Sept. 2, 1924. 1,507,318

C. L. LEE

MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 1

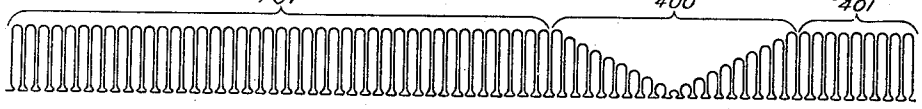


Fig. 40

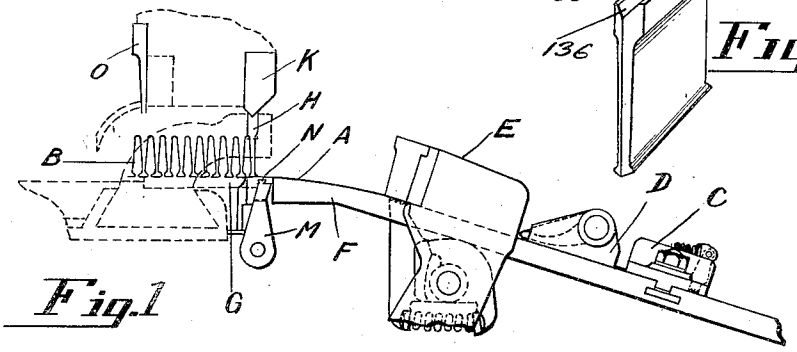


Fig. 1

Fig. 11

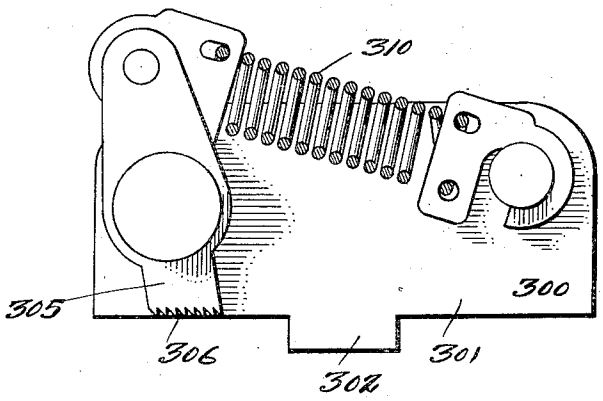


Fig. 35.

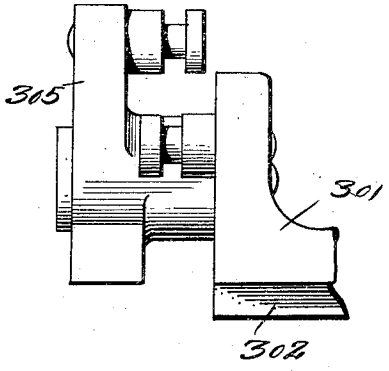


Fig. 36.

Witnesses

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His Attorney

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C. L. LEE

MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 2

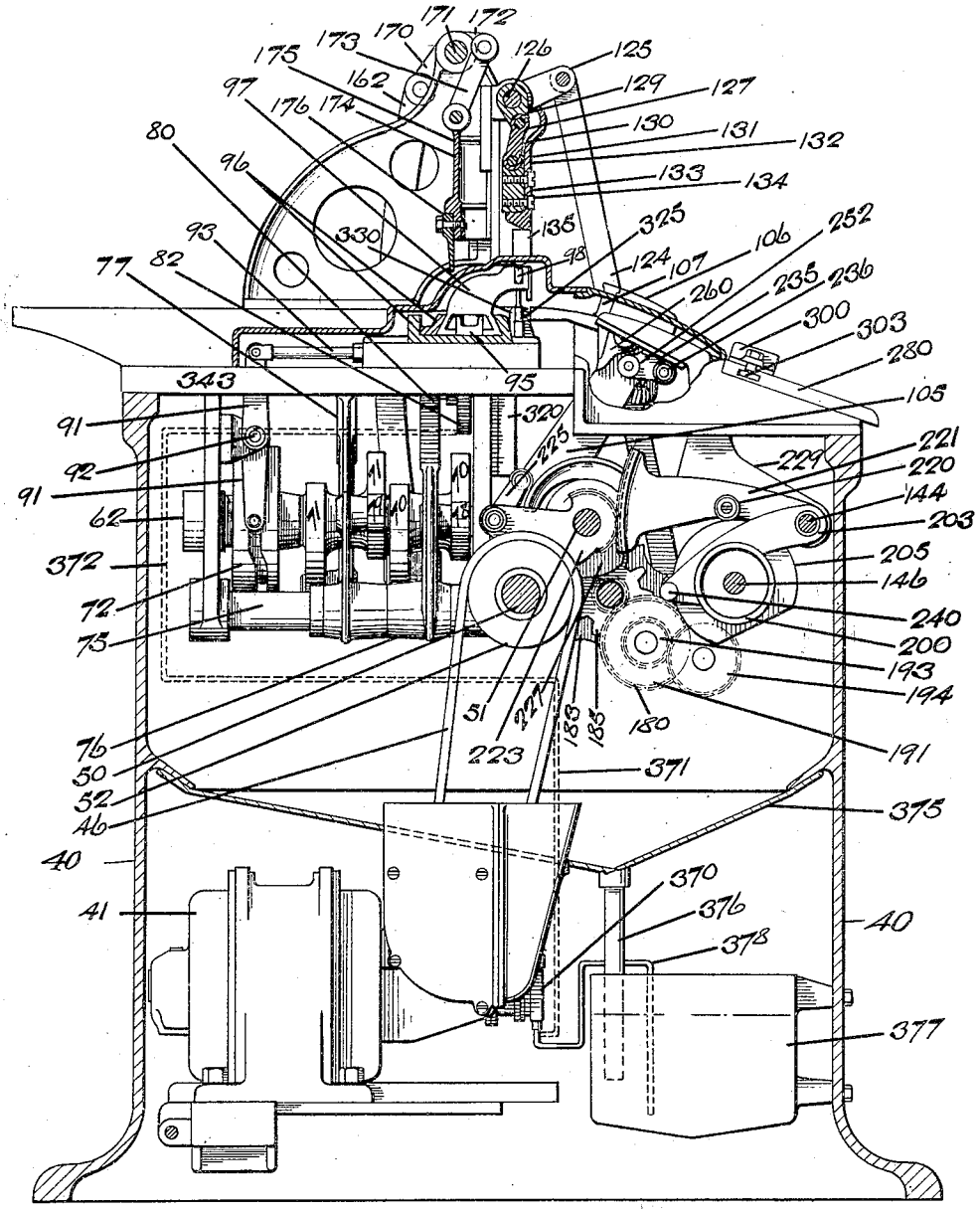


Fig. 2

Witnesses
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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 3

