

April 12, 1949.

H. R. HARBORD

2,466,947

SHEET SHEARING AND FLANGING MACHINE

Filed June 26, 1946

3 Sheets-Sheet 1

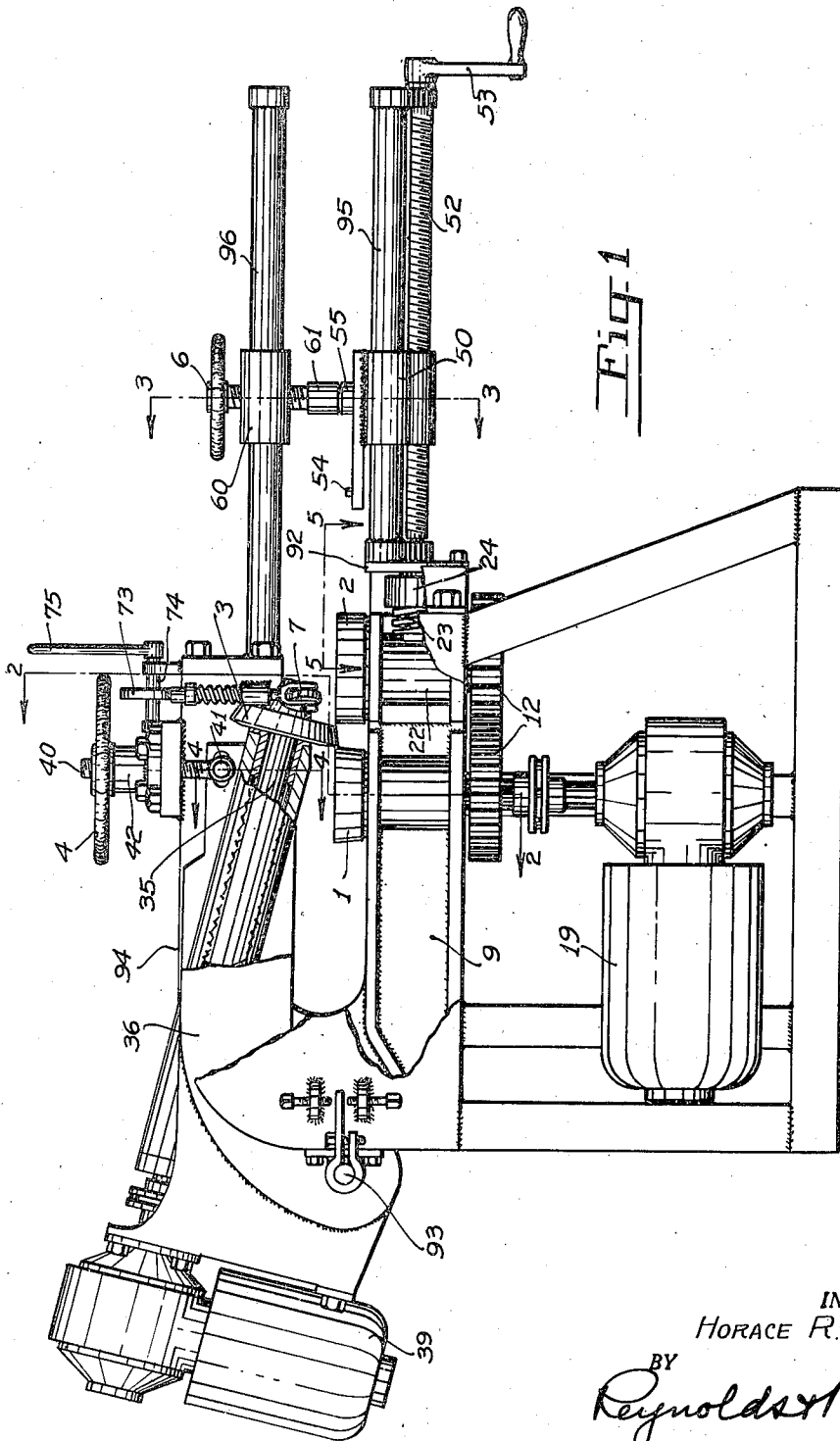


Fig. 1

INVENTOR.
HORACE R. HARBORD

BY
Reynolds & Beach
ATTORNEYS

April 12, 1949.

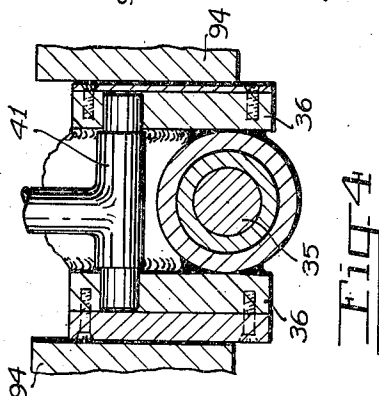
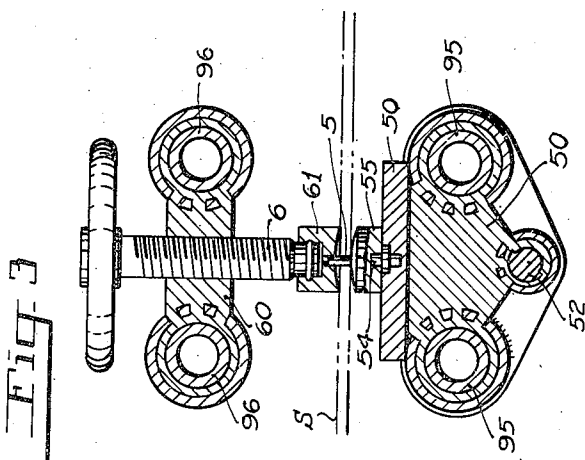
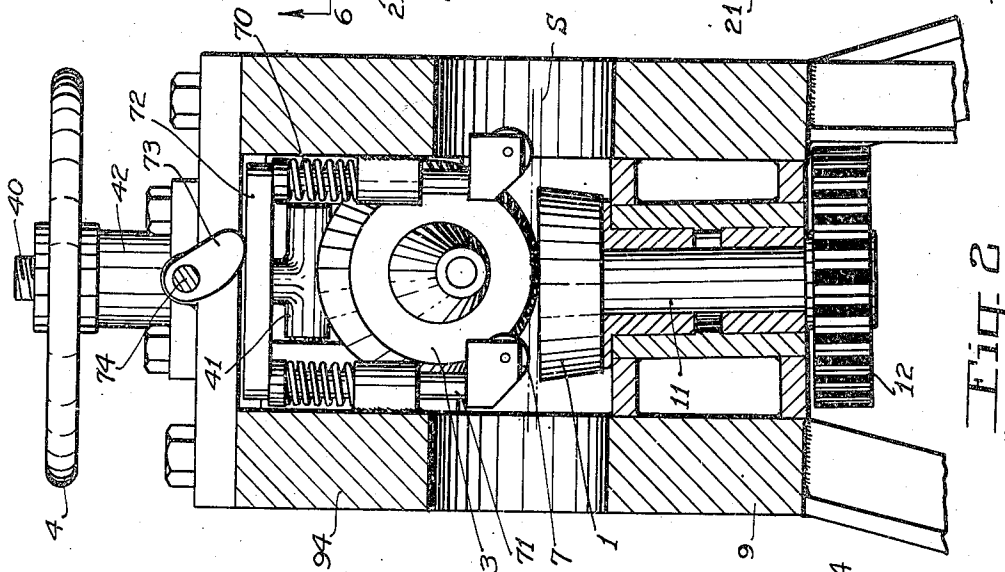
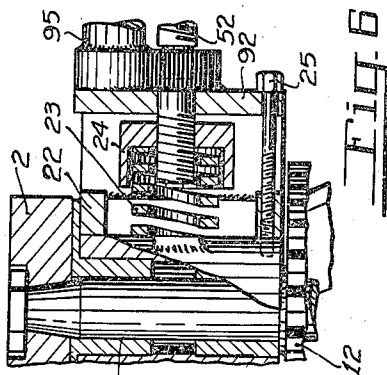
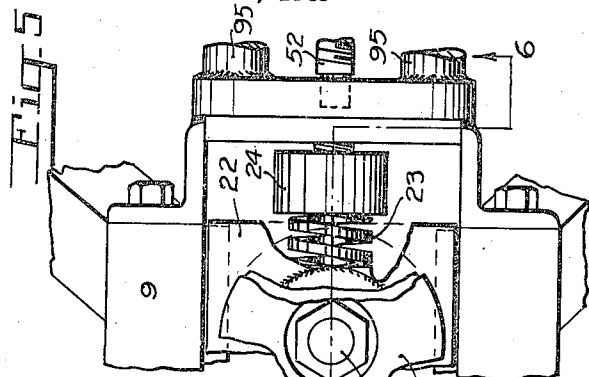
H. R. HARBORD

