Dec. 2, 1952 E. A. DE VOSS 2,620,013

MACHINE FOR FORMING DOUBLE LAP FLARING ON TUBING

Filed Feb. 26, 1949 3 Sheets-Sheet 1

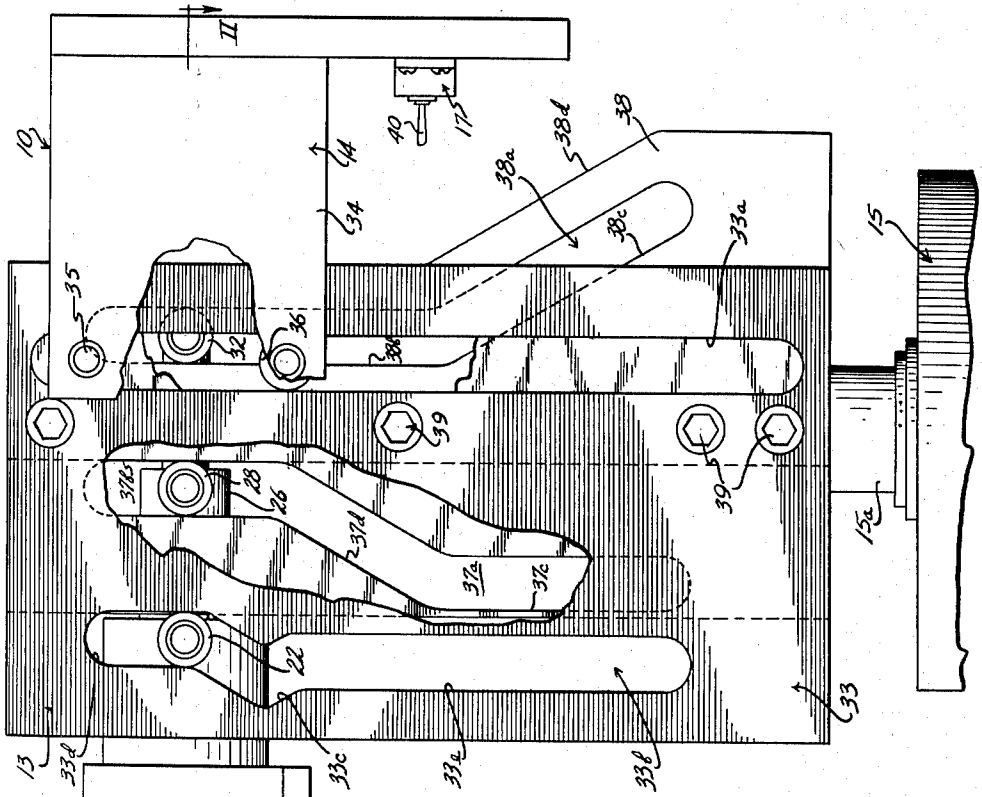


Fig. 1

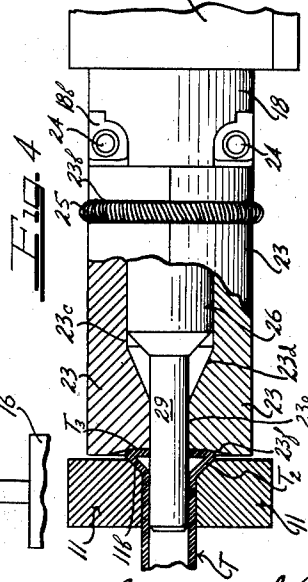


Fig. 4

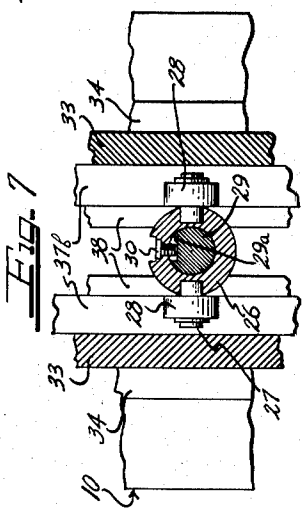


Fig. 7

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Dec. 2, 1952 E. A. DE VOSS 2,620,013

