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METAL FORMING MACHINE

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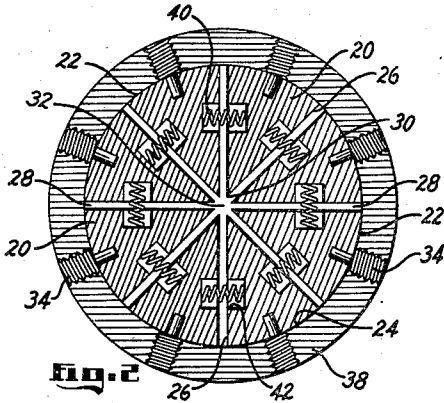


Fig. 2

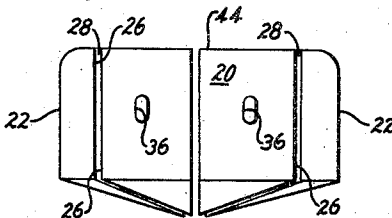


Fig. 3

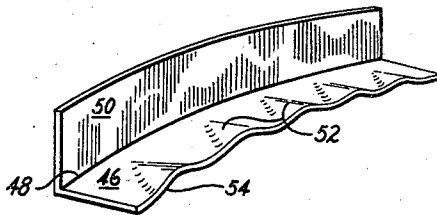


Fig. 5

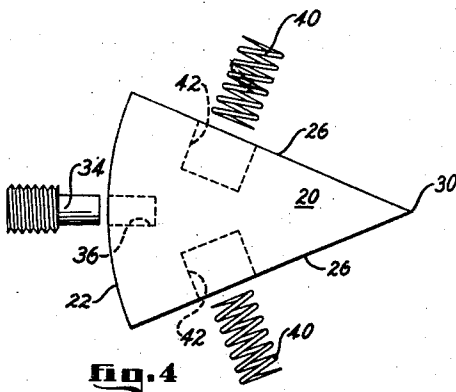


Fig. 4

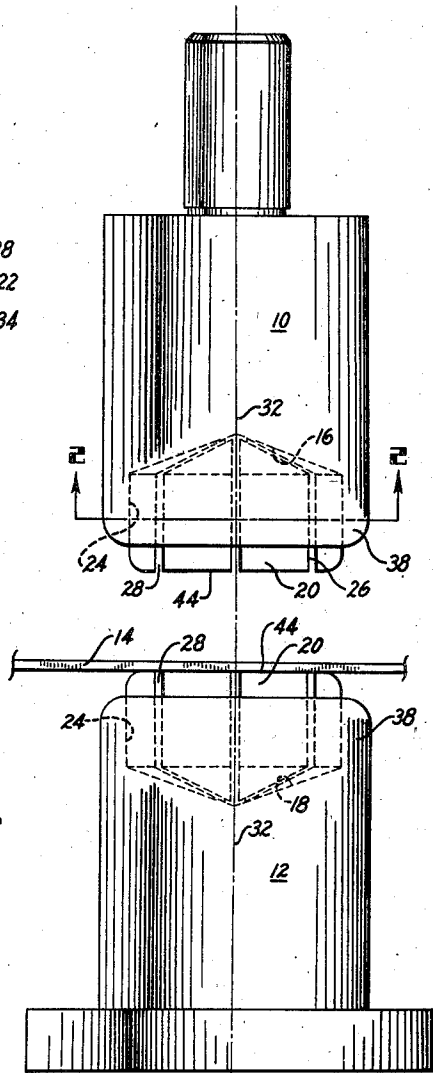


Fig. 1

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METAL FORMING MACHINE

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13 Claims. (Cl. 78-61)

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This invention relates to a machine for forming metal and particularly to a machine for shrinking or stretching sheet metal.

Sheets of metal in their final fabricated form or at some intermediate stage in the process of fabrication may have a surface shape or a condition requiring correction. The sheet may be planar and have localized bulges or ridges. It may have a generally cylindrical or other curvilinear shape interrupted by local deformations. Or it may have a plane surface or generally curved surface in which it is desired to form bulges or other local deviations from its general surface contour. Or a sheet of metal may have the desired surface contour but possess internal stresses which are of a weakening or otherwise harmful character in view of the use to which it is to be put. In many such cases a machine of this invention is of useful application.

