Feb. 3, 1948. C. C. GROTNES 2,435,306

EXPANDING DIE FOR SIZING, CURLING, AND BEADING METAL DRUMS

Filed Dec. 20, 1945 4 Sheets-Sheet 1

Fig. 1.

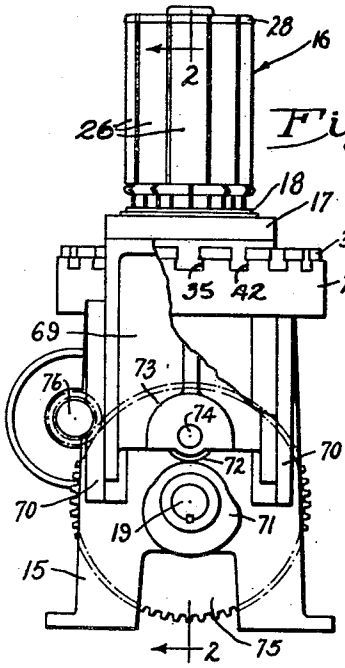


Fig. 2.

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Fig. 3.

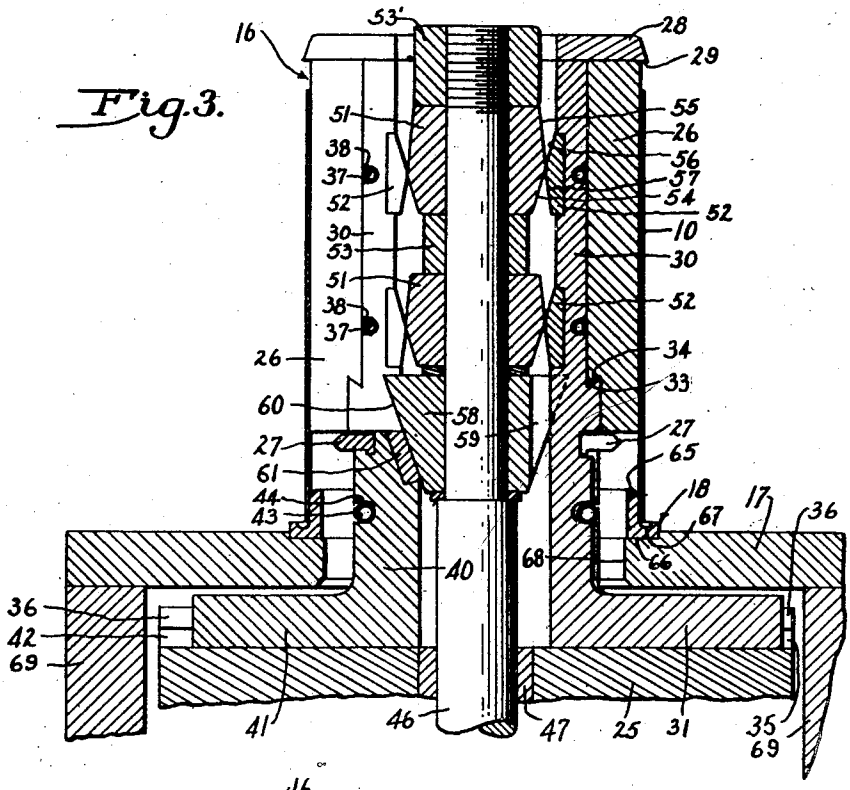
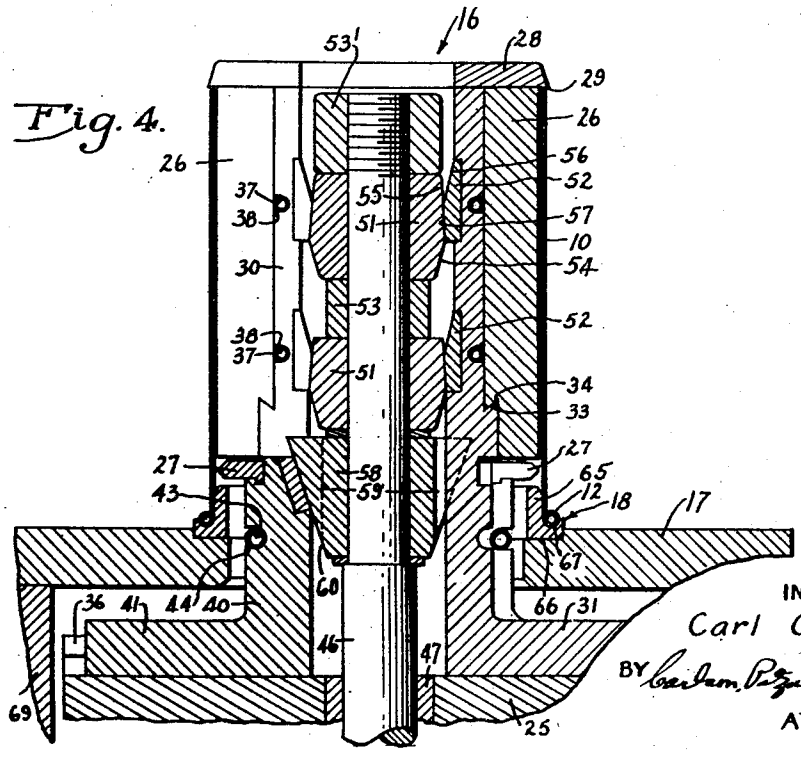


