

ROTARY APPARATUS WITH MULTIPLE GUIDES AND METHOD OF FORMING

FIELD OF THE INVENTION

The invention relates to the forming of sheet metal using rotary forming apparatus with dies mounted on the rotary apparatus for rotation and sequential contact with the sheet metal and to such an apparatus having multiple guides for the rotary apparatus and to a method of forming sheet metal.

BACKGROUND OF THE INVENTION

Sheet metal studs with a simple c - section have been made for many years, since at least the 1930's. Proposals have been made for forming openings in the sheet metal studs, such US Patent 2088781 and Canadian Patent 1192015.

Forming these openings is difficult. In machines with dies travelling around a circular path, the sheet metal is travelling on a linear path. During a brief time span, there is a slight change in linear speed between the linear speed of the dies themselves and the linear speed of the metal. This speed change causes distortion of the sheet metal. Also, in a rotary apparatus the planes of each of the dies in any one pair must be brought parallel to one another just prior to closing on the sheet metal and must remain parallel through closing and after opening, for a certain length of time. The dies themselves are mounted on die carriers, which are mounted on semi rotary bearings. Guide rollers are provided along both the leading and the trailing edges of the die carriers. The leading and trailing guide rollers must follow different paths as they rotate. Speed adjustments are also required to match the linear speeds of the die carriers with the linear speed of the sheet metal.

It may also be desirable to provide a rotary apparatus in which the shafts are supported on bearings stands only at one end of each of the shafts, leaving the opposite end of each shaft unsupported. This type of "open sided" rotary apparatus may have advantages over the more conventional design.

BRIEF SUMMARY OF THE INVENTION

The invention comprises a rotary forming apparatus having a pair of central rotors, and one or more die carriers swingably mounted on each of the rotors, rotor supports for supporting the rotors at least at one end there and characterised by dies carrier guides on the die carriers at an end adjacent to said rotor supports, and at least two cam plates adjacent to each said rotor support, for guiding said die carrier guides.

Preferably there are two rotor supports, one at each end of rotors and said cam plates are mounted on one of said supports.

Preferably there is a first cam plate, and a second cam plate of two parts having a gate, for the die carrier guides.

Preferably the rotors are driven by a variable speed motor, and include a control for controlling the motor in timed relation to the movement of the sheet metal work piece.

Preferably the control speeds up the motor at one position and slows down the motor towards a second position, and then speeds up the motor.

Preferably there are two rotors each having a first end and second end, and a rotor support supporting the one end and by two separate supports for the other end.

Preferably there are a plurality of die carriers and a plurality of rotors.

Preferably there is a guide bridge on the second guide cams swingable to allow contact of a guide roller at one position in the rotation.

The invention also gives a method of forming a sheet metal work piece.

IN THE DRAWINGS

Figure 1 is a perspective of a rotary apparatus illustrating the invention;

Figure 2 is a section along line 2 - 2 of Figure 1;

Figure 3 is a perspective of one form of stud workpiece of the type which may be produced by the apparatus of Figure 1 and 2;

Figure 4 is a side elevation of Figure 3;

Figure 5 is a perspective of a die carrier, showing a die mounted, in isolation from the rotary apparatus;

Figure 6 is a side elevation of a die carrier;

Figure 7 is an end view of one end of a die carrier;

Figure 8 is a perspective of the rotor support plate and cams on the right hand end of Figure 1;

Figure 9 is an elevational of the rotor support of the Figure 8 ;

Figure 10 is a perspective of the left hand rotor support plate of the apparatus of Figure 1;

Figure 11 is an elevational of the bearing support plate of Figure 10;

Figure 12 is a perspective of the first and second cam plate portions;

Figure 13 is an elevational of the cam plate portions of Figure 12;

Figure 14 is perspective of a semi arcuate cam portion;

Figure 15 is an elevational of semi arcuate cam plate portion of Fig 14;

