

Aug. 31, 1954

J. H. FRIEDMAN
APPARATUS FOR FORMING BLANKS

2,687,660

Filed Oct. 17, 1951

7 Sheets-Sheet 1

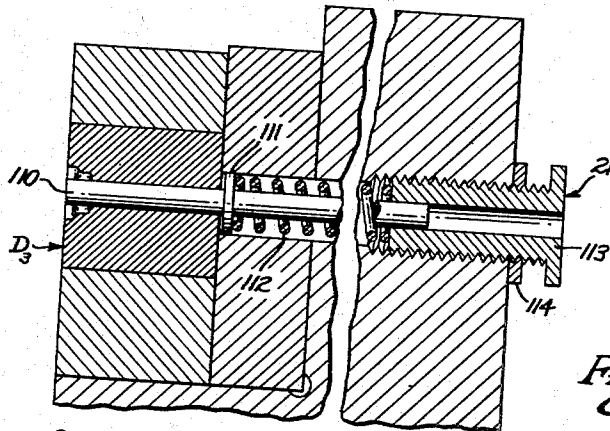


Fig. 6

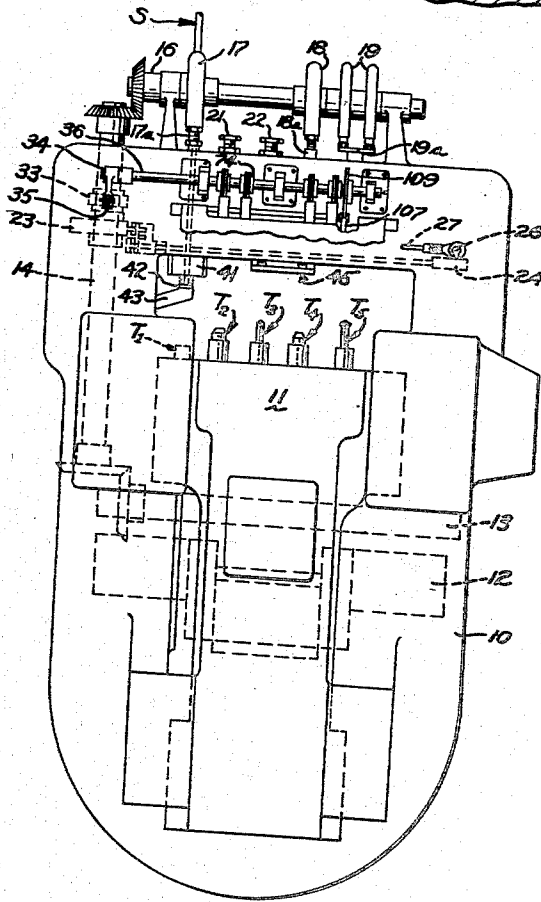


Fig. 1

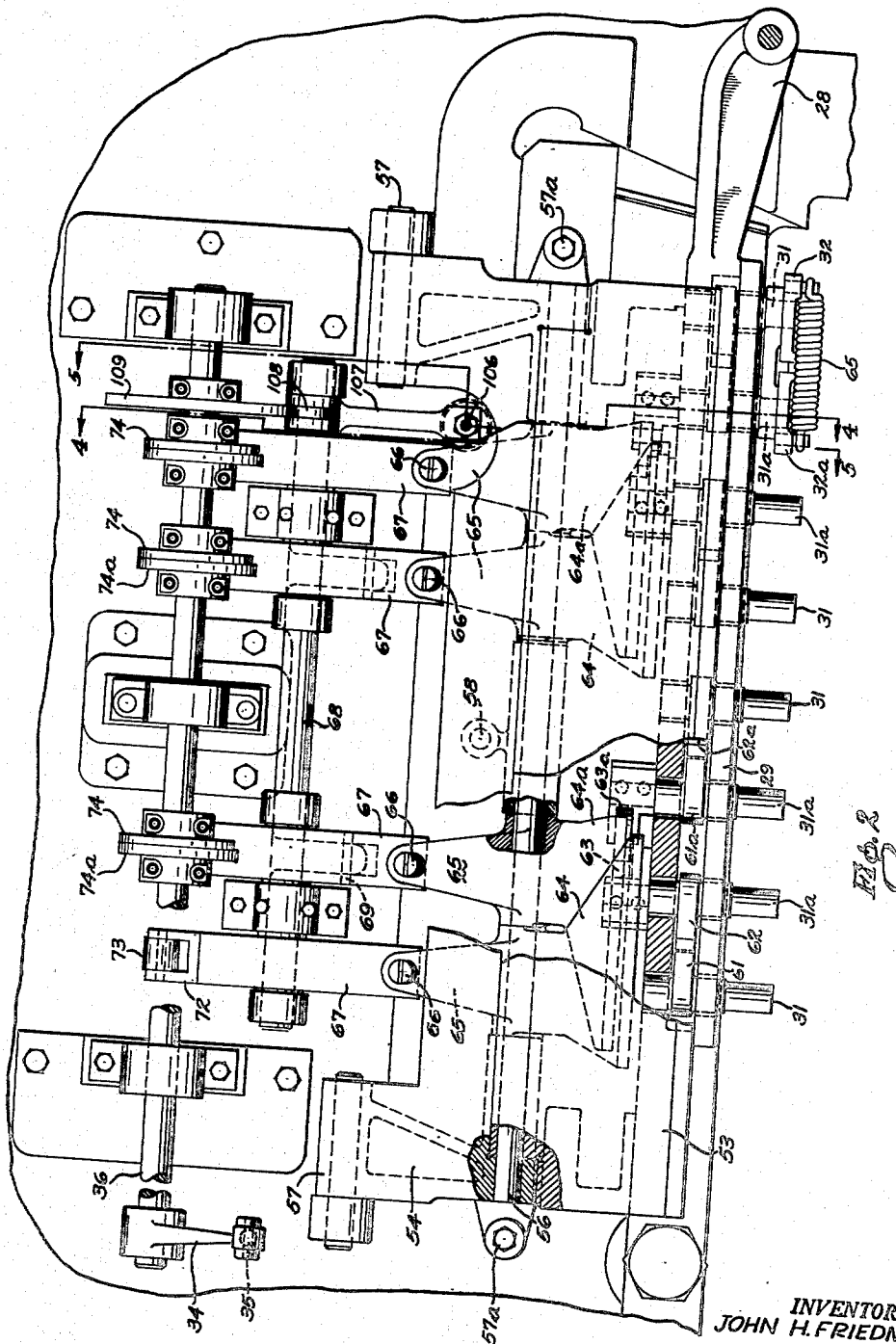
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7 Sheets-Sheet 2