Fig. 4.



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Fig. 5.

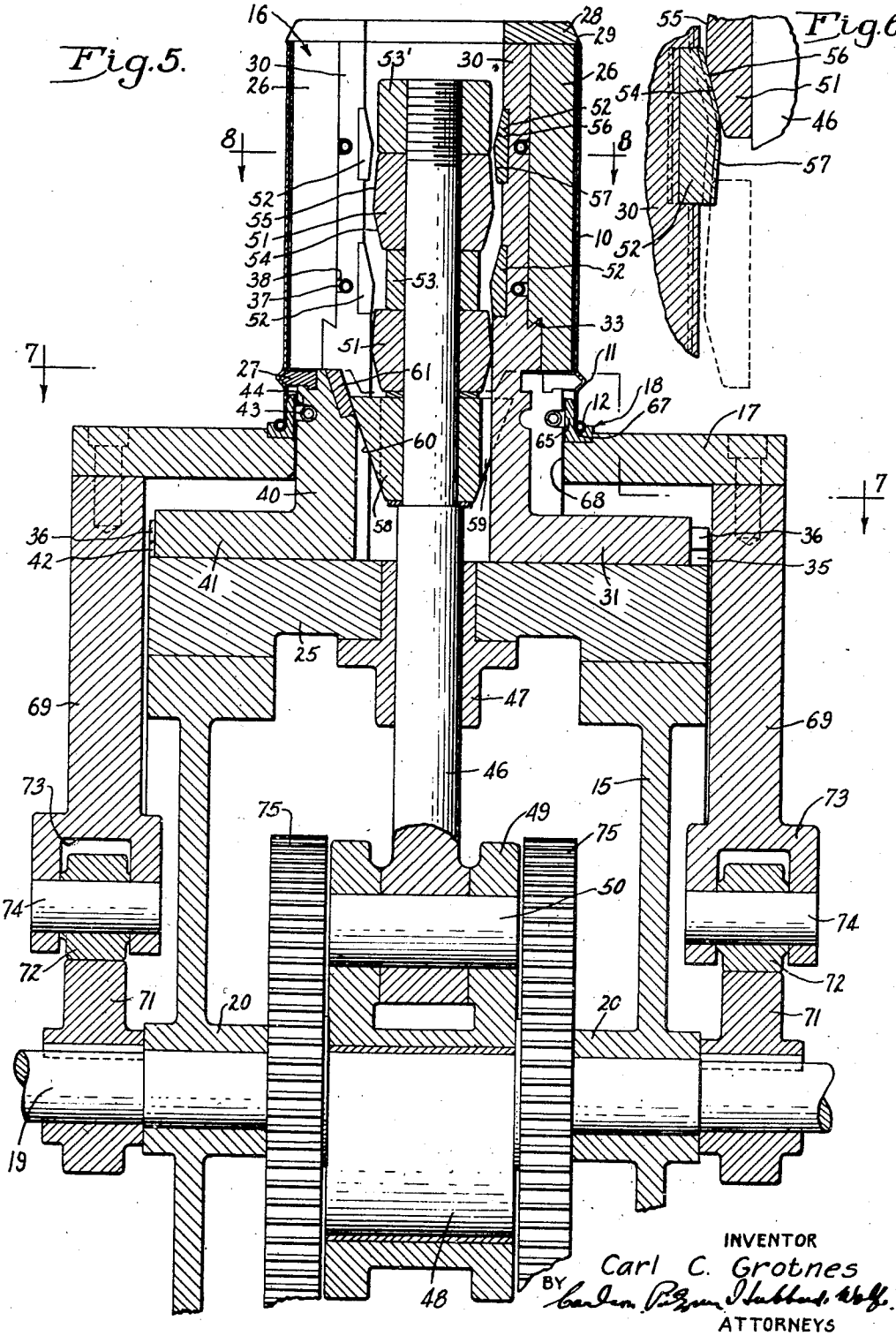


Fig. 6.

