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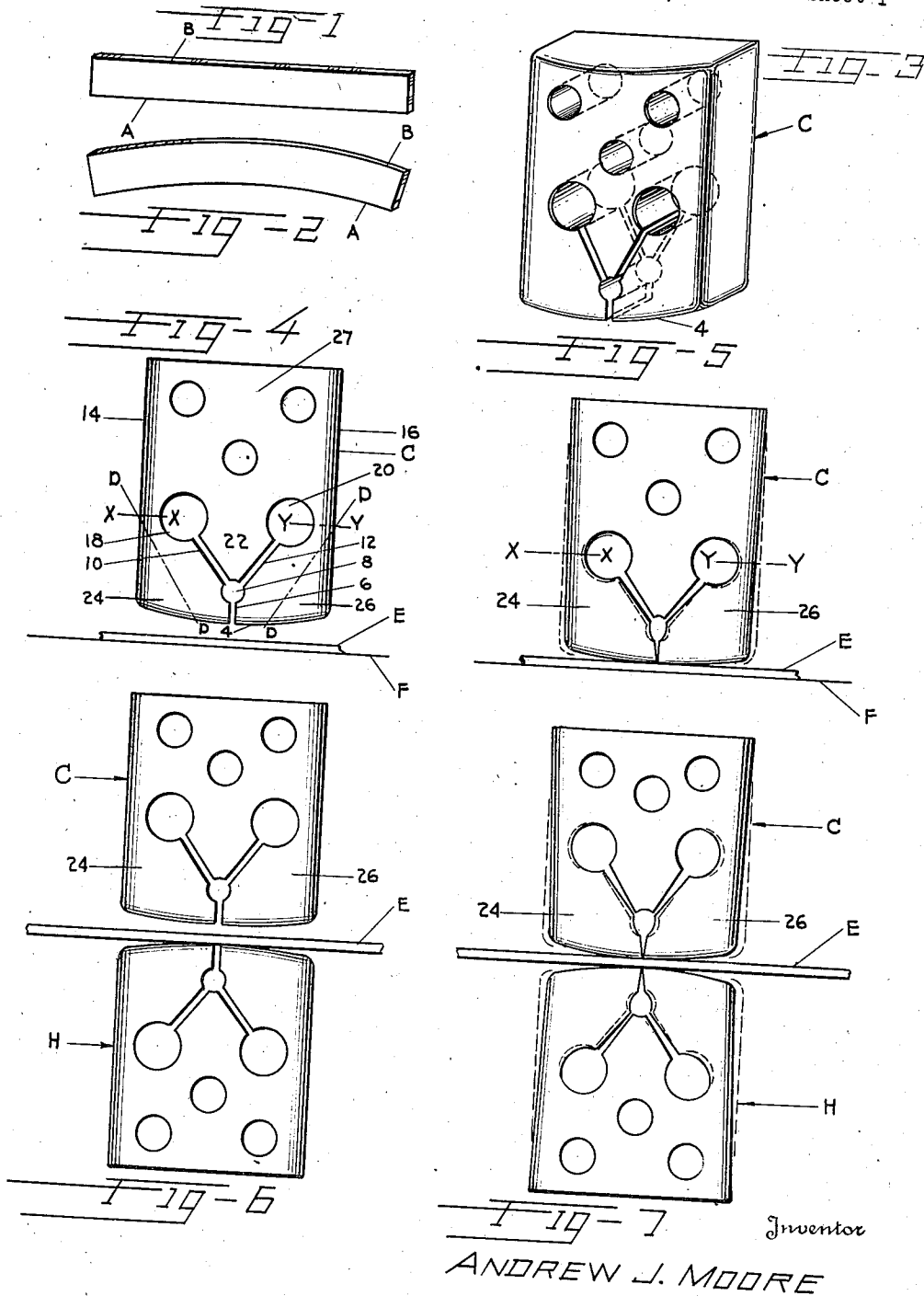
A. J. MOORE