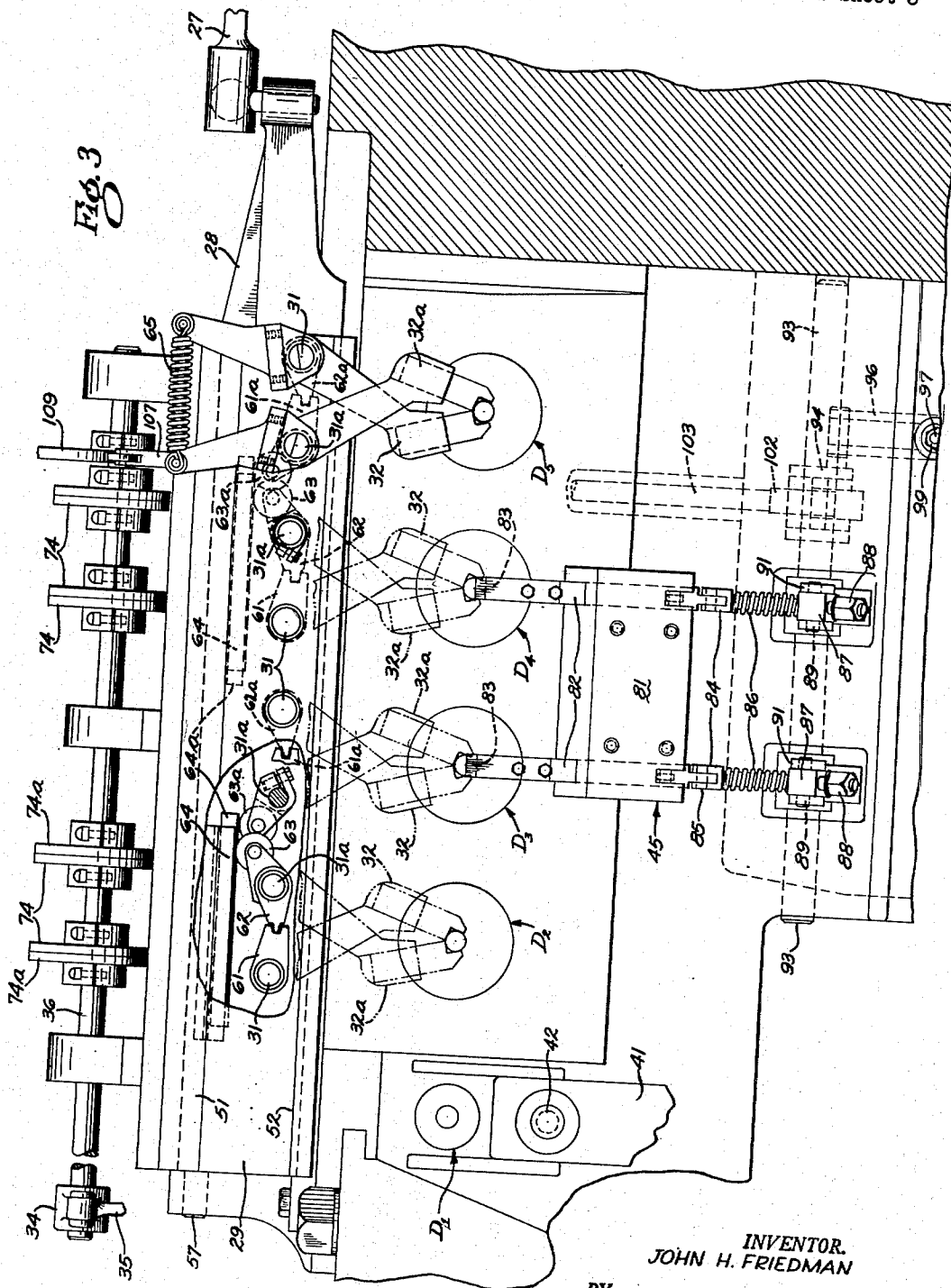
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7 Sheets-Sheet 4