2,466,947

SHEET SHEARING AND FLANGING MACHINE

Filed June 26, 1946

3 Sheets-Sheet 2



INVENTOR.
HORACE R. HARBORD

BY
Reynolds & Beach
ATTORNEYS

April 12, 1949.

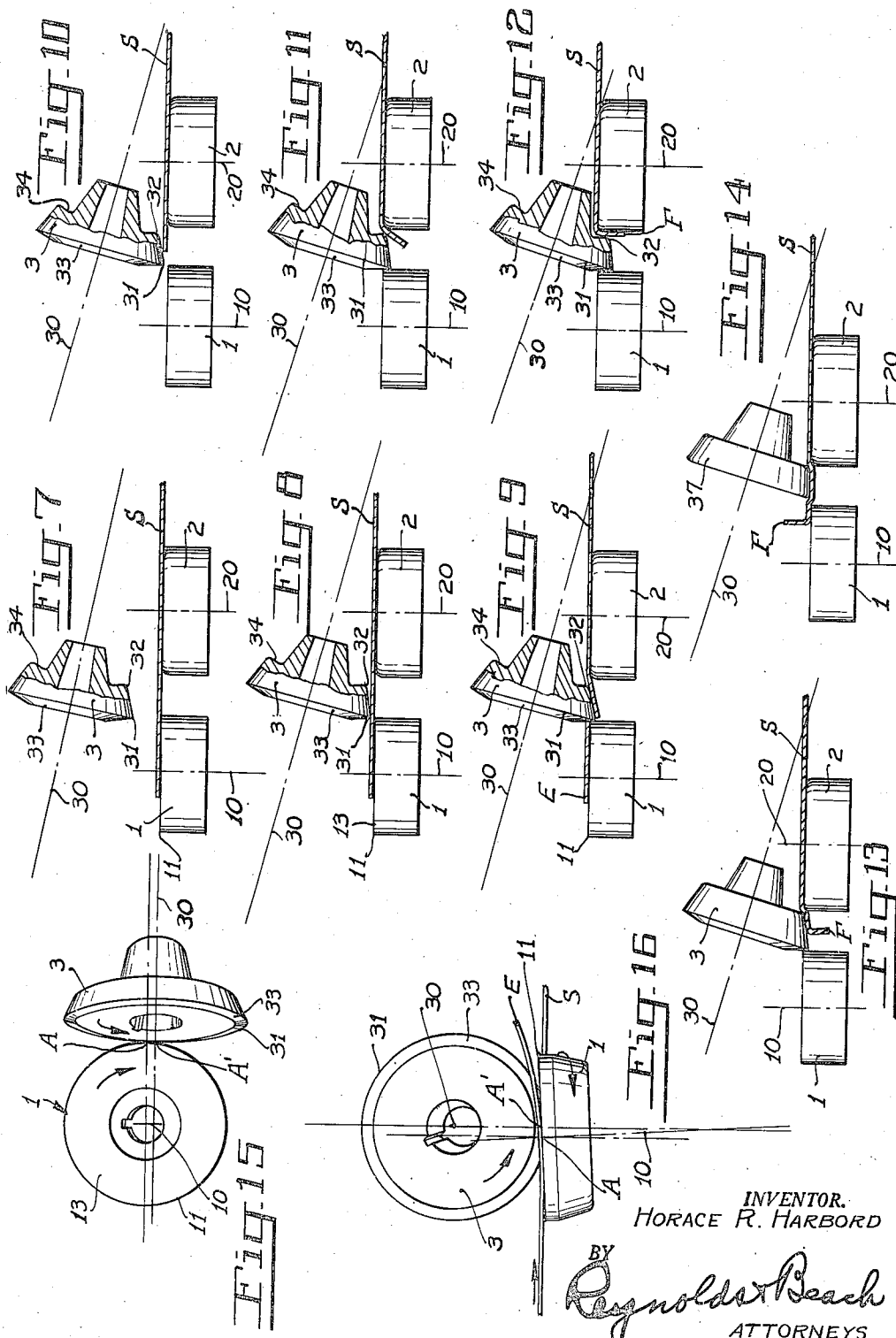
H. R. HARBORD

2,466,947

SHEET SHEARING AND FLANGING MACHINE

Filed June 26, 1946

3 Sheets-Sheet 3



INVENTOR.
HORACE R. HARBORD

BY
Reynolds & Beach
ATTORNEYS

UNITED STATES PATENT OFFICE

2,466,947

SHEET SHEARING AND FLANGING MACHINE

Horace R. Harbord, Tacoma, Wash.

Application June 26, 1946, Serial No. 679,366

26 Claims. (Cl. 153—2)

1

The present invention concerns a machine whereby a metal sheet or plate can be sheared to correct size, and subsequently flanged.