Figure 16 is a perspective of a one piece cam guide ;

Figure 17 is a side elevation Fig 16;

Figure 18 is a bottom plan of Fig 16;

Figure 19 is a elevation of the right-hand support plate of Figure 8;

showing the positions of the cam rollers at top and bottom dead centres;

Figure 20 is a perspective of Fig 19 showing the cam rollers of the upper and lower rotors at their top dead centre positions;

Figure 21 is a perspective of an alternate embodiment of the apparatus, designed for single sided operation on a sheet metal workpiece;

Figure 22 is a side elevation of the apparatus in Figure 21;

Figure 23 is an end elevation of the apparatus of Figure 21;

Figure 24 is a graph showing the variation in rotational speed before, during, and after contact, to the point of separation of the dies from the sheet metal;

Figure 25 is a perspective of another embodiment ;

Figure 26 is a side elevation of Fig 25;

Figure 27 is a block diagram of the speed controls for speeding up and slowing down the rotors.

DESCRIPTION OF A SPECIFIC EMBODIMENT

The invention relates to a rotary apparatus for the rotary forming of various formations and openings in a sheet metal work piece.

For example, if openings are being blanked out through a metal stud then the cut length must be carried out between two openings. The apparatus provides a means of positioning the openings, and a means of temporarily skipping an opening so as to leave a greater length of sheet metal, across which the cut may be made.

The work piece (W) has a central web (10), and two side edge bends (12) and (14). The central web (10) is formed with a series of openings (16). These openings, in this case, are of generally triangular shape and the orientation of each triangle alternates along the length of the web. In this way, struts (18) of sheet metal are defined between the adjacent openings (26). These struts (18) form a generally zigzag or diagonal shape along the length of the work piece (W). Edge flanges (20) are formed around the openings (16).

The longitudinal side edge bends (12) and (14) are formed lengthwise continuously along the length of the work piece (W). One such bend may be sufficient or in other cases, there may be two or three such bends to provide greater strength or for various different applications. In some cases one of the side edges may be bent outwardly to form a hook (22) as shown in phantom. Such a hook (22) is used in the formation of composite concrete and stud building panels.

Typical embedment flanges are shown in US Patent 4602467. This patent relates to conventional C-section studs.

The embedment formations (22) are used when forming thin shell concrete panels to enclose a building. The studs or work pieces (W) are being embedded at spaced intervals for example 16" or two feet apart along the length of a panel, and upper and lower work pieces are also associated from a rectangular grid.

Work pieces (W), or metal studs, have been shown in patents to US Patents 2088781 and 2167666.

A stud of this general type is merely one of many different products which may be produced, however. The production speed is high, the accuracy of formation is excellent, and the flexibility to produce work pieces of varying widths and varying lengths and with varying formations is possible.

Figure (1) and (2), illustrate a rotary apparatus (30). The rotary apparatus (30) comprises upper and lower main rotor assemblies (32) and (34). Each rotor has two die carriers (36) in this embodiment. Each die carrier (36) supports a die (38). Dies (38) are similar in most respects to conventional male and female dies used in stationary presses i.e. presses which reciprocate vertically but do not rotate.

Each of the central rotors (32) and (34) in this embodiment, comprises a relatively slender central shaft portion (40), and two massive end bearing shafts (42). Each of the end bearing shafts (42) is mounted in a respective bearing system (44), and the bearing systems (44) are mounted in end plates (46) and (48). End plates (46) and (48) will typically be mounted on bases (50) so that they may be placed in position in a production line. The upper and lower rotors (32) and (34) are coupled together by means of a lower drive gear (52) mounted on an end extension (54) of lower rotor end bearing shaft (42), and an upper gear assembly (56) mounted on an end extension (58) of upper rotor end bearing shaft (42). The lower rotor end shaft extension (54) is adapted to be connected to any suitable prime mover (60) and gear box. Typically, the prime mover in this case will be a direct current electric motor (Figure 26). The motor (60) will be of the type having a speed control (62) so that its rotational speed may be precisely controlled and varied. Speed control (62) in turn is controlled by a CPU. The upper