MACHINE FOR FORMING DOUBLE LAP FLARING ON TUBING

Filed Feb. 26, 1949 3 Sheets-Sheet 2

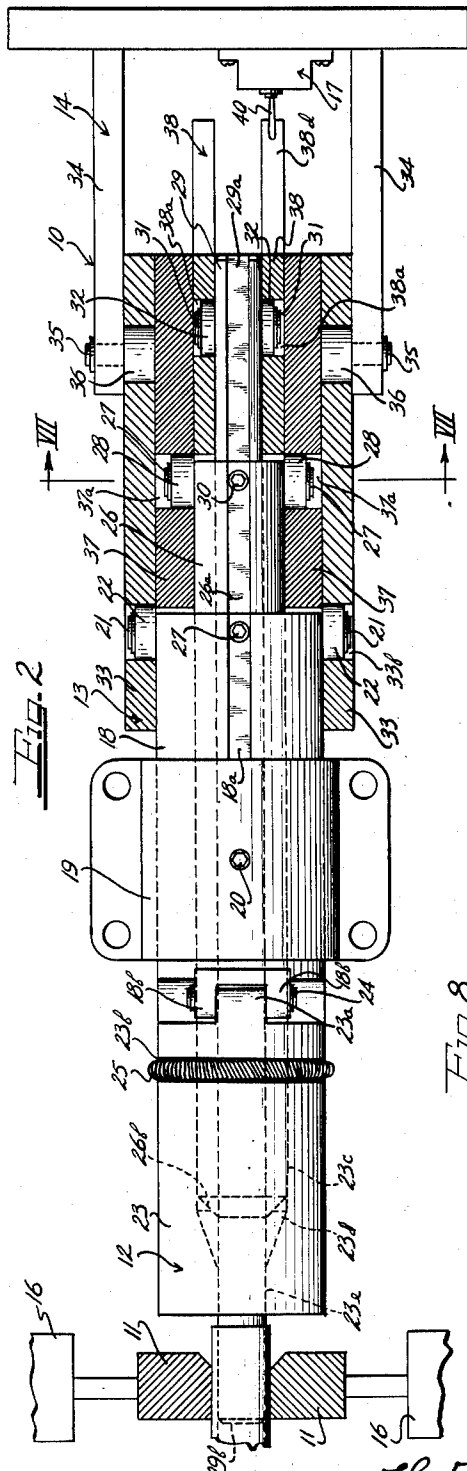


Fig. 2

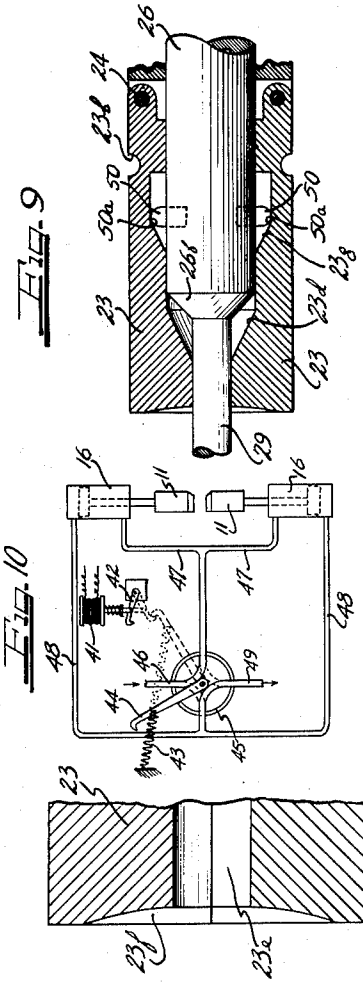


Fig. 9

Fig. 10

Fig. 8

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Dec. 2, 1952 E. A. DE VOSS 2,620,013