2,428,173

DEVICE FOR UPSETTING METAL

Filed Oct. 29, 1945

5 Sheets-Sheet 1



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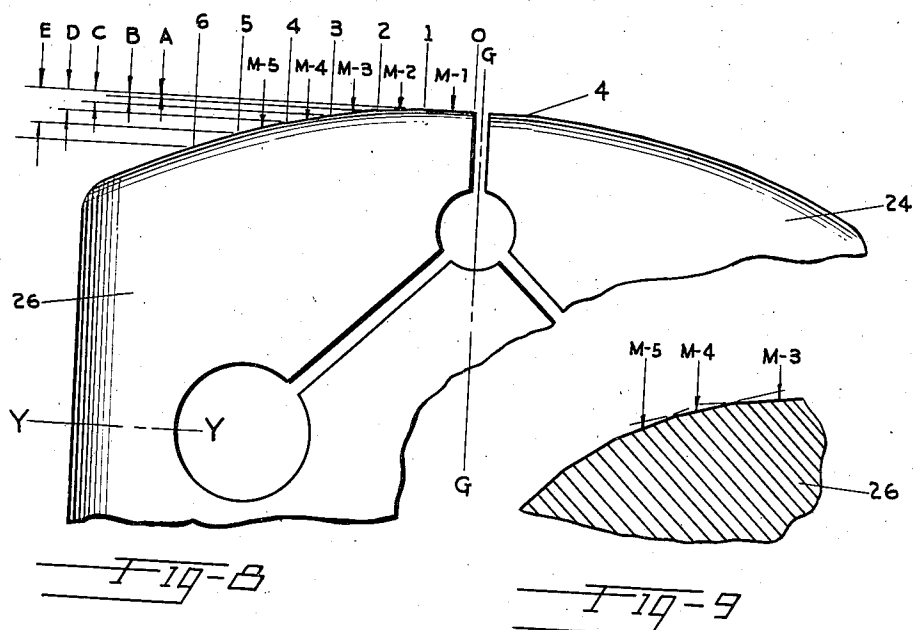
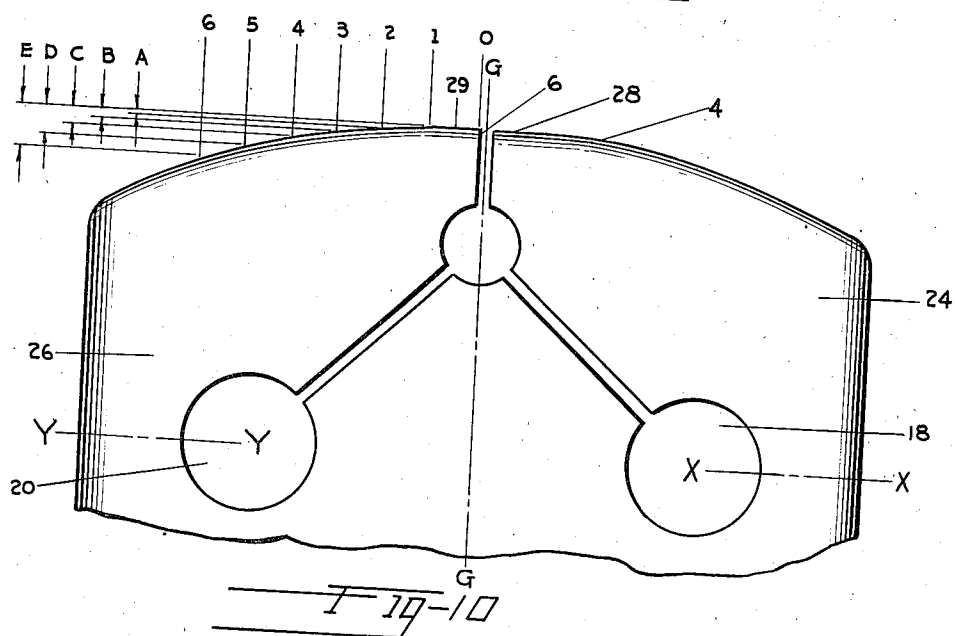
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5 Sheets-Sheet 2