gear assembly (56) comprises a main gear portion (64) and an outer back lash compensator gear (66). The back lash compensator gear (66) may be adjustably rotated relative to the main gear portion (64) and fastened so as to eliminate any back lash between the upper gear assembly (56) and the lower drive gear (52). Each of the four end bearing shaft (42) is formed in essentially the same manner as shown in Figure (2), apart from the shaft extensions.

Each of the end bearing shaft (42) is provided with two bearing recesses (68), spaced apart angularly around the axis of each rotor by 180°. Within each bearing recess (68) there is a bearing or bushing (70), which is held in position by a suitable cap.

Each of the die carriers (36) in Figures 5, 6 and 7 is provided with an end stub shaft (74), at each end thereof. The end stub shafts (74) are received in the bearings (68) in the bearing recesses (68) of the end bearing shaft portions (42). In this way, each of the die carriers (36) is swingable about the axis extending between the two stub shafts (74). Each die carrier (36) is formed along its length with a generally planar die receiving area (76) in Figure 5, facing outwardly with respect to the rotors (32) and (34). On the reverse side of each die carrier (36), a generally convex profile (78) is formed, for each die carrier (36).

Each of the upper and lower rotors (32) and (34) will carry two separate die carriers (36), each of which is adapted to receive a forming die (38) thereon. The invention is not however restricted to the use of two die carriers per rotor. Four die carriers have been used in some cases.

The two rotors rotate, in opposite directions, one being clockwise and the other anti-clockwise, being connected by the gears (52) and (56). The upper and lower dies (38) on the die carriers (36) will thus be brought into registration with one another at approximately the closest point of the two rotors (32) and (34), ie at about 180 degs and 360 degs respectively, and will then progressively move away from one another.

The die carriers will be farthest away from one another at approximately 90° and 270°. The dies (38) on the die carriers (36) on the upper rotor (32) will usually be the male dies, and the dies (38) on the lower rotor (34) will usually be female or recess dies. Portions of sheet metal

which are actually blanked out of the sheet metal workpiece will form waste or what are known as "slugs", and those slugs will remain temporarily in the recesses of the dies (38) on the lower rotor (34) and will be ejected by suitable slug ejector pins (80) to be described below. Die ejector pins (80) are operated by transverse ejector rods (82) mounted in the lower rotor (34) and having end portions (82) extending outwardly to one end of the lower rotor (34). The inner ends (84) of the rods (82) are formed with an angled surface (86), and when the rods (82) are moved inwardly, the angled surfaces (86) engage the ejector pins (80) and cause them to eject a slug from the die (38). The rod (82) is operated in the reverse direction by springs and the ejector pins (80) are also retracted by springs.

Operation of each of the die ejector rod (82) in sequence is achieved by means of an operating roller (88) mounted on end plate (48) Fig 2.

Die Carrier Guidance

The guidance of the die carriers (36) includes first cams (90) and second cams (92) are mounted on end plates (46) and (48) adjacent to each end of each of the rotors (32) and (34). First cams (90) are one piece plates formed in a generally oval shape as shown. It will be seen that the second cams (92), Figure (12), (13) and Figure (14), comprises a first generally oval shape centre cam portion (94), and a second semi-arcuate cam portion (96), Figs 15, 16 and 17. The oval portion (94) and the semi-arcuate portion (96) define a roller channel (98) between them, and at each end of the space there is what is in effect a "gate" (100) and (102). The function of the gates will be explained below.

The first and second cams (90) and (92) and arcuate portions (96) are found on both right and left side bearing plates (46) and (48), arranged as mirror images of each other, and also arranged in registration with both the lower rotor (34) and the upper rotor (32). There are thus, four first cams (90) and four second cam portions (94) and four arcuate portions (96).