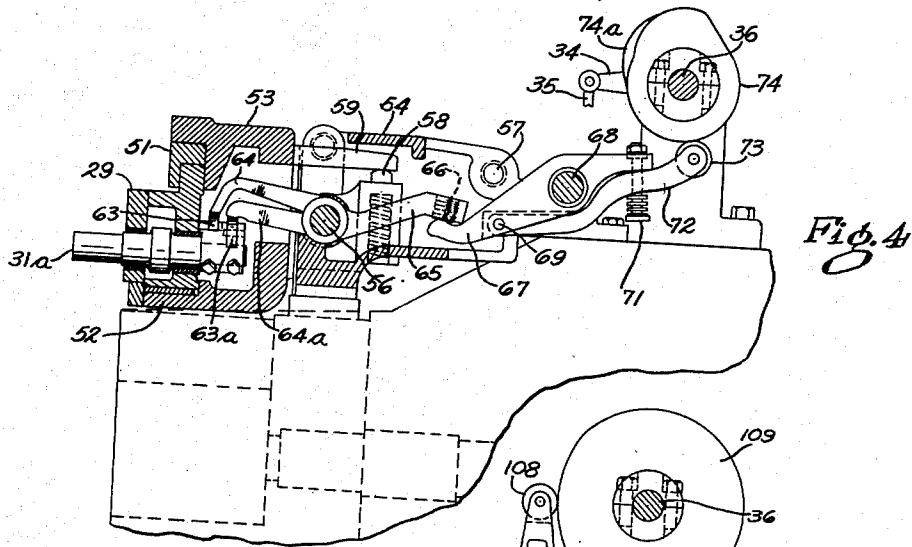


Fig. 4

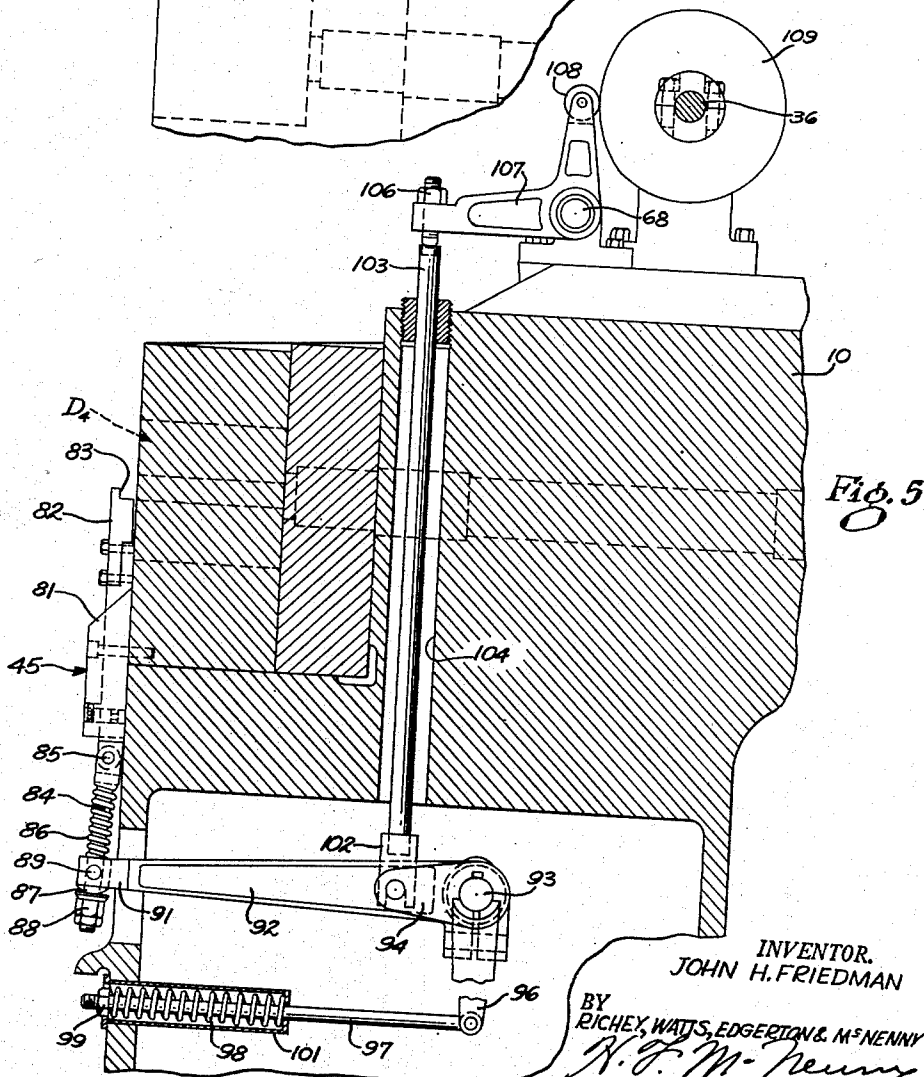


Fig. 5

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7 Sheets-Sheet 5

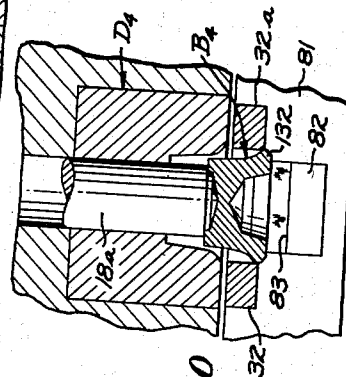
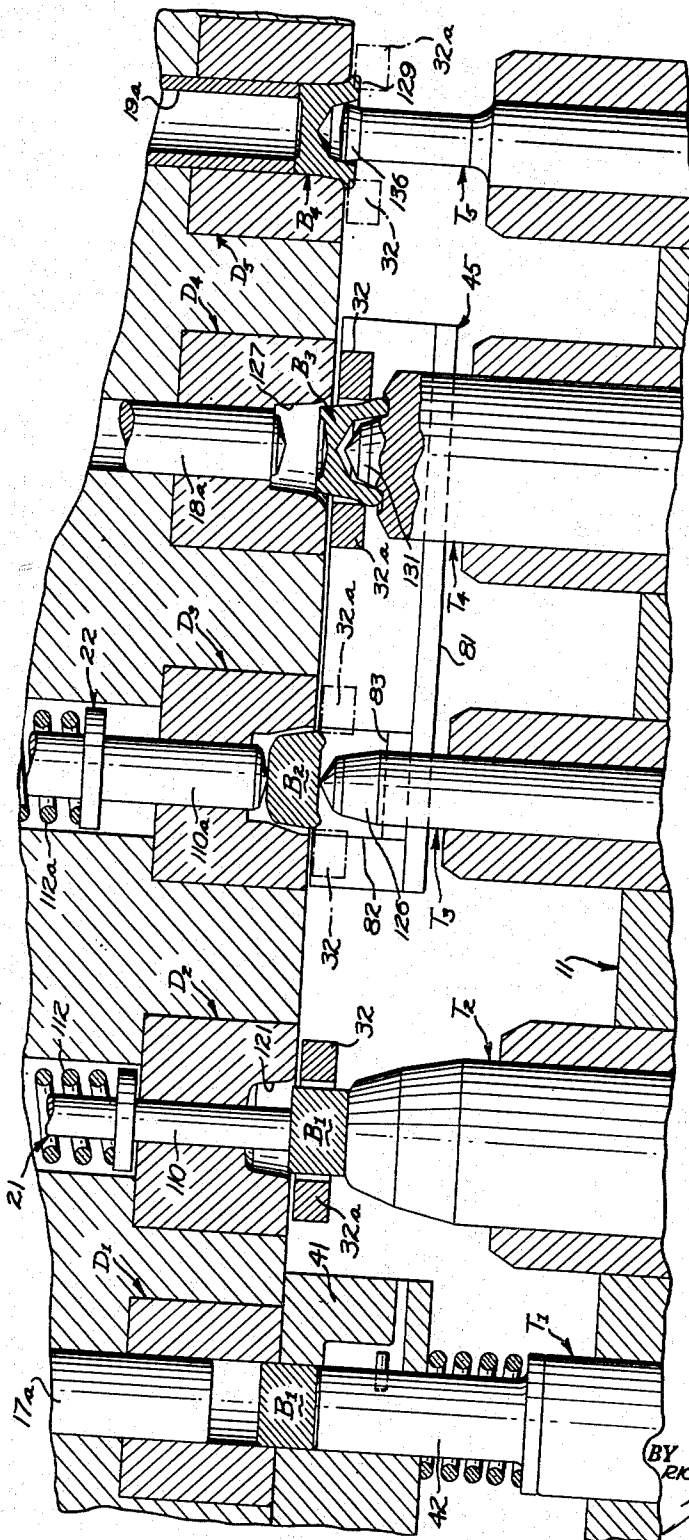