MACHINE FOR FORMING DOUBLE LAP FLARING ON TUBING

Filed Feb. 26, 1949 3 Sheets-Sheet 3

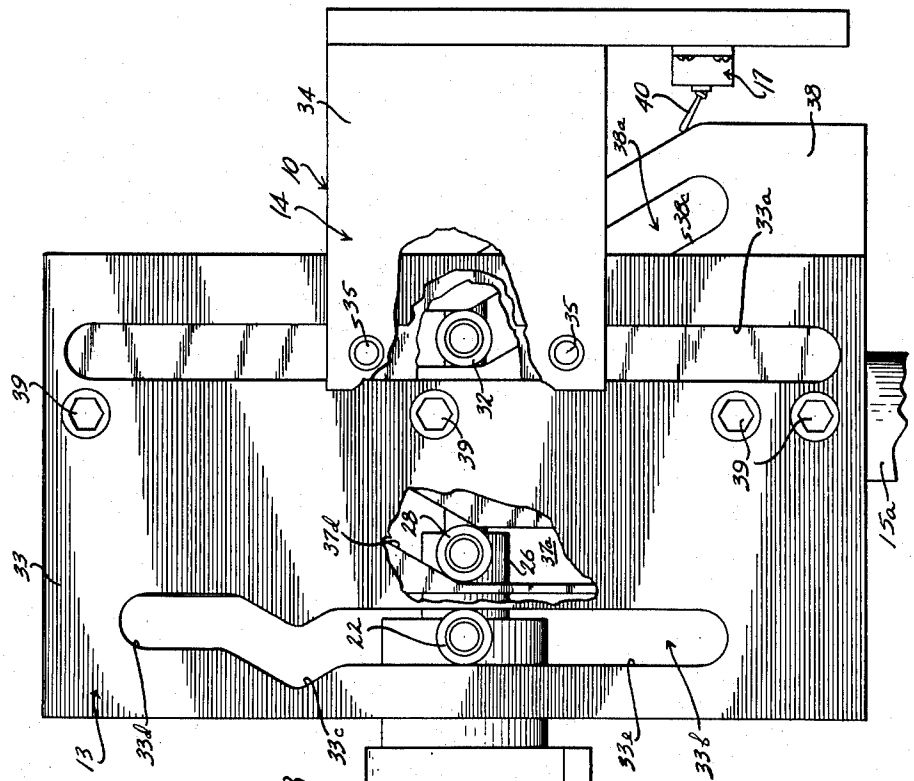


Fig. 3

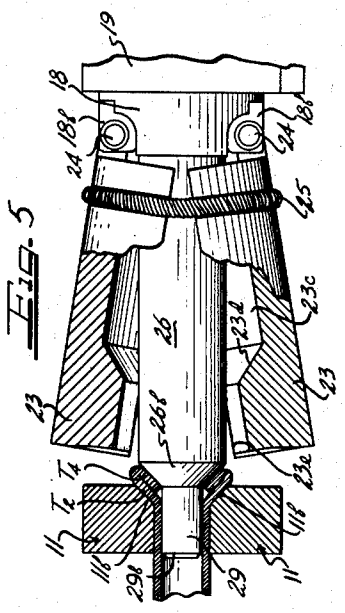


Fig. 5

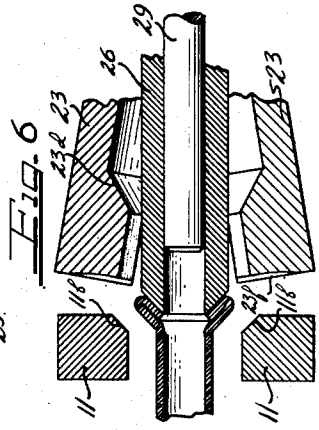


Fig. 6

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UNITED STATES PATENT OFFICE

2,620,013

MACHINE FOR FORMING DOUBLE LAP FLARING ON TUBING

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Application February 26, 1949, Serial No. 78,616

6 Claims. (Cl. 153—80.5)

1

This invention relates to a machine for forming a double lapped flared end on tubing.

Specifically, the invention relates to a machine for supporting the inside of a hollow article such as a tube against collapse in a die while punches successively act on the member to first bow it against the die, and to then fold the end portion of the member into the bowed portion for forming a double walled flared end on the member.

The machine of this invention is especially useful in forming double lapped flared ends on metal tubing of the type used in automotive, airplane, mechanical refrigerator, and the like conduits wherein a fitting such as a union, elbow, nipple, or tee has a tapered end inserted in the flared end of the tube and wherein a compression nut bottomed on the flared end of the tube has a tapered shoulder coacting with the tapered end of the fitting to sealingly clamp the double lapped portion therebetween.