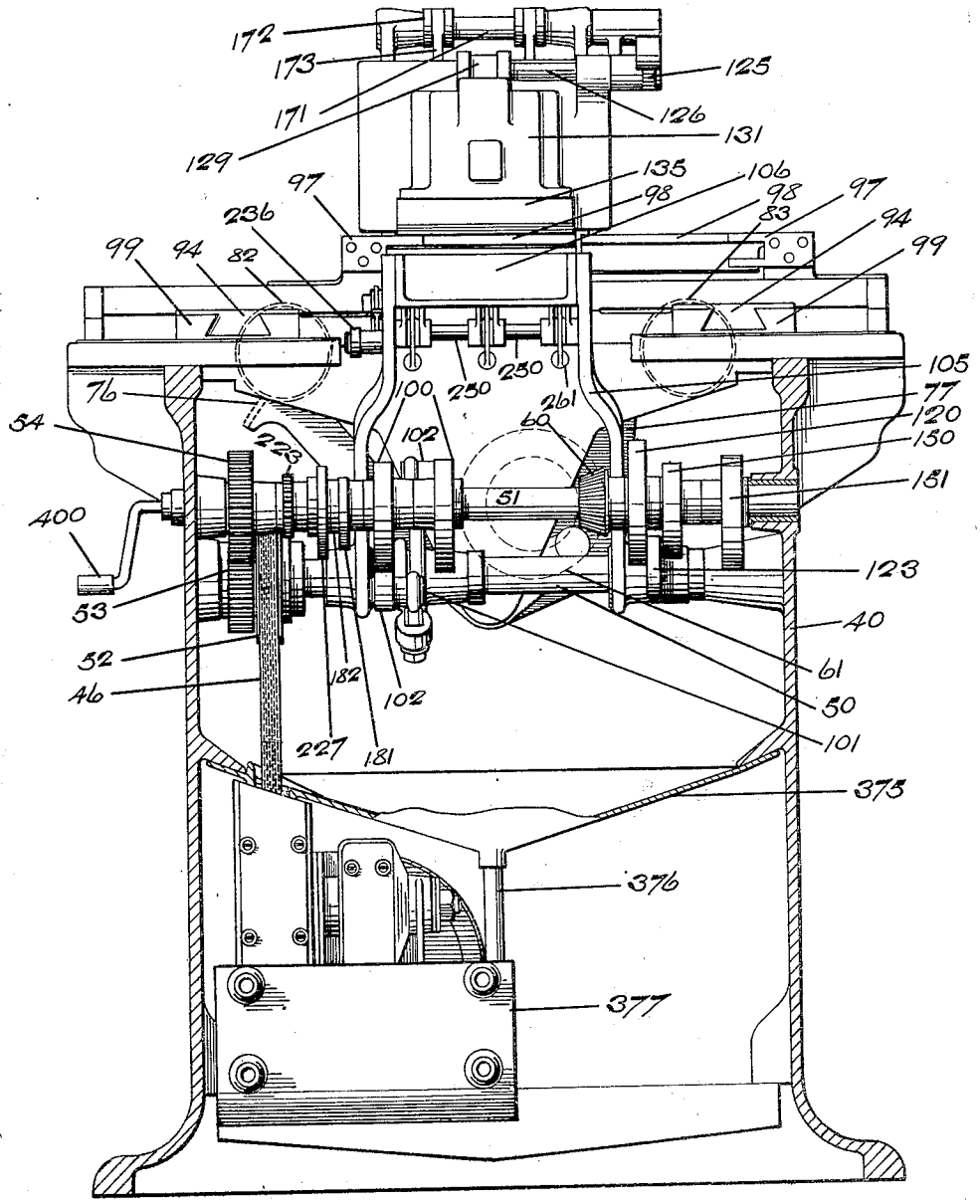


Fig. 3

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 4

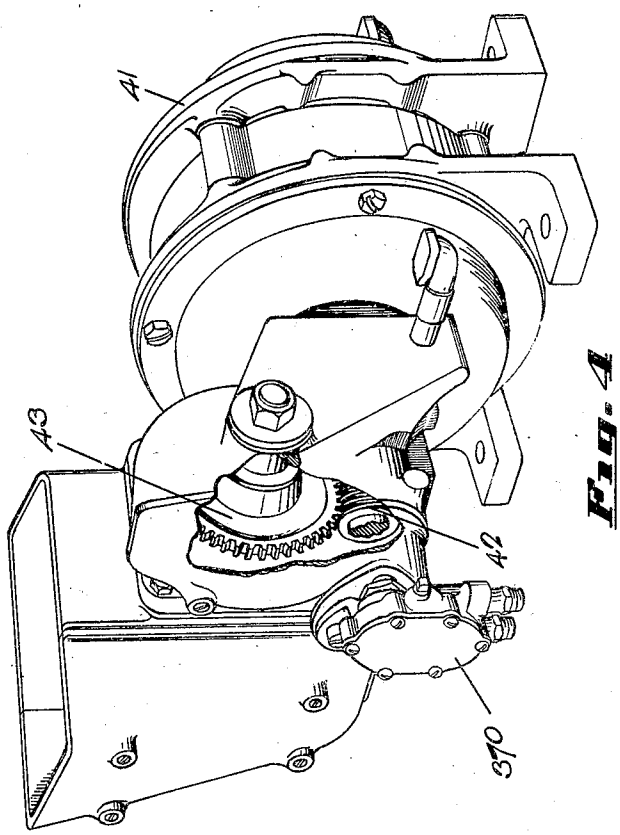


Fig. 4

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 5

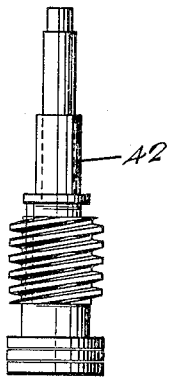


Fig. 5

Fig. 6

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 6

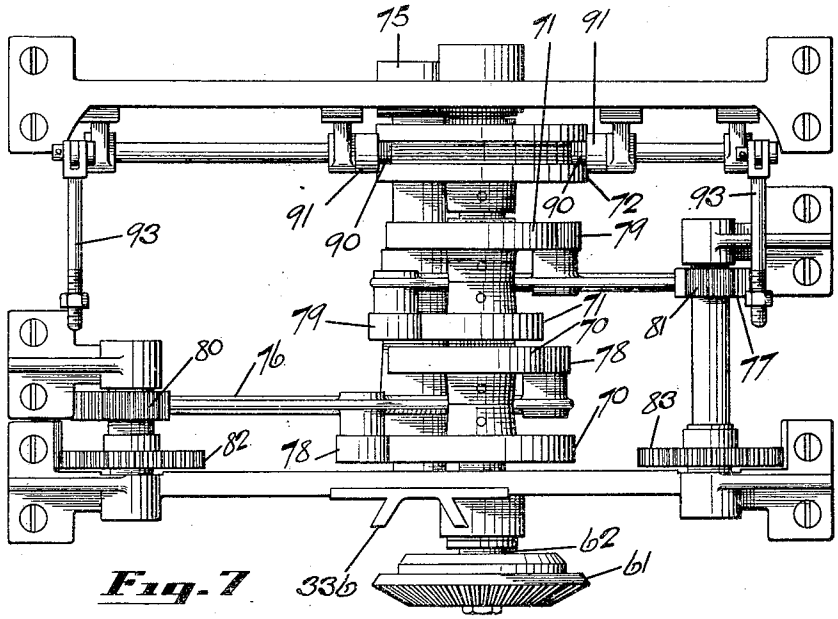


Fig. 7

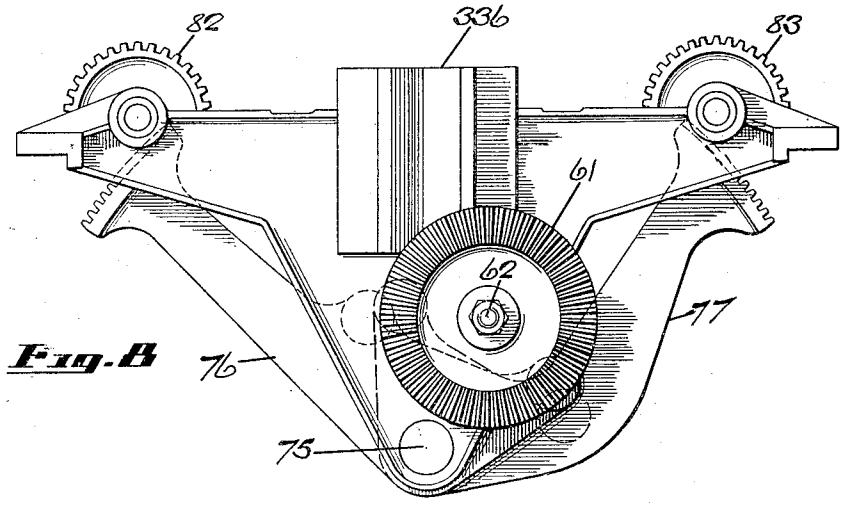


Fig. 8

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 7

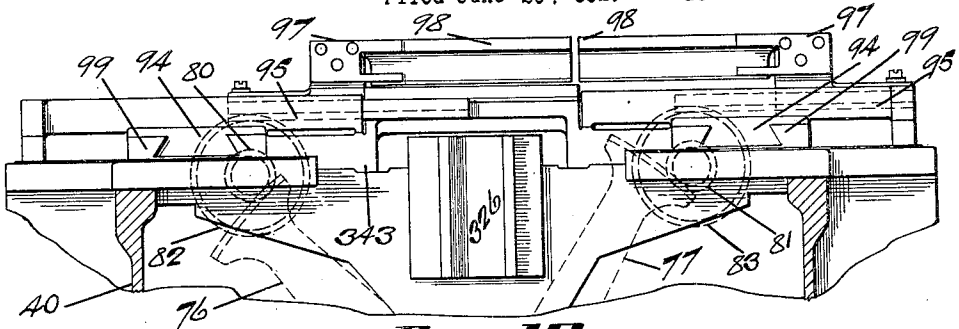


Fig. 10

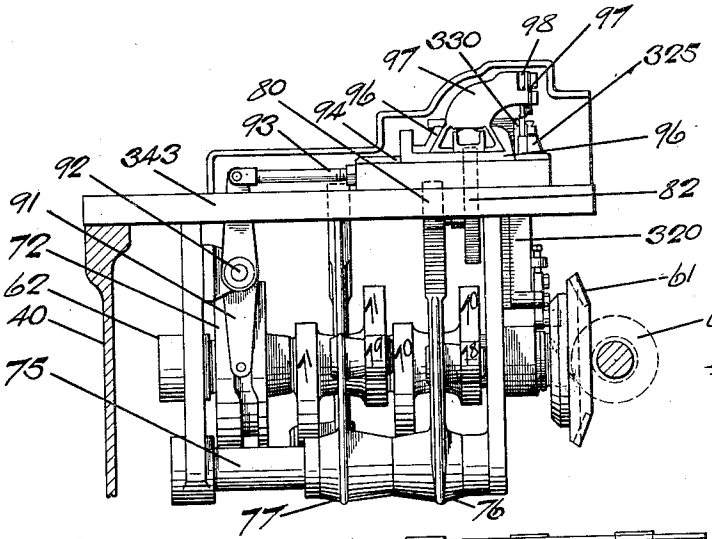


Fig. 9

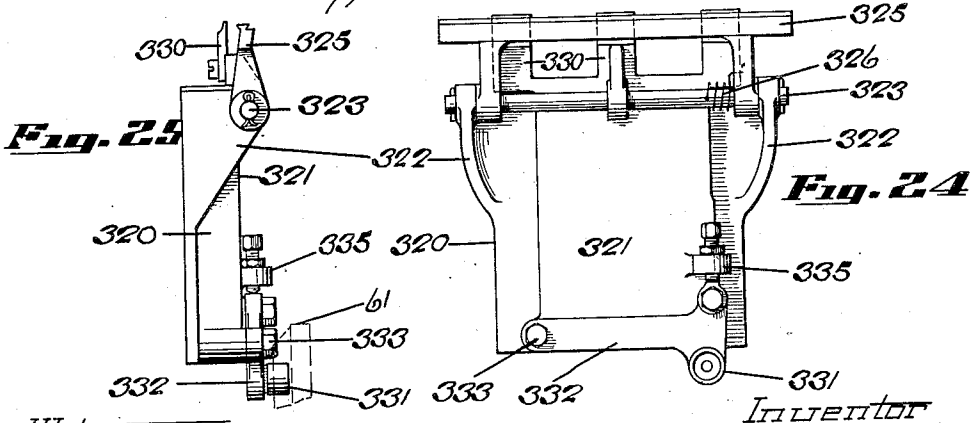


Fig. 25

Fig. 24

Witnesses
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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 8