Fig. 7

Fig. 10

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7 Sheets-Sheet 6

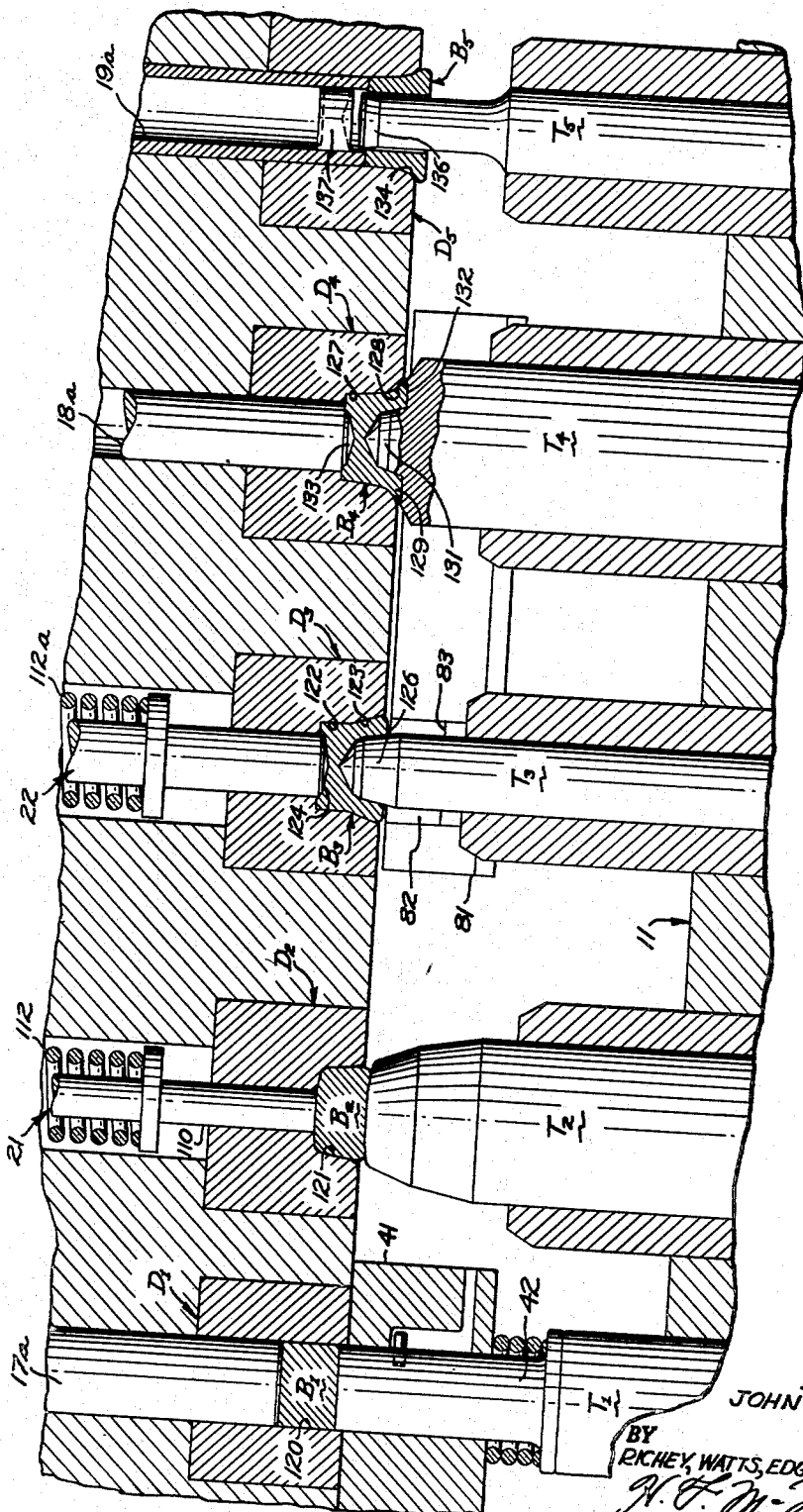


Fig. 8

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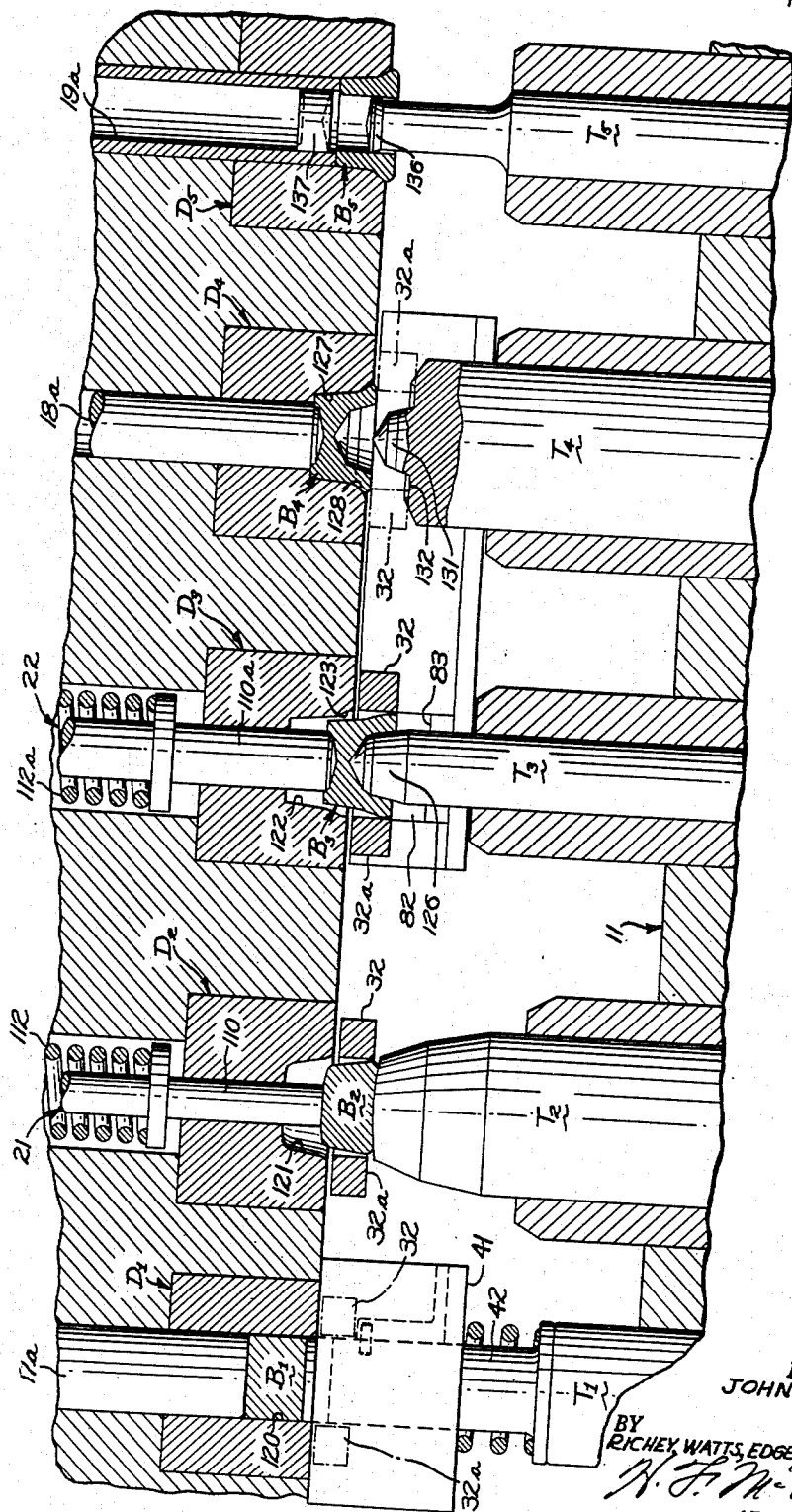
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APPARATUS FOR FORMING BLANKS

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Application October 17, 1951, Serial No. 251,801

12 Claims. (Cl. 78-99)

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This invention relates to metal working and more particularly to apparatus for forming metal blanks having contours heretofore difficult to form by forging or heading operations, particularly with automatic machinery of the type referred to in the art as cold headers.