The machine of this invention includes dies for securely gripping the outer circumference of the tube to be flared, together with tapered die faces for shaping the conical outer face to be formed on the end of the tube. A compound punch assembly coacts with the dies and includes telescoped mandrel, finish or cone punch, and upset punch parts. Suitable mechanism actuates these parts in proper sequence to close the dies around a mandrel supported portion of a tube, advance the upset punch while guided by the mandrel to bow the end of the tube against the tapered die face, open the upset punch, advance the finish or cone punch into the bowed portion to form the double lap, and to then open the dies and withdraw the mandrel from the finished tube end. These successive operations can be conveniently controlled by cam mechanisms and a preferred embodiment of such mechanisms includes a fluid pressure-actuated cam carrier. A suitable die control includes fluid pressure actuated dies and an electrically operated fluid valve controlled from a switch that is automatically shifted under the influence of the cam mechanism.

An important feature of the invention resides in the provision of the mandrel to support the tube against collapse and to guide and align the punches.

Another feature of the invention is the provision of a cone or finish punch which rides on the mandrel and, when being moved toward operative position, automatically opens up the upset punch.

It is, then, an object of this invention to provide a machine for quickly and uniformly forming double lapped flared ends on tubes.

2

A further object of the invention is to provide a mandrel for aligning a tube in a die and mechanism for pulling the mandrel out of the tube.

A still further object of the invention is to provide a machine for forming double-walled flared ends on tubes while supporting the tube against collapse.

A further object of the invention is to provide a multiple punch assembly composed of telescoped mandrel, finish punch, and split upset punch parts, together with means for successively actuating these parts.

A further object of the invention is to provide a machine with a compound punch assembly which automatically supports the work against collapse, upsets the work, finishes the upset, and opens up the upset punch parts when the finish punch is moved into active position.

A specific object of the invention is to provide a compound punch for a double lap flaring machine with a tube-supporting and punch-guiding mandrel.

Another specific object of the invention is to provide a compound punch for a double lap tube flaring machine with a finish punch and a split upset punch so arranged that the upset punch is automatically opened as the finish punch comes into operating position.

A further specific object of the invention is to provide a machine for forming double-walled flared ends on tubing wherein fluid pressure means and cams automatically control sequential operation of the machine parts for minimizing manual adjustments and operations.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of a preferred example only, illustrate one embodiment of the invention and one variation from a portion of this embodiment.

On the drawings:

Figure 1 is a side elevational view, with parts broken away to show underlying parts and with portions in vertical cross section, of a double lap tube-flaring machine according to this invention, and showing the starting position of the parts with the tube end disposed over the mandrel and the dies closed around the mandrel-supported tube end.

Figure 2 is a horizontal cross-sectional view, with parts in top plan, taken along the line II—II of Figure 1.

Figure 3 is a view similar to Figure 1 but illustrating the positions of the parts of the machine upon the completion of the double lapped flared end on the tube but illustrating the mandrel still in the tube.

Figure 4 is a fragmentary side elevational view, with parts in vertical cross section, illustrating a portion of the machine in the position assumed thereby upon completion of the bowing or upsetting operation.

Figure 5 is a view similar to Figure 4 but illustrating the positions of the parts upon completion of the finish or cone punch operation.

Figure 6 is a view similar to Figures 4 and 5 but illustrating the positions of the parts after completion of all of the operations, showing the manner in which the mandrel is retracted from the tube while the cone punch holds the flared end of the tube against deformation under the influence of the retracting action of the mandrel.

Figure 7 is a fragmentary transverse cross-sectional view, with parts in elevation, taken along the line VII—VII of Figure 2.

Figure 8 is an enlarged fragmentary vertical cross-sectional view of the split upsetting punches showing the rounded upsetting faces of these punches.

Figure 9 is a vertical cross-sectional view, with parts in side elevation, illustrating a modified arrangement for opening the split upsetting punches as the cone punch or finish punch is moved into active position.

Figure 10 is a diagrammatic view illustrating the manner in which the dies are controlled.

As shown on the drawings:

The machine 10 of Figures 1 to 3 includes a pair of dies 11, a compound punch assembly 12, a cam assembly 13 for actuating the punches of the assembly 12, a cam carrier 14, a cam-actuating fluid pressure cylinder 15, a pair of fluid pressure cylinders 16 for actuating the dies 11, and a switch 17 on the cam carrier 14 for controlling actuation of the cylinders 16.