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EXPANDING DIE FOR SIZING, CURLING, AND BEADING METAL DRUMS

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Fig. 7.

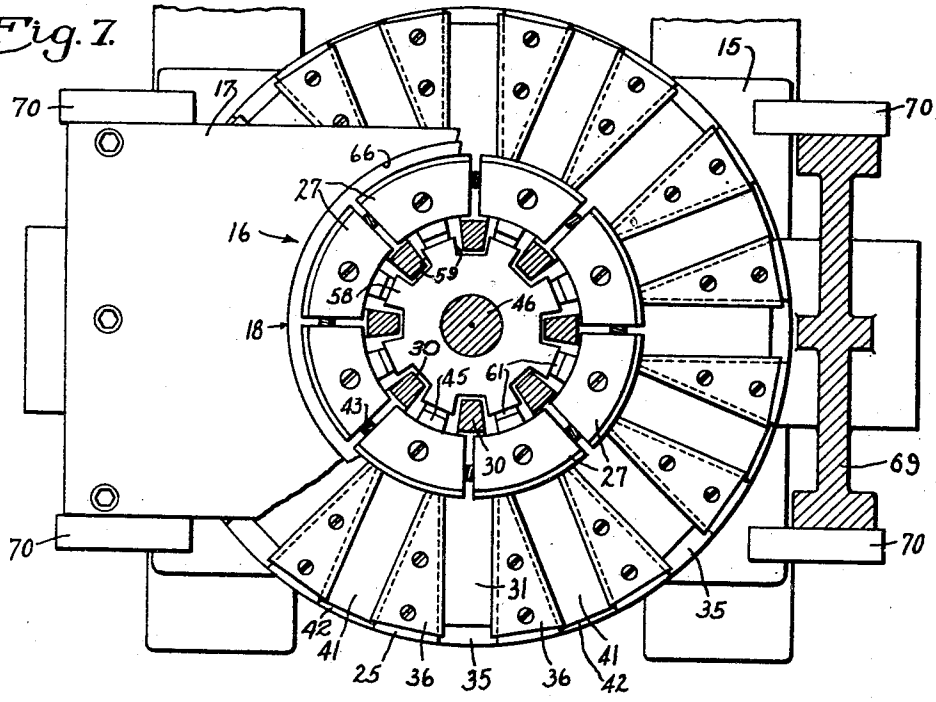
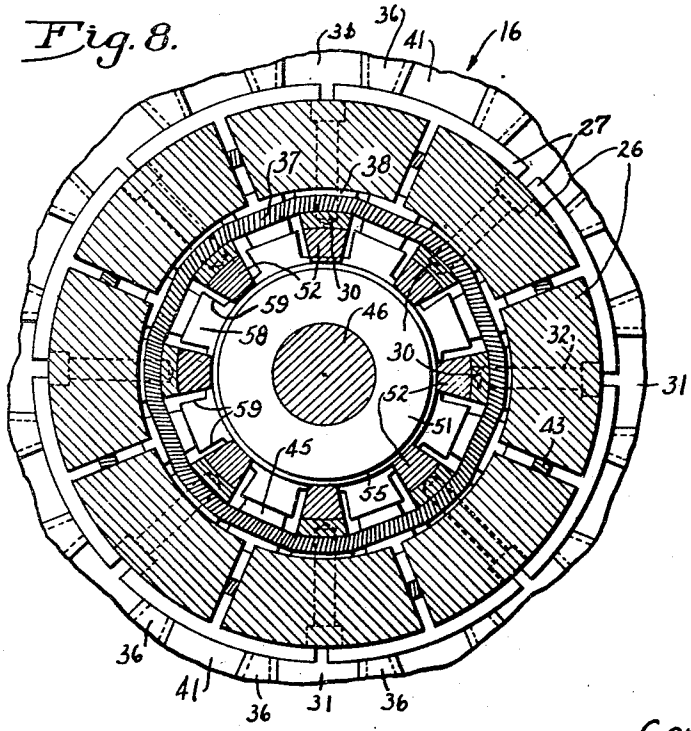


Fig. 8.