An object of the invention is to facilitate the formation by cold working of blanks having irregular, tapered, flanged, or other external contours, as well as to facilitate the formation of such blanks without excessive work hardening.

Experience has shown that such blanks present special problems with reference to the use of automatic multiple-station metal working machinery such as cold headers, particularly with respect to blank handling including the automatic transfer of the blanks from work station to work station in the machine.

Machines of the aforesaid type comprise a bed frame, a die breast and a set of dies, a header slide having a plurality of tools thereon aligned with the dies, means to intermittently feed stock, means to shear off lengths of stock and present them to the first work station, and means to successively transfer the blanks from station to station and out of the machine when completed.

Another object of the invention is facilitating the formation of blanks having external contours of the type referred to on multiple-station headers.

Furthermore, the fact that the dies are normally substantially fixed in the die breast and the working tools are fixed to and all move together with the header slide presents problems in regard to the handling of blanks having substantial variation in their axial length as they progress through the cycle. For example, it may be desired to perform operations wherein a blank is flattened at one station by a short, blunt tool and is elongated and pierced by a long, slender tool at another station. Since these tools advance together, it may be found that the blunt tool operating on the shorter blank will interfere with the transfer fingers of the conventional type machine whereas this difficulty will not be encountered with the slender tool because in this case the tool will clear the transfer fingers.

Another object of the invention is the provision of blank-handling apparatus that will accommodate blanks of substantially different axial length, some of which may be tapered. Difficulty has arisen in connection with the formation of externally tapered blanks, because a tapered blank is laterally freed from the tapered die cavity almost as soon as the knockout process begins,

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and such blank should be gripped by the knockout fingers immediately. On the other hand, elongated blanks of the straight side wall type can be almost completely knocked out of the die cavity before the fingers need be brought into place to receive the blank. Thus, the problems of ejecting and holding the blanks on a single machine are varied.

Another object of the invention is to accurately guide and grip tapered blanks. In accordance with the invention, tapered blanks are readily handled, even where variations in blank lengths and potential interference difficulties between the tools and the transfer finger exist, by the use of spring knockouts instead of the usual positively operated cam or lever type knockout. The spring knockouts serve to hold the blanks against the associated tools as the header slide recedes so that where tool interference is likely, the transfer fingers need not be immediately positioned at the die, even if the blank is tapered during the cycle. As a result, I have found that the flexibility of the machine is increased if the transfer fingers at certain stations are moved into or away from the dies ahead of or behind the corresponding motion of other transfer fingers. Problems of this type have restricted the use of prior apparatus, wherein the transfer fingers all move into and out of position or open and close simultaneously by actuation of a single timing cam or similar device to the formation of relatively simple blanks. Another object of the invention is to impart flexibility to the control and timing of the transfer fingers in order to provide an increased variety of blanks that may be produced. My invention includes making the opening and closing motions of each pair of the transfer fingers completely independent of each other, with independent or individual timing means at each set of fingers, whereupon the timing means of each set of fingers may be adjusted with regard to the dictates of the shape of the blank and the nature of the tool and die set, as well as being adapted to most effectively work with various types of knockouts. As a result of the various features and improvements described, flanged and tapered blanks, and blanks with various diameter variations along the exterior thereof and of different axial dimensions during the cycle, may be readily formed in automatic, multiple die, heading machinery.

I have found that other problems arise in connection with the ejection or knockout of flanged or tapered blanks from the dies into the transfer fingers. For example, if a blank having

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a flanged outer end and a tapered body is formed, when ejection begins the transfer fingers must be initially opened enough to receive the large flanged end of the blank and then must close rapidly to maintain a grip on the tapered body. However, since the blank is tapered, once ejection or knockout is initiated, the blank may be freed from compression by the die and may tend to be thrown axially out of the die faster than the fingers can close to accommodate and grip the irregular contour. Such blanks may therefore be dropped or lost in the machine. I have found that this problem, which is a part of the larger problem of blank handling referred to, can be solved by providing properly timed stop or back-up fingers which are moved into the path of axial motion of blanks being ejected, to limit the axial motion of such blanks and assure that the fingers may eventually close upon and properly grip and transport these blanks.

Another object of the invention resides in facilitating the manufacture of certain specially shaped blanks such as blanks for the flanged and tapered inner race for an anti-friction bearing. Such bearing races may be formed, in accordance with the invention, rapidly and accurately and without excessive cold working by shearing a length of bar stock, shortening and enlarging the diameter of the stock with a blunt tool, piercing and elongating the stock with a slender tool and simultaneously expanding it against the mouth of a tapered die, flanging or completing the flange in another tapered die with a blunt tool, and punching a hole in the blank by completing the pierced recess previously formed with a relieved punch.

The manner in which these and other objects and advantages are obtained will be apparent in the following detailed description of the preferred embodiment of the invention.

In the drawings:

Fig. 1 is a general plan view of a typical type of cold header that may be employed to carry out the invention;

Fig. 2 is a plan view of the transfer mechanism;

Fig. 3 is a front view of the die breast;

Figs. 4 and 5 are sections taken on 4-4 and 5-5 of Fig. 2 with parts removed for clarity;

Fig. 6 is a fragmentary section showing a suitable spring-type knockout assembly;

Fig. 7 is a section through the tools and die as the various blanks are being pushed into the dies by the tools;

Fig. 8 shows the completion of the blanks in the dies;

Fig. 9 shows a stage in the knockout or ejection of the blanks from the dies; and

Fig. 10 shows one of the blanks engaging a stop or restraining finger.

Fig. 1 is a plan view showing the elements of a typical cold header suitable for carrying out the invention. Such headers are well known to those skilled in the metal working art and in the interests of clarity only the constructional details of header apparatus peculiar to this invention will be completely described.

The header comprises a massive bed frame 10, a reciprocating header slide 11 carrying tools T₁-T₅ and connected to the usual crank shaft 12 driven by suitable means known in the art. Also provided is a cross shaft 13 driven at crank shaft speed by a suitable gearing also known in the header art.

In the construction shown in Fig. 1 the longitudinal shaft 14 is geared to shaft 13 which in turn drives a cross shaft 16 which operates the knockout means for the dies or work stations. The details of the cams and levers or the like for operating the knockouts and the timing of such devices relative to the other parts of the machine are not critical to the invention and the general principles of such timing and a suitable drive mechanism to accomplish it are known in the art. For example, the construction and timing arrangement of a suitable machine is disclosed in the patent to Clouse, 2,139,936, December 13, 1938. A knockout drive mechanism indicated generally at 17 operates a knockout 17a at the first work station and the same applies to 18 and 18a and to 19 and 19a at other work stations except that knockout 19a is arranged to permit ejection of a punched slug without interference of the knock-out cams and levers. In the embodiment of the invention shown, spring knockouts 21 and 22 are mounted at the second and third work stations.