The dies 11 each have semi-cylindrical tube-gripping recesses 11*a* and conical die faces 11*b* diverging from the gripping faces 11*a*. The leading end of a tube T is seated in the dies and is gripped by the seat 11*a* adjacent its leading end to provide a portion T_1 (Figure 1) projecting through and beyond the die faces 11*b* for forming the double lapped flared end on the tube.

The punch assembly 12 includes a carrier 18 in the form of a hollow cylindrical block slidably mounted in a surrounding bearing 19. As shown in Figure 2, the carrier 18 has a longitudinal groove 18*a* along the top thereof and the bearing 19 has a set screw 20 threaded through the top thereof to extend into the groove 18*a* for holding the carrier 18 against rotation in the bearing while accommodating longitudinal sliding action of the carrier through the bearing.

The front end of the carrier is milled to form longitudinally aligned spaced pairs of ears 18*b* on the top and bottom thereof. The rear end of the carrier 18 has pins 21 extending from the opposite sides thereof and rotatably supporting rollers 22.

The upset or bending punch 23 is composed of two half sections each of which is in the form of a semi-cylinder. Each section has a lug 23*a* on the rear end thereof extending between a pair of ears 18*b* of the carrier and pivotally attached thereto by a pin 24. Thus, as shown in Figure 1, top and bottom segments constitute the split punch 23 and each segment is pivotally supported at its rear end on a pin 24 carried by the carrier 18. A coil spring 25 surrounds the split punch 23 and is seated in a groove 23*b* provided in the punch segment in spaced relation forwardly from the lugs 23*a* thereof for holding the segments in closed position.

The split punch 23 has a large diameter cylindrical bore 23*c* extending forwardly from the rear end of the punch to a tapered shoulder 23*d* which converges to a smaller diameter bore 23*e*. This smaller diameter bore extends through the forward end face of the punch and, as shown in Figure 8, the forward or active end face of the punch is dished at 23*f*, to provide a concave end wall converging toward the bore 23*e*. This concave end wall serves to guide the tube during the bowing or upsetting operation for better control of the bowed section as will be more fully hereinafter described. In addition, this concave end face 23*f* coacts with the tube end inwardly of the pivot pins 24 to hold the dies closed during the upsetting operation, as shown in Figure 4.

A cone punch 26 in the form of a hollow rod is slidably mounted in the bore of the carrier 18 and in the bore 23*c* of the split punch 23. This finish punch 26, as best shown in Figure 2, has a longitudinal groove 26*a* along the top thereof and a set screw 27 in the groove 18*a* of the carrier 18 projects into this groove 26*a* to hold the cone punch against rotation in the carrier. The forward end of the cone punch has a tapered face 26*b* forming the active end of the punch to fold the end portion of the bowed tube for forming the double lap or double wall arrangement as will be hereinafter more fully described. The rear end of the cone punch projects beyond the carrier 18 and has pins 27 extending laterally therefrom for rotatably supporting rollers 28.

A mandrel, in the form of a solid cylindrical rod 29, is slidable through the hollow cylindrical cone punch 26 and is longer than the punch to project beyond both ends thereof. The top of the mandrel 29 has a longitudinal groove 29*a* therein adapted to receive a set screw 30 threaded through the groove 26*a* of the cone punch 26 to prevent rotation of the mandrel in the cone punch. The forward end of the mandrel is preferably slightly beveled as to 29*b* to facilitate insertion of the mandrel into the tube. The rear end of the mandrel has pins 31 projecting laterally therefrom and carrying rollers 32.

The cam assembly 13 includes outer side plates 33, 33 each with a vertical slot 33*a* near the rear end thereof and a vertical slot 33*b* near the front end thereof. The vertical slot 33*b*, however, has an intermediate forwardly offset portion 33*c* between an upper vertical portion 33*d* that is rearwardly displaced relative to the main elongated bottom portion 33*e* of the slot beneath the offset portion 33*c*.