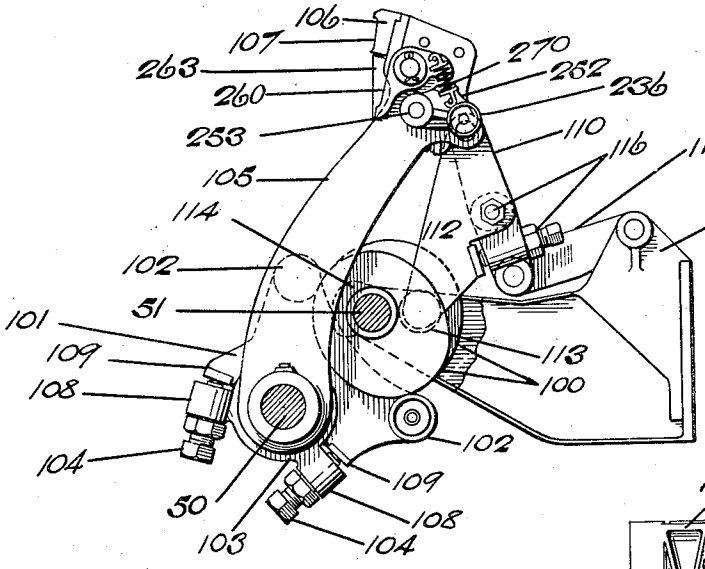


Fig. 12

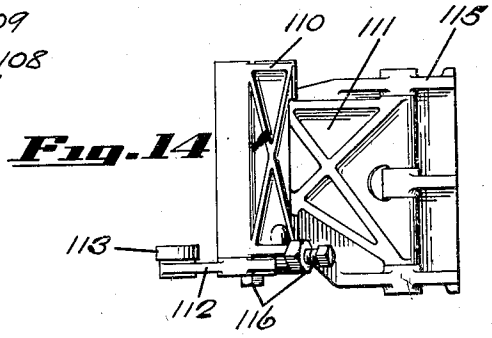


Fig. 14

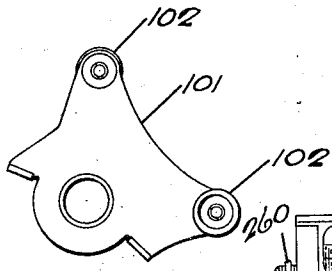


Fig. 15

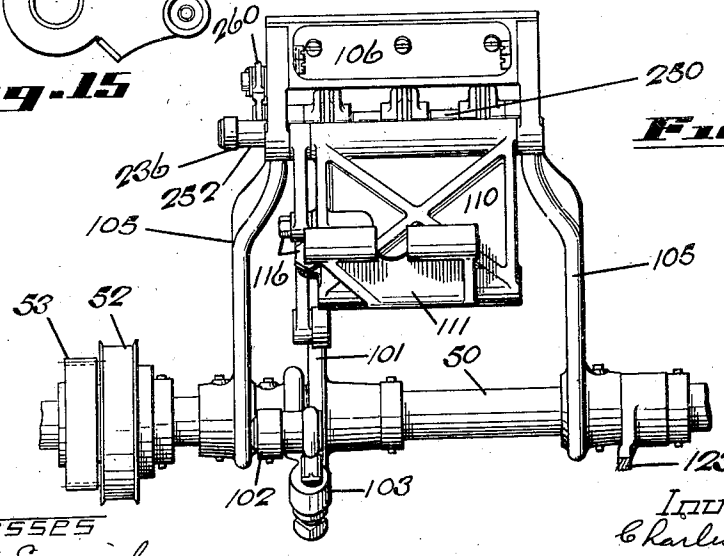


Fig. 13

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 9

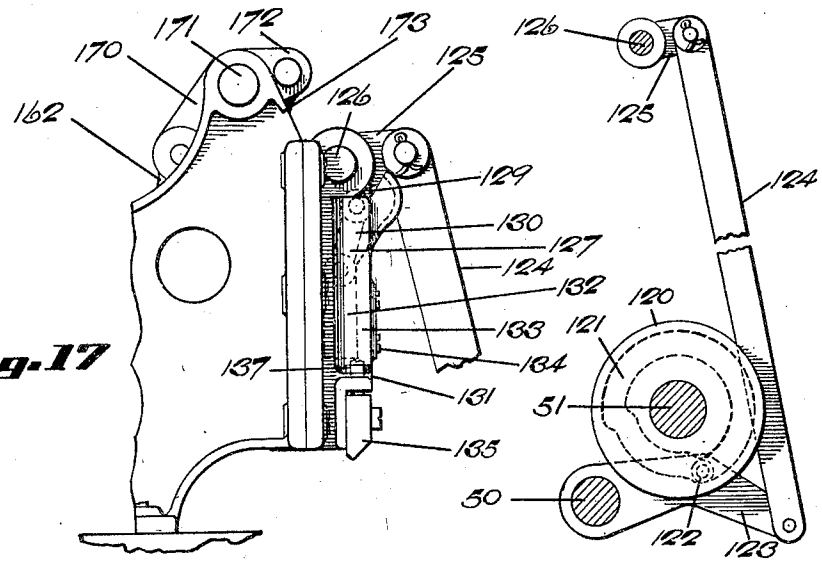


Fig. 17

Fig. 16

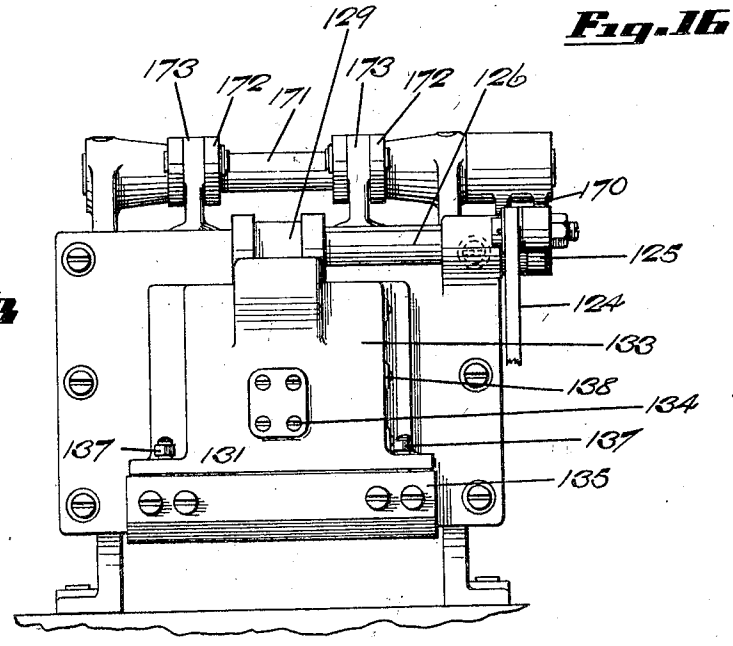


Fig. 18

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 10

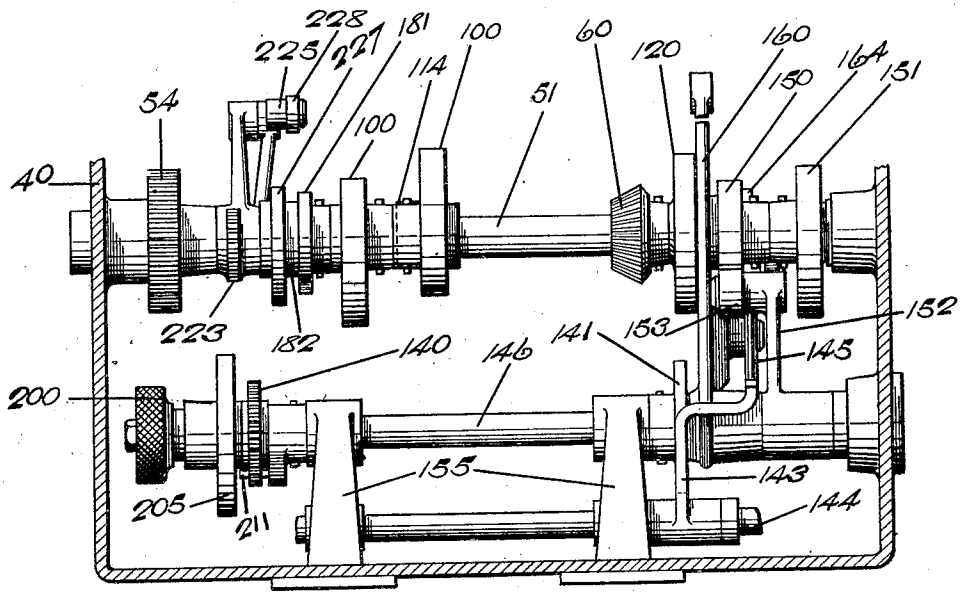


Fig. 19

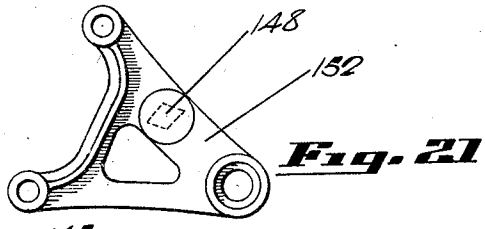


Fig. 21

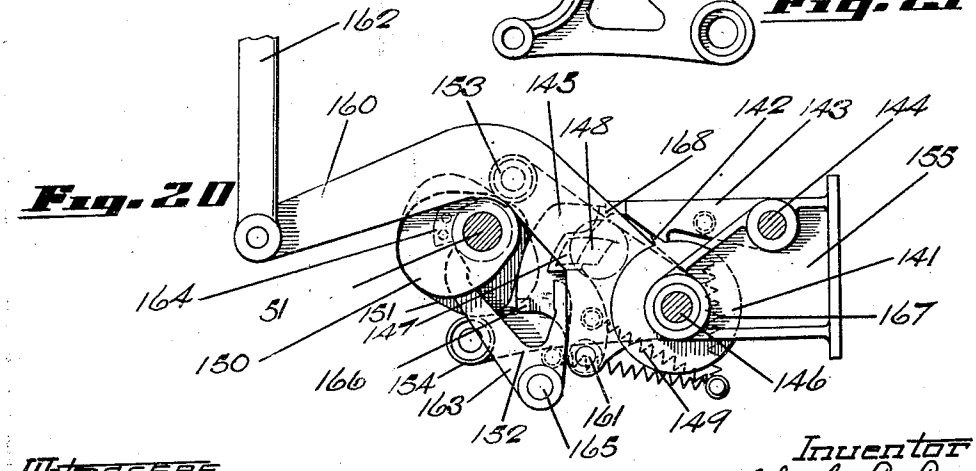


Fig. 20

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Sept. 2, 1924. 1,507,318

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 11

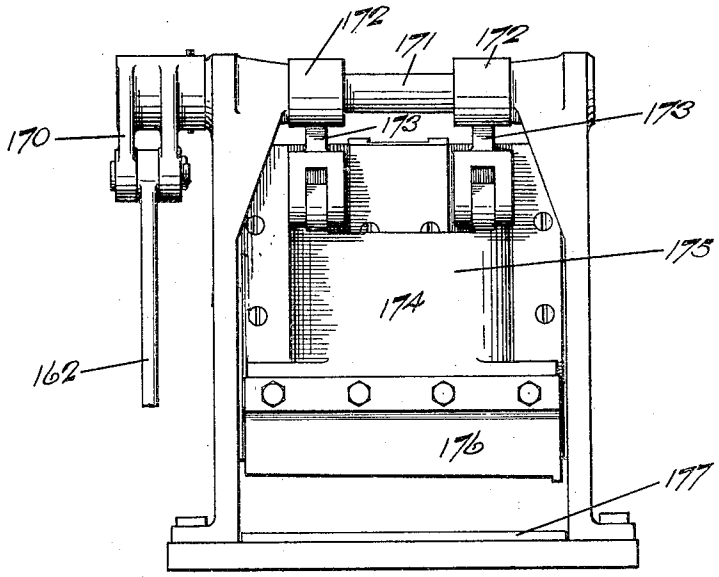


Fig. 22

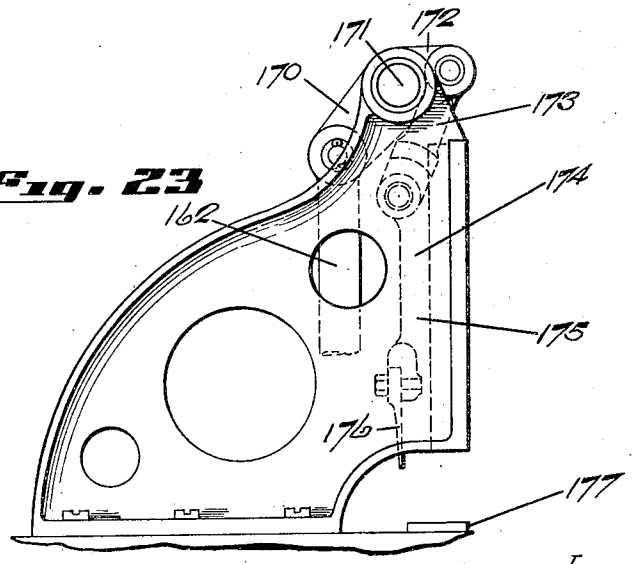


Fig. 23

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 12

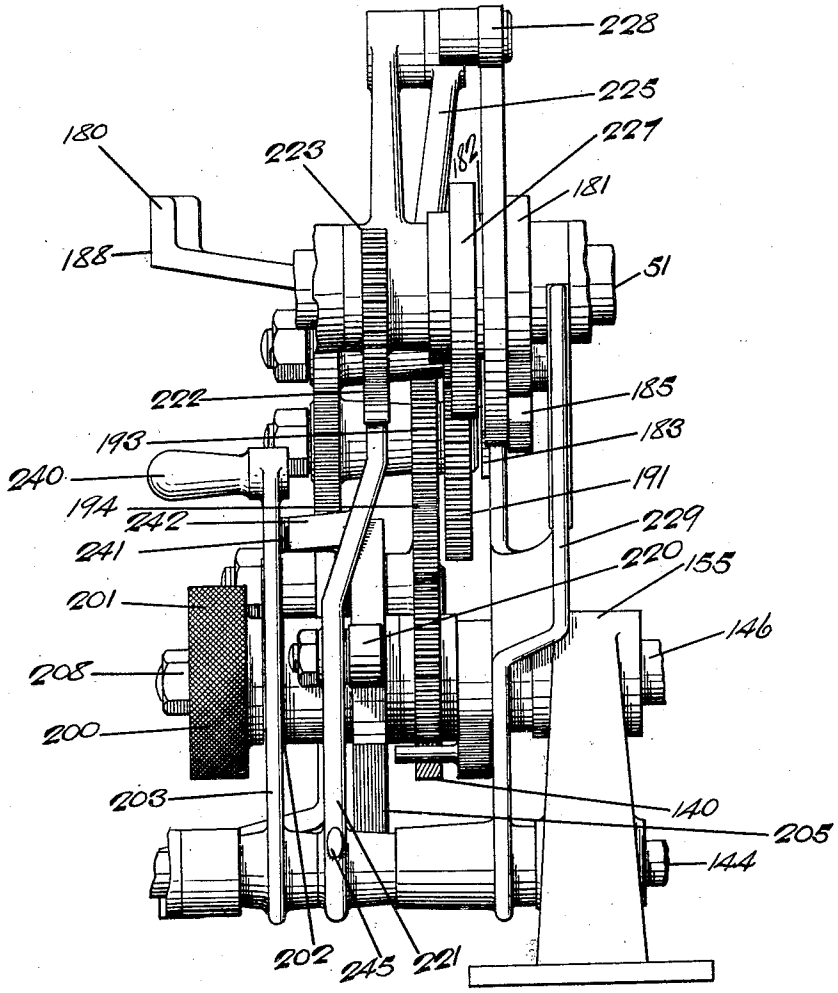


Fig. 26

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 13

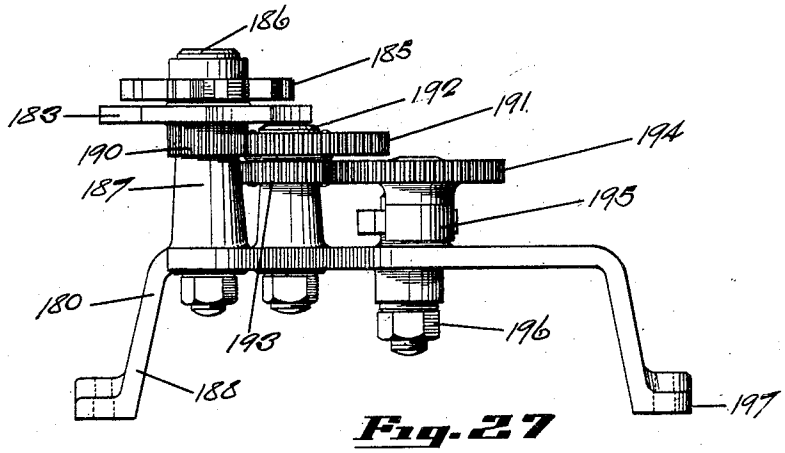


Fig. 27

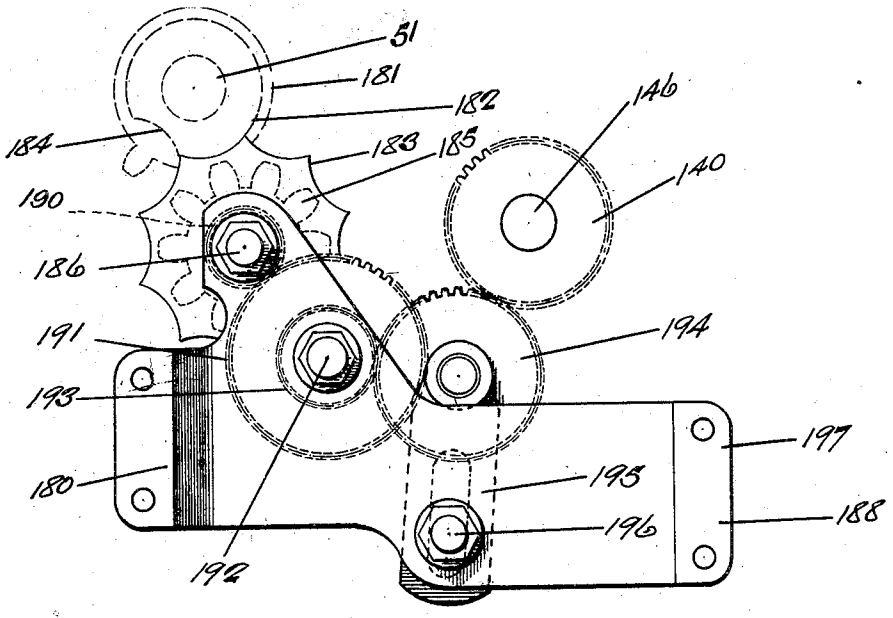


Fig. 28

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 14

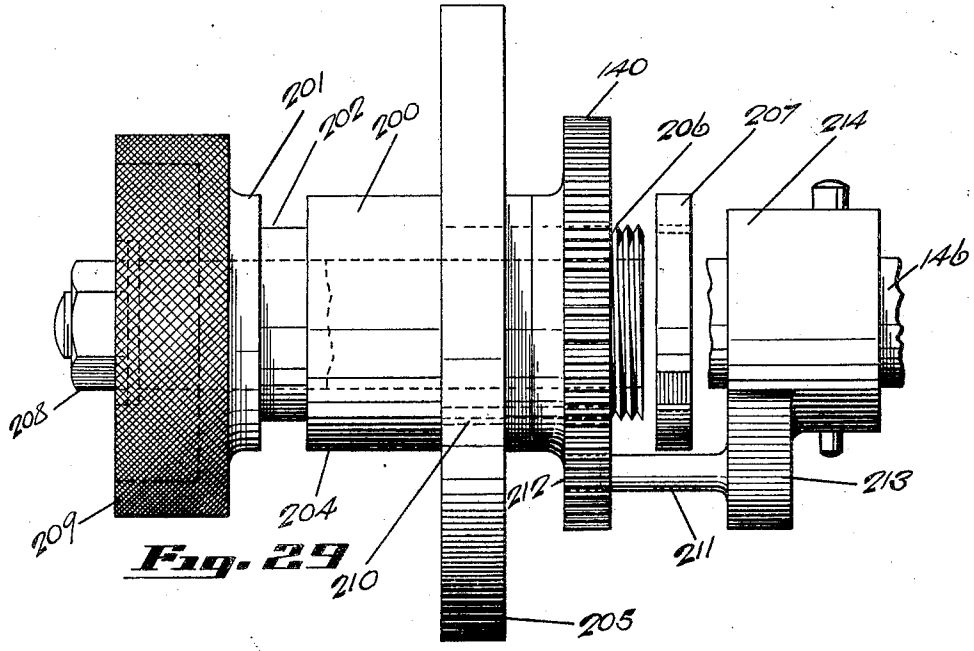


Fig. 29

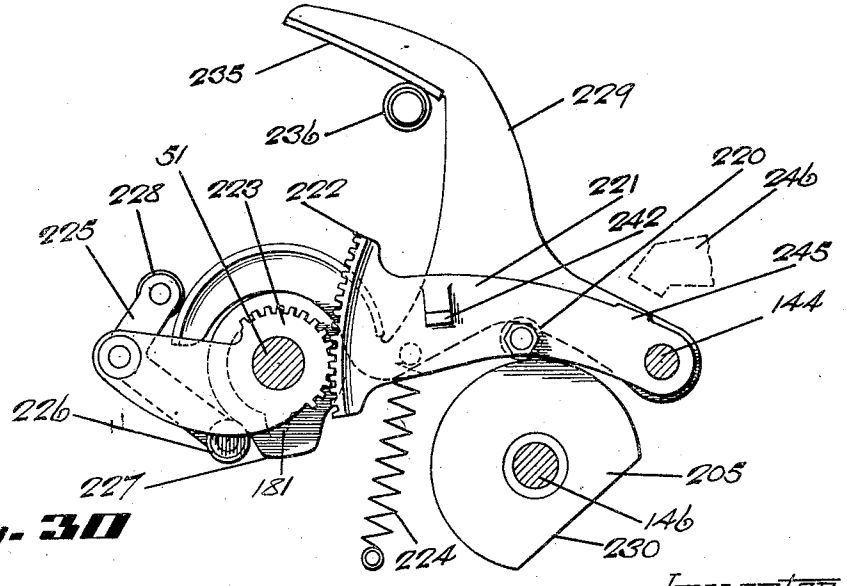


Fig. 30

Witnesses
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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 15