The blank transfer mechanism (in the form of the invention shown) is operated from shaft 14 by any suitable mechanism not critical to the invention unless otherwise mentioned. Suitable means for reciprocating the transfer fingers between work stations and means for supplying power to open and close the fingers are disclosed in detail in the patent to Clouse, 2,026,823, January 7, 1936. For example, in order to reciprocate the transfer fingers, the cam 23 mounted on shaft 14 moves a rod 24 which is geared or otherwise connected to a vertical shaft 25 causing the shaft to oscillate and in turn reciprocate a rod 27 which connects to the carriage as at 28 (Fig. 3) that mounts the transfer fingers. This carriage indicate at 29 is mounted for reciprocation relative to the die breast and carries the shafts 31 and 31a which mount respectively the transfer fingers 32 and 32a best shown in Fig. 3.

Power for opening and closing the transfer fingers is (as shown in detail in the aforesaid Clouse patent) obtained from a cam 33 (Fig. 1) mounted on shaft 14 for reciprocating the crank 34 (Fig. 1) by means of a vertical shaft 35 (shown in part in Fig. 3) the lower end of which engages the cam 33. This causes timed oscillation of a cross shaft 36 which operates novel mechanism for causing independent opening and closing of each set of transfer fingers, the latter mechanism to be described in detail presently.

A shear 41 (part of which appears in Fig. 3) reciprocates between a lower station which includes the usual shearing quill through which stock S is fed by intermittently operating feed rolls driven by mechanism known in the art, a suitable feed roll drive appearing in the patent to Clouse, 1,856,027. The means for reciprocating the shear and the proper time relationship are not critical to the invention, a suitable construction and timing chart appearing in the aforesaid patent to Clouse, 2,139,936. The shear 41 carries a combined stock gauging and ejecting pin 42 which is urged against a stop 43 (Fig. 1) by the feeding action of the stock feed rolls. The shear is then lifted into position in front of the first die or work station D₁, thereby shearing off the first blank and presenting it to die D₁. The shear is shown in its retracted or lower position in Fig. 3 of the drawings.

The complement of basic elements of the pre-

ferred form of the invention is completed by the blank stop means indicated generally at 45 (best seen in Figs. 3 and 5) the constructional details of which will be described presently.

In accordance with the invention, the shafts 31 and 31a that mount the transfer fingers have their opening and closing motions independently timed. Referring to Figs. 2, 3, and 4, guides 51 and 52 are provided in a housing 53 and serve to permit reciprocation of the finger carriage 29 and the fingers mounted thereon. The guides are seen in section in Fig. 4. A second housing 54 carries a cross or rocker shaft 56 and as best seen in Fig. 2 the housing is pivotally mounted on the frame as at 57. The housing 54 is retained in position by bolts 57a in Fig. 2 but this construction permits lifting the entire assembly clear for repair adjustment. Housing 53 is spring-mounted to prevent damage to the transfer fingers in case of interference between them and the blanks during the knockout operation, by means of a spring-biased plunger 58 which as seen in Fig. 4 engages a projection 59 of the housing 53.

Referring to Fig. 3, a gear sector 61 extends from shaft 31 and mates with a gear sector 62 on shaft 31a. Gear sector 62 on shaft 31a is moved by means of a crank and roller extension 63 which engages an elongated member 64 serving to open the transfer fingers controlled by crank and roller assembly 63. Each set of fingers is urged towards the closed position by springs 65, as best shown in Fig. 3. Another elongated rocker arm 64a engages another crank extension 63a (best seen in Fig. 3) which is mounted on another finger shaft 31a, the same shaft carrying a sector arm 61a which meshes with a sector 62a mounted on the other finger shaft 31. Members 64 and 64a form part of a lever assembly pivotally mounted on rocker shaft 56 and have rearward extensions 65 carrying set screws 66 for providing adjustable operation of the opening motions of the transfer fingers. It will be noted that with the construction just described, each pair of transfer fingers may, by properly timed pressure against the set screws 66, be opened independently of the other pairs of transfer fingers. As best seen in Figs. 2 and 4, the finger-control mechanism includes lever 67 mounted on a rocker shaft 68 and having a rearward extending arm pivoted thereon as at 69 and including a rearward extension 72 and a roller 73 for engaging a pair of cams 74 and 74a mounted on shaft 36. These cams are so shaped that by relative adjustment thereof as well as adjustment relative to the shaft 36, a wide range of opening and closing motions for the sets of transfer fingers are obtainable.

The blank stop mechanism previously indicated generally at 45 is best seen in Figs. 3 and 5. It has been omitted from Figs. 2 and 4 in the interests of clarity. In the construction shown, a block 81 is bolted to the face of the die breast and sliding therein is a pair of fingers 82 which are notched as at 83 to provide shoulders for restraining blanks that may be ejected from dies D₃ and D₄. The positioning of these fingers in front of their respective dies is controlled by the following mechanism. The fingers are pivoted to rods 84 as at 85, the rods being surrounded by coil springs 86 engaging blocks 87 retained by means of nuts 88, giving a controlled adjustment of the vertical position of the fingers. Blocks 87 are pivoted as at 89 in a clevis 91 forming part of levers 92 mounted on a cross

shaft 93 below the die breast. The cross shaft is in turn oscillated by means of a crank 94 suitably keyed thereto. In order to bias the stop assembly, another crank 96 extends downwardly from shaft 93 and has pivotally connected thereto a rod 97 surrounded by a coil spring 98 which abuts against a nut 99 on the rod on one end and a spring casing fixed at 101 in the other end.

To drive the stop fingers, fork 102 surrounds a pin of crank 94 and is connected to a vertical rod 103 passing through vertical bore 104 in the frame. The upper end of rod 103 is urged by means of the aforesaid spring 98 against an adjustable set screw 106 mounted in a bell crank lever 107 which rocks on shaft 68 and carries a roller 108 that is urged against control and drive cam 109 by spring 98, the latter cam being fastened to the timing shaft 36, which is the same shaft that carries the finger-opening cams 74 and 74a. The timing of the stop fingers 82 is adjusted by means of cam 109 to cause them to rise into the path of blanks being ejected from dies D₃ and D₄ during a knockout operation and to cause them to be retracted to clear the header tools during the blank-working operation.