The carrier 14 has side plates 34, 34 straddling the rear ends of the plates 33 and having pins 35 projecting inwardly therefrom to rotatably support rollers 36 riding in the slots 33*a*. The cam assembly 13 is thus guided for vertical movement by the carrier 14.

A second pair of vertical plates 37, 37 lie within the plates 33, 33 rearwardly of the slot 33*b*. These plates 37 each have slots therein which have vertical top portions 37*b* and forwardly offset vertical bottom portions 37*c* connected by inclined portions 37*d* as best shown in Figure 1.

An additional pair of vertical plates 38, 38 are interposed between the plates 37, 37 and all three sets of plates are held together on opposite sides

of the mandrel 29 by transverse connecting bolts or screws 39 shown in Figure 1. The plates 38 project rearwardly from the plates 33 and 37 but terminate adjacent the slots 37a of the plates 37. These inner plates 38 have slots 38a with vertical top portions 38b and rearwardly inclined bottom portions 38c. The inclined bottom portions 38c of the slots 38a are in the extended portions of the plates 38 and these extended portions of the plate afford inclined top edges 38d in the path of the switch 17 as will be more fully hereinafter described.

The cam assembly 13, as shown in Figure 1, is secured at its bottom to the piston rod 15a of the cylinder 15 to be raised and lowered while guided by the rollers 36 of the carrier 14. The rollers 22 of the split die carrier 18 ride in the slots 33b of the plates 33 and, as will be evident from Figure 1, as the assembly 13 is raised by the piston rod 15a, the rollers 22 will shift the carrier 18 forwardly when the rollers ride from the slot portion 33d along the offset portion 33c to the forward end of this offset portion. During this cycle of movement, the split upsetting punch 23 is shifted from the position shown in Figure 1 to the position shown in Figure 4, whereupon the projecting portion T_1 of the tube T is bowed or buckled to form a flared leg T_2 pressed against the die face 11b and an inturned flange leg T_3 extending inwardly from the flared portion T_2 and formed by the concave face 23f of the split punch 23. Prior to the engagement of the punch 23f with the end of the tube T, the leading end of the tube has been placed around the mandrel 29 and the dies 11 have been closed by the cylinders 16 to grip the tube T in their recesses 11a while the mandrel prevents collapse of the gripped tube. In this position, as shown in Figure 1, the rollers 32 on the mandrel 29 are in the portion 38b of the slots 38a in the plates 38. It will be noted that the rollers 32 are longitudinally aligned with the rollers 22, and that the portion 38b of the slot 38 extends along a straight vertical path during the time that the rollers 22 are being moved forwardly by the offset portion 33c of the slot 33b. This arrangement thus insures insertion of the mandrel into the tube before the split punch 23 is shifted forwardly to engage the tube end.

As the cam assembly 13 rises to shift the peak of the offset groove portion 33c above the rollers 22, the rollers are retracted rearwardly to withdraw the split punch 23 to a position away from the buckled end of the tube T. In this position, the split punch face 23f will not interfere with subsequent shaping of the tube end.

As shown in Figure 1, as the split punch is being retracted away from the bowed end of the tube, the rollers 28 of the cone punch or finish punch 26, which project into the slots 37a of the plates 37, are being advanced along the forwardly inclined portions 37d of the slots. This causes a forward shifting of the core punch 26 in the carrier 18 and split punch 23 to first cause the tapered front face 26b of the punch to ride on the shoulder 23d in the split punch 23 thereby spreading the punch sections apart as shown in Figure 5 to open up the punch passage 23e for receiving the cone punch 26 therethrough. The conical end wall 26b of the cone punch 26 thereupon engages the flange T_3 of the buckled tube end to form therefrom the underlapped wall T_4 underlying the flared wall T_2. When the cam rollers 28 are advanced forwardly to the portion 37c of the grooves 37a, the tube portion T_4 is firmly pressed against the tube portion T_2, and this portion T_2, in turn, is pressed firmly against the shaping faces 11b of the dies 11.