While machines are known which attempt to shear and flange a sheet simultaneously, these are subject to certain limitations and objections which are avoided by the present machine, and by sequential operation. Flanging displaces material from the plane of the sheet and decreases the peripheral extent of the marginal edge; the material must flow within the flange, or it wrinkles, and in order to flow, and to decrease its marginal extent, the margin must be free. Since the margin is only freed, in such prior machines, while the flanging is in progress, it follows that it has not the necessary freedom during the flanging operation. Moreover, flanging should not be done in a single pass through the flanging rolls, but progressively, and requires more extended relative movement of the dies than does shearing, yet when flanging and shearing must be done simultaneously, usually the entire operation is finished in a single pass, for with the flange started the shearing dies can not retrace their original path, but must cut completely through at the first pass, so, to insure this, the dies are pressed together to the maximum extent. Besides, the shearing edges and the flanging rolls, heretofore usually unitary, must be at least a minimum distance apart, to avoid to the greatest degree possible the interference between shearing and flanging operations, already mentioned, yet the normal flange depth, or the desired flange depth, is less than such spacing between the two dies, and wastage of material, and other undesirable results, occur. Hence, while simultaneous shearing and flanging appears to advance efficiency, more careful examination demonstrates that this is not the case. On the other hand, the removal of shearing dies and the substitution of flanging dies for successive operations upon each single work piece set in the machine, or the removal of the piece after shearing, and its resetting for a subsequent flanging operation, are neither one conducive to expedition nor efficiency.

To obtain the advantages of independently performed shearing and flanging operations, yet to avoid removal and resetting of the sheet for a subsequent operation, the present invention provides means whereby a piece once set up in the machine is first sheared to size and shape, and then, without resetting, and with only a slight adjustment in position, or in some cases without any adjustment, can be flanged by dies already

2

located. In performing these successive operations one die roll may accomplish the shearing in conjunction with a companion shearing die roll, and then the same first-mentioned die roll may accomplish the flanging in conjunction with a companion flanging die roll, so that a die set of three rolls, of which one is common to the other two, performs both operations.

The machine is particularly adapted to the formation of flanged circular covers for septic tanks, or for flanging the ends of other tanks of circular section, and the like, such as must be made of fairly thick sheet material, fairly closely to size, yet which must be made inexpensively. The invention, however, is not limited only to such uses, nor to circular shapes, as will appear hereafter.

The general objects of the invention have already been indicated. In particular, it is desired to emphasize that one of the objects of the present invention is to provide means whereby resetting of the sheet, or its removal and replacement upon a different machine, or the substitution of flanging dies for shearing dies, can be avoided, so that in successive operations, the sheet can be sheared to the proper shape and size, and then, with a minimum of or no adjustment in the position of the plate or sheet, and without loss of time, it can be flanged. As a further refinement, optionally usable, by a further such slight readjustment a stiffening rib can be formed, without resetting the work.

Among other objects are to provide a machine which is readily adjustable to perform such operations upon different sizes of sheets, or even without adjustment on sheets of different thickness; to provide a machine which is simple and rugged and easily controllable; to provide a machine in which the shearing and flanging operations are under nice control, to the ultimate end that, the shearing operation and the flanging operations being separate, and independent operations, each can be performed as gradually, yet as precisely, as good practice requires, without compromise of operating conditions of either operation to accommodate the other operation, such as occurs when one must merge into the other; to provide hold-down means readily adapted for use independently of the rolls, but in position adjacent the operative point of the rolls; and in general to provide a machine which is well adapted to the ends already indicated.

In connection with the shearing operation, it is also an object to provide rolls so relatively arranged as to accomplish the shearing, with the

3

axis of one thereof displaced or canted with relation to the axis of the other, so that the shearing operation can be effected most efficiently, with a minimum of folding and the maximum of pure shear, accompanied by a deflection of the sheared-off material upwardly, rather than by depression of the edge of the sheet downwardly.

It is a further object to provide a machine capable, additionally, of performing a ribbing or stiffening operation about the margin of the sheet, whenever desired, with little or no change in the machine, or in the setting therein of the work.

With these and other objects in mind, as will appear from a more detailed study of the present specification, the present invention comprises the novel machine, and the novel combination and arrangement of the operative parts thereof, as shown in the accompanying drawings, described in this specification, and as will be pointed out more particularly in the claims which define the scope of the invention.

In the accompanying drawings the invention is shown embodied in an operative form such as is at present preferred by me.

Figure 1 is a general side elevation of the machine, with parts broken away, the better to show the interior mechanism.

Figures 2, 3, 4 and 5 are sectional views taken on the respective lines 2—2, 3—3, 4—4, and 5—5 of Figure 1, while Figure 6 is a similar sectional view taken on the line 6—6 of Figure 5.

Figures 7, 8 and 9 are diagrammatic views, illustrating successive steps in the shearing operation, and Figures 10, 11, and 12 are similar views showing successive steps in the flanging operation.

Figure 13 is a view similar to Figures 7 to 12 inclusive, showing an optional stiffening or rib-forming operation, and Figure 14 is a similar view of an alternative way of forming such a rib, employing an upper roll which differs from that used in normal cutting and flanging.

Figure 15 is a plan view, and Figure 16 an end elevation, somewhat exaggeratedly illustrating the relationship of the cooperating shearing dies and their relative disposition one to another, the lower such die being of modified shape.

According to the present invention the shearing and the flanging operations are accomplished as two separate, successive operations. Two rolls or dies 1 and 2, the one for use in shearing, and the other for use in flanging, are set side by side, somewhat spaced apart, for rotation about upright axes 10 and 20, respectively, in a frame generally indicated by the numeral 9. Cooperating with each of these dies 1 and 2 is a third or upper die 3, which is also in the form of a roll, rotative about an axis 30 which lies in the same general plane defined by the axes 10 and 20, respectively, of the dies 1 and 2. The axis 30 is disposed above the upper end faces of dies 1 and 2, and extends transversely to both these axes 10 and 20. It is to be noted that the cooperating dies 1 and 3, in the one case, and 2 and 3 in the other case, are not disposed upon parallel axes, as in prior machines for the same purposes, but rather upon intersecting axes, or upon axes which nearly intersect, in the case of the rolls 1 and 3, as will shortly be made clear. In addition, it is to be noted that the dies may assume various shapes, and, in particular, the dies or roll 1 or its counterpart in other figures varies. In Figure 1 this roll is shown with straight sides which slope inwardly and downwardly at a small relief angle to facilitate free separation of the sheared metal edges.

4

The upper die or roll 3 is of a peripheral width sufficient to fit between the rolls 1 and 2 at their point of closest approach, which width is usually greater than the depth of flange desired. The roll 3 has two edges 31 and 32 which cooperate with the upper edges of the respective rolls 1 and 2. The edge 31 of the die 3 cooperates with the upper edge 13 of the die 1, and moves past the same with the end face 33 of the upper roll generally tangentially of the upper peripheral edge of the roll 1, to effect a shearing action upon a sheet S resting upon the upper face 13 of the die 1. In similar fashion the edge 32 of the upper roll 3 cooperates with the upper edge of the roll 2, and the end face 34 of the roll 3 moves in tangential relationship to the periphery of the roll 2 to effect a flanging action on a sheet S which overlies the upper end face of the roll 2.