The advantages of the apparatus will be apparent in the following description of the carrying out of applicant's method with an improved tool and die set mounted in the header for production of an inner anti-friction bearing race. The steps in the production of this article are illustrated in Figs. 7 to 10. Referring to Fig. 7, the sheared blank B₁ has, after the shearing operation, been raised into position in front of the die D₁ by the shear 41. The header slide has partially completed its forward stroke. Tool T₁ is in the process of moving pin 42 to eject the blank from the shear into the die D₁. The mechanism controlling the transfer finger carriage is in its advanced or right-hand position as seen in Fig. 3 (no blanks appearing in the latter figure). A previously sheared and squared blank B₁ has been presented by the transfer fingers to die D₂ and is being forced into the die cavity 121 by the header tool T₂. Tool T₂ is a short blunt tool arranged for flattening and enlarging the diameter of the blank in die D₂, and as seen in Fig. 7, the spring knockout 110 urges the blank B₁ against tool T₂ and assists in centering it as it enters the tapered die cavity 121. The transfer fingers 32 and 32a may remain in position to assist in guiding the blank but in view of the blunt nature of the tool T₂ it will be seen that they must be soon opened to clear the tool.

The flattened blank B₂ which was previously formed in die D₂ is being forced by tool T₃ into die D₃. This tool, since it is to perform a piercing operation of the blank well within the die is longer than tool T₂ and has so proceeded further towards projecting the blank B₂ into the die D₃ than has tool T₂. Thus the transfer fingers associated with this stage may be now retracted or opened, the almost complete ejection of blank B₂ into the die D₃ coupled with the centering action of the spring knockout 124 serving to align and guide the blank after retraction of the transfer fingers.

With regard to the conditions at die D₄, blank B₃ made in the previous die is shown partially inserted into die D₄, and the transfer fingers at this station are still in place to assist in centering the blank. However, before the tool T₄ strikes the transfer fingers, blank B₃ will be well aligned by the conical cavity 127 in the die so that the

transfer fingers at die D₄ may be then opened to clear the blunt-nosed tool T₄.

At die D₅, the blank B₄ was advanced early in the stroke into the centered position by the relatively long punch T₅ which, coupled with the shape of the die cavity, makes the centering of the blank relatively easy in the die and has permitted opening of the transfer fingers before possible interference between such fingers and the flanged portion 129 of the blank.

The aforesaid description of the carrying out of a portion of applicant's method by the apparatus described illustrates the advantages attendant upon independent control of the opening motion of the transfer fingers.

Fig. 8 shows the completion of the heading stroke and illustrates the sequences of stations and applicant's method of forming a bearing race. The blank B₁ is squared in die D₁ by tool T₁ and pin 42. The blank is flattened and the diameter thereof is increased and the blank is tapered somewhat in die D₂ by the blunt tool T₂. The flattened blank B₂ is pierced in die D₃ and given a tapered external contour by an elongated piercing tool T₃. In die D₄, the tapering of the blank is accentuated and the blank is flanged as at 129 by a blunt tool having a nose 131 for prevention of filling in of the pierced cavity previously produced. At die D₅, the blank is punched to separate the slug 137 by means of the punch T₅ which is formed with an enlarged nose 136 that provides clearance and reduces wear of the parts. The die cavity 134 of die D₅ is substantially like the die cavity in die D₄. The sleeve 19a serves to receive the slug 137 and to back up the blank during punching and it also acts as a knockout member.

Fig. 9 shows a stage of the knockout operation. The header slide has partially retracted and the transfer fingers at die D₁ need not, due to the cylindrical nature of the blank, be in position until knockout 17a is actuated. The transfer fingers are shown retracted or open at this die, made possible by the individual timing, and for the same reason they could be left in position for holding the blank if so desired. At die D₂, the spring knockout 110 assists in centering the blank against tool T₂ because, due to the tapered wall 121 of the die cavity, the blank B₂ is not guided by the die cavity after knockout begins. The transfer fingers at this stage are individually timed to close in front of the die cavity as soon as the blunt tool T₂ has retracted to give sufficient clearance. This illustrates the cooperation between spring knockout means and independently-controlled transfer fingers.

At die D₃, the blank is centered by cooperation of the conical nose 126 of the tool T₃ and the spring knockout 110a. Here the transfer fingers can be brought into position early in the ejection cycle because of the slender nature of tool T₃.

At die D₄, knockout 18a has not yet been projected by its cam or lever because the blunt tool T₄ would interfere if the transfer fingers were positioned in front of the die. This also illustrates the relationship between the nature of the blank, the independent timing of the transfer fingers, the nature of the tools, and the means for operating the knockouts, in that they all cooperate and make possible the production of a blank heretofore difficult to form on automatic headers.

In view of the tapered and flanged nature of

the blanks in dies D₃ and D₄, they tend to be released from compression in the die as soon as knockout begins and furthermore, the transfer fingers may not be able to close fast enough on the blanks to follow the tapered contour and prevent projecting and shooting the blanks completely clear of the fingers. To prevent the latter, stop bars 82 are lifted (upon retraction of the tools) so that the shoulders 83 act as a guard and insure that the blanks cannot be projected far enough from the die breast to make it difficult for the transfer fingers to close upon and grip the blanks. For example, in Fig. 10 the transfer fingers, which can be timed to be presented so as to initially grip the flange 132 of the blank B₄, must now be rapidly and precisely closed to follow the tapered contour of the blank. If this does not occur and if the blank were otherwise unrestrained, the blank could easily be projected clear of the fingers. This problem is also present if spring knockouts are used, but can be readily solved by adding stop bars 82 where necessary.

Having completed a detailed description of a preferred embodiment of the present invention so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is not limited by said preferred embodiment but rather is defined in what is claimed.

What is claimed is:

1. Apparatus for forming metal articles comprising a frame, a die breast thereon having two or more work stations for the reception of blanks, a header slide reciprocable on said frame, a carriage reciprocable laterally on said die breast, a plurality of pairs of blank transfer fingers on said carriage, means to move the fingers of individual pairs to a blank-gripping and a blank-releasing position independently of each other, blank knockouts for said work stations, means to reciprocate said carriage and all pairs of fingers simultaneously back and forth between a blank-receiving position in front of one work station and a blank-depositing position in front of the adjacent work station, and timing means for said finger-moving means, said timing means being constructed and arranged that when the carriage is in one of its positions relative to the work stations one pair of fingers is moved to one of its positions relative to its blank ahead of the movement of another pair of fingers to the same position relative to its blank.

2. In a metal blank working machine, a bed frame, a reciprocating header slide, a plurality of aligned dies in said frame, tools on said slide for acting on blanks in said dies, a transfer carriage reciprocable along said dies, a plurality of pairs of transfer fingers pivotally mounted on said carriage for reciprocation between adjacent dies, means for reciprocating said carriage, means for moving the fingers of each pair to grip and to release blanks, timing means for said finger moving means for opening one pair of fingers at a different time from another pair, a cam-driven knockout for one of said dies, a spring blank-exPELLING knockout for another of said dies, a blank stop finger movable into position in front of one of said dies, means for moving said stop finger in front of said one die while the knockout for said die is ejecting a blank into a pair of transfer fingers disposed in front of the die.