Upon completion of the forward stroke of the cone punch 26, the rollers 32 on the mandrel 29 which project into the slots 38a of the inner plates 38 begin to enter the rearwardly inclined portion 38c of these slots and the inclined top edge 38d of one plate 38 engages an actuating lever 40 of the switch 17 to raise this lever and close the switch. Closing of the switch 17 momentarily energizes a solenoid 41 diagrammatically illustrated in Figure 10 for releasing a lock 42 thereby permitting a spring 43 to pull a lever 44 of a valve 45 for shifting the valve to the position shown which connects the fluid inlet 46 with intake hoses 47 on the ends of the cylinders 16 which are adjacent the dies 11 and, at the same time, connects hoses 48 on the other ends of the cylinders with the outlet 49. Fluid under pressure is thereby admitted to the cylinders on one side of the pistons and is exhausted from the cylinders on the other side of the piston to effect an opening of the dies to the position shown in Figure 3.

After the dies 11 are opened, the inclined portion 38c of the groove 38a retracts the rollers 32 to move the mandrel 29 out of the tube. During this retracting movement, however, the cone punch 26 remains in engagement with the tube portion T_4 as shown in Figure 6, so that retraction of the mandrel cannot deform the shaped tube end or pull the tube through the dies.

From the above descriptions it should therefore be understood that the leading end of a tube T is placed over the mandrel and seated in the open dies 11 with the cam assembly 13 at the bottom of its stroke, as shown in Figure 1. When the tube end is properly seated, the valve handle 44 is shifted to engage the lock 42 whereupon fluid will enter the outer ends of the cylinders 16 and will be removed from the inner ends of the cylinders to shift the pistons for closing the dies to grip the tube in the dies and around the mandrel. The cam assembly 13 is then raised to advance the split punch 23 against the projecting end of the tube to deform the portion T_1 to the bowed shape of Figure 4. Upon completion of this step, the split punch is retracted away from the bowed end of the tube and the cone punch 26 is advanced to open the split punch and engage the flange T_3 of the bowed tube end for lapping it under the flared portion T_2 as shown at T_4 in Figure 5. Continued upward movement of the cam assembly then actuates the switch 17 for momentarily energizing the solenoid 41 and permitting spring 43 to shift the valve 45 to open the dies shown in Figure 3. The mandrel 29 is then retracted from the tube while the cone punch is held against the tube wall T_4 shown in Figure 6. The tube with the double lapped flared end is then removed from the dies and the cam assembly 13 is lowered, to return it to its starting position.

If desired, instead of pressing the active end face 26b of the cone punch 26 on the shoulder 23d of the split punch 23, to open this split punch (see Fig. 9), the cone punch can be equipped with dowel pins 50 having rounded outer ends 50a for riding on a secondary shoulder 23g in the split punch 23 rearwardly from the shoulder 23d. These pins 50 will engage the shoulder 23g before the active face 26b of the cone punch reaches the shoulder 23d, whereupon the split

punch will be opened without subjecting the active face 26b to any rubbing action.

The machines of this invention, as will be apparent from the above descriptions, provide full support for the tube portion being acted on and successively buckle and underlap the tube ends. Uniformity of the buckling and underlapping operations is insured by the centering of the upsetting and underlapping punch on the same mandrel which supports the gripped tube. Misalignments are thereby eliminated.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A machine for forming double lapped flared ends on tubes which comprises coacting dies having tube-gripping recesses and tapered flare-shaping faces, a punch assembly including telescoped mandrel, cone punch, and split bending punch parts, a carrier for said assembly, a bearing slidably supporting said carrier, means for shifting said carrier to advance and retract the bending punch toward and away from a tube in said dies, means for retracting said mandrel out of a tube in said dies, means for advancing and retracting said cone punch on said mandrel and in said bending punch, said cone punch having an inclined cam face coacting with tapered shoulders inwardly disposed on said split bending punch for spreading the sections thereof as the cone punch is advanced into operative position, and means for automatically opening said dies upon completion of the cone punch operation to permit retraction of said mandrel.

2. A double lap flaring machine comprising coacting dies having tube-gripping recesses and flare-shaping faces, means for opening and closing said dies, a mandrel adapted to receive a tube thereon, said dies adapted to receive the tube on the mandrel, a split bending punch slidable on said mandrel and having an active face for buckling the end of a tube to form a flare bottomed on the shaping face of the dies and an inturned flange bottomed on the mandrel, a finish punch slidable on said mandrel in said bending punch and having an active end face for underlapping the inturned flange on said tube against the flared wall of the tube to form a double lapped flared wall, said end face of said finish punch coacting with tapered inner shoulders formed on said split bending punch for spreading the sections of the split bending punch, and a control assembly for successively closing the dies around the mandrel-supported portion of the tube, advancing the upset punch against the tube end, retracting the upset punch, advancing the finish punch against the tube end, opening the dies, and retracting the mandrel from the tube.