The upper roll 3 is mounted upon one end of a rotative shaft 35 journaled in an arm 36, which is pivotally mounted in the frame at 93 for limited swinging movement, so that the roll 3 on the swinging end of the arm 36 moves on a long radius into the space between the lower rolls 1 and 2. The roll 3 is rotated by a motor 39 or in any other suitable way, while a motor 19 drives the roll 1 substantially directly, and the roll 2 through the spur gears 12. All the rolls rotate at the same, or substantially the same, peripheral speed.

While the shaft of the roll 1 is fixedly journaled in the frame 9, as indicated at 11 in Figure 2, the roll 2 is mounted for some slight movement in the frame towards and from the roll 1. Thus the journal 21 of the shaft of roll 2 is carried in a carriage 22, which is slidably guided for limited movement laterally within the frame 9. A spring 23, reacting from the end of the frame at 92 and adjustable as to force as indicated at 24, urges the roll 2 towards the roll 1 to the limit permitted by the adjustable stop 25, but permits separation of the roll 2 from the roll 1 upon the encountering of sufficient force. The purpose of this is to permit the roll to be self-accommodating to the flanging of sheets of different gauge, and to accommodate transient and other variations in the thickness of the sheets during the flanging operation.

The disposition of the motor 39 and its gear box at one side of the pivot 93 and the roll 3 upon a long arm at the opposite side rather effectually counterbalances the arm 36, and facilitates sensitive control of its tilting, and consequently of the vertical position of the roll 3 relative to the rolls 1 and 2. Tilting of the arm 36 is accomplished by any suitable means reacting between this arm and the frame, but as herein shown, a jack screw 40 having a T-head 41 engaged in slots in the arm 36, is threaded within a nut in the form of a hand wheel 4, swiveled upon a collar 42 supported upon the upper arm 94, which with the lower part of the frame 9 defines a lateral opening for the reception of a plate to be sheared or flanged. By rotating the hand wheel 4 one way or the other the roll 3 may be moved upwardly for insertion of a sheet S between rolls 3, and 1 and 2, or downwardly past the upper edge of the cooperating rolls 1 or 2, to shear or to flange the sheet.

It may be noted here that it is a convenient arrangement to form the shearing edge 31 and the flanging edge 32, respectively, on the common roll 3, and such an arrangement requires but a minimum of resetting as between shearing and flanging operations upon a given sheet S. That arrangement, however, is not essential to the

5

intended operation of the device. These edges 31 and 32, respectively, might be formed upon separate rolls engaging the cooperating rolls 1 and 2, respectively, at their points of closest approach, or, if the edges 31 and 32 are more widely spaced, they might engage the cooperating rolls 1 and 2, respectively, at their points of farthest spacing, one from another. In any event, the edge 31 and end face 33 with respect to the roll 1, and the edge 32 and end face 34 with respect to the roll 2, are substantially tangent as they move into operative relationship, and as is shown in Figures 7 to 12, inclusive.

The objective, in shearing, is to transmit force acting purely in shear along a single pattern line upon the sheet. With cooperating rolls to effect shearing, this objective is not readily attainable. If the upper, downwardly moving roll 3 has its axis 30 in a plane common to the axis 10 of the fixedly positioned cooperating roll 1, pure shear is produced, theoretically, when the edge 31 contacts the upper surface of the sheet S, for then the edge 31 is substantially tangent to the upper edge 11 of the roll 1. Thereafter, and practically, as the roll 3 continues downwardly, and when the actual shearing is taking place, the point of shearing engagement of the edge 31 with the sheet S progresses along progressively longer chords of the edge 31 subtended by the plane defined by the edge 11, or subtended by the plane of the sheet's upper surface. This displacement of the point of shearing engagement displaces it progressively from the receding curvature, as viewed in plan view, Figure 15, of the edge 11. It follows that the force departs from pure shear, and produces a tendency to bend and depress the sheet, and to tear it by tensional components.

The more nearly the edge 31, where it engages the sheet S, can be retained in engagement with the edge 11, at the point of tangency, the more nearly does the progressive downward movement of the roll 1 result in pure shear, and the more clean-cut and accurate is the job. I have discovered that such a result can be obtained by offsetting the axis 10 from the axis 30, in one of several ways. Since another desirable result flows from canting of the axis 10 relative to the axis 30, so that the two avoid intersecting by a small amount, this is the preferred way, and this arrangement has been illustrated; see, in particular, Figures 15 and 16 where the roll 1 is of somewhat modified shape, having sides which for a short distance from the cutting edge are normal to the die's upper face and then break away sharply at a comparatively large relief angle. The amount of such canting need not be great, and while it has been exaggeratedly shown in these figures, it is actually so slight (2° in a practical machine) that no attempt has been made to show it in the diagrammatic side elevations, Figures 7 to 14, inclusive. This canting or inclination of the axis 10 is, however, closely bound up with the sense of rotation of the rolls 1 and 3, and this rotational sense must be kept in mind. The roll is not shown canted in Figure 1 because canting is slight and could not be convenient of illustration in such a small scale drawing.

With the rolls rotating as shown by the arrows in Figures 15 and 16, the sheet S is frictionally fed between the rolls in the sense also, shown by an arrow. The edge 31 first engages the sheet S at A, vertically beneath the axis 30, but this point A' of engagement is on the off-feeding side of the rolls from their point A of closest approach, which in Figure 16, lies directly in line with the

6

axis 10. But now, as the roll 3 moves downwardly, the working point of engagement of the edge 31 with the sheet S approaches the point A, and generally coincides therewith, unless the sheet is thicker than normal. In any event, the working point of engagement lies close to the point of closest approach A of the cooperating shearing edges, because it was initially offset therefrom in a manner and in such sense as to cause it to approach, rather than to recede from, the point A of closest approach, or point of tangency, of the shearing edges during actual shearing. A cleaner, more accurate cut results, with no appreciable tendency to flange or bend, and hence to tear, the sheet.

The canting of the axis 10 in the manner shown and described has the effect of offsetting this axis, at its upper end, from a vertical plane through the axis 30; at the upper surface 13 of the roll 1, in a typical installation, there is an offset of $\frac{1}{16}$ ". While the "general plane of the axes 10 and 20" has been referred to hereinbefore, as a convenient and approximately correct mental concept, and the axis 30 was described as disposed and movable in that "general plane," it now is clear that while axes 20 and 30 lie in a common vertical plane, axis 10 does not precisely coincide therewith. Now, reverting to the offsetting of the axis 10 at the plane of roll surface 13, it becomes clear that such offsetting alone, without canting of that axis 10, would produce substantially similar results, except for the upward deflection of the marginal scrap E, to which reference will be made hereinafter.

While Figure 9 shows a downward depression of the sheet's margin such as was referred to above, this is purely for the purpose of graphic simplicity, and in this respect is technically incorrect. It could represent true conditions, were the roll 3, in shearing, to be moved so far downwardly relative to the upper surface 13 of the die 1, but this is never necessary, in shearing, for severance is accomplished by downward movement less than the thickness of the sheet. Because this is so, and because much greater downward movement of the roll 3 relative to die 2 is necessary for flanging, it illustrates why it is preferable to effect shearing and flanging as two separate operations, and why delicate control of downward movement of die 3 is desirable.