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2,435,306

UNITED STATES PATENT OFFICE

2,435,306

EXPANDING DIE FOR SIZING, CURLING, AND BEADING METAL DRUMS

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Application December 20, 1945, Serial No. 636,204

13 Claims. (Cl. 153—2)

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The invention relates to metal working machines and more particularly to machines for operating on sheet metal shells or drums.

One object of the invention is to provide an improved machine of the above general character adapted to perform a plurality of shaping operations on a sheet metal shell or drum in a single operating cycle, thereby eliminating repeated handling of the shell and reducing the number of machines as well as the time required for the production of the finished article, all of which contribute to a substantial reduction in manufacturing costs.

Another object is to provide an improved machine for operating on sheet metal shells in which the parts are arranged in a novel manner to facilitate the placement of the workpieces on the machine.

Another object is to provide improved means in a machine of the character set forth whereby a plurality of annular forming dies required to perform the different shaping operations on a sheet metal shell are supported and guided by a single supporting structure.

The invention also resides in the novel means provided for holding and positioning the workpieces for successive operations and for controlling the sequence and timing of such operations.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawings in which:

Fig. 1 is a side elevational view of a metal working machine embodying the features of the invention.

Fig. 2 is a sectional view of the machine taken in a vertical plane substantially on the line 2—2 of Fig. 1 showing the position of the parts at the beginning of an operating cycle.

Fig. 3 is a sectional view of the die head similar to that shown in Fig. 2 but showing the parts in the positions occupied in the first stage of the operating cycle.

Fig. 4 is another sectional view of the die head showing the parts in the positions occupied in the second stage of the operating cycle.

Fig. 5 is a sectional view similar to Fig. 2 but showing the positions of the parts at the end of the operating cycle.

Fig. 6 is an enlarged sectional view showing the form and relationship of the coacting cam and follower elements for actuating the sizing die.

Fig. 7 is a transverse sectional view through the die head of the machine taken in a horizontal plane substantially on the line 7—7 of Fig. 5.

Fig. 8 is an enlarged transverse sectional view through the die head of the machine taken in a horizontal plane substantially on the line 8—8 of Fig. 5.

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While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the claims.

For purposes of illustration the invention has been shown as embodied in a machine for operating on cylindrical sheet metal blanks or shells 10 to form them for use in the manufacture of pails, drums, etc. The blanks or shells as supplied to the machine are plain cylinders of approximately the desired diameter. In each operating cycle of the machine a shell is accurately sized, that is, expanded to the required diameter, trued up to circular cross section, a circumferential outwardly pressed bead 11 formed therein, and one end of the shell formed with a curled edge or bead 12.

Referring to Fig. 1 of the drawings, the machine selected to illustrate the invention comprises generally a rigid frame or bed 15 supporting at its upper end a multiple die head 16 and a vertically movable table or platform 17 carrying an annular edge curling die 18. The frame 15 also supports and encloses mechanism for actuating the dies of the head 16 and for shifting the table 17 to render the curling die 18 effective, such mechanism including a horizontally disposed shaft 19 journaled in bearings 20 (Figs. 2 and 5) carried on opposite sides of the frame.

To facilitate placement of the shells 10 thereon, the die head 16 is supported in a vertical position with its upper end free and unobstructed. This feature, together with the novel arrangement and relationship of the dies included in the head 16 and the edge curling die 18 which serve to automatically position the shell for the different forming operations, substantially reduces the labor required for operating the machine and materially increases its productive capacity.

Referring more particularly to the drawings, the die head 16 includes two independently operable sets of forming dies each comprising an annular series of die elements supported and guided for radial movement by a common supporting plate 25 rigidly mounted at the top of the frame 15. In the exemplary machine the die head is provided with one set of die elements 26 (Figs. 2–5 and 8) for sizing and shaping the shell 10, and a second set of die elements 27 (Figs. 2–5 and 7) operable to form the bead 11 in the shell.

As will be seen by reference to Figs. 4 and 8 of the drawings, the die elements 26 comprise rigid metal blocks segmental in cross section and

elongated axially to extend from the bead 11 to the remote end of the shell 10. The outer face of each die block is formed on a radius corresponding to that of the finished shell so that when the blocks are shifted radially outwardly or expanded to their limit positions the set of die blocks presents a substantially cylindrical surface of the required diameter. It will be understood that the width of each block is such that the entire series may be shifted radially inwardly or contracted to a diameter substantially smaller than that of the blank or shell 10 so that the latter may be telescoped thereover without interference.