3. A machine for forming double-walled flared ends on tubes which comprises coacting dies having tube-seating and flare-shaping surfaces, a compound punch assembly coacting with said dies including telescoped relatively movable split bending punch, finish punch, and mandrel parts, said finish punch being slidable through the split bending punch, said mandrel part being slidable through the finish punch and the split bending punch parts, means disposed on the finish punch coacting with means internally formed on the split bending punch for spreading the sections thereof, and cam means for successively inserting the mandrel in a tube, closing the dies thereabout, advancing the bending punch against the tube, retracting the bending punch, advancing the finish punch against the tube, opening the dies, and retracting the mandrel and the finish punch from the tube.

4. A machine for forming flared ends on tubes which comprises a set of shaping dies, a compound punch coacting with said dies, said punch including a shiftable carrier, a plurality of bending punch segments shifted on said carrier and together defining an active end face for bending the end of a tube projecting from said dies to form a flared portion of the tube against the shaping face of the dies and to form an inturned end flange on the divergent end of the flared tube portion, a finish punch slidable through said bending punch to lap said end flange portion of the tube against the flared tube portion, said finish punch having means thereon coacting with inwardly formed tapered means on said bending punch segments to radially spread apart said segments, and a mandrel slidable through said finish punch to project therefrom for supporting the tube end against collapse and for guiding the inturned end flange under the flared tube portion.

5. A machine for forming double-lapped flared ends on tubes which comprises coacting dies having tube-gripping faces and flare-defining faces, a compound punch assembly coacting with said dies, said assembly including a mandrel for receiving a tube to align the tube for seating in said dies, the peripheral face of said mandrel supporting the tube against inward collapse and limiting the inward deformation of the tube end, a finish punch slidable on said mandrel and having an active end face for coacting with the end of the tube, a longitudinally split bending punch slidable on said finish punch, said split punch having a concave active end face converging toward the mandrel, a carrier for the sections of the split punch, means pivotally connecting said sections with said carrier, said pivot means being positioned radially outward from the active portions of the end face of the split bending punch, the concavity of said active portions maintaining the split punch in closed position as it is loaded against the tube end to form a bowed tube end portion with one leg bottomed against the shaping face of the die and a second leg extending inwardly from the bowed portion to the peripheral face of the mandrel, coacting means on said finish punch and said bending punch sections for spreading the bending punch as the finish punch is advanced therethrough to act on the inwardly extending leg on the bowed portion of the tube for underlapping said leg against the outwardly flared portion of the tube, and cam mechanism for successively advancing the bending punch against the tube end to buckle the tube end against the dies, retracting the bending punch away from the buckled end of the tube, advancing the finish punch against the buckled tube end, and retracting the mandrel while maintaining the finish punch against the finished end of the tube.

6. A double lap tube flaring machine which comprises coacting dies defining a tube-gripping recess and a tapered shaping face, cylinders for opening and closing said dies, a compound punch coacting with said dies including a mandrel adapted to receive a tube thereon and align the

tube for seating in said dies, a split bending punch having tapered shoulders slidable on the mandrel for bending the ends of the tube against the shaping face of the dies, and a cone punch for forming a double lap on the bent end of the tube, said cone punch having an inclined face complemental to the tapered shoulders of said split bending punch, a cam assembly for actuating the parts of the compound punch, a carrier for said cam assembly, a cylinder for actuating said cam assembly, and means controlled by said cam assembly for actuating the cylinders of said dies, said cam assembly being constructed and arranged to extend the mandrel beyond the punch for receiving the tube to align the tube in the dies to close the dies upon the mandrel-supported tube, to next advance the bending punch on the mandrel against the tube end, to retract the bending punch away from the tube end to advance the finish punch on the mandrel against the tube, to open the dies, and to retract the mandrel out of the tube.

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