It has heretofore been practiced to shrink or stretch sheet metal along straight or curved lines in one direction only. Two pairs of gripping dies or jaws are used, each pair contacting a surface of the metal sheet and the two dies of a pair moving toward and away from each other along a single straight or curvilinear directional line. The die surfaces are roughened to grip the metal sheet so that in the shrinking machine as they approach each other they may push the metal particles together, thickening the sheet along transverse lines and shortening the sheet longitudinally, and in a stretching machine as they move apart they may similarly elongate a sheet. Processing of sheet metal in accordance with this prior practice is limited for the most part to shrinking and stretching of relatively narrow strips of sheet metal which it is desired to shorten or elongate as a whole or along only one edge portion thereof. For it is mechanically difficult to mount and operate dies of this type which are long enough to reach from side to side of a wide sheet. If shorter dies are used, the metal just beyond the ends of the strip which is being acted upon by the dies inhibits the shrinking action of the dies upon the metal within the strip.

Again the single directional shrinking is an inefficient way of removing "cans" or local bulges from a metal sheet or of eliminating internal stresses apt to cause "cans" or otherwise interfere with the use of the sheet. Such defects, because of their two dimensional character are not usually readily eliminated by upsetting the metal in a single directional manner.

The machine of this invention involves essentially the upsetting of sheet metal, while held im-

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movably to a surface contour, by forces acting in all radial directions, but in the same sense, with respect to a common center. If the forces act in a centrifugal sense the result is a stretching of the metal from the center and if the forces act in a centripetal sense the result is a shrinking of the metal toward the center. The machine of the invention may be utilized to redistribute the metal in a sheet to remove bulges, to form bulges, to eliminate internal stress, to shorten or elongate either narrow or wide strips of sheet metal, either as a whole or along one edge portion thereof and to thicken or thin sheet metal either in local areas spaced from the edges of the sheet or in bands extending to the edges of the sheet. Shortening or elongating a wide sheet, or otherwise correctively forming it over elongated zones or strips, may be accomplished by repeatedly applying the machine at aligned loci.

It is one object of the invention to provide a machine for upsetting a sheet of metal centripetally or centrifugally while it is constrained to a prescribed surface contour.

It is another object of the invention to provide a machine for the fulfillment of the above object by means of two sets of sector shaped dies arranged with their apexes at a common center and capable of moving radially with respect to the center from an initial position.

It is another object of the invention to provide for the resilient return of the dies of such a machine to their initial position.

It is another object of the invention to provide for the registering axial alignment of the dies of one set with the corresponding dies, respectively, of the other set.

It is another object of the invention to provide a die machine for centrally shrinking the metal in a generally circular zone of a metal sheet, which shall provide for the above described resilient return and registering alignment of the dies.

While the machine described below represent one embodiment of the invention which is designed for centripetal shrinking of sheet metal, other sheet metal shrinking machines may likewise embody the invention. The invention may also with obvious modifications of structure be embodied in a machine for centrifugal stretching of sheet metal.

In the drawing which are illustrative only,

Figure 1 is a side elevation of the upper and lower dies and die holders of a machine of this invention.

Figure 2 is a sectional view of the set of upper

dies and die holder therefor taken along the line 2-2 of Figure 1.

Figure 3 is a side elevation of one of the sets of dies.

Figure 4 is an enlarged plan view of one of the dies.

Figure 5 is a perspective view of a flanged member, illustrating a work article which may be processed by a machine of this invention.

An upper die holder 10 and a lower die holder 12 are mounted on a machine (not shown) which provides means for moving the upper die holder toward the lower die holder to effect a pressural relation of the dies with a sheet of metal 14 disposed therebetween. The upper die holder 10 has a conically bottomed recess 16 in its lower face. The lower die holder 12 is similarly formed in its upper face with a recess 18.

The recesses 16 and 18 each hold an equal number of sector shaped dies 20, which are sized and shaped so that when their rim faces 22 engage the cylindrical side wall 24 of the recess of the corresponding dieholder, side walls 26 of any two proximate dies are separated by a clearance space 28 and the apexes 30 of the dies are spaced a small distance from the axial center 32 of the die holding recess. In the drawing each die holder is shown as mounting eight dies.