Fixed to the upper end of each die block 26 is a segmental stop element 28 having its forward edge projecting over the face of the die block. The stop elements are dimensioned so that they project only slightly beyond the blocks 26 so as not to interfere with the placement of the shell 10 on the die head when the sizing die is contracted, while forming an annular abutment 29 engageable by the end of the shell when the die set is either fully or partially expanded. The abutment thus formed serves to limit the endwise movement of the shell relative to the die head for purposes to appear presently.

Support for the die blocks 26 is provided by a series of L-shaped supporting members each having an upright die carrying section 30 and a horizontal base section 31. The die block is removably secured as by machine screws 32 (Fig. 8) to the upright section of each member which is provided on its front face with an undercut shoulder 33 (Fig. 2) adapted to coact with a complemental shoulder 34 on the rear face of the die block to accurately locate the block thereon.

The base sections 31 of the supporting members are slidably received in radially disposed guide slots 35 formed in the upper face of the plate 25. Segmental retaining plates 36 (Fig. 7) secured to the plate 25 overlap the side edges of the sections 31 to hold the parts in assembled relation, the said side edges of the sections being recessed to accommodate the retaining plates.

Means is provided for yieldably urging the die blocks 26 and their supporting members inwardly to a retracted position in which the outer faces of the die blocks present a cylindrical surface of minimum diameter. As herein shown, this means comprises a pair of annular springs 37 (Figs. 2 and 8) encircling the upright sections 30 of the supporting members. The springs are preferably spaced upright axially of the members and are seated in suitable recesses 38 formed in the front faces of the upright sections.

The die elements 27 of the beading die are herein located immediately below the die elements 26 and are carried by somewhat similar L-shaped supporting members each having an upright section 40 (Figs. 2 and 7) upon which the die element is mounted and a horizontal base section 41. The base sections 41 are slidable in radially disposed guide slots 42 in the plate 25, such slots being interposed alternately between the guide slots 35 for the sizing die supporting members. As in the case of the base sections 31, base sections 41 are recessed along their side edges for cooperation with the retaining plates 36 which serve to hold the supports in assembled relation with the guide plate 25. An annular spring 43 encircling the upright sections 40 and seated in recesses 44 therein yieldably urges the beading die elements and their supports inwardly to the contracted position.

Referring to Figs. 7 and 8 of the drawings it will be observed that the upright sections 40 of the die block supports are segmental in cross section and that each is formed with a narrow vertically disposed inwardly tapering rib 45 adapted to fit between the upright sections 30 of a companion set of die block supports. The latter are also of relatively narrow width and taper inwardly so that ample space is provided for the installation of the two independently operating die sets on the single mounting plate 25.

Novel actuating means is provided for actuating the die sets above described in predetermined timed relation. Such actuation consists in shifting the die elements radially outwardly from the retracted positions in which they are normally held by the springs 37 and 43. The arrangement is such that the die elements 26 are first actuated to size and shape the shell 10 and are then retracted sufficiently to free the shell for upward movement against the abutment 29 under the action of the curling die 18. Following the curling of the lower edge of the shell by the latter die, the die elements 27 are actuated to form the bead 12. Finally, all of the parts are returned to normal rest position to allow the completely formed shell to be removed from the machine.

The means for actuating the sizing and beading die sets as herein shown includes a drawbar 46 extending axially between the die block supports of the die sets and guided for vertical movement by a sleeve member 47 carried by the supporting plate 25. The drawbar is arranged to be reciprocated by suitable power driven means herein shown as including a cam or eccentric 48 rigid with the shaft 19. The eccentric 48 is fitted with a yoke 49 to which the lower end of the bar is pivotally secured as by a cross pin 50.

For actuation of the sizing die set, the bar 46 is provided with a pair of annular cams 51 spaced apart axially of the bar and adapted to coact with hardened follower plates 52 carried on the rear faces of the upright sections 30 of the die supporting members. The cams are held in vertically spaced relation on the bar by means of an annular spacer 53 interposed between them and a stop nut 53' fastened on the end of the drawbar holds the cams and spacer in assembled relation therewith.

Each of the cams 51 is formed with a generally conical or inwardly tapering lower cam surface 54 (Fig. 4) merging into an oppositely inclined conical upper cam surface 55. The follower plates 52 are similarly formed with oppositely sloping cam surfaces 56 and 57 for cooperation respectively with the cam surfaces 54 and 55 in the longitudinal movements of the drawbar. The slopes of the surfaces 54 and 56 are comparatively steep so that the die blocks 26 are shifted outwardly relatively rapidly as the cam surfaces ride downwardly over the follower surfaces in the initial movements of the drawbar. The die blocks reach their outer limit positions as the crests of the cams pass over the crests of the follower plates.