Each of the die carriers (36) is provided with leading guide rollers (104) and trailing guide rollers (106), arranged in registration with the leading and trailing edges of their respective die carriers (36), and spaced equally on opposite sides of the central axis of the die carriers stub shaft (40).

The leading guide rollers (104) are mounted on shafts (108), which displace the leading guide rollers outwardly with respect to their respective die carriers (36). The trailing guide rollers (106) are mounted on shafts (110), which position the trailing guide rollers (106) more closely adjacent to their die carriers (36), than are the leading guide rollers (104). The displacement of the leading and trailing guide rollers in this way permits the leading and trailing guide rollers to ride on respective first and second cams (90) and (92), and thus follow leading and trailing guide paths which have different profiles from one another, being defined by the respective first and second guide cam (90) and (92). It will be understood that as the rotors (32) and (34) rotate, the die carriers (36) will be rotated around 360 degrees with their respective leading and trailing guide rollers (104) and (106) engaging the respective first and second cams (90) and (92). The guide paths defined by the leading and trailing guide rollers (104) and (106) will cross twice in each 360° revolution. The cross over of these two paths occur at the gates (100) and (102) defined between the second cam plate (94) and the semi-arcuate cam portion (96).

The semi arcuate cam portions (96) are formed with additional guidance bars (112), for the leading and trailing guide rollers, at the point of closure and openings of the die carriers. shown in Figures 15, 16 and 17. Such guide bars (112) are formed with two upper and two lower shallow semi-arcuate guide surfaces (114) and (116), which are oriented to engage the leading and trailing guide rollers (104) and (106) respectively from the point just prior to closure, and continue during closure, and to release upon opening. Such guide bars (112) are formed integrally with semi arcuate cam portions (96) and are mounted along side the first and second guide cams (90) and (92) as shown in Figure (19).

In Operation

In operation, the lower and upper rotors (32) and (34) rotate in opposite directions, as shown for example by arrows in Figure 1, and a sheet metal workpiece indicated as (W) passes between them. As the lower and upper rotors rotate, their respective lower and upper die carriers (36) will be rotated, and in sequence pair of lower and upper die carriers (36) will approach to contact the sheet metal. As they close the dies (38) will punch it and/or form it, and then open again separating away from each side of the sheet metal (W). During the closing and opening of the lower and upper die carriers (36), the linear speeds of the die carriers (36) will vary

slightly and will not be precisely matched to the linear speed of the sheet metal which is moving at a constant speed. Just prior to closure on the sheet metal, the die carriers (36) will be moving in a linear manner at a slower speed. At the top and bottom dead centre positions of the rotors (32) and (34) 180 degs and 360 degs, the linear speed of the die carriers will then match the linear speed of the workpiece (W). The linear speeds of the carriers (36) will then slow down relative to the workpiece as they open again.

In order to overcome this problem, the motor (60) is controlled through the speed control (62) and the CPU so as to momentarily speed up the rotation of the lower and upper rotors (32) and (34) at a point just prior to closing, and then progressively slow down the rotation of the rotors as the rotors bring the die carriers (36) to bottom and top dead centres, and then the motor once again speeds up the rotors as the die carriers open. The speed control (62) then functions to return to the motor to its regular speed, until the next pair of die carriers (36) is just approaching the closing location. This progressive momentary speed up, followed by a slow down, followed by a speed up, followed by a slow down, takes place according to increments, with the largest increments being at the position of greatest angular displacement of the die carriers relative to 180 degs and 360 degs. . During closing or during opening, each increment progressively decreases, as the angular displacement of the die carriers (36) progressively decreases from the point before contact, to dead centre and then progressively increases once more from the point of dead centre to the point of opening. The increments of speed variation are shown in the graph of Figure 24.

In this way, it is possible for the die carriers to move along arcuate paths, at the point just prior to closing and upon opening, in which their linear speed is identical to the linear speed of the sheet metal workpiece.