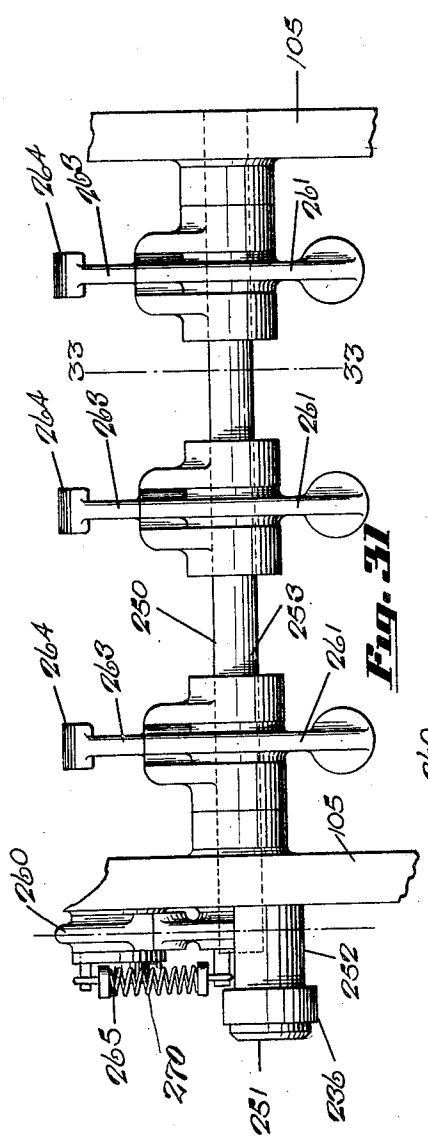


Fig. 31

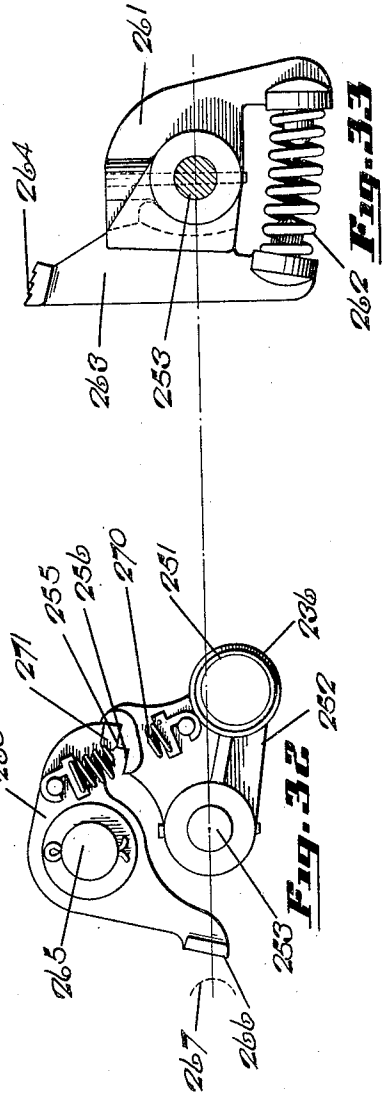


Fig. 32

Fig. 33

Witnesses
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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 16

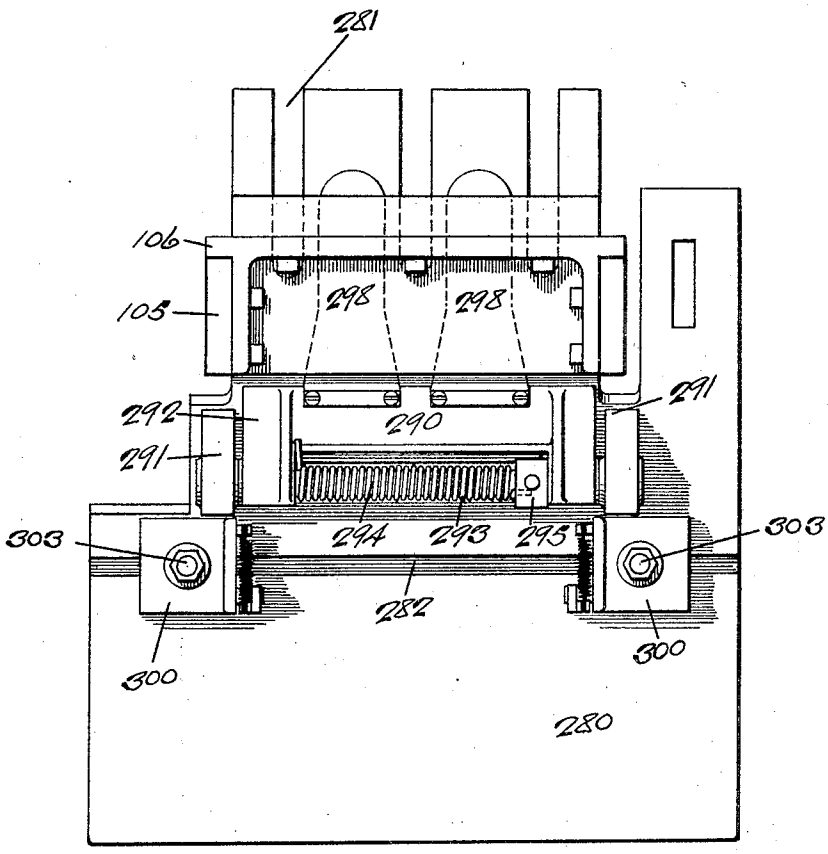


Fig. 34

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 17

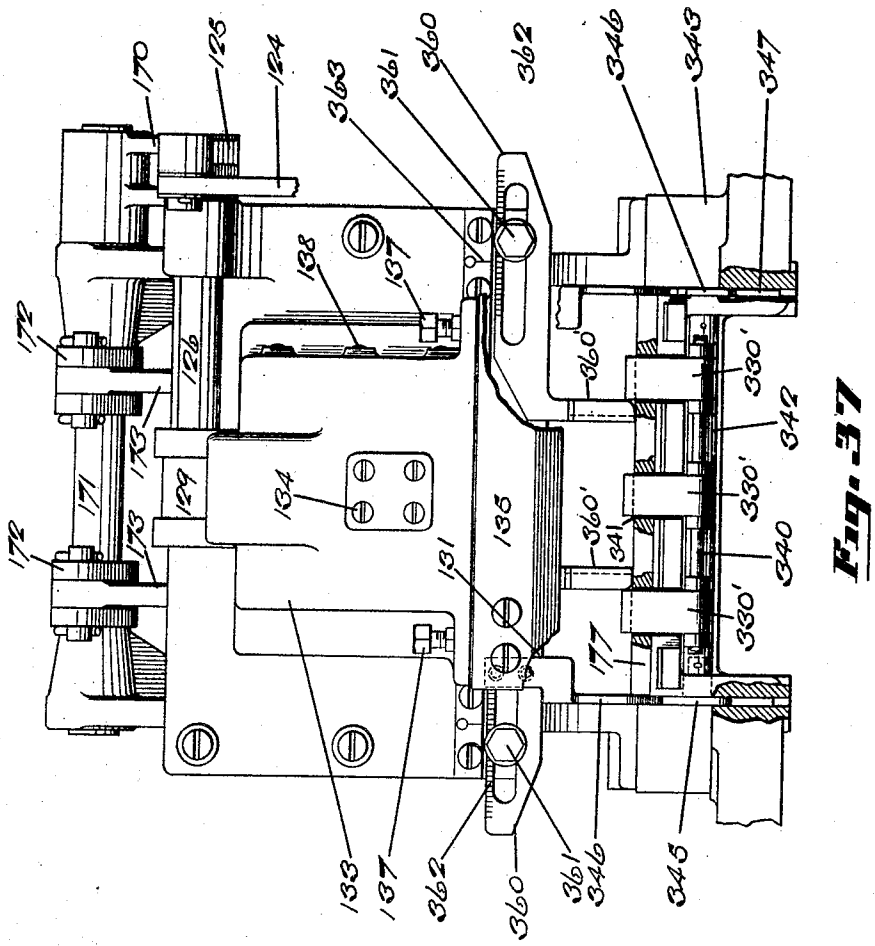


Fig. 37

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MACHINE FOR FOLDING SHEET MATERIAL

Filed June 20, 1921 18 Sheets-Sheet 18

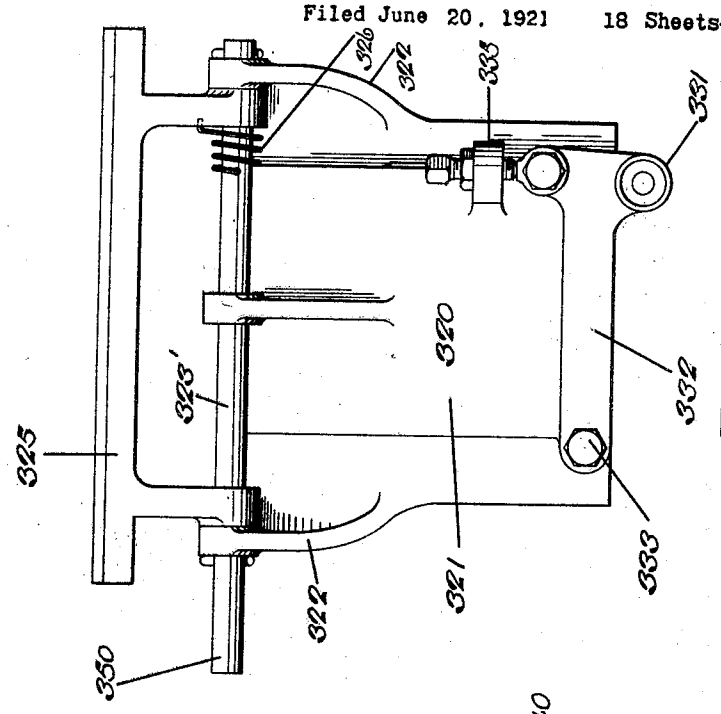


Fig. 39

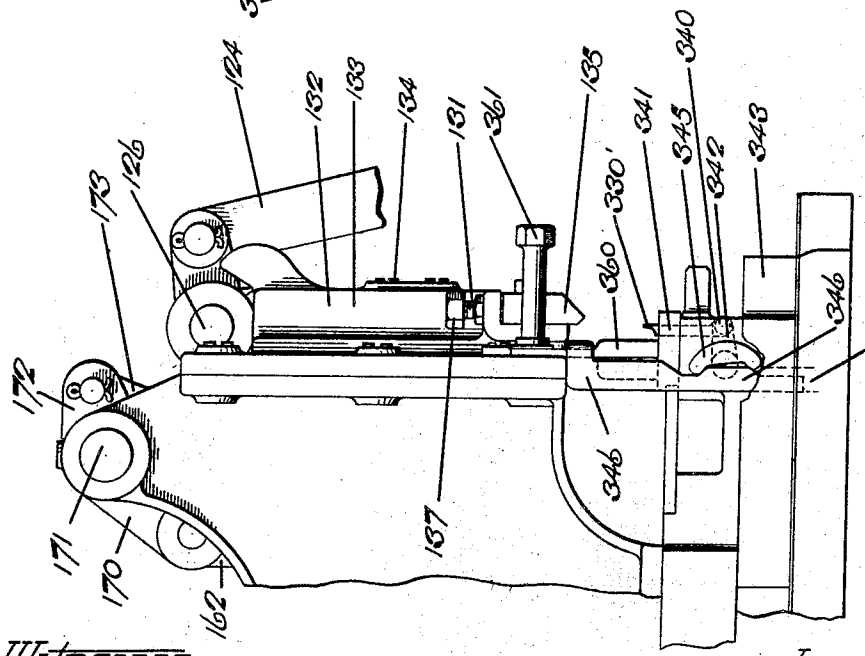


Fig. 38

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Patented Sept. 2, 1924. 1,507,318

UNITED STATES PATENT OFFICE.

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MACHINE FOR FOLDING SHEET MATERIAL.

Application filed June 20, 1921. Serial No. 478,793.

To all whom it may concern:

Be it known that I, CHARLES L. LEE, citizen of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Machines for Folding Sheet Material, of which the following is a full, clear, and exact description.

The present invention relates to machines for folding sheet material and in its preferred form of embodiment, which has been chosen for the purpose of description and illustration, relates more particularly to a machine for folding sheet metal in a form suitable for cooling fins to be applied to the cylinders of internal-combustion engines and also suitable for various other purposes.

Among the objects of the invention are to fold such metal from a continuous strip so that the folds or convolutions are of predetermined size and uniformly spaced, and, if desired, to cut the material in lengths suitable for the purpose for which it is folded.

Another object is the control of such a machine in a simple and efficient manner.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred forms of embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 is a side view, more or less diagrammatic, showing the means which cooperate to cause the formation of the folds, and showing the fold material in various stages.

Fig. 2 is a side view, partly in section and partly in elevation, of the machine as a whole, showing particularly the cooperation of the various mechanisms.

Fig. 3 is a front view of the machine partly in section and partly in elevation.

Fig. 4 is a view in perspective of the motor drive showing the oil pump for the system and with part of the casing removed.

Fig. 5 is a detail showing the worm shaft.

Fig. 6 is a view, partly in section and partly in elevation, of the motor drive showing the shaft which cooperates with the worm shaft and the clutch mechanism.

Fig. 7 is a top view of the matrix operating mechanism showing the relation of the various elements to the main drive shaft.

Fig. 8 is a front view of the mechanism shown in Fig. 7.

Fig. 9 is a side view of the mechanism shown in Figs. 7 and 8 showing the cooperation therewith of the matrix mechanism.

Fig. 10 is a front view of the matrix mechanism showing the position of the matrices for one operating condition.

Fig. 11 is a view in perspective of the matrix.

Fig. 12 is a side view of the ram mechanism showing more particularly the operation thereof by the main drive shaft.

Fig. 13 is a front view of the ram mechanism.

Fig. 14 is a top view of the toggle joint, a part of the ram mechanism.

Fig. 15 is a side view of the U-shaped member with the rolls secured thereto, a part of the ram mechanism.

Fig. 16 is a side view of means for operating the clamp.

Fig. 17 is a side view of the clamp mechanism.

Fig. 18 is a front view of the clamp mechanism.

Fig. 19 is a top view of the main drive shaft and the master shaft, showing more particularly the cooperation therewith of the knife operating mechanism.

Fig. 20 is a side view of the knife operating mechanism.

Fig. 21 is a side view of the U-shaped member forming a part of the knife operating mechanism.

Fig. 22 is a view from the rear of the machine showing the knife mechanism.

Fig. 23 is a side view of the knife mechanism.

Fig. 24 is a front view of the base forming mechanism.

Fig. 25 is a side view of the base forming mechanism showing more particularly means for its operation.