In the further movement of the drawbar, the cam surfaces 55 ride down the sloping follower surfaces 57 permitting retraction of the die blocks by their springs 37. It will be observed that the slopes of the surfaces 55 and 57 are less steep than the companion surfaces with the result that the retracting movements of the die block are effected at a slower rate than their expansion. In practice the cam and follower sur-

faces 55 and 57 are shaped so as to permit the die blocks to be retracted sufficiently to free the shell 10 for axial movement on the die head while maintaining the abutment 29 in position to be engaged by the end of the shell while the curling die 18 is performing its operation.

Actuation of the beading die set is effected by a cam member 58 mounted on the drawbar 46 below the bottom cam 51 and spaced therefrom by a suitable washer. To provide clearance for the upright die supports 30 of the sizing die, the body of the cam 58 is formed with a series of vertical slots 59 (Figs. 5 and 8) while the intervening portions are formed with sloping cam surfaces 60 (Figs. 2–5) adapted to engage hardened wear plates 61 mounted on the rear faces of the die supports 40. The slope of the cam surfaces 60 and the wear plates 61 is such that the die elements 27 are shifted into engagement with the shell 10 immediately after the curling of the edge 12 of the shell is completed. Outward movement of the die blocks is continued and the blocks reach their outer limit positions substantially at the end of the downward movement of the drawbar 46 thus pressing out or expanding the bead 11 and completing the formation of the shell in the downward stroke of the drawbar.

As indicated above, the curling die 18 is actuated intermediate the actuation of the sizing and beading die sets. The curling die, as shown, comprises an annulus 65 having a radially projecting flange 66 at its lower end. An annular groove 67 in the upper face of the flange closely adjacent the annulus 65 is adapted to receive the edge of the shell and, in the upward movement of the table 17, the shell is curled into a rounded bead as shown in Fig. 5.

As previously stated, the curling die 18 is mounted on the upper face of the table 17. The table 17 is apertured as at 68 (Figs. 2 and 5) to provide clearance for the die head 16. Fixed at opposite ends of the table are depending end members 69 adapted to slide between spaced vertical guide rails 70 (Figs. 1 and 7) rigid with the machine base. The table is thus guided in its vertical movements between the position shown in Figs. 2 and 5 of the drawings wherein the curling die 18 is shifted from the normal rest position to the operative position.

To coordinate the actuation of the curling die 18 with the actuation of the sizing and beading dies, provision is made for raising and lowering the table 17 through the medium of the shaft 19 which actuates such dies. For this purpose, the shaft is provided at opposite ends with suitably shaped cams 71 adapted to coact with follower rollers 72 carried by the end members 69. As shown in Figs. 2 and 5, the lower end of each member 69 is formed with a semi-cylindrical recess or compartment 73 having spaced side walls for supporting a shaft 74 upon which the roller 72 is journaled. The rollers are arranged to rest directly on the cams 71 which thus provide support for the table 17 and impart the required vertical movements thereto in the rotation of the shaft 19.

Suitable means is provided for driving the shaft 19 through a single revolution in each operating cycle of the machine. In the particular machine illustrated, the shaft is arranged to be driven through a pair of gears 75 keyed thereto on opposite sides of the eccentric 48 (Figs. 2 and 5) and meshing with pinions carried by a drive shaft 76 (Fig. 1). Control mechanism for limiting the rotation of the shaft to a single revolution in each cycle may be associated with the drive shaft in well known manner.

In the operation of the machine a plain cylindrical shell 10 to be operated on is slipped over the die head 16, passing over the contracted stop elements 28 and die blocks 26, while the parts are in their normal rest position as shown in Fig. 2. The shell rests on and is supported by the curling die 18 which at this time is in its lowermost position. As the shaft 19 is started in its single revolution cycle, the drawbar 46 is moved downwardly to actuate the die blocks 26 of the sizing die through the medium of the cams 51 and followers 52. More particularly the die blocks are forced outwardly to the position shown in Fig. 3 thus shaping the shell to true circular cross section and expanding it to the required diameter. The sizing and truing operation is completed as the crests of the cams 51 pass the crests of the followers 52.