One further advantage of canting the axis 10, thereby inclining the upper surface 13 of die 1, is that the severed edge or scrap E (Figure 16) is deflected upwardly as the shearing progresses, and the margin of the cut sheet S need not be deflected downwardly. Shearing usually requires but one pass of the sheet through the dies, though several passes can be made as accurately as one, if desired, and shearing is completed by a depression of the die 3 not appreciably farther than the thickness of the sheet.

There has been no description heretofore of any means for positioning and guiding the sheet to be sheared or flanged, for the reason that such positioning means may take any one of a number of forms, or conceivably may be omitted altogether. If the sheet were to be sheared or flanged along an irregular or non-circular pattern line, the positioning means of the sheet would have to be such as would present the edge of the sheet to the shearing or flanging pairs of rolls in proper relationship to accomplish the desired operation. However, if the shearing and flanging are to be along a circular line, which is the usual case, a

positioning mechanism, such as is now to be described, will be found desirable.

Formed as an extension outwardly of the upper arm 94 of the frame is a guide 96, and a similar guide 95 forms an outward extension of the main frame 9 parallel to the extension 96. These extensions may take the form of tubes rigidly secured to the supporting frame parts. Upon the lower guide 95 is mounted a carriage 50 formed with a nut 51 in which is threaded a screw 52 rotatable by a crank 53 or similar means. Thus the carriage 50 may be adjusted inwardly and outwardly along the guide 95. A similar carriage 60 is slidable along the guide 96, but usually it is unnecessary to provide means to accomplish its adjustment, as it may be adjusted readily by hand. The carriage 60 has a screw 6 threaded therein upon a vertical axis, and swiveled upon its lower end is a centering head 61.

The carriage 50 is formed with one or more locating pins 54 slightly upstanding from its upper surface, and upon either of these may be seated a stand 55 carrying a locating pin 5 directed upwardly and receivable within a socket in the lower surface of the head 61.

Preferably two locating pins 54 are provided, spaced lengthwise of the guide 95, whereon the center 55 is alternatively mounted, to permit one of the locating pins 54 to overlie frame elements inwardly of the guides 95, so that the center 5 may be located at a sufficiently short distance from the rolls 1 and 2, should the diameter of the disk to be formed be less than than which can be accommodated by the outward pin 54.

To complete the description of the machine, hold-down means, such as the rollers 7, are optionally employed (usually, whenever thin sheets are being sheared or flanged), located in the vicinity of the point of operative engagement as between the upper die and one, at least, of the lower dies, and these rollers are positively pressed downwardly against the sheet, to hold the latter against the upper end face of the die 2, for example. The rollers 7 are mounted for swiveling or casting about upright axes 71, so that they are self-accommodating to the rotation of the disk, whatever may be the radius of the latter. The swiveling posts 71 of the hold-down rollers 7 are both engageable by a yoke 72, which may be acted upon by a cam 73 or the like upon a rock shaft 74, so that by throwing a control handle 75 in one direction or the other the rollers 7 may be positively held down in contact with the sheet, or may be permitted to rise under the influence of the springs 70.

In a typical operation a square sheet of width and breadth slightly in excess of the flange diameter of the intended cover is centrally bored for the reception of the locating or centering pin 5. The bored sheet is inserted between the extensions 95 and 96, and between the main frame 9 and the upper arm 94 thereof, the hold-down rollers 7 and the head 61 being upraised for entry of the sheet S. The sheet's center hole receives the centering pin 5, and its edge is adjusted by the screw 52 inwardly or outwardly with respect to the shearing roll 1, to bring the edge of the latter into registry with the circle about which shearing is to be accomplished. The head 61 is now screwed down to hold the sheet fairly firmly between the members 55 and 61. The rollers 7 may be lowered to rest upon the sheet. The upper roll 3 at this time is upraised.

Now the motors 19 and 39 may be energized, and by manipulation of the adjusting means at

4 the roll 3 may be brought downward slowly from the position of Figure 7 to the position of Figure 8, where it contacts with the sheet S. The sheet being engaged by the periphery of the roll 3, and by the end face 13 of the roll 1, both of which may be knurled for better contact, commences to rotate about the center 5. With the sheet thus rotating, the roll 3 is depressed further, but only sufficiently to shear off the edge E, and the shearing is accomplished with parts in somewhat the relationship exaggeratedly shown in Figure 9; see also Figure 16. The shearing usually requires not much more than a single revolution of the sheet, after the roll 3 begins to press downwardly upon it.

The roll 3 is now raised by manipulation of the adjustment at 4, and since in the usual case the flange is of less depth than the spacing between the rolls 1 and 2, the disk's center at 5 is backed off to the desired degree, leaving parts in the position corresponding to Figure 10. This backing off is quickly and easily accomplished by means of the screw at 52, and the hold-down at 6 can be slacked off slightly, if need be, to permit such adjustment, and then as readily restored to clamping position in the new location. Now the downward movement of the roll 3 commences, and with the rolls 1 and 2 this time effecting rotation of the sheet or disk, the latter is broken about the upper edge of the roll 2, as in Figure 11, and with about two rotations of the sheet, and an appropriate degree of downward movement of the roll 3, a flange is completed, as indicated in Figure 12. The roll 3 is now lifted, the clamp at 6 is relaxed, and the flanged sheet or disk can now be removed. In Figures 7 to 12, inclusive, just described, and also in Figures 13 and 14 the lower rolls 1 and 2 for convenience of illustration are both shown of simple, straight-sided form although it is to be understood their forms may vary. From the same reason, roll 1 is shown uncanted.

If a further stiffening operation is desired, it can be performed in the manner indicated by Figure 13. The flange F having been formed, the sheet is displaced to space the flange from the roll 2, within the space between the rolls 1 and 2. A second flanging operation, on a smaller radius, is begun, but since the machine's controls are delicate, is not permitted to progress far. The result is a marginal depression about the sheet, as shown in Figure 13, which stiffens the sheet. A similar operation can be performed as illustrated in Figure 14, by reversing the flanged disk or cover, and by using an upper roll 37 which has no shearing edge, but which is otherwise substantially the same as the roll 3. Here, it will be observed, the sheet S is so located that its peripheral edge overlies the upper face of the roll 1, and the ribbing is accomplished by depressing the material between the rolls 1 and 2 by depression of the roll 37. The latter style of ribbing may take a variety of shapes; preferably it follows the flanging, since otherwise the setting of the sheet would have to be changed twice, instead of once.