This control feature, also enables the rotors (32) and (34) to be momentarily stopped or skipped, to provide for a gap between the formations in the sheet metal workpiece. Studs must be made in specific lengths. At the top and bottom end of each stud the metal must be unbroken by any opening. By means of programming the CPU, the motor can be momentarily stopped, at a point where for example the die carriers are positioned approximately 90E and 180E on either

side of top and bottom dead centre. At this point, the sheet metal workpiece (W) will be able to pass freely between the rotors (32) and (34). The sheet metal workpieces will normally be cut to desired lengths by a suitable form of shear (not shown) located downstream of the rotor (32) and (34). The timing and operation of the shear will take place in timed relation to the "skipping" of openings being formed in the workpiece to make the desired lengths.

A further feature of the controllability of the motor controlling the speed of rotation of the rotors (32) and (34) is that it enables variations to be made in the spacing of the centres of the opening and formations formed in the workpiece (W). The CPU is reprogrammed to operate the rotors (32) and (34) at a sufficient speed, between top and bottom dead centres, with brief pauses while the die carriers are at the 90E and 270E position.

This will permit more or less of the workpiece to pass between the rotors without the dies contacting the workpiece and making formations.

Alternate Embodiments

In some cases, it may be desirable to provide for an open sided rotary apparatus, in which the rotors are supported at one end only, leaving the other end of the rotors unsupported. Such alternate form of rotary apparatus shown in Figures 21, 22, and 23. The basic formation of the rotors (32) and (34) and the die carriers (36) all substantially the same as described above, with the exception that the die carriers (36) will be provided with leading and trailing guide rollers, and cams and cam portions only in one end plate. The outward ends of the lower and upper rotors (32) and (34) will be supported by massive cross beams (120) and (122), and support arms (124) and (126), providing bearings for the outer end of the rotors (32) and (34).

In this way a metal workpiece (W) may be placed in position through the open side of the apparatus as shown in Figure 21, and the formations will be made, by the rotors and die carriers and dies in essentially the same manner as described above.

The one edge of the workpiece can extend out between the arms (124) and (126).

This provides for great flexibility in use of the apparatus.

In some cases, it may be desirable in order to provide for a different guidance system to achieve a smooth transition from the surface of the second cam (94) and the semi-arcuate cam portion (96). For this variation, Figure 25 and 26 , a swing arm or bridge (130) may be swingably mounted on each of the semi-arcuate cam portions (96) . The bridge (130) is swingable between open and closed positions and guides the leading and trailing guide rollers (104) and (106) as they transition from contact with the semi-arcuate cam portions (96) to the guidance bars (116) .

The bridge (130) has a lobe (132) which extends into the path of the trailing guide roller (106). A spring (134) connects between bridge (130) and guide bar (112).

Figs 25 and 26 show the bridge in two positions, namely open , in the upper bridge, and closed in the lower bridge.

Spring (134) biases the bridge (130) into the closed (lower) position as shown in Fig (25) , and permits it to swing open (upper) in Fig 25 when required for either forward, or reverse rotation.

PARTS LIST (1120PCT107)

10	central web	54	endwise shaft
12	side bend	56	upper gear
14	side bend	58	endwise shaft
16	opening	60	motor
18	struts	62	speed control
20	edge flanges	64	main gear
22	hook (phantom)	66	compensator gear
24		68	bearing recesses
26		70	bearing
28		72	
30	apparatus	74	stub shafts
32	upper rotor	76	planar die area
34	lower rotor	78	convex profile
36	die carriers	80	ejector pins
38	dies	82	ejector rods
40	central shaft	84	end portions
42	end shaft portions	86	angled surfaces
44	bearing system	88	ejector rollers
46	end plate	90	first cams
48	end plate	92	second cams
50	bases	94	centre portion
52	lower gear	96	semi-arcuate portion
98	channel		

