating said valve in accordance with reciprocation of said carriages.

25. The machine defined in claim 23, together with independent fluid motors for actuating said gripping devices, and common means for reciprocating said carriages, for actuating said transfer mechanism and for controlling the flow of fluid energy to said fluid motors.

26. The machine defined in claim 23, together with independent fluid motors for actuating said work gripping and clamp devices, and common means for reciprocating said carriages, for actuating said transfer mechanism and for controlling the flow of fluid energy to said fluid motors in predetermined timed relationship.

27. The apparatus defined in claim 18, wherein said gripping means comprises a movable fluid-controlled work gripping element, together with power driven means automatically controlling the supply of fluid to said fluid-controlled work gripping element automatically in accordance with operation of said work supporting and gripping devices.

28. A machine having at least two parallel work forming means disposed in side-by-side relationship, means for causing said work forming means to perform successive operations on a work piece in automatic timed sequence, and trans-

fer means operable to pick up and transfer a work piece bodily from one of said work forming means to the other in timed relationship to operation of said work forming means, said transfer means comprising a mechanism rockable at one end about an axis disposed between and extending substantially parallel to said work forming means, said mechanism terminating at its free end in a work gripping device operable to pick up and lift a work piece from one of said work forming means and deliver it to the other work forming means when said mechanism is rocked about said axis, said transfer mechanism embodying means for causing said work gripping device to rock about an axis substantially normal to said first-named axis and reverse the work piece end-for-end when said gripping device transfers a work piece from one of said work forming means to the other.

29. The apparatus described in claim 28 wherein said transfer mechanism includes a power operated drive means; an oscillatory rotatable shaft driven by said drive means; a grip carrying member rotatable with said shaft and also about an axis at an angle thereto; and means rotating said member about said axis by power supplied by said rotatable shaft.

30. The apparatus described in claim 28 wherein said transfer mechanism includes a power operated drive means; an oscillatory rotatable shaft driven by said drive means; a grip carrying member rotatable with said shaft and also about an axis at an angle thereto; and means rotating said member about said axis by power supplied by said rotatable shaft, said last-mentioned means includes a stationary element which cooperates with said member to cause rotation thereof about said axis by said shaft in its movement.

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