With particular reference to the primary flanging operation, it will be clear that the flanging is finally accomplished by interengagement of the end face 34 of the upper die 3 and the periphery of the lower die 2, where the two are tangential one to the other, and yet it will be evident that the wiping action of the die 3 with respect to the die 2 tends to spin the flange to a certain extent, and to iron out wrinkles which may tend to

occur, these wrinkles being progressively constricted as the flange moves into the point of tangency. The two dies 3 and 2 cooperate in the manner indicated, regardless of the thickness or gauge of the sheet, due to the fact that the spring 23 will permit slight yielding of the roll 2 with respect to the end face 34 of the roll 3, in accordance with the thickness of the interposed sheet, and this, in turn, accommodates any local or transient irregularity, such as might be caused by wrinkles.

I claim as my invention:

1. A machine for shearing and flanging a sheet, comprising two lower rolls, one arranged for shearing and the other for flanging, spaced apart in approximately the same plane, and rotative about generally parallel upright axes, to support a sheet with its edge overlying one or both said rolls at their points of closest approach, a third roll of peripheral width to fit between the lower rolls, rotative about an axis transversely above and generally coplanar with the axes of the two lower rolls, with one end face formed and arranged for substantially tangential cooperative shearing engagement with the periphery of the lower shearing roll, and with its other end face formed and arranged for substantially tangential cooperative flanging engagement with the periphery of the lower flanging roll, and means to effect relative approach of the upper roll and of the two lower rolls, to effect a shearing or a flanging action upon a sheet interposed therebetween, according to the operative disposition of the edge of such sheet relative to the shearing face or to the flanging face, respectively, of its upper roll.

2. A machine for shearing and flanging a sheet, comprising two lower rolls, one arranged for shearing and the other for flanging, spaced apart and rotative about generally parallel upright axes, to support a sheet with its edge overlying one or both said rolls at their points of closest approach, a third roll of peripheral width to fit between the lower rolls, rotative about an axis transversely above and generally coplanar with the axes of the two lower rolls, with one end face formed and arranged for substantially tangential cooperative shearing engagement with the periphery of the lower shearing roll, and with its other end face formed and arranged for substantially tangential cooperative flanging engagement with the periphery of the lower flanging roll, and means to effect relative approach of the upper roll and of the two lower rolls, to effect a shearing or a flanging action upon a sheet interposed therebetween, according to the operative disposition of the edge of such sheet relative to the shearing face or to the flanging face, respectively, of the upper roll, the lower shearing roll having its axis canted slightly, relative to the axes of the other two rolls, to avoid intersection with the axis of the upper roll, the canting being in such direction, relative to the direction of advance of the sheet into engagement with the dies, as will deflect upwardly the sheared-off edge, in shearing, above the general plane of the sheet.

3. A machine for shearing and flanging a sheet, comprising two lower rolls, one arranged for shearing and the other for flanging, spaced apart in approximately the same plane, and rotative about generally parallel upright axes, to support a sheet with its edge overlying one or both said rolls at their points of closest approach, a third roll of peripheral width to fit between the lower rolls, rotative about an axis transversely above

and generally coplanar with the axes of the two lower rolls, with one end face formed and arranged for substantially tangential cooperative shearing engagement with the periphery of the lower shearing roll, and with its other end face formed and arranged for substantially tangential cooperative flanging engagement with the periphery of the lower flanging roll, means to effect relative approach of the upper roll and of the two lower rolls, to effect a shearing or a flanging action upon a sheet interposed therebetween, according to the operative disposition of the edge of such sheet relative to the shearing face or to the flanging face, respectively, of the upper roll, and power means to rotate said rolls, to advance a sheet between the upper roll and one of the lower rolls.

4. A machine for shearing and flanging a sheet, comprising two lower rolls, one arranged for shearing and the other for flanging, spaced apart and rotative about generally parallel upright axes, to support a sheet with its edge overlying one or both said rolls at their points of closest approach, a third roll of peripheral width to fit between the lower rolls, rotative about an axis transversely above and generally coplanar with the axes of the two lower rolls, with one end face formed and arranged for substantially tangential cooperative shearing engagement with the periphery of the lower shearing roll, and with its other end face formed and arranged for substantially tangential cooperative flanging engagement with the periphery of the lower flanging roll, means to effect relative approach of the upper roll and of the two lower rolls, to effect a shearing or a flanging action upon a sheet interposed therebetween, according to the operative disposition of the edge of such sheet relative to the shearing face or to the flanging face, respectively, of the upper roll, and means urging the lower flanging roll towards the flanging face of the upper roll, but yieldable in accordance with the thickness of the sheet being flanged.

5. A machine for shearing and flanging a sheet, comprising two lower rolls, one having its upper edge arranged for shearing, and the other having its upper edge arranged for flanging, said two lower rolls being held spaced apart, and each being rotative about an upright axis generally parallel to the other's axis, means to support a sheet with its edge overlying one or both said rolls at their points of closest approach, and to guide such edge for movement in a definite path relative to either roll, means to adjust the last-mentioned means for disposition of the sheet with respect, alternatively, to the shearing roll or to the flanging roll, and a third roll of peripheral width to fit between the lower rolls, with one end face formed and arranged for substantially tangential cooperative shearing engagement with the periphery of the lower shearing roll, and with its other end face formed and arranged for substantially tangential cooperative flanging disposition relative to the periphery of the lower flanging roll, upon movement of the upper or third roll into the space between said lower rolls to effect alternatively a shearing or a flanging action in accordance with the disposition of the sheet's edge by said adjusting means.

6. A sheet shearing and flanging machine comprising two lower rolls spaced apart and rotative about generally parallel upright axes, a third roll of a peripheral width to fit between the two lower rolls, rotative about an axis generally coplanar with the axes of the two lower rolls, and

transversely above such rolls, means to support a sheet with its edge overlying one or both said lower rolls, and means to move said upper roll downwardly past the upper end surface of, and with its respective end surfaces generally tangent to the peripheries of, the two lower rolls, one end surface of the upper roll, and the complemental upper end surface of one lower roll, being relatively formed and arranged to shear a sheet so supported, and the second end surface of the upper roll, and the complemental upper end surface of the other lower roll, being relatively formed and arranged to break a flange upon a sheet so supported.

7. A sheet shearing and flanging machine comprising a lower shearing roll rotative about an upright axis, a complemental upper roll having a shearing edge and end face disposed generally tangentially of the lower shearing roll, and movable downwardly past the same in shearing relationship, a flange-forming roll spaced from the lower shearing roll, and rotative about an upright axis lying in the general plane defined by the first two rolls, the upper roll and the flange-forming roll being complementally formed and arranged to break a flange upon a sheet upon downward movement of the upper roll past the periphery of the flange-forming roll, means so to move the upper roll, for shearing or for flanging, and means to retain a sheet in a single plane, in position for engagement alternatively or successively with the shearing rolls and with the flanging rolls.