Fig. 26 is a top view of the timing mechanism showing the operation thereof by the main drive shaft.

Fig. 27 is a top view of one of the movements of the timing mechanism.

Fig. 28 is a side view of the mechanism shown in Fig. 27, showing the relation there-

of to the main drive shaft and the master shaft.

Fig. 29 is a view of means for controlling the size and number of folds and means for varying the contour of a set of folds.

Fig. 30 is a side view of the selective mechanism as a part of the timing mechanism shown in Fig. 26.

Fig. 31 is a front view of the grip mechanism, secured to the ram as shown in Figs. 12 and 13 and cooperating with the selective mechanism as shown in Fig. 29.

Fig. 32 is an end elevation from the left of Fig. 31.

Fig. 33 is a view of the grip mechanism along the line 33—33 of Fig. 31.

Fig. 34 is a top view of means for feeding the sheet material to the point of formation of the folds.

Fig. 35 is a side view of a guide showing in particular the grip for the sheet material.

Fig. 36 is a front view of the guide shown in Fig. 35.

Fig. 37 is a front view of the clamp mechanism shown in Fig. 18, showing more particularly means for operating the matrix stops.

Fig. 38 is a side view of the clamp mechanism shown in Fig. 37.

Fig. 39 is a front view of a form of base forming mechanism with the matrix stops removed.

Fig. 40 is a side elevation of a series of folds produced by the machine set up as in the present description.

In order to clearly set out the operation of the machine, reference should be had to Fig. 1 which is a more or less diagrammatic fragmentary view of certain parts of the machine illustrating very clearly those elements which act directly upon the sheet material to form folds of a desired shape and size.

In this Fig. 1 the sheet material is indicated at "A" and is shown as having been formed into a series of folds indicated at "B." The material will be supplied from a suitable roll which in the present form of machine is supported by some exterior roll holder (not shown) and is fed from the right hand side of this mechanism through guides "C," under the grip or clamp "D," under the head of the ram "E," and, as indicated, over the apron or platform "F."

When the machine is in operation, the matrix "H" occupies the position shown in this figure, being secured in place against the top plate "G" by means of the clamp "K," and as the ram moves over the apron "F" towards matrix "H," the grips upon the ram fasten to the sheet material and cause it to buckle between the face of the ram and the matrix "H" whereupon the base forming element "M" is lifted from the position shown to allow the small bead "N" to project up above the upper plane of the apron "F" and come between the matrix "H" and the face of the ram, in order to form the base or bottom portion of the fold. By the time the base forming element "M" has been lifted into position, the face of the ram forces the sheet of material against the matrix "H" and the bead "N," forming a fold such as is indicated at "B."

As soon as the ram starts upon its first return or releasing movement the base forming element "M" drops to the position illustrated. The ram then moves forward to complete the forming of the fold, after which it returns to its original or outermost position. A second matrix, of the same contour as the first matrix "H," moves forward and slides in front of the first matrix and the newly formed fold. Before the second matrix has completed its travel in front of the first matrix, the clamp "K" operates to release this first matrix and these two matrices move to the left a distance of the width of a fold, carrying therewith the sheet material and folds. The second matrix then completes its movement in front of the first matrix, occupying the former position of matrix "H" so that the ram may repeat its operation on the material to form another fold.

When a suitable number of folds have been formed by the several operations just described, the strip is cut by means of a knife illustrated at "O."

With these preliminary statements of the operation of the machine, reference should now be had to Figs. 2 to 39.

In Fig. 2, the machine is illustrated as carried within a frame or casing 40 which has in its upper part the folding mechanism and controls therefor, while in the lower part is provided a motor and suitable driving connections for driving the mechanism in the upper part of the casing.

The motor drive is illustrated very clearly in Figs. 2 and 4 to 6, inclusive, and consists of a motor 41 to the armature shaft of which is attached a short worm drive shaft 42 cooperating with a worm wheel 43 which is keyed on shaft 44. The latter shaft also carries a drive gear 45 which through a suitable belt or chain 46 drives the mechanism in the upper part of the housing or casing 40. The drive gear 45 is mounted loosely upon the shaft 44, and has secured thereto, one member 47 of a clutch. The member 47 is adapted to coact with a driving member 48 splined on shaft 44 and movable longitudinally by means of a yoke 49 operated by suitable means such as a hand lever, as clearly indicated in Fig. 6. Some form of clutch mechanism at this point is desirable since it relieves the motor of heavier starting loads, eliminates frequent starting and stopping of the motor and enables the machine to be adjusted by

hand. The driving mechanism may have a suitable casing as indicated in Figs. 4 and 6.

The mechanism in the upper part of the housing 40 is made up of several separate but coacting units, the several units being synchronized to carry out the operation, mentioned in the short description of Fig. 1.

These units comprise, first, the matrix operating unit, second, the ram operating mechanism, third, the clamping mechanism for the matrices, fourth, the knife operating mechanism, and fifth, the timing and selecting mechanisms.

As may be readily observed by reference to Figs. 2 and 3, the casing 40 is traversed in the plane of Fig. 3 by two main shafts designated by the numerals 50 and 51. Shaft 50 is preferably mounted so as to permit oscillation while shaft 51 is rotatable.

Mounted loosely upon shaft 50 is the belt or chain driven gear 52 receiving the driving impulse from the motor through its drive as described above. This gear has rigidly attached thereto a second gear 53 which meshes with gear 54 upon shaft 51, which latter shaft 51 can properly be called the "main drive shaft" as from this is driven all of the remaining mechanisms.

Suitably mounted upon shaft 51 in addition to gear 54 is a bevel gear 60 which through its coacting bevel gear 61 drives a transverse shaft 62 for actuating the matrix operating mechanism.

The matrix operating mechanism comprises a distinct unit of the machine, and is shown quite clearly in Figs. 2 and 7 to 10 inclusive.

As shown in these last mentioned figures, the matrix operating mechanism preferably comprises, in addition to shaft 62, upon which are mounted a series of cams designated by the numerals 70, 71 and 72, a second shaft 75 upon which oscillate the two sectors 76 and 77 carrying rollers 78 and 79 respectively. These rollers operating in conjunction with cams 70 and 71 cause the oscillation of the sectors 76 and 77.

The sectors 76 and 77 are provided with suitable gear teeth adapted to coact with small gears 80 and 81 keyed to short shafts upon which latter are also keyed gears 82 and 83 adapted to coact with racks 95 mentioned below for sliding into and out of operative position, the matrices as hereinafter described.

Carried also upon shaft 62 is a cam 72, which may be in the form of a cylindrical member with a cam shaped groove therein cooperating with a pair of rollers 90 carried on the ends of two levers 91. These levers are pivoted intermediate their ends as at 92, and are connected through links 93 to blocks 94 carrying the racks 95 adapted to cooperate with gears 82 and 83. The shape of cam 72 is such that its rotation causes the forward and backward movement of the matrices incident to placing the one and then the other in position next to the ram, as shown and described in connection with Fig. 1.

The blocks 94 operate in guides 99 which form a part of the frame of the machine and permit the forward and backward movement. These blocks also operate in another set of guides 96 which permit the in and out movement of the matrices.

Operating in the guides 96 are upwardly and forwardly projecting arms 97 carrying the matrices 98, the contour of which is shown clearly in Fig. 11, although it should be understood that other forms may be used with minor changes in the machine.

Operating synchronously with the matrix operating unit just described is a ram 106 serving as indicated in connection with Fig. 1, to form the sheet material against the matrix.

The ram is operated by two cams 100 mounted on shaft 51, hereinbefore mentioned. These cams operate the ram through the U-shaped member 101, which is provided with rollers 102 coacting with the surfaces of cams 100, and which is adapted to oscillate shaft 50. One of these cams with its roller serves to throw the ram forward and the other serves to return it to its outer position assuring thereby positive operation of the shaft 50. The forward throwing cam is adapted to give two forward movements to the ram, the second one following immediately after the first movement and after a partial release of the ram to permit the lowering of the base form from between the matrix and ram. The other or backward throwing cam cooperates with the forward throwing cam to permit and assist this action.

It is desirable to have secured also to the shaft 50 an adjusting piece 103 for the U-shaped member 101. By the use of this piece, the U-shaped member may be adjusted into a different angular position relative to the shaft 50 and consequently may cause the shaft to oscillate through an arc with different limits for the purpose of varying the width of fold.

As has been previously referred to, the motion of the U-shaped member 101 is transmitted to the ram. This is accomplished by the U-shaped member operating the adjusting piece 103 which latter is fixed to the shaft 50, through its adjusting screws 104. Thus the nearness of the ram to the matrix when the ram is in its forward position, may be varied, varying the width of the fold. The adjustments are accomplished by screwing in one screw 104 and releasing the other screw 104 in their respective lugs 108 so that the space between the lugs 108 and their re-

spective bosses 109 may correspondingly be varied.

The arm, shown more clearly in Figs. 3 and 12, is carried by arms 105, keyed to shaft 50 and adapted to be oscillated thereby, and has its forward face 107 suitably shaped to conform with one side of a desired fold of the sheet material. In order to increase the pressure exerted by the ram upon the material so as to make sure that the latter conforms to the face of the ram, and to the matrix and base form, it is desirable to provide suitable means to add to the force of the ram on its forward movement. A satisfactory means for this purpose is the toggle indicated at 110 and 111, which toggle consists of the two members 110 and 111, the former being attached to arms 105 and the latter to the housing through supporting member 115. The toggle is preferably operated through arm 112 attached to one member thereof, which arm is provided with roller 113 coacting with a cam 114 mounted on shaft 51 and preferably formed on the back of one of the cams 100. For purposes of adjustment, suitable means as indicated at 116 may be provided to vary the relation of the arm 112 and the member 110.

It should be noted that, on account of the force applied between the ram and matrix in folding somewhat stiff material, it is highly desirable to hold the matrix very securely in place under the blow of the ram. Incidentally, securing the matrix in the manner about to be described also serves to prevent movement of the material during the forward motion of the ram.

This securing of the matrix is accomplished by means of mechanism operated by a cam 120 also mounted upon shaft 51, which cam in the present instance, is preferably provided in one of its faces with a groove as clearly shown in Fig. 16. The groove, indicated at 121, cooperates with a roller 122 carried by an arm 123 which is mounted loosely upon shaft 50 and which at its other end is connected by a link 124 to a crank arm 125 pivotally mounted on a shaft 126. The arm 125 by means of the shaft 126 operates a second toggle joint 127. This toggle joint 127 comprises the arm 129 fixed to shaft 126 and its cooperating member 130 which latter is connected to the sliding member, indicated as a whole at 131.

This sliding member 131 comprises preferably an upper portion 132 having a cover 133 attached at 134 as shown and a lower clamping portion 135 having its bottom face tapered in such a manner as to fit into a groove 136 formed in the upper edges of the matrix 98, and upon operation of the mechanism to securely clamp it in place. The lower portion 135 is adapted to be adjusted, so as to insure the proper relation of the clamp to the matrix, by means of adjusting screws 137. The outer portion or cover 133 has means for adjusting a gib, not shown, against the guide for the slide member 131, as shown externally at 138.

As the face cam 120 revolves, the roller operates the arm 123 causing the link 124 to pull down the arm 125. The toggle joint 127 then causes the sliding member 131 to descend and the bottom face of member 135 to engage the matrix 98 in the groove 136, clamping the matrix tightly against the material to be folded and securing it against the force of the ram.

It is obvious that for certain forms of folds that the clamp might be utilized in place of the matrix for a folding operation. This could be conveniently accomplished by extending the clamp so as to secure the material to be folded in place. A suitable feeding mechanism could then be used permitting the lowering of the clamp in front of the new fold preparatory to repeating the folding operation.

As mentioned in connection with Fig. 1, provision is made for cutting off the strip of folded material after the desired number of folds have been formed.

The cutting off mechanism is illustrated in Figs. 19 to 23 and is operated once for each revolution of a timing gear indicated at 140. This gear 140 is one of a set of removable and interchangeable gears having different numbers of teeth, the number of teeth upon the gear in use corresponding to the number of folds formed in the sheet material between two operations of the knife or cutting off mechanism.

Gear 140 cooperates with the timing mechanism hereinafter described and causes operation of the knife mechanism through shaft 146, upon which is fixed a cam 141. Cam 141 is so formed that, for each revolution of the gear 140, it operates a trip lever 143, pivotally mounted on a shaft 144, to raise it and permit operation of lever 145, hereinafter referred to as the "lock arm lever."

The gear 140 and cam 141 are both mounted upon and revolve with shaft 146, hereinafter referred to as the master shaft and cam 141 is fixed thereto in any suitable manner as by a pin or key. Gear 140, however, in order to be easily removable is loose upon the shaft and is provided with a hole through which passes pin 211 fixed in an arm 213 secured to the shaft 146 as hereinafter more specifically described.

The two shafts 144 and 146 are supported by a bracket 155 secured to the casing 40.

The lock arm lever 145 above referred to is provided with a slotted portion 147 adapted to cooperate with a pin 148, constructed and arranged to engage the slot, and mounted upon a U-shaped member or roll carrier 152, and when the trip lever 143 has been lifted,

the lock arm lever is pulled over by spring member 149 causing the locking of the slot 147 with the pin 148.

Mounted upon the main drive shaft 51 are two cams 150 and 151 which during the rotation are adapted to give positive motion to the U-shaped member 152 by cooperating with the corresponding rollers 153 and 154 (see Fig. 20). This U-shaped member is pivotally mounted upon the master shaft 146 and has secured to its body portion the pin 148 as hereinbefore stated. As the cams revolve with the main drive shaft 51, the U-shaped member is caused to operate up and down once every revolution. Thus with the coaction of the slot 147 and the pin 148, the lock arm lever 145, which is pivotally mounted at 161 on lever 160, known as the knife operating lever, is caused to move up and down due to the movement of the U-shaped member 152. Correspondingly, the lever 160 is caused to move up and down and by means of link 162 causes the operation of the knife mechanism. It is obvious that the lever 160 is caused to operate this link only when the slot 147 engages the pin 148, that is, when the cam 141 has made one complete revolution and the portion 142 causes the lifting of the trip lever 143.