Retaining pins 34, threadedly secured in the cylindrical walls 36 of the die holders engage apertures 36 in the dies to prevent rotational movement of the dies and accidental disassembly of the dies from the die holder. These apertures are dimensioned to permit limited longitudinal axial movement of the dies.

Springs 40 seated in recesses 42 in the side walls 26 of the dies hold the dies resiliently apart to the extent permitted by the walls of the die holding recesses.

The work contacting faces 44 of the dies are sand-blasted or otherwise roughened to prevent the dies slipping on the sheet metal work article.

The opposite end face of each die has the shape of a conical sector conforming to the bottom of the recess.

When in the operation of the machine the dies of the two sets are brought into contact with the opposite sides, respectively, of a sheet of metal which is to be processed, as for instance to be locally shrunk to eliminate a planar deviation such as a "can" or bulge, the axially acting pressure of the machine causes the sixteen dies to move centrally by reason of the cam action of the conically shaped bottom faces of the two recesses 16 and 18. A circular portion of the metal sheet containing at least a portion of the bulge is gripped and pressed into the general plane of the sheet and the metal thereof is moved toward the central axis 32 of the die holders, shrinking slightly the total area of the portion as measured before being flattened between the dies so that when the die pressure is released the slack of the bulge is gone and the sheet cannot spring back to its bulged condition. Upon release of the pressure of the dies when the upper die holder 10 is retractively elevated, the springs 40 return the dies to their normal or initial position as shown in Figure 2.

A machine of the invention has many fields of use in forming sheet metal bodies. For example, a flange 46 shown in Figure 5, which is integrally joined to a web 50 on a convexly curved joint line 48 lying in the plane of the flange, quite frequently has a surface contour presenting scallop-like waves or wrinkles 52 departing from its general

plane in a direction normal to the flange. If the shrinking dies are applied to this flange with their axial center adjacent to the outer edge 54 of the flange at spaced intervals along the flange, the metal of the flange is crowded together to a varying extent, the action of the dies being such as to thicken and shorten the metal to a maximum degree adjacent the edge 54, the degree of thickening and shortening decreasing across the flange and reaching zero at the joint line 48. A pair of dies moving in a single direction to and from each other as in prior practice, are obviously operating at a disadvantage, the metal near the web resisting the movement of the dies and inhibiting the desired shrinkage of the metal near the edge 54.

A machine constructed in accordance with this invention will move the metal readily, wherever applied. If any portion of the metal resists movement due to its surface contour or to adjacent stiffening metal formations, such as the web 50, the dies contacting that portion tend to have less movement relative to the work object as a whole, and the opposite dies to have greater movement relative to the work object causing a slight shifting of the work object. This feature of the invention adapts the machine for use on many different kinds of work articles and for effecting a number of different results.

This feature is also an advantage when the principle of the invention is embodied in a stretching machine in which the dies in their operation are moved outwardly along radial lines from an initial or normal central position by reversely sloping cam surfaces or other means, as for instance in eliminating internal tensile stresses in a flange joined to a web on a concavely curved joint line.

I claim:

1. In a device for producing a change of form in a piece of sheet metal, the combination of: two sets of gripping jaws, the sets being movable toward and away from each other, and each said set comprising at least three sector shaped jaws with their apexes at a common center and their gripping faces faired to form a common substantially circular surface juxtaposed to a similar cooperating common surface formed by the gripping faces of the other set of jaws; means mounting the jaws of each set for limited radial movement from an initial position with respect to said center; a first means for axially relatively moving the jaws of each set toward the other set to press both sets against a work sheet; and a second means acting coordinately with said first means for radially moving said jaws in the same sense from said initial position with respect to said center.

2. The combination defined in claim 1 and in addition thereto; means for resiliently retrieving said jaws to their initial position.

3. The combination defined in claim 1, in which said first and second means include cam faces on the surfaces of said jaws of each set opposite their gripping faces, forming a generally conical surface coaxial with said jaw centers and further include opposing pressure members having corresponding cooperating conically shaped cam surfaces thereon.

4. In a device for producing a change of form in a piece of sheet metal, the combination of: two sets of gripping jaws, the sets being movable toward and away from each other, and each said set comprising at least three sector shaped jaws with their apexes at a common center and their gripping faces faired to form a common substan-

tially circular surface juxtaposed to a similar cooperating common substantially circular surface formed by the gripping faces of the other set of jaws; means mounting the jaws of each set to hold them resiliently apart with a small radial clearance space between each two proximate jaws; a first means for axially relatively moving the jaws of each set toward the other set to press them against a work sheet; and a second means acting coordinately with said axially moving means for radially moving said jaws of each set against the resilient action of the mounting means to diminish the clearance spaces.