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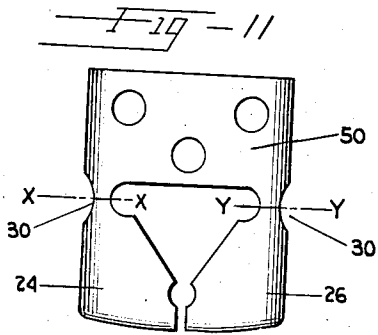
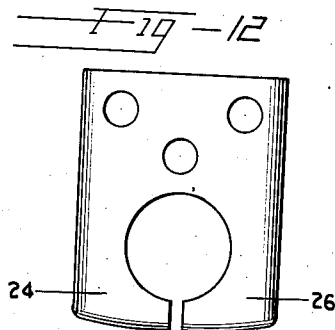
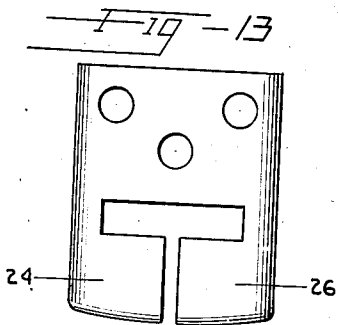
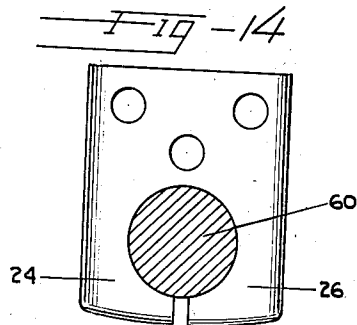
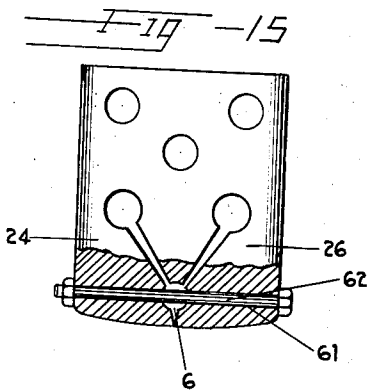
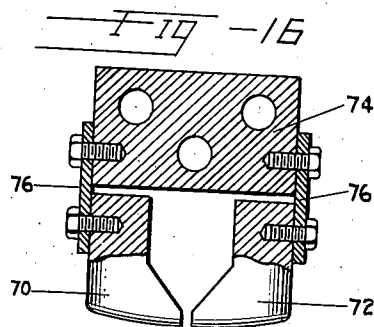
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2,428,173