While the above described mechanism operates very efficiently to cause operation of the knife at the desired time, means should also be provided to prevent the repetition of the knife stroke and also to prevent its operation at times other than when the cam 141 has made its revolution. Such means is provided in the present structure and is indicated clearly in Fig. 20. In the present structure this means comprises a latch lever 163 pivotally mounted on a stud 165 secured to the frame of the machine which lever is oscillated at each revolution of the main drive shaft 51 by a cam or trip 164 preferably fixed to the face of cam 150. The face of one of the arms of this lever coacting with a lug 166 on the lock arm lever 145 serves to throw the lock arm lever out of engagement with the pin 148 at any time when they may be in engagement, the face ceasing to strike the lug under other operating conditions. The trip 164 is properly positioned so that the lever will have made its upper movement before the action of latch lever causes the disengagement of the lock arm lever and U-shaped member 152. Also, the cam 141 will have rotated sufficiently to permit the trip lever 143 to be pulled down by a spring member 167 against the cam 141 and to permit the engagement of this lever 143 with the lock arm lever 145 at 168 as shown. By such means a single operation of the knife at the proper time is assured.

The knife and the mechanism immediately connected thereto are shown more clearly in Figs. 22 and 23. In these figures, the knife blade 176 is shown as suitably attached to a block 174 adapted to slide up and down in suitable guides upon the upright frame members 175 which also support and guide the clamping mechanism. The block and knife are actuated through the oscillation of lever 160 by means of the cams 150 and 151. The oscillation of lever 160 causes the link 162 attached thereto to lift or pull down lever arm 170 fixed to shaft 171 to which latter are also fixed lever arms 172 connected through links 173 to block 174, the upward movement of lever 160 and link 162 causing the descent of the block. In operating to cut off a series of folds of the material being worked upon, the knife 175 cooperates with shearing action with a fixed straight edge 177 and severs the folds at the bottom thereof. However, it is obvious and contemplated that this mechanism may be used to cut off material fed without undergoing the folding operation, for example cutting metal into strips or sheets.

As has already been indicated the operation of the knife is controlled in accordance with the number of folds to be formed in the sheet material, and that the number of folds is determined by the number of teeth in a gear 140 called the timing gear. This gear 140 is also connected with other mechanism controlling the size of the fold and called herein the "selective" mechanism.

The timing and selective mechanisms are shown more clearly in Figs. 27 to 30, Fig. 26 showing an assembly thereof.

In Figs. 27 and 28 the timing gear mechanism is designated as a whole by the numeral 180, and is operated from the main drive shaft 51 by means of a single tooth timing gear 181 and a roll or collar 182 adapted to hold a star wheel 183 in position and with the star wheel to constitute a lock for the timing gears. The collar 182 has a portion 184 cut away to permit the movement of the star wheel when gear 185, which operates the star wheel, is moved by the single tooth gear 181. The single tooth gear and the roll 182 are secured to the main drive shaft 51, and the gear 185 and star wheel 183 are pivotally mounted upon a stud 186 secured in a boss 187 upon a suitable bracket 188. It will be seen therefore that for each revolution of the main drive shaft 51 the gear 185 will be moved one tooth.

Suitably secured to the gear 185 and the star wheel 183 and also pivoted on the stud 186 is a small gear 190 which is adapted to rotate the gear 191 pivotally mounted upon the stud 192 secured in another boss on bracket 188. Secured to the gear 191 is a smaller gear 193 also pivotally mounted upon the stud 192 and adapted to rotate gear 194. The gear 194 is pivotally mounted on a sliding arm 195 adjustably secured to bracket 188 at 196 as illustrated. The gear

ratios used for the gears making up this mechanism as described, are preferably such that for every revolution of the main drive shaft 51, the gear 194 will move through an arc equal to the distance between the centers of consecutive teeth on the gear. This gear 194 meshes with a gear 140, mounted on the master shaft 146 as hereinbefore referred to.

As it has already been stated that the number of folds constituting a set depends upon the number of teeth in the gear 140, it is evident that the number of folds can be varied by substituting for the gear 140 another gear having similar sized teeth but having a different number thereof. Consequently, gear 194 is mounted as illustrated in order to mesh with any sized gear substituted for the gear 140 and at the same time mesh with the pinion 193 as before.

The bracket 188, upon which the timing mechanism is secured, is preferably mounted upon the casing 40 by suitable means such as extended portions and flanges 197 as shown.

The selective mechanism associated with the timing mechanism is shown in the assembly Fig. 26 but more in detail in Figs. 29 and 30.

In Fig. 29 a portion of the selective mechanism, conveniently known as the form cam selective device or master, and designated as a whole by the numeral 200, is mounted upon the master shaft 146. This portion consists preferably of a sleeve 201 having a circumferential slotted portion 202 for an arm 203 adapted to retain the sleeve in place relative to the shaft 146, and a shoulder 204 adapted to receive the abutment of a cam 205. This latter cam is adapted to control the size and contour of the folds as will be brought out later. The sleeve 201 is adapted to fit over the master shaft 146 and has at its inner end a portion adapted for mounting thereon the cam 205 and the gear 140 with a threaded portion 206 at the extreme end permitting the securing of the cam and gear in place with a lock nut 207. This sleeve may be retained on the master shaft 146 by a nut 208 abutting the shaft as illustrated and has an adjusting knob 209 at its outer end adapted to assist in making certain changes in the selective mechanism to be described later.

The cam 205 and the gear 140 are secured to each other and the sleeve 201 preferably by means of key 210 indicated in dotted lines and having a fit permitting ready disengagement. This gear is adapted to rotate the master shaft by driving through an extended pin 211 cooperating with a hole 212 in the gear 140, the pin being secured to an arm 213 of the collar 214 as illustrated, the collar being fixed upon the master shaft 146. It is evident that by this method of securing the gear and cam and driving the master shaft that this gear and cam may be readily substituted for and, in fact, once the arm 203 is disengaged from the slot 202 and the nut 208 is removed from the shaft 146, the sleeve 201, carrying the cam and gear, may be removed from engagement with the master shaft 146 and the collar 213. Thus by removing the lock nut 207 from this sleeve, differently shaped cams and gears having different numbers of teeth thereon may be installed.

The arm 203 is adapted to retain the sleeve in constant position on the shaft 146 and consequently, the gear 140 always in proper mesh. However, if the arm 203 be disengaged with the slot 202, the sleeve may be moved over on the shaft 146 until the inner surface of the adjusting knob abuts the inner face of the nut 208, disengaging the gear 140 from the gear 194. This movement however, is insufficient to disengage the pin 211 from the hole 212. In this condition the mechanism on the shaft 146 may be rotated by turning the knob 209 so as to set the mechanism for cutting off a set of folds at any point. The gear 140 in its new position may be remeshed with the gear 194 without having changed the position of the latter gear.

This feature of being able to regulate the point of cutting off the folds is very valuable, especially when inserting material from a new roll into the machine, as adjustments may be made to waste only a minimum of material. Also, the form cam 205 may have its relative rotative position changed in this manner, which is valuable for varying the form of fold as will be evident from the following description.

Referring now to Fig. 30, mechanism for controlling the size and shape of the folds is clearly illustrated. This mechanism is operated by the cam 205 hereinbefore referred to as mounted upon the master shaft 146. Operating upon this cam is a roller 220 secured to segment arm 221, although in some instances it may be desirable to use a rigid follower, tapered down to a knife shaped riding surface so as to follow difficult contours of cams substituted for cam 205, in place of the roller 220 and in fact this is contemplated. This segment arm 221 is pivotally mounted conveniently upon shaft 144 and on its outer face has an arc shaped toothed portion 222 adapted to actuate a segment 223 pivotally mounted upon the main drive shaft 51 preferably by means of coacting teeth as illustrated. The roller 220 may be caused to follow the contour of the cam 205 by means of a spring member 224 as indicated. Pivotally mounted upon the segment arm 223 is a bell crank or roller carrier 225 having one roll 226 adapted to cooperate with a

cam 227 secured to the main drive shaft and another roll 228 adapted to transmit the motion caused by the action of the cam 227 against the roller 226, to cam 229, preferably known as the grip cam.

As cam 227 rotates with the shaft 51 the grip cam will be operated once for every revolution of the main drive shaft. The exact time of causing this motion relative to the motion of the main drive shaft depends upon the position of the roller 226 relative to the main drive shaft. For example, if the roller 220 were to ride upon a flat surface 230 of the cam 205, the segment arm 221 would operate the segment 223 to throw the roller 226 to the left of and higher relative to the main drive shaft. Thus it is evident that the cam 227 will cooperate with the roller 226 later, assuming the clockwise rotation with the shaft 51, and consequently, the grip cam will be operated later.

The grip cam has an arc shaped face 235 which rides up on a roller 236 and which, in cooperation with this roller, is adapted to operate the grip mechanism to be described later.

Referring back to the assembly of the timing mechanism in Fig. 26, the relation, both operative and structural of the different units previously described, is shown.

In this figure the engagement of the arm 203 with the slot 202 is more clearly illustrated. This arm 203 has a handle 240 for convenient operation. Also upon this arm it is very desirable to have an extended portion 241 cooperating with a similar extended portion 242 upon the segment 221 to tend to retain the arm 203 constantly within the slot 202. Also these extended portions may cooperate to raise the segment arm in case of a large sized cam or gear or both used for cam 205 and gear 140 to permit the removal of the form cam selective device 200 from the master shaft 146 without striking of parts.

It may be desirable to have a boss 245 on the segment 221 adapted to coact with a boss 246 extending from the casing 40 as indicated in Fig. 30, to prevent the teeth of the segments 221 and 223 from being disengaged and consequently the machine being thrown out of time.

As has been previously indicated in the description and explanation relating to Fig. 1, a set of grips cooperates with the ram to engage firmly against the bottom face of the ram the material which is being folded during a part of a folding operation. The grip mechanism, designated as a whole by the numeral 250, is attached at the head of the ram 106 and also extends between arms 105, its position being most clearly indicated in Fig. 13.

The grip mechanism itself is very clearly illustrated in Figs. 31 to 33. As has been previously stated with reference to the description of Fig. 30, the grip cam 229 is adapted for operating the roller 236. This roller is a part of the grip mechanism and operates on a stud 251 secured in a boss on lever 252. This lever in turn is secured to a shaft 253 which extends between arms 105 of the ram as indicated. The upper portion of the arm has two notches 255 and 256, which notches are adapted to coact with an arm or latch 260 under different operating conditions as will be explained later. Secured to the shaft 253 between the arms 105 are a plurality of levers 261. These levers along with springs 262 coact with the grips 263 to cause the gripping of the material to be folded as has been previously described. The grips 263 are pivotally mounted upon the shaft 253, being located by the levers 261, and have fingers 264, whose upper surfaces are adapted, preferably by means of teeth as illustrated, to secure the grips firmly against the material to be folded. The springs 262 are adapted to maintain the levers 261 and the grips 263 in constant proper operative relation.

The latch 260 which is pivotally mounted upon a stud 265 has an extended portion or boss 266 adapted for abutment against a stop, diagrammatically represented at 267 in Fig. 32. A retracting member, preferably a spiral spring 270, is secured to the latch 260 and the lever 252 and is adapted to constantly exert a force upon these two members drawing them together at the notches 255 and 256 as illustrated. Coacting with these notches is an extended portion or boss 271, a part of the latch 260. Thus as the boss 266 comes in contact with the bumper 267 the force overcomes the tension of the spring 270 to cause the boss 271 to engage the stop notch 255 of the lever 252. Consequently, the shaft 253 is given counterclockwise rotative movement causing the levers 261 to release the grips 263 from the material to be folded.

However, when the grip cam 229 operates the roller 236 to give the shaft 253 a clockwise rotative movement a reverse action takes place which allows the grips 263 to be forced firmly by the spring 262 against the material to be folded, causing this material to be tightly held against the ram. At the same time the boss 271 is drawn down by the spring member 270 to engage lock notch 256 which is offered due to the rotation of shaft 253, thus maintaining a continued firm grip on the material to be folded until the portion 263 coacts with the bumper 267 to release the grip as hereinbefore described.

It is more or less obvious, that when folding a strip material, suitable guides

for the strip are desirable in order that the folds may not be uneven and irregular. Such means for guiding the material being fed into the machine is shown in Fig. 34.

In this figure, the platform over which the sheet material is fed is indicated at 280. The means for guiding the material preferably comprises guide grips designated as a whole by the numeral 300 and an auxiliary grip mechanism designated as a whole by the numeral 290.

The platform 280 has a plurality of slotted portions 281 adapted to permit the operation therein of the grips 263 against the ram shown in plan view at 106. Groove 282 is also formed in the plaform and in this the guiding grips 300 may be adjusted to suit the width of material fed into the machine.

The auxiliary grip mechanism 290 is supported in bearing members 291 and consists of a grip plate 292 pivotally mounted upon a shaft 293 and which has its bottom face held firmly against the platform 280 by means of a spiral spring 294 or other suitable means for exerting pressure upon the plate. The spiral spring has an adjustable collar 295 for adjusting the tension thereof and consequently the pressure of the grip plate 292 against the material to be folded. This auxiliary grip mechanism is very desirable in that it serves to retain the material to be folded against the platform 280.

Attached to the auxiliary grip mechanism 290 are a plurality of extending strips 298 adapted to further retain the material to be folded, against the platform 280 and to prevent its buckling upon the return motion of the ram. These strips are very desirable when the end of the material to be folded is going through the machine, in that they prevent the ram from catching the end of the material and generating a fold higher than is capable of running through the machine. It is also desirable that these strips are of a thin durable metal for example, flexible thin sheet metal.

Figs. 35 and 36 illustrate in an enlarged view one of the guide grips 300. This device preferably consists of a guide plate 301 having an extended portion 302 for operating within the groove 282 of the platform 280 and being adapted to engage a guide bolt 303 (shown in Fig. 34) to retain the guide in the groove 282 as shown in Figs. 2 and 34. Pivotally mounted upon the guide plate 301 is a grip 305 having a toothed portion 306 adapted to permit the forward but not the backward motion of the material to be folded. A retracting member 310, preferably a spiral spring, coacts with the grip 305 to cause its face 306 to be maintained firmly against the material to be folded in such a manner that, under operating conditions, the material is supplied readily only in the direction for proper feed. This spring is installed in the manner clearly illustrated in Fig. 35.