Continued movement of the drawbar 46 carries the cam faces 55 over the inclined follower surfaces 57 which, as previously explained, are inclined to permit limited retraction of the die blocks 26. This retraction is sufficient to release the shell 10 for movement axially of the die head against the abutment 29 which is maintained in blocking relation to the end of the shell during this portion of the machine cycle.

The cams 71 are timed so as to raise the table 17 and curling die 18 immediately after the shell 10 is released, whereby the shell is forced upwardly until blocked by the abutment 29. Continued upward movement of the curling die causes it to perform its edge curling function while the shell is held stationary by the abutment 29.

Throughout the downward movement of the drawbar 46 the beading die elements 27 are shifted outwardly by the action of the cam 58. The extent of movement required to bring the beading die elements into engagement with the shell is such that the engagement takes place substantially upon the completion of the edge curling operation. At this time the shell is supported and rigidly held between the curling die 18 and the abutment 29 thus positioning the shell with a high degree of accuracy for the formation of the bead 11. The final movements of the drawbar of course are effective to shift the die elements 27 outwardly to the position shown in Fig. 5 to expand the bead 11 in the shell.

As the shaft 19 turns through the second half of its cycle of revolution the drawbar 46 and the die elements actuated thereby are returned to normal position. At the same time the table 17 and curling die 18 are returned to their normal rest positions. At the completion of the cycle the dies of the die head are completely retracted so that the completely formed shell is released and may be lifted from the die head and replaced by a new shell to be operated on.

It will be apparent from the foregoing that the invention provides a metal working machine of novel and advantageous character particularly suitable for shaping sheet metal shells for use in the manufacture of pails, drums, etc. Substantial savings in time and labor are effected through the novel construction and arrangement of the machine which enables a plurality of operations such as shaping, sizing, beading and edging to be performed in a single machine cycle. Moreover, the die mechanism for performing these shaping operations is constructed and mounted in a novel manner which greatly facilitates the placement

of the workpieces thereon so that no time is lost in the handling of the work.

The invention also provides a novel die head construction wherein a plurality of independently operable annular die sets are supported and guided by a common supporting member. The improved machine also embodies novel means for holding and positioning the workpieces or shells with respect to the die elements during the various shaping operations together with novel means for controlling the sequence and timing of such operations.

I claim as my invention:

1. In a machine of the class described, in combination, a sizing die comprising a plurality of axially elongated die elements arranged in a circular series and supported for radial movement, means carried by said die elements forming a radially projecting abutment at one end of the die, means normally holding said die elements in a retracted position to condition the die for receiving a sheet metal shell to be operated on, an edge curling die supported adjacent the other end of said sizing die for movement toward and from the same, and actuating means operating successively to shift said die elements radially outwardly to expand the shell to predetermined dimensions and then to force said curling die against the end of the shell to curl the edge thereof, said actuating means releasing said die elements for partial retraction after the sizing operation to permit the shell to move into engagement with said abutment when engaged by said curling die.

2. In a machine of the class described, in combination, a sizing die comprising a plurality of axially elongated die elements arranged in a circular series and supported for radial movement, means carried by said die elements forming a radially projecting abutment at one end of the die, means normally holding said die blocks in a retracted position to condition the die for receiving a sheet metal shell to be operated on, and actuating means for said sizing die including a member movable axially of the series of die elements and operative in one portion of its movement to shift the die elements outwardly for expanding the shell to predetermined size and operative in another portion of its movement to permit limited retraction of the die elements whereby to release the shell therefrom while maintaining said abutment in position for engagement with the end of the shell.

3. In a machine of the class described, in combination, a frame, a generally cylindrical die head mounted in an upright position on said frame to receive a sheet metal shell in telescoping relation, a table disposed adjacent the lower end of said die head, means on said frame supporting and guiding said table for movement axially of said die head, an annular die element supported on said table in coaxial alinement with said die head, said head including a plurality of independently operable die sets for shaping the shell, and said die element being operative in the movement of the table for curling the edge of the shell, and radially retractable abutment means carried by said die head for holding the shell against endwise movement during the operation of said die element.

4. In a machine of the class described, in combination, a frame, a generally cylindrical die head mounted on said frame with one end free and unobstructed to facilitate the placement of a sheet metal shell thereon, said head including

radially movable die elements for sizing and shaping the shell, a die element supported on said frame adjacent the other end of said die head for movement axially thereof against the adjacent end of the shell, abutment means adjacent the free end of said die head retractable radially to permit placement of the shell on the die head and adapted to be moved into a position to prevent movement of the shell relative to said die head by said axially movable die element, and cyclically operable means for actuating said die elements and positioning said abutment means.