8. A machine for shearing and flanging a sheet, comprising two lower rolls rotative about generally upright axes, an upper roll surface, rotative upon a transverse axis above one such roll, and guided for movement tangentially past the latter's periphery, the edges of the latter lower roll surface, and of the upper roll surface, being cooperatively formed and arranged to shear the edge of an interposed sheet, a second upper roll surface, rotative upon a transverse axis above the second lower roll, guided for movement tangentially past the periphery of the second lower roll, the edges of the second lower roll and of the latter upper roll surface being cooperatively formed and arranged to flange the edge of an interposed sheet, means to support a sheet in operative relationship relative to the shearing roll and roll surface or to the flanging roll and roll surface, respectively, and means to shift said supporting means, and a sheet so supported, from one such operative disposition to the other, to effect successive shearing and flanging operations without release or resetting of the supported sheet relative to its support.

9. Two shearing rolls arranged on axes generally transversely disposed, and for movement of one to engage its end face with and to move the same across a peripheral edge of the other, to shear an interposed sheet rested against the end face of the peripherally engaged roll, the axis of the peripherally engaged roll being offset, relative to the sense of rotation of the rolls, towards the off-feeding side.

10. Two cooperating shearing rolls arranged for conjoint rotation on axes generally transverse and coplanar, and for movement of one in such plane to engage its end face tangentially with and to move the same across a peripheral edge of the other, to shear an interposed sheet, the axis of the peripherally engaged roll being canted to avoid intersection with the axis of the other roll, the inclination of such canted axis being such,

relative to the sense of rotation of the rolls, to locate the point of initial engagement of the tangentially disposed roll with the sheet upon the off-feeding side of the sheet.

11. A sheet shearing machine comprising a first roll rotative about its axis, a cooperating second roll rotative about an axis which, as projected in a plane which includes the axis of the first roll, is disposed at an angle to the axis of said first roll, and which axis of the second roll is additionally canted in a plane transverse to the axis of the first roll, whereby the two axes approach closely but avoid intersecting, said rolls being disposed, at initiation of a shearing operation, with their shearing edges nearly mutually tangent, but spaced apart for the reception of a sheet to be sheared beneath the periphery of the first-mentioned roll and across the end face of the second-mentioned roll, and means to effect relative approach of said rolls to depress the sheet by engagement by the periphery of the first-mentioned roll, beyond the end face of the second-mentioned roll, the canting of the latter being in a sense such as to cause the sheared-off edge of the sheet to ride up such end face of the second-mentioned roll.

12. A sheet shearing machine comprising a first roll rotative about its axis, a cooperating second roll rotative about an axis which, as projected in a plane which includes the axis of the first roll, is disposed at an angle to the axis of said first roll, and which axis of the second roll is additionally canted in a plane transverse to the axis of the first roll, whereby the two axes approach closely but avoid intersecting, said rolls being disposed, at initiation of a shearing operation, with their shearing edges nearly mutually tangent, but spaced apart for the reception of a sheet to be sheared beneath the periphery of the first-mentioned roll and across the end face of the second-mentioned roll, means to rotate at least one of said rolls in a sense to advance the engaged sheet towards the rolls, and means to effect relative approach of said rolls to depress the sheet by engagement by the periphery of the first-mentioned roll, beyond the end face of the second-mentioned roll, the canting of the latter being in a sense such as to cause the sheared-off edge of the sheet to ride up such end face of the second-mentioned roll.

13. A sheet shearing machine comprising a first roll rotative about its axis, a cooperating second roll rotative about an axis which, as projected in a plane which includes the axis of the first roll, is disposed at an angle to the axis of said first roll, and which axis of the second roll is additionally canted in a plane transverse to the axis of the first roll, whereby the two axes approach closely but avoid intersecting, said rolls being disposed, at initiation of a shearing operation, with their shearing edges nearly mutually tangent, but spaced apart for the reception of a sheet to be sheared beneath the periphery of the first-mentioned roll and across the end face of the second-mentioned roll, power means to rotate both said rolls in a sense to advance the interposed sheet towards the rolls, and means to effect relative approach of said rolls to depress the sheet by engagement by the periphery of the first-mentioned roll, beyond the end face of the second-mentioned roll, the canting of the latter being in a sense such as to cause the sheared-off edge of the sheet to ride up such end face of the second-mentioned roll.

14. A sheet flanging machine comprising a first

13

roll rotative about its axis, a cooperating second roll rotating about an axis transverse to the axis of the first roll, so that the two axes intersect in a common plane, said rolls being disposed, at initiation of a flanging operation, with their flange-forming edges nearly mutually tangent, but spaced apart for the reception of a sheet to be flanged beneath the periphery of the first such roll and across the end face of the second such roll, means to effect relative approach of said rolls, preserving spacing to accommodate the thickness of the sheet, to deflect the flange from the sheet by engagement by the periphery of the first roll, and its movement past the end face of the second roll, and spring means urging the second roll towards the first, but yieldable to accommodate variations in thickness of the sheets being flanged.

15. A machine for shearing and/or flanging a sheet, comprising a frame to support a lower shearing roll and a lower flanging roll spaced apart upon upright axes, with their upper end faces in substantially a common plane, means to support a sheet outwardly of the rolls, with its edge overlying one or both said rolls, and for movement in a definite path relative to the latter, an upper member rotative upon an axis above, transverse to, and in a plane generally common to the axes of the two lower rolls, and cooperatively formed and disposed, relative to the lower shearing roll to shear a sheet overlying the latter, an upper member coaxial with the first-mentioned upper member, cooperatively formed and disposed, relative to the lower flanging roll, to flange a sheet overlying the latter, an arm supporting the upper members for rotation, and pivotally mounted to advance the upper members into and from operative engagement with the lower rolls, and means to adjust the sheet-supporting means, in the general plane of the sheet, to dispose its edge alternatively in operative relationship to the shearing roll or to the flanging roll.

16. A machine for shearing and/or flanging a sheet comprising a frame, means supported thereon to center a sheet for rotation about an upright axis, two rolls spaced apart and supported upon said frame for rotation about upright axes, the three axes referred to being generally in a common plane, means guiding said sheet-centering means for movement in such plane towards and from the other two axes, to dispose the sheet's edge beyond one or the other roll, a third roll rotative about an axis above a sheet so disposed, and lying transversely of and in the same general plane as the axes of the two lower rolls, said upper or third roll being of a peripheral width to fit between the two lower rolls, and formed and arranged for cooperative action with one lower roll to shear an interposed sheet, and for cooperative action with the second lower roll to flange an interposed sheet, and means controllable to move said upper roll downwardly into shearing relationship, and into flanging relationship, with the respective lower rolls.

17. A machine for shearing and/or flanging a sheet comprising a frame, means supported thereon to center a sheet for rotation about an upright axis, two rolls spaced apart and supported upon said frame for rotation about upright axes, the three axes referred to being generally in a common plane, means guiding said sheet-centering means for movement in such plane towards and from the other two axes, to dispose the sheet's edge beyond one or the other roll, a third roll rotative about an axis above a sheet so disposed,

14

and lying transversely of and in the same general plane as the axes of the two lower rolls, said upper or third roll being of a peripheral width to fit between the two lower rolls, and formed and arranged for cooperative action with one lower roll to shear an interposed sheet, and for cooperative action with the second lower roll to flange an interposed sheet, an arm wherein said upper roll is journaled, pivot means at the end of said arm distant from said upper roll to support the same for swinging, and means reacting between the frame and said arm, under control, for moving said roll downwardly into shearing or flanging relationship, as the case may be, with the respective lower rolls.