DEVICE FOR UPSETTING METAL

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5 Sheets-Sheet 3



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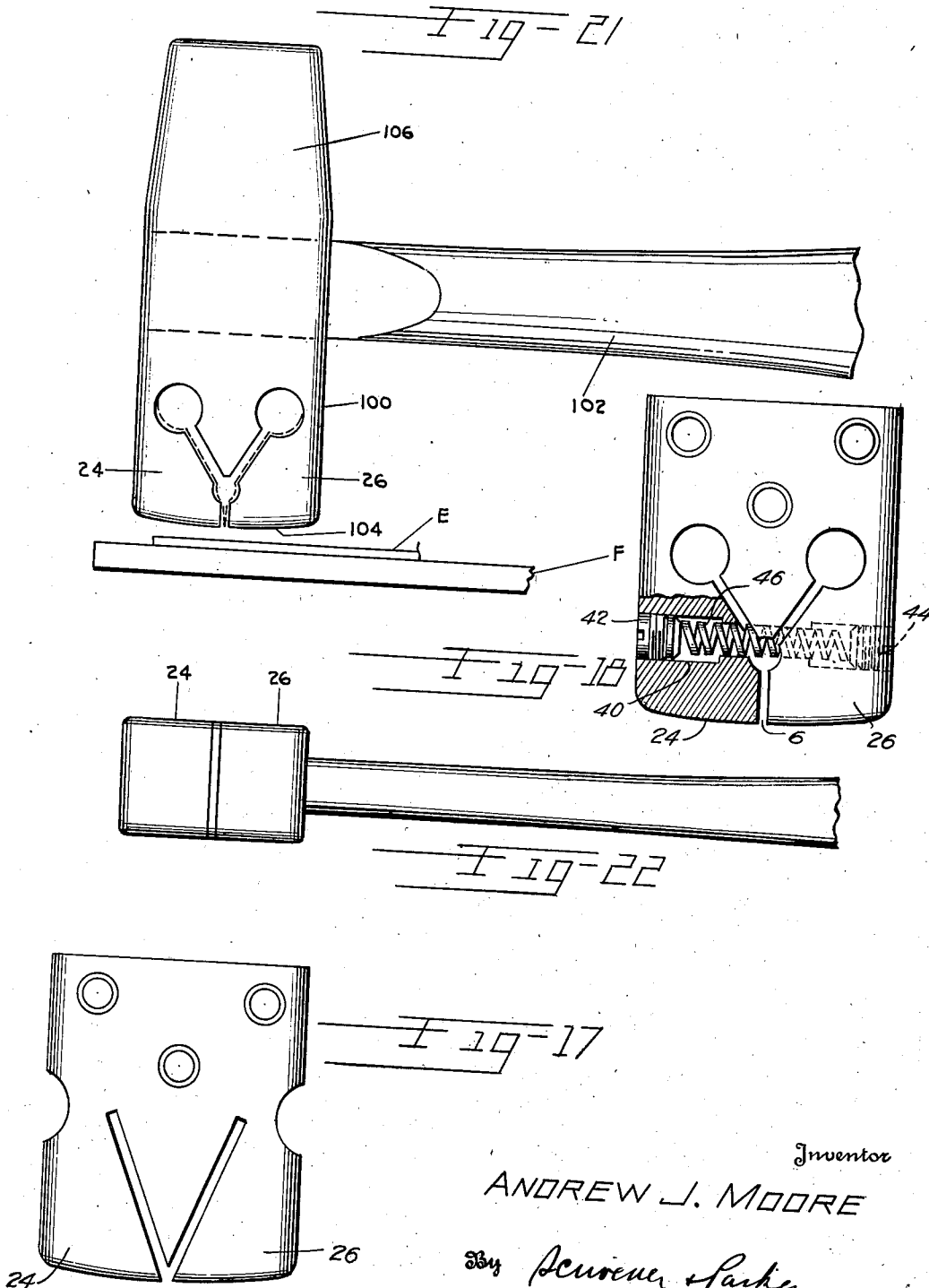
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DEVICE FOR UPSETTING METAL