5. In a machine of the class described, in combination, a frame, a die head mounted on said frame with one end unobstructed to facilitate the placement of a sheet metal shell thereon, said die head including independently operable sizing and beading dies, an edge curling die supported on said frame adjacent the other end of said die head for movement axially thereof into engagement with the end of the shell, retractable abutment means adjacent the free end of said head for holding the shell against endwise movement during the operation of said curling die, means for actuating said dies in predetermined timed relation comprising a cyclically driven shaft, an actuator operable by said shaft, cams carried by said actuator for actuating said sizing and beading dies in succession and for positioning said abutment means for engagement by the shell, and other cam means carried by said shaft for actuating said curling die, said cam means being constructed and arranged to effect the actuation of said curling die and the positioning of said abutment means intermediate the actuation of said sizing and beading dies.

6. In a machine of the class described, in combination, a frame, a die head mounted on said frame with one end unobstructed to facilitate the placement of a sheet metal shell thereon, said die head including independently operable sizing and beading dies, an edge curling die supported on said frame adjacent the other end of said die head for movement axially thereof against the end of the shell, retractable abutment means carried by said head for holding the shell against endwise movement during the operation of said curling die, and means for actuating said dies and said abutment means in predetermined timed relation to first expand the shell to predetermined size, to curl one edge of the shell, to form a circumferential bead therein, and finally to release the shell for removal from the machine.

7. In a machine of the class described, in combination, a frame, a die head mounted on said frame with one end unobstructed to facilitate the placement of a sheet metal shell thereon, said die head including independently operable sizing and beading dies, an edge curling die supported on said frame adjacent the other end of said die head for movement axially thereof against the inner end of the shell, normally inactive abutment means adapted to be positioned for engagement by the outer end of the shell to hold the same against axial movement during the operation of said curling die, means for actuating said dies and positioning said abutment means in predetermined timed relation, and a cyclically operable shaft for driving said actuating means.

8. In a machine of the class described, in combination, a generally cylindrical die head including a first set of axially elongated segmental die blocks arranged in an annular series, a second set of segmental die blocks arranged in an an-

nular series adjacent one end of said first set and coaxially alined therewith, means supporting said sets of die blocks for independent radial movement including a generally L-shaped supporting member for each die block, said die blocks being mounted on the upright sections of said members, and a supporting plate having a series of radially disposed guide slots for slidably receiving the base sections of said members.

9. In a machine of the class described, in combination, a plurality of generally L-shaped die supporting members arranged in a circular series, each of said members having an upright die supporting section and an outwardly projecting base section, segmental die elements mounted on the upright sections of alternate ones of said members to present a substantially continuous cylindrical surface, die elements mounted on the upright sections of the other members presenting a substantially continuous annular ridge adjacent the end of said cylindrical surface and coaxially alined therewith, and means supporting and guiding said members for independent radial movement comprising a generally circular supporting plate having a plurality of radially disposed slots for slidably receiving the base sections of said members.

10. In a machine of the class described, in combination, a generally cylindrical die head including a first set of axially elongated segmental die blocks arranged in an annular series, a second set of segmental die blocks arranged in an annular series adjacent one end of said first set and coaxially alined therewith, and a single stationary member for directly supporting and guiding each set of die blocks for independent radial movement.

11. In a machine of the class described, in combination, an annularly arranged set of sizing die elements, an annularly arranged set of bead expanding die elements disposed in axial alinement with said sizing die elements, a member for supporting each die element, and a single supporting plate for directly supporting and guiding said members for independent radial movement.

12. In a machine of the class described, in

combination, a frame, a generally cylindrical die head mounted in an upright position on said frame to receive a sheet metal shell in telescoping relation, a table disposed adjacent the lower end of said die head, means on said frame supporting and guiding said table for movement axially of said die head, an annular die element supported on said table in coaxial alinement with said die head, said die element being operative in the movement of said table to curl the edge of the shell held by said head, and means for actuating the dies of said head to block the shell against axial movement and for subsequently moving said table to effect said edge curling operation.

13. In a machine of the class described, in combination, a frame, a generally cylindrical die head mounted in an upright position on said frame to receive a sheet metal shell in telescoping relation, a table mounted on said frame adjacent the lower end of said die head, an annular die element supported on said table in coaxial alinement with said die head, and means for actuating the dies of said head and for shifting said table, said annular die acting initially to position the shell for action by the dies of said head and the dies of said head acting subsequently to position the shell for action by said circular die.

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