5. In a device for producing a change of form in a piece of sheet metal, the combination of: two sets of gripping jaws, the sets being movable toward and away from each other, each said set comprising at least three sector shaped jaws with their apexes at a common center and their gripping faces faired to form a common substantially circular surface juxtaposed to a similar cooperating common surface formed by the gripping faces of the other set of jaws; means mounting the jaws of each set to hold them resiliently apart with a small radial clearance space between each two proximate jaws, said jaws having axially outwardly inclined converging cam faces on the surfaces of said jaws opposite their gripping faces; and a pair of opposing pressure exerting means for said sets of jaws respectively having cam faces corresponding to and cooperating with the cam faces on the jaws to move said jaws toward and away from said common center.

6. The combination defined in claim 4 in which said mounting means includes a coiled spring disposed across the clearance space between each two proximate jaws and seated at its ends in sockets in the sides of said proximate jaws.

7. The combination defined in claim 1, and in addition thereto; means for preventing rotative movement of said jaws in said mounting means.

8. The combination defined in claim 1 in which said mounting means are held non-rotatively and in addition thereto; interacting means on each of said jaws and the mounting means therefor preventing relative rotative movement thereof, and holding the jaws of one set in opposing registry with the jaws of the other set.

9. A device for shrinking a metal sheet comprising two jaw housing members movable towards and away from each other, a plurality of gripping jaws reciprocally disposed side by side in each housing member with the outer ends of one set of jaws facing the outer ends of the other set of jaws, the jaws of each set being relatively movable laterally in a manner to shrink the sheet from at least four directions towards the longitudinal axis of the housing members and cooperating cam surfaces on each set of jaws and the carrying housing member coacting upon movement of the housing members towards each other to move the jaws of each set laterally in at least two directions.

10. In a device for producing a change of form in a piece of sheet metal, the combination of:

two sets of gripping jaws, the sets being movable toward and away from each other, and each set comprising at least three jaws disposed with their sheet gripping faces in a common plane and juxtaposed on a common axis to the sheet gripping faces of the other set; means for mounting the jaws of each set to be movable in at least three substantially different radial directions respectively with respect to said axis as a center; a first means for axially relatively moving the jaws of each set toward the other set to press both sets against a work sheet; and a second means acting coordinately with said first means for moving said jaws in said radial manner and in the same sense.

11. In a device for producing a change of form in a piece of sheet metal, the combination of: two sets of gripping jaws, the sets being movable toward and away from each other, and each set comprising at least three jaws, each jaw having two side faces converging to an edge, said edges being disposed adjacent to a common longitudinal axial centerline of said sets and each jaw further having an outer gripping face, said gripping faces being faired to form a common surface juxtaposed to a similar cooperating common surface formed by the gripping faces of the other set of jaws; means mounting the jaws of each set for limited radial movement from an initial position with respect to said center line; a first means for axially relatively moving the jaws of each set toward the other set to press both sets against a work sheet; and a second means acting coordinately with said first means for radially moving said jaws in the same sense from said initial position with respect to said center line.

12. The combination defined in claim 11 in which said first and second means include cam faces on the surfaces of said jaws of each set and further include opposing pressure members having cam surfaces corresponding to and cooperating with said first cam surfaces to cause axially directed forces to apply radially acting forces to said jaws.

13. A sheet metal shrinking device comprising a pair of jaw supporting members adapted to be moved toward and away from each other along a common longitudinal axis, each of said members presenting a recess axially aligned with the recess of the other member and opening toward the other member, each of said recesses having surfaces which slope with respect to said axis to provide cam surfaces radially facing in at least three directions with respect to said axis; and two sets of sheet metal gripping jaws, each set having a jaw for each of said directions, the jaws of the respective sets being axially reciprocable in their respective recesses and having cam surfaces conforming respectively to the first mentioned cam surfaces whereby upon movement of the supporting members toward each other the respective sets of jaws are moved laterally inwardly toward the longitudinal axis of the jaw supporting members.

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