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5 Sheets-Sheet 4



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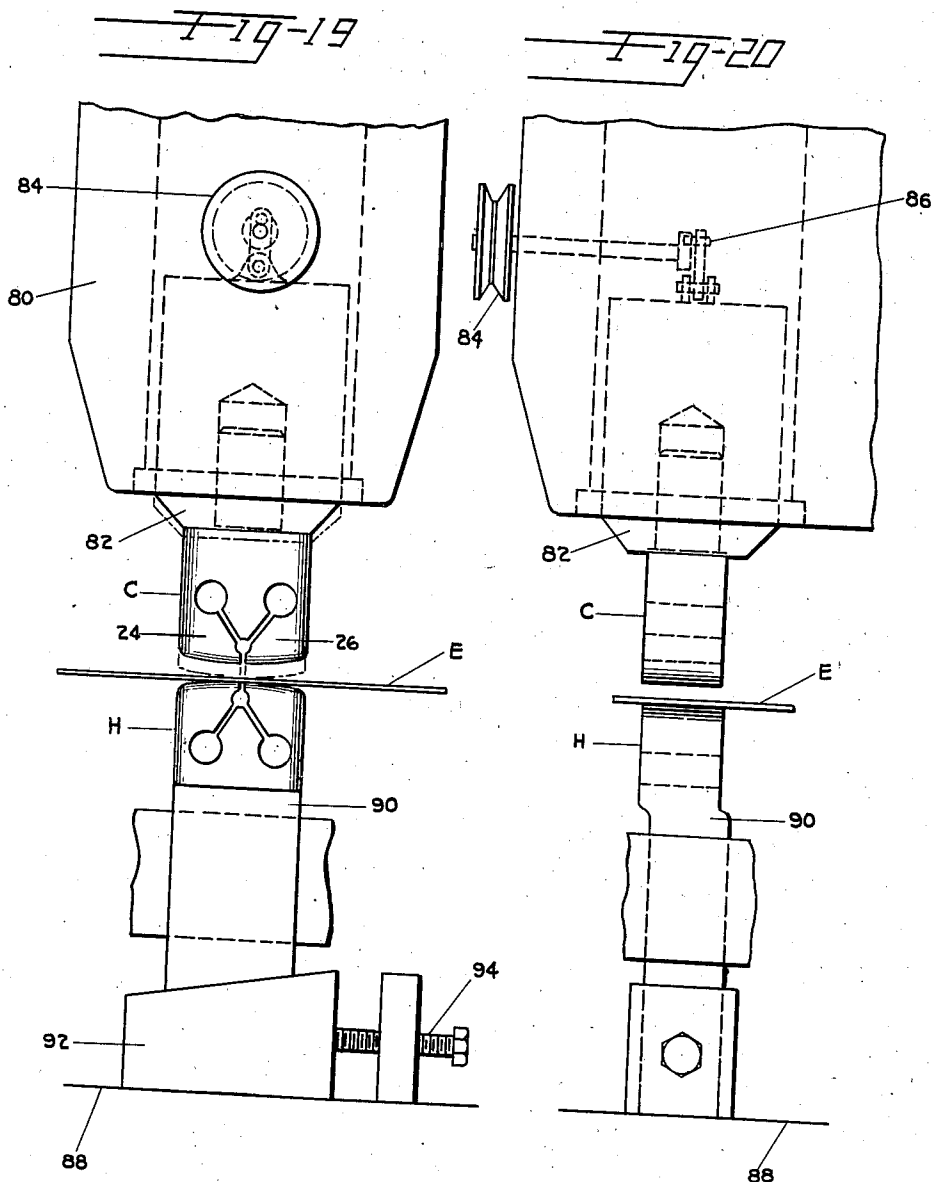
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DEVICE FOR UPSETTING METAL

2,428,173

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,428,173

DEVICE FOR UPSETTING METAL

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Application October 29, 1945, Serial No. 625,142

3 Claims. (Cl. 78-61)

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This application is a continuation in part of my copending application Serial No. 508,077.

This invention relates to the art of metal forming and, more particularly, to the art of upsetting metal by shrinking or stretching it.

In metal working, and particularly in the formation of aircraft and other parts from aluminum and magnesium sheet, it is often necessary to shrink or stretch the metal over all or a part of the area thereof and it is very desirable to do this without wrinkling or marring the metal. A typical shrinking operation is the curvature of an elongated strip of sheet metal substantially within its own plane. In other typical shrinking or stretching operations flat metal sheet is curved out of its normal plane over all or a part of the area thereof, in either simple or compound curvature.

Devices for shrinking metal are now known to the art. These devices comprise a pair of jaws which may be moved toward each other into engagement with the opposite surfaces of a piece of metal to clamp the same therebetween, a second pair of jaws which is operable in the same way to clamp the metal therebetween over an area closely spaced from the area of operation of the first jaws, and some means to move the two pairs of jaws toward each other while maintaining their clamping engagement with the metal. Known metal stretching devices operate in very much the same way, except that the sets of jaws are moved apart after each set has clamped the work piece. This invention is not to be considered as a mere improvement on these known devices but as a departure therefrom to provide a new, improved and radically different device for effecting sheet metal shrinking and stretching.

In making this invention a principal object has been to provide a simplified device or tool to take the place of the complicated arrangement of four jaws of the known devices. Another of the objects of the invention has been to provide a tool which might be used by itself to shrink or stretch sheet metal or, alternatively, might be used with other tools or devices, of the same or different construction, to produce the desired result. Still another object has been to provide a device or tool for the described purposes which might be adjusted in accordance with changes in the thickness of the sheet metal being operated on, to produce the most efficient operation for every thickness within the range of possible operation of the device or tool.