It will be remembered that, in connection with Fig. 1 it was stated, that when the ram moved forward against the matrix, the base forming element M was moved up into its path and caused the formation of the particular form of base upon the fold. Further, it was stated that upon the first withdrawal motion of the ram, the base forming element dropped to the position indicated in this figure (Fig. 1).

The mechanism for performing this function is illustrated clearly in Figs. 9, 24 and 25 (Sheet 7).

Referring to these figures, this mechanism designated as a whole by the numeral 320 comprises a base form slide 321 having extended portions 322 for mounting therein a shaft 323. Upon this shaft is pivotally mounted the base form member 325, which member is shaped at the top to form a bead as illustrated to fit between the matrix and the forward face of the ram so as to give proper shape to the material in the process of folding. Secured at one end to the base form and at the other end to the shaft 323 is a retracting member 326 preferably a spiral spring. This spring is adapted to throw the base form in a direction away from the matrix. This action is desirable in order that, as the base form is inserted between the matrix and the ram, a gradual forming of the fold will occur between the matrix and the base form.

Also, there may be secured to the slide 321, a plurality of stops 330. These stops are adapted to be inserted between the matrices and to brace the forward matrix against the force of the ram, thus maintaining the matrix in place.

The base form slide 321 is actuated by a roller 331 which operates within the groove of a face cam formed upon the back of gear 61. This roller is secured to a lever 332 pivotally mounted upon the base form slide 321 at 333 and has means for adjusting the angular relation of the lever to the base form slide at 335 as indicated. This adjustment of the angular relation facilitates the inserting of the base form between the matrix and the ram at its proper cooperating height. The base forming mechanism operates upon a guide 336 clearly illustrated in Figs. 7 and 8.

The form of stop 330 above described is very suitable for the machine when folds of thin material are being made. However, when heavier material is to be folded, another method of mounting the stops, illustrated in Figs. 37 and 38, is more suitable.

In the latter instance, a plurality of stops 330′ (see Fig. 37) are pivotally mounted upon a shaft 340 and operate through corresponding slots 341. Shaft 340 is pivotally secured to a stop holder or lever 342 itself pivotally mounted in the plate 343. Rigidly secured to and operating this lever are the cam followers 345, one being removed to show the installation of the stop cam 346 within its guide 347. These stop cams are secured to the clamp sliding member 131.

As the clamp mechanism is lowered to cooperate with the matrix, the cam 346 operates its follower 345 to reinforce the forward matrix by inserting in the rear thereof the plurality of stops 330′ which are braced by the slots 341 in which they operate. With this method of operating the stops, reinforcement is given to the matrix during both forward motions of the ram, namely the first or forming motion in which the base form cooperates with the matrix and ram to give shape to the fold and the second or final forming motion in which the base form is removed and the clamp is forced solidly against the matrix by the toggle action.

With the stops 330 removed, the base form will now resemble the illustration in Fig. 39. It is also desirable to extend the shaft 323′ so as to offer a surface at 350 against which the portion 266 (see Fig. 32) may abut as a part of the operation of the grip mechanism. It is especially convenient to use this extension 350 with the latter form of stop operating mechanism, since it is not desirable to release the material to be folded from the hold upon it by the grips 263 until the ram starts upon its return to its outermost position. This is readily accomplished by means of the extended portion 350 in that with the base form cooperating between the matrix and the ram, the portion 266 of the grip mechanism sticks below extended portion 350. Upon the lowering of the base form, however, from between the matrix and ram, the extended portion 350 comes in the path of the portion 266 of the grip mechanism so that at the end of the second forward motion of the ram the releasing action takes place.

In addition to the means for guiding the strip of sheet material into the machine as already set forth, it is quite desirable to provide also means for guiding the folded material so as to assist in maintaining the regularity of the folds and also to insure their parallelism with the knife when the latter is about to be operated.

Such means is illustrated in Fig. 37 which shows how guides are provided for the folds which have been formed and which guides are adapted for adjustment to accommodate the different widths of material supplied. A suitable form of guide is the slotted member indicted by the numeral 360, clamping member 361, preferably in the form of an extended stud as shown, being used to permit the adjustment of the guides. These guide members are provided with depending portions 360′ extending down at the ends of the folds and acting as guides proper for the folded material. It is very desirable that the guides keep central the folded material and to facilitate this, scales 362 may be provided to cooperate with the adjustment lines 363 preferably equidistant from the center of feed of the machine. Thus by aligning corresponding points on the scales 362 of the guides 360 with the adjusting lines 363, proper adjustment of the guides may be maintained. It is obvious that scales similar to 362 may be provided for the guides 300.

It is obvious that, with a machine having many moving parts such as the present structure, it is highly desirable to furnish some means for efficient lubrication. In the present machine such means is provided and is illustrated more or less diagrammatically in Fig. 2. In this figure there is shown as being driven by the motor drive a small pump 370. This pump supplies lubricant through a conduit 371 having several different branches, one of which is indicated at 372, the others being omitted for the sake of clearness of the drawing. The top of the branch 372 extends over a number of the moving parts of the machine and has a series of holes therein permitting the dropping of the lubricant upon such parts. The lubricant which drops down through and off the mechanism is collected in a basin 375 having a drain 376 into a reservoir 377, from which the supply of lubricant is taken constantly by the pump 370 by means of a line 378 extending close to the bottom thereof. Doors are provided in the casing 40 to permit refilling of the reservoir 377 with fresh lubricant whenever desirable.

Although in the foregoing description, the machine has been referred to as operating upon "material," without specification, to generate folds therefrom, it was devised to operate upon some form of sheet metal and will be found particularly suitable for such operations. In fact the form of matrix, base form, and ram described, was designed to form sheet copper into folds suitable for fins to be secured to cylinders of air-cooled internal-combustion engines as cooling elements.

The following description and explanation which will refer more particularly to the operation of the machine, will be confined to the use of copper as a material fed to the machine and reference may be had to copper in the description of certain parts of the machine. However, it is to be understood that as in the previous description and explanation, the machine may operate just

as readily on other materials or metals in the form of sheets, wires, strips, etc., and that the use of copper is merely for greater convenience in description and explanation.

A roll of sheet copper is selected of a width corresponding to the length of the fin desired for attachment to a cylinder.

The guide grips 300 are set to correspond to the width of the copper, being spaced equally on each side of the center of the line of feed. Correspondingly, the guides 360 are set to accommodate the same width and are so adjusted that the copper fins may be centrally guided through the machine. The form cam selective device 200 is adjusted by disengaging its gear 140 from the gear 194 and rotating the device together with the master shaft so that upon remeshing the gears 140 and 194 the knife mechanism will operate to cut off the fins formed by the newly fed material with a minimum waste.

It may be desirable to start the machine by means of the crank 400 shown in Fig. 3 until one or two fins have been generated, but from this point, the copper having been lined up properly with its guides, the machine may be power operated. This may be accomplished by supplying power to the motor 41 and throwing in the clutch 47.

The machine now operating under power has its shaft 51 constantly rotating. Due to this rotation as hereinbefore referred to, the transverse shaft 62 is constantly rotated by the action of the main drive shaft 51 operating the matrices and base form, the ram is caused to operate, the clamp operating mechanism is put in motion as is also the knife operating mechanism, and the timing and selective mechanisms are actuated, all as has been described briefly in connection with Fig. 1.

Referring to the rotation of the shaft 62, the matrix operating mechanism, due to its cam and other movements, causes one of the matrices 98 to be placed in proper position in front of the copper which is being fed. Once a matrix is in place, due to the correct timing of the machine, the clamp operating mechanism is operated to clamp the matrix rigidly in place. While this operation is in progress, the cams operating the ram mechanism cause the ram to start its forward motion. At some time during this forward motion, depending upon the shape of the form cam 205, the grip cam causes the grip mechanism 250 to coact with the bottom surface of the ram to take a firm hold upon the copper strip and force it forward, causing it to buckle up between the ram and matrix.

As the copper gradually buckles and assumes its folded shape, the base form mechanism is operated by the cam 61 to have its bead properly inserted between the matrix and the ram. Thus, as the ram is forced forward, it catches the base form and pushes it up against the matrix, with a force which is augmented by the toggle mechanism, to cooperate in giving shape to the bottom portion of the fin.

By the coaction of the ram, the matrix and the base form, assuming for convenience of description that the other elements are acting properly, a copper fin is formed. Immediately following its first forward motion against the base form and matrix, the ram is caused to move slightly backward due to the shape of cams 100, which cams cause the operation of the ram, during which backward motion, the bead of the base form is released and withdrawn from between the matrix and the ram. Immediately upon the withdrawal of the base form, the ram is given a further forward motion, due also to the shape of the cams 100, to give the final shape to a fin.

During this time, the matrix operating mechanism has caused the remaining matrix to be withdrawn from behind the forward matrix and, when the ram is finally backed away, has caused it to be moved forward and inserted in front of this forward matrix and the fin. This remaining matrix does not slide entirely in front of the forward matrix, immediately, but, for example, when it has covered approximately two-thirds or other fraction, preferably over half, of this movement, the clamping mechanism operates to release the forward matrix, and, by action of the slides previously described, both matrices are moved back a distance of the width of one fold, carrying therewith the material and completed fins. The remaining matrix then assumes the position of and becomes the forward matrix as it is used for the formation of the next fin. When the ram starts its final return movement, the copper grip mechanism is operated by the coaction of its boss 266 with the extended portion 350 of the shaft 323′ to release the copper so that the ram may return freely without any drag on the copper or buckling thereof behind the ram, to its former position preparatory to forming a new fin.

This operation may be repeated and depending upon the number of teeth on the gear 140, a corresponding number of fins may be formed before the mechanism which directly operates the knife, is actuated to cut off a set of fins. This cutting off operation for a set of fins, is preferably a shearing action as is obvious from the shape of the knife illustrated in Fig. 22.

The form of cam 205, as will be noted from Figs. 2 and 30, is, in the described set-up, circular with a segment of somewhere near 90° removed. This form of cam gives a fold series contour such as is shown in Fig. 40. In such a series the folds decrease and then increase as the cam follower 220 passes

along the flat part 230 and approaches and recedes from the axis of the cam. These shorter folds are indicated at 400 in Fig. 40 while those produced when cam follower 220 is upon the circular part of cam 205 are indicated at 401.

It is thought that further explanation of the operation of the machine is unnecessary, in view of that brought out in the description and explanation of the construction of the machine and its various parts set out above.

While the forms of mechanisms herein shown and described, constitute preferred forms of embodiments of the present invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What I claim is as follows:

1. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; and means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold.

2. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during folding operation; and means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold.

3. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; and means for cutting off the folded material.

4. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; separate forming means for the bottom portion of the fold; and means for supplying to the ram and the matrix the desired amount of material to form a complete fold.

5. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; and means for guiding the material through the machine.

6. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; and means for cutting off the folded material.

7. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; separate forming means for the bottom portion of the fold; and means for supplying to the ram and the matrix the desired amount of material to form a complete fold.

8. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; and means for guiding the material through the machine.

9. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; and means for cutting off the folded material.

10. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; means for guiding the material through the machine; and means for cutting off the folded material.

11. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; and means for guiding the material through the machine.

12. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; and means for cutting off the folded material.

13. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; means for guiding the material through the machine; and means for cutting off the folded material.

14. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place dur-

ing the folding operation; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; and means for guiding the material through the machine.

15. A machine for folding sheet material comprising a matrix; a ram; means for moving the ram toward the matrix; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; means for guiding the material through the machine; and means for cutting off the folded material.

16. A machine for folding sheet metal comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; separate forming means for the bottom portion of the fold; means for supplying to the ram and the matrix the desired amount of material to form a complete fold; means for guiding the material through the machine; and means for cutting off the folded material.

17. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; and means carried by the ram for measuring the amount of metal to be supplied to the ram and matrix to form a fold.

18. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; and means carried by the ram for measuring the amount of sheet metal to be supplied to the ram and matrix to form a fold.

19. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold, cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

20. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; and means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold.

21. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means carried by the ram for measuring the amount of sheet metal supplied to the ram and matrix to form a fold; means for guiding the material through the machine; and means permitting only forward motion of material fed.

22. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

23. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; and means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold.

24. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; and means permitting only forward motion of material fed.

25. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that

the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

26. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; means permitting only forward motion of material fed; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

27. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; and means permitting only forward motion of material fed.

28. A machine for forming sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

29. A machine for folding sheet metal comprising a matrix for forming one half of a fold; a movable ram for forming the other half of a fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; means permitting only forward motion of material fed; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

30. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; and means permitting only forward motion of material fed.

31. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; means permitting only forward motion of material fed; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

32. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material at the matrix during the folding operation; forming means adapted to cooperate with the matrix and ram to form the bottom portion of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; means for guiding the material through the machine; means permitting only forward motion of material fed; cutting off mechanism for the folded material; and means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds.

33. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during

the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold, and to release the sheet material upon the return of the ram; and means for withdrawing the matrix from the folded material upon the return of the ram to its original position.

34. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and the ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; and means for withdrawing the matrix from the folded material upon return of the ram to its original position.

35. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

36. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to be inserted between the matrix and ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; and means for withdrawing the matrix from the folded material upon the return of the ram to its original position.

37. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means for withdrawing the matrix from the folded material upon return of the ram to its original position; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

38. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix druing the folding operation; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

39. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; and means for withdrawing the matrix from the folded material upon the return of the ram to its original position.

40. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding opera-

tion; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

41. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for cutting off the folded material after a predetermined number of folding operations; and means for varying the number of folding operations between the operations of the folding mechanism.

42. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon the return of the ram to its original position; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

43. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

44. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon the return of the ram to its original position; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

45. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the

desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

46. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and the ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

47. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

48. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; means adapted to secure the matrix against the abutment of the ram and to secure the sheet material beneath the matrix during the folding operation; means adapted to be inserted between the matrix and the ram and to cooperate therewith during the forward motion of the ram to form the bottom portion of the fold; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to release the securing means during the return of the ram to its original position; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

49. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

50. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to

the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

51. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

52. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of a fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

53. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grip; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second matrix; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

54. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing

the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

55. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

56. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

57. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

58. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means

adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

59. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

60. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the rams; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

61. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

61. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material

through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

62. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

63. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

64. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of

the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

65. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix; a backward releasing movement, a final forward movement and a backward movement to its outermost position; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

66. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its outermost position; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

67. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its outermost position; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

68. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its outermost position; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing backward move-

ment of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; and means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram.

69. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its outermost position; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operation of the cutting off means.

70. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its outermost position; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; and means for guiding the material through the machine adapted to permit forward motion only to the material fed and to prevent buckling of the material during the backward motion of the ram.

71. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its original position; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram

and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

72. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to positively operate the ram so that it is given a forward movement to its adjacent matrix, a backward releasing movement, a final forward movement and a backward movement to its original position; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for bracing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the releasing movement of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; means for guiding the material through the machine adapted to permit forward motion only of the material fed and to prevent buckling of the material during the backward motion of the ram; means for cutting off the folded material after a predetermined number of folding operations; and means adapted for varying the number of folding operations between the operations of the cutting off means.

73. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; means carried by the ram for including between the ram and the matrix the desired amount of material to complete a fold; and means adapted to prevent the formation of an oversized fold.

74. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means consisting of a plurality of thin metal strips over which the ram operates adapted to prevent the formation of oversized folds; and means for withdrawing the matrix from the folded material upon the return of the ram to its original position.

75. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; means consisting of a plurality of thin metal strips over which the ram operates adapted to prevent the formation of oversized folds; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

76. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; and gripping mechanism carried by the ram and cooperating

therewith at a predetermined time during its travel to supply the desired amount of metal to complete a fold.

77. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time to supply the desired amount of metal to complete a fold; and means adapted to vary the time of causing the operation of the gripping mechanism.

78. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to be inserted between the matrix and the ram and to cooperate therewith to form the bottom portion of the fold; and means for supplying between the ram and the matrix the desired amount of material to complete a fold.

79. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; means for guiding the metal through the machine; and means permitting only forward motion of the metal fed.

80. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to vary the distance between the matrix and the ram in its farthest forward position; and means for supplying between the ram and the matrix the desired amount of metal to complete a fold.

81. A machine for folding metal comprising a matrix; a ram; means for moving the ram toward the matrix; means adapted to vary the distance between the matrix and the ram in its farthest forward position; means adapted to secure the matrix in position during the folding operation; and means for supplying between the ram and the matrix the desired amount of metal to complete a fold.

82. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to vary the distance between the matrix and the ram in its farthest forward position; and means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of the sheet between the ram and the matrix is the proper amount to complete a fold.

83. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means adapted to vary the distance between the matrix and the ram in its farthest forward position; means adapted to secure the matrix in position during the folding operation; and means carried by the ram for gripping the sheet metal at such a distance from the matrix that the length of metal between the matrix and the ram is the proper amount to complete a fold.

84. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to vary the distance between the ram in its farthest forward position and its adjacent matrix; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and to insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

85. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; means adapted to vary the distance between the ram in its farthest forward position and its adjacent matrix; means adapted to secure the forward matrix in position during the folding operation and to hold the sheet material in place; means adapted to release the securing means during the return of the ram to its outermost position; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

86. A machine for folding sheet metal comprising a matrix; a ram; means for moving the ram toward the matrix; means for supplying between the ram and the matrix the desired amount of sheet material to complete a fold; and means adapted to operate during the return stroke of the ram to move the matrix, carrying therewith the folded material, after the completion of a fold.

87. A machine for folding sheet metal comprising a matrix; a ram; means for moving the ram toward the matrix; means for supplying between the ram and the matrix the desired amount of sheet material to complete a fold; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; and means for cutting off the folded material.

88. A machine for folding sheet metal comprising a matrix; a ram; means for moving the ram toward the matrix; means for supplying between the ram and the matrix the desired amount of sheet material to complete a fold; means adapted to operate during the return stroke of the ram to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold, and means for guiding the sheet material through the machine.

89. A machine for folding sheet metal comprising a matrix; a ram; means for moving the ram toward the matrix; means for supplying between the ram and the matrix the desired amount of sheet material to complete a fold; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; means for guiding the sheet material through the machine; and means for cutting off the folded material.

90. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the ram and the matrix to complete a fold and to release the sheet material upon the return of the ram; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; and means for withdrawing the matrix from the folded material upon the return of the ram to its original position.

91. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold, and to release the sheet material upon the return of the ram; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; means for withdrawing the matrix from the folded material upon the return of the ram to its original position; and means for cutting off the folded material.

92. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold, and to release the sheet material upon the return of the ram; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; means for withdrawing the matrix from the folded material upon return of the ram to its original position; and means for guiding the sheet material through the machine.

93. A machine for folding sheet metal comprising a matrix; a ram movable toward and away from the matrix; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to move the matrix, carrying therewith the folded material, away from the ram after the completion of a fold; means for withdrawing the matrix from the folded material upon return of the ram to its original position; means for guiding the sheet material through the machine; and means for cutting off the folded material.

94. A machine for folding metal comprising a stationary member forming a part of a die for the fold; a moving member completing the die; and means carried by the moving member for measuring the amount of material to be included in a fold.

95. A machine for folding sheet metal comprising a member adapted to feed the folded material through the machine and forming a part of a die for the fold; means for securing this member in place during the folding operation; a moving member completing the die; and means carried by the moving member for measuring the amount of material to be included in a fold.

96. A machine for folding metal comprising a matrix; a ram; means, including a toggle joint for moving the ram toward the matrix, and means for selecting and measuring the length of metal to be supplied between the ram and matrix to be formed into a fold.

97. A machine for folding metal comprising a matrix; a ram; means, including a toggle joint for moving the ram toward the matrix; means adapted to secure the matrix in place during the folding operation; and

means for supplying between the ram and the matrix the desired amount of metal to complete a fold.

98. A machine for folding metal comprising a matrix; a ram; means, including a toggle joint for moving the ram toward the matrix; forming means for the bottom portion of the fold; and means for supplying between the ram and the matrix the desired amount of metal to complete a fold.

99. A machine for folding metal comprising a matrix; a ram; means, including a toggle joint for moving the ram toward the matrix; means adapted to secure the matrix against the abutment of the ram; forming means for the bottom portion of the fold; and means for supplying between the ram and the matrix the desired amount of metal to complete a fold.

100. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means, including a toggle joint, adapted to give positive operation to the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

101. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means, including a toggle joint, adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for securing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

102. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means, including a toggle joint adapted to give positive operation to the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

103. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means, including a toggle joint, adapted to give positive operation to the ram; securing means, having a plurality of stops to brace the bottom portion of the forward matrix and a clamping bar for the forward matrix, adapted for securing the matrix against the abutment of the ram on its forward motion and for holding the sheet material in place at the matrix during the formation of the fold; means adapted to operate the securing means during the forward motion of the ram and to release the securing means during the backward motion of the ram; means adapted to be inserted between the ram and its adjacent matrix during the forward motion of the ram and be withdrawn during the backward motion of the ram and to cooperate with the forward matrix and the ram to form the bottom portion of the fold; a plurality of grips carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply a sufficient amount of sheet material between the ram and its adjacent matrix to complete a fold; means adapted to release

the grips upon the return of the ram to its outermost position; means adapted to vary the time of causing the operation of the grips; and means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix.

104. A machine for folding sheet metal comprising a matrix for forming one half of the fold; a movable ram for forming the other half of the fold; means carried by the ram for gripping the sheet metal at such distance from the matrix that the length of metal sheet between the ram and the matrix is the proper amount to complete a fold; cutting off mechanism for the folded material; means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds; and a selective device adapted for controlling the number of folding operations between operations of the cutting off mechanism and adapted for varying, for any fold, the time for causing the operation of the gripping means.

105. A machine for folding sheet metal comprising a pair of matrices; a ram movable toward and away from the matrices; means adapted to give positive operation to the ram; gripping mechanism carried by the ram and cooperating therewith at a predetermined time during the forward motion of the ram to supply the desired amount of sheet material between the matrix and ram to complete a fold and to release the sheet material upon the return of the ram; means adapted to withdraw from the folded material the matrix farthest from the ram and insert it in a position in front of the first mentioned matrix upon the return of the ram to its outermost position while the first mentioned matrix is being moved back to the position of the second mentioned matrix; cutting off mechanism for the folded material; means adapted to operate the cutting off mechanism after the formation of a predetermined number of folds; a selective device adapted for controlling the number of folding operations between operations of the cutting off mechanism and adapted for varying, for any fold, the time for causing the operation of the gripping means; and means permitting the substitution of parts of the selective device without disassembling the remainder of the machine.

106. A machine for folding metal comprising means for clamping the metal in place; a ram, means for moving the ram toward the clamping means; and means for automatically varying the amount of metal supplied between the ram and clamp to be included in a fold.

107. A machine for folding metal comprising means for clamping the metal in place; a ram, means for moving the ram toward the clamping means; means for automatically varying the amount of metal supplied between the ram and clamp to be included in a fold; and means for cutting off the folded material.

108. A machine for folding metal comprising means for clamping the metal in place; a ram, means for moving the ram toward the clamping means; separate forming means for the bottom portion of the fold; and means for supplying between the ram and clamp the desired amount of metal to complete a fold.

109. A machine for folding metal comprising means for clamping the metal in place; a ram, means for moving the ram toward the clamping means; means carried by the ram for measuring the amount of material to be supplied to the ram and matrix to form a fold; and means for guiding the metal through the machine.

110. A machine for folding metal comprising means for clamping the metal in place; a ram, means for moving the ram toward the clamping means; separate forming means for the bottom portion of the fold; means for supplying between the ram and clamp the desired amount of metal to complete a fold; means for guiding the metal through the machine; and means for cutting off the folded material.

111. A cutting off device having operating means therefor, comprising a movable cutting edge; a stationary cutting edge; actuating mechanism for the movable cutting edge; and means adapted to disconnect the actuating mechanism from the operating means for the device.

112. A cutting off device having operating means therefor, comprising a movable cutting edge; a statonary cutting edge; actuating mechanism for the movable cutting edge; and means adapted to connect the actuating mechanism to the operating means for the device; and means adapted to vary the time between connections of the actuating mechanism and the operating means for the device.

113. A cutting off device having operating means therefor, comprising a knife; a shear plate; actuating mechanism for the knife; means adapted to connect at a predetermined time the actuating mechanism to the operating means for the device; and means adapted to vary the time between connections of the actuating mechanism and the operating means for the device.

114. In a machine for folding sheet material, comprising a matrix, a movable ram cooperating with the matrix to form a fold, and means for supplying the material to said matrix and ram; means for selecting

the length of material necessary for a single fold of a predetermined size.

115. In a machine for folding sheet material, comprising a matrix, a movable ram cooperating with the matrix to form a fold; and means for supplying the material to said matrix and ram; means for selecting the length of material necessary for a single fold of a predetermined size; the latter means comprising grips for the material operable at a time during the movement of the ram corresponding to the size of the fold determined upon.

116. In a machine for folding sheet material comprising a matrix; a movable ram cooperating with the matrix to form a fold, means for supplying the material to said matrix and ram; and means for selecting the length of material necessary for each fold of a series or set the folds of which may vary in size according to predetermination.

117. In a machine for folding sheet material comprising a matrix; a movable ram cooperating with the matrix to form a fold; means for supplying the material to said matrix and ram; means for selecting the length of material necessary for each fold of a series or set of predetermined sized folds; and the latter means comprising a cam of which the size and contour control the size and variation in size of the folds constituting the set.

118. A machine for folding sheet material comprising a first die portion; a movable second die portion cooperating with the first to form a fold; means for supplying the material to said die portions; and means for selecting the length of material necessary for each fold of a series or set the folds of which may vary in size according to predetermination.

119. In a machine for folding strip material into series or sets of folds, selective mechanism for determining the length of strip to be included in each fold, the mechanism comprising an element whose contour corresponds to the contour of one side of a series; and means cooperating with said mechanism to count the folds, to properly locate the portions of the contour of said series and to cause operation of cutting-off devices at the completion of a series.

120. A machine for folding metal, comprising a forming die having stationary and movable portions; means for inserting metal between the two die portions; a base forming element; means for inserting the base forming element between the two die portions; means for moving the movable die portion toward the stationary die portion to form the metal; means for moving the movable die portion away from the stationary die portion; means for retracting the base forming element from between the two die portions; and means for again moving the movable die portion toward the stationary die portion to set the formation of the metal therebetween.

121. A machine for folding metal, comprising a top plate; means for feeding metal across the top plate; a forming die including a movable clamping matrix and a movable ramming matrix; means for moving the former matrix into engagement with the metal on the top plate and clamp it tightly on said plate; means for moving the ramming matrix toward the clamping matrix thereby causing buckling of the metal on the top plate, between these two matrices; a base forming element; means for moving said element into the path of the ramming matrix to complete the initial forming operation of the machine; means for returning the ramming matrix toward its normal inoperative position; means for retracting the base forming element from between the metal fold after the ramming matrix has been moved away; and means for again moving the ramming matrix toward the clamping matrix to complete the final bending operation and set the metal formation.

122. A machine for folding metal, comprising a top plate; means for feeding metal onto said top plate; forming means including a movable clamping matrix and a movable ramming matrix; means for moving the clamping matrix into engagement with the metal to clamp it tightly on the top plate; means for moving the ramming matrix toward the clamping matrix a plurality of times to form a fold; a base form; means for moving the base form into the path of travel of the ramming matrix and in front of the clamping matrix during the first movement of the ramming matrix toward the clamping matrix; and means for retracting the base form from between the matrices during the following movement of the one matrix toward the other.

123. A machine for folding sheet material comprising a top plate; a matrix; a ram; means for inserting sheet material between the matrix and the ram; means for moving the matrix to engage the sheet material and clamp it against the top plate; means for moving the ram toward the matrix; a base form; means for projecting the base form into the path of the ram, in front of the matrix; means for retracting the base form from the fold; a second matrix adapted to be moved in front of the first named matrix after the retraction of the base form and ram; and means for moving both the matrices away from the ram whereby the machine is again ready for another folding operation.

In testimony whereof I hereto affix my signature.

CHARLES L. LEE.

Witnesses:
L. H. EMRICK,
R. K. LEE.