18. A machine for shearing and for flanging a sheet comprising a frame having a laterally open U-shape, means supported thereon towards the outer end of the U to center such a sheet for rotation about an upright axis, two rolls spaced apart and journaled in said frame, inwardly of and upon axes generally in a plane common to the sheet's rotative axis, means guiding and controlling said sheet-centering means for movement in such plane towards and from the other two axes, to vary the disposition of the sheet's edge relative to each of the two rolls, a rotative shaft pivotally supported from said frame to swing in the aforesaid plane, above said rolls, a third roll upon the swinging end of said shaft, of a size and so located to fit between the two lower rolls, and formed and arranged relative to each of the latter to shear a sheet interposed between itself and one of the lower rolls, or to flange such a sheet interposed between itself and the second lower roll, means to effect and control swinging of the shaft to such ends, power means to drive each roll, and means urging the lower flanging roll towards the cooperating end face of the upper roll, but yieldable in accordance with the thickness of the sheet being flanged.

19. A machine for shearing and/or flanging a sheet, comprising a frame to support a lower shearing roll and a lower flanging roll spaced apart upon upright axes, with their upper end faces in a common plane, means to support a sheet outwardly of the rolls, with its edge overlying one or both said rolls, and for movement in a definite path relative to the latter, an upper member rotative upon an axis above, transverse to, and in a plane generally common to the axes of the two lower rolls, and cooperatively formed and disposed, relative to the lower shearing roll to shear a sheet overlying the latter, an upper member coaxial with the first-mentioned upper member, cooperatively formed and disposed, relative to the lower flanging roll, to flange a sheet overlying the latter, an arm supporting the upper members for rotation, and pivotally mounted to advance the upper members into and from operative engagement with the lower rolls, means to adjust the sheet-supporting means, in the general plane of the sheet, to dispose its edge alternatively in operative relationship to the shearing roll or to the flanging roll, and hold-down means yieldably engaging the upper surface of the sheet in the vicinity of the point of engagement of an upper member with its cooperating lower roll.

20. Shearing and flanging apparatus comprising lower shearing and flanging rolls rotatable about upright axes and spaced apart with their upper end faces in approximately the same horizontal plane, a coacting upper roll common to said shearing and flanging rolls rotatable about

a transverse axis included in the approximate plane of the axes of rotation of said shearing and flanging rolls, a pivotal support for said upper roll located at a point remote from said shearing and flanging rolls and in the vicinity of the plane of their upper faces, for swinging vertically to move said upper roll downwardly into working engagement with said shearing and flanging rolls, the axis of rotation of the upper roll being inclined upwardly in the direction of said pivotal support away from said shearing and flanging rolls, said shearing roll being located intermediate to said flanging roll and pivotal support, and means to support a work sheet for rotation by conjoint action of the rolls, about an axis located substantially directly opposite to the point of said pivotal support, from said rolls.

21. The shearing and flanging apparatus as defined in claim 20 in which the shearing roll is nearer the pivotal support than the flanging roll, and the upper common roll has a shearing edge at its end face nearest the pivotal support for coaction with the peripheral edge of the shearing roll in tangential relation thereto, and a reentrant annular groove whose sides extend inwardly from its side face and end face remote from said pivotal support, complementarily with the working edge of the flanging roll's periphery.

22. The shearing and flanging apparatus as defined in claim 20, in which the upper common roll is of generally frusto-conical shape tapering towards its end face which is remote from the pivotal support, with its end face nearest said support being beveled to form a peripheral cutting edge inclined with respect to the roll's axis and approximately parallel to the peripheral edge of the shearing roll when in overlapping relation thereto, and with its opposite end face recessed peripherally to form a reentrant peripheral groove of a reentrant angle conforming substantially to the upper corner angle of the flanging roll.

23. Shearing and flanging apparatus as defined in claim 20, in which the axis of the shearing roll is canted at a small angle with respect to the plane of a work sheet supported substantially flatly on the upper end face of the flanging roll beneath the upper common roll, and in such direction with respect to the direction or rotation of said rolls that the point of closest approach of the shearing roll and the upper roll closely approaches the general plane of the axes of the several rolls during cutting, so that the scrap material cut from the sheet is deflected upwardly.

24. Shearing and flanging roll mechanism for operating upon metal plates, comprising a lower shearing roll rotatable about an upright axis and adapted to support a work sheet upon its upper end face, a flanging roll separated laterally from said shearing roll and rotatable about an upright axis approximately parallel with the axis of said shearing roll, and with its upper end face approximately in the plane of the upper end face of said shearing roll, a coacting single shearing

and flanging roll having one end face cooperable with said shearing roll, and its opposite end face formed reentrantly annularly, cooperable with said flanging roll, said coacting single shearing and flanging roll being rotatable about an axis inclined upwardly from said flanging roll in the direction of said shearing roll, the rotation axis of all three rolls being approximately in the same plane, the single roll being supported for pivoting about a horizontal axis located remotely from said shearing and flanging rolls on the side of said shearing roll, means to drive at least one of said rolls rotatably, and means to depress said coacting single roll downwardly into the space between said shearing and flanging roll to shear or to flange sheet material placed thereon.

25. Flanging apparatus comprising a lower flanging roll rotatable about an upright axis, means to support a blank to be flanged substantially in the plane of the upper face of said flanging roll, a coacting upper flanging roll cooperable with the upper peripheral edge of said first flanging roll on the side opposite said blank supporting means, said cooperable flanging roll being supported pivotally for vertical swinging about an axis remote from said first flanging roll and located in the vicinity of the plane thereof on the side of said cooperable flanging roll, means to support said upper roll for self-rotation about an inclined axis contained substantially in its plane of swing and sloping upwardly in the direction of said pivotal support away from said first flanging roll, said cooperable flanging roll being frusto-conical in shape and having an annular reentrant groove in its end face nearest the flanging roll formed to register in parallel relation with the adjacent peripheral corner faces of said first flanging roll, with a flanged work blank interposed between.

26. The flanging apparatus as defined in claim 25, in which the cooperable flanging roll of frusto-conical shape has a cone angle which is approximately twice the angle of incline of its self-rotation axis with such roll in its initial engaging position with said first flanging roll.

HORACE R. HARBORD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
740,730	Zeh	Oct. 6, 1903
1,105,668	Lange et al.	Aug. 4, 1914
1,360,450	Scott	Nov. 30, 1920
1,383,618	Gray	July 5, 1921
1,775,864	Olson	Sept. 16, 1930
1,907,664	Preston et al.	May 9, 1933
2,031,604	Ingels	Feb. 25, 1936

FOREIGN PATENTS

Number	Country	Date
6,826	Germany	1878