3. In a metal blank working machine, a bed frame, a reciprocating header slide, a plurality of aligned dies in said frame, tools on said slide for acting on blanks in said dies, a transfer carriage

reciprocable along said dies, a plurality of pairs of transfer fingers pivotally mounted on said carriage for reciprocation between adjacent dies, means for reciprocating said carriage, means for moving the fingers of each pair to grip and to release blanks, a cam shaft on said frame, cams on said cam shaft for moving one pair of fingers at a different time from another pair, a cam-driven knockout for one of said dies, a spring blank-expelling knockout for another of said dies, a blank stop finger movable into position in front of one of said dies, a finger-operating cam on said cam shaft and means between said latter cam and said finger for moving said stop finger in front of said one die while the knockout for said die is ejecting a blank into a pair of transfer fingers disposed in front of the die.

4. In a metal blank working machine, a bed frame, a reciprocating header slide, a plurality of aligned dies in said frame, tools on said slide for acting on blanks in said dies, a transfer carriage reciprocable along said dies, a plurality of pairs of transfer fingers mounted on said carriage for reciprocation between adjacent dies, means for reciprocating said carriage, means for moving the fingers of each pair to grip and to release blanks, knockout means for ejecting blanks from said dies, a blank stop finger movable into position in front of one of said dies, said stop finger having a blank supporting surface aligned with the bottom wall of the die to support an ejected blank, and means for moving said stop finger in front of said one die while the knockout for said die is ejecting a blank into a pair of transfer fingers disposed in front of the die.

5. In a metal blank working machine, a bed frame, a reciprocating header slide, a plurality of aligned dies in said frame, tools on said slide for acting on blanks in said dies, a transfer carriage reciprocable along said dies, a plurality of pairs of transfer fingers mounted on said carriage for reciprocation between adjacent dies, means for reciprocating said carriage, means for moving the fingers of each pair to grip and to release blanks, knockout means for ejecting blanks from said dies including a spring ejection knockout at one die, a blank stop finger movable into position in front of one of said dies, said finger having a blank supporting surface, said spring knockout urging the blank against the associated tool as the header slide retracts from its forward position, and means for moving said stop finger into the path of the spring-ejected blank to limit the outward motion of said blank and support the blank after the said tool is free of the blank.

6. Blank-gripping and transporting apparatus comprising frame means having a plurality of work stations, a carriage reciprocable on said frame means, a plurality of pairs of blank-gripping fingers mounted on said carriage with the fingers of each pair being movable for opening and closing on a blank, finger-moving means on said frame means for independently opening and closing the fingers of each pair, means timing the finger-moving means for one pair of fingers to move such fingers relative to a blank before another pair of fingers are so moved, and means for reciprocating said carriage to simultaneously move each pair of fingers between adjacent work stations.

7. Blank-gripping and transporting apparatus comprising frame means having a plurality of work stations, a carriage reciprocable on said frame means, a plurality of pairs of blank-gripping fingers mounted on said carriage, means

coupling the fingers of each pair together for opening and closing on a blank, a finger-opening crank for each pair of fingers, a cam shaft rotatable on said frame, a cam on said shaft for each pair of fingers, cam follower and lever means between each cam and one of said pairs of fingers, each of said lever means having a crank-engaging portion that is at least as long as the spacing of said work stations, spring means for closing said pairs of fingers, and means for reciprocating said carriage to move each pair of fingers between adjacent work stations.

8. Blank-gripping and transporting apparatus comprising frame means having a plurality of work stations, a carriage reciprocable on said frame means, a plurality of pairs of blank-gripping fingers mounted on said carriage, means coupling the fingers of each pair together for opening and closing on a blank, a finger-opening crank for each pair of fingers, a cam shaft rotatable on said frame, a cam on said shaft for each pair of fingers, independent cam follower and lever means between each cam and one of said pairs of fingers, each of said lever means having a crank-engaging portion that is at least as long as the spacing of said work stations, spring means for closing said pairs of fingers, and means for reciprocating said carriage to move each pair of fingers between adjacent work stations.

9. Apparatus for forming metal articles comprising a frame, a die breast thereon having two or more work stations for the reception of blanks, a header slide reciprocable on said frame, a carriage reciprocable laterally on said die breast, a plurality of pairs of transfer fingers on said carriage for transporting blanks progressively from work station to work station, means to open and close individual pairs of said transfer fingers independently of each other, blank knockouts for said work stations, means to reciprocate said carriage back and forth between a blank-receiving position and a blank-depositing position to advance blanks progressively from station to station, the finger-closing means for one pair of fingers disposed in front of one of said stations when the carriage is in the blank-receiving position being timed to close about its blank before the fingers in front of the other station are closed, a blank stop movable into position in front of the ejecting path of a blank in one of said stations, and means to move said stop into said blank path before the knockout operation on said blank is completed.

10. In a metal blank working machine, a bed frame, a reciprocating header slide thereon, a plurality of aligned dies in said frame having blank-receiving cavities, tools on said slide for acting on blanks in said dies, a transfer carriage reciprocable along said dies, a plurality of pairs of transfer fingers mounted on said carriage for reciprocation between adjacent dies, means for reciprocating said carriage to move all pairs of fingers a distance equal to the die spacing, finger-moving means for opening and closing said pairs of fingers to release and grip blanks, knockout means for ejecting blanks from said die cavities into said fingers, said tools including one tool having a blank-engaging portion that will not pass between closed transfer fingers and another tool having a blank-engaging portion that will pass between closed transfer fingers, and timing means for said finger-moving means that moves a pair of fingers in front of said one tool at a different time than a pair of fingers in front

of the other tool are so moved, so that there is no interference between said one tool and the fingers as the header slide is positioned adjacent said dies.

11. In a metal blank working machine, a bed 5 frame, a reciprocating header slide, a plurality of aligned dies in said frame, tools on said slide for acting on blanks in said dies, a transfer carriage reciprocable along a plane parallel to said aligned dies, a plurality of pairs of transfer fin- 10 gers mounted on said carriage for reciprocation therewith between adjacent dies, means for reciprocating said carriage, means for moving the fingers of each pair of fingers to grip and release blanks, and timing means for said finger 15 moving means for moving one pair of fingers at a different time than another pair.

12. Apparatus for forming metal articles comprising a frame, a die breast thereon having two or more work stations for the reception of blanks, 20 a header slide reciprocable on said frame, a carriage reciprocable laterally on said breast, a plurality of pairs of transfer fingers on said car-

riage for transporting blanks progressively from work station to work station, means to open and close individual pairs of transfer fingers independently of each other, blank knockouts for said work stations, means to reciprocate said carriage back and forth between a blank-receiving position and a blank depositing position to advance blanks progressively from station to station, the finger-closing means for one pair of fin- 5 gers disposed in front of one of said stations when the carriage is in the blank-receiving position being timed to close about its blank before the fingers in front of the other station are closed.

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