100	gate
102	gate
104	leading roller
106	trailing roller
108	shaft
110	shaft
112	guide bars
114	semi-arcuate surface
116	semi-arcuate surface
118	
120	cross beam
122	cross beam
124	support arm
126	support arm
128	
130	bridge
132	Lobe
134	Spring

CLAIMS

1. A rotary forming apparatus of the type having a pair of rotors, and one or more die carriers swingably mounted on the rotors, for repeatedly forming a sheet metal work piece moving along a linear path, and having;
 - rotor bearing supports for supporting the rotors at least at one end thereof;
 - die carriers on said rotors; and
 - die carrier guides on the die carriers at an end thereof adjacent to said rotor bearing supports; and being characterised by;
 - at least two cam plates adjacent to each said rotor bearing support, at said at least one end, for guiding said die carrier guides, and,
 - gates in the cam plates for passage of said die carrier guides.
2. A rotary forming apparatus as claimed in claim 1, characterised two rotor bearing supports, one at each end of rotors and wherein said cam plates are mounted on one of said bearing supports, the other of said bearing supports being free of such cam plates.
3. A rotary forming apparatus as claimed in claim 1 or 2 characterised by at least a first integral one piece cam plate, and a second cam plate of at least two part construction, said second cam plate defining a gate, through which said die carrier guides may pass.
4. A rotary forming apparatus as claimed in claim 1, 2 or 3 characterised by carriers define leading and trailing edges, and including die carrier guides on at least one said leading edge and one said trailing edge.
5. A rotary forming apparatus as claimed in anyone of the claims 1 to 4 characterised by a variable speed motor, and including control means for slowing and speeding up said motor intermittently, in timed relation to the movement of the sheet metal work piece.
6. A rotary forming apparatus as claimed in claim 3 characterised by the second cam plate being a generally oval shaped cam portion and a semi arcuate cam portion spaced from said oval shaped portion, and a guide channel defined between said oval portion and said semi 15

arcuate portion.

7. A rotary forming apparatus as claimed in claim 6 characterised by gates are defined between said ends of said semi arcuate portion and said oval shaped portion.

8. A rotary forming apparatus as claimed in claim 7 characterised by leading edge guides mounted on shafts, and including rollers rotatably mounted on said shafts between said leading edge guides and said die carriers.

9. A rotary forming apparatus as claimed in anyone of the preceding claims characterised by the motor control is operable to speed up the motor at a first predetermined position of said die carriers, and slow down the motor at a second predetermined position of said die carriers, and thereafter speed up the motor at a third predetermined position of said die carriers, and thereafter to slow down said motor.

10. A rotary forming apparatus as claimed in anyone of the preceding claims characterised by a bearing support supporting the first end of each said rotor, the second end of each rotor being unsupported, and the two rotors being mounted for rotation in opposite directions to one another, for engaging a sheet metal work piece passing there between.

11. A method of forming a sheet metal workpiece by passing it between two rotors, each said rotor carrying at least one die for forming said sheet metal and characterised by the steps of;

rotating said rotors in opposite direction at a predetermined first speed of rotation;

speeding up said rotors at a first predetermined position ;

progressively slowing down said speed of rotation until a second predetermined position;

progressively speeding up said speed of rotation until a third predetermined position,

and,

thereafter slowing down said speed of rotation to said predetermined first speed.

12. The method as claimed in claim 11 and characterised by first predetermined position is at a point just prior to contact of said dies with said sheet metal and said third predetermined

position is at a point just after separation of said dies from said sheet metal.

13. The method as claimed in claim 11 or 12 and characterised by dies are attached to die carriers, and wherein the die carriers are swingably mounted on respective rotors, and including the steps of guiding the die carriers as the rotors rotate and bringing said dies thereon into planes parallel with one another at said first predetermined position, and maintaining said dies in said parallel planes until said predetermined third position.