All of these objects, as well as others, have been achieved and are provided by the invention described and illustrated in this application. It will be understood, however, that the description and drawings of this application are only for the purpose of illustrating the invention, and place

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no limitation thereon not imposed by the appended claims.

Referring to the drawings, in which similar reference numerals refer to like parts,

Fig. 1 is a perspective view of an elongated, rectangular piece of metal;

Fig. 2 is a perspective view of the piece of metal of Fig. 1 after shrinking or stretching one or the other edge thereof by means of the present invention;

Fig. 3 is a perspective view of a tool according to this invention, being shown in its normal or undeformed condition;

Fig. 4 is front elevational view of the tool disclosed in Fig. 3;

Fig. 5 is a view which is similar to Fig. 4 but in which the tool is shown in the deformed condition assumed while effecting a shrinking operation;

Fig. 6 is a view of a pair of tools formed according to this invention and in position to cooperate in shrinking a piece of metal, being shown in their normal or undeformed condition;

Fig. 7 is a view which is similar to Fig. 6 but in which the two tools are shown in the deformed conditions assumed while effecting a shrinking operation;

Fig. 8 is an enlarged view of part of a shrinker head according to the invention, showing the shape of the working face thereof;

Fig. 9 is an enlarged view of part of the head shown in Fig. 8, illustrating more particularly the shape of the working face thereof;

Fig. 10 is an enlarged view of part of a shrinker head according to the invention showing a preferred shape of the working face thereof;

Figs. 11, 12 and 13 are front elevational views of modified forms of tools formed according to this invention;

Figs. 14 and 15 are front elevational views of tools formed according to this invention and modified to cause them to effect a stretching rather than a shrinking operation;

Figs. 16, 17 and 18 are front elevational views of modified forms of the invention;

Figs. 19 and 20 are front and side elevational views of a machine embodying tools according to this invention, and

Figs. 21 and 22 are side and front elevational views of a hand tool for shrinking sheet metal, formed according to this invention.

A typical operation performed by the tool or device provided by this invention is illustrated in Figs. 1 and 2 and consists in the deformation of the elongated rectangular piece of metal of Fig. 1 in such a way that it becomes curved substantially in its own plane, as illustrated in Fig. 2, without wrinkling or other deformation. This change in form may be effected by shrinking one

3 longitudinal edge A of the piece without shrinking the opposite edge B, and the required shrinking is effected by the tool provided by this invention, either when operated alone or in cooperation with another tool of the same or different structure. The same result may be achieved, if desired, by stretching the edge B without operating on the edge A. Other typical operations which may be performed by the means provided by this invention are the curvature of a metal piece out of its own plane, in simple or compound curvature and over all or a part of the area thereof. It is to be understood that the invention is generally useful in shrinking or stretching sheet metal and that the examples of the use of the invention which are described in the specification or shown in the drawings herein are for purposes of illustration only.

My invention consists primarily in the provision of a metal shrinking device comprising a unitary metallic block having jaw members formed as parts thereof and converging from spaced parts thereof, the outer surfaces of the free ends of such jaw members being adjacent but normally separated and forming working surfaces disposed laterally between the connections of the jaw members to the body of the device, whereby when such working surfaces are pressed into engagement with a work piece the jaw members will be flexed inwardly and the working surfaces will be forced together, thereby causing the metal to flow together and at the same time preventing wrinkling or the formation of ridges.

A metal upsetting device according to the invention is disclosed in Figs. 3, 4 and 5 of the drawings and comprises a unitary, integral metallic device which is denoted generally by letter C. This device is preferably formed as a block having the general shape of a parallelepiped as this promotes the ease of manufacture but, if desired, the parts outside the dotted lines D—D of Fig. 4 may be omitted or removed. The block C has a lower or working surface 4 which is adapted to be forced into engagement with the work piece E which is to be shrunk or stretched and which work piece insofar as the disclosure and discussion of Figs. 4 and 5 is concerned, is carried by a rigid support F. A narrow opening 6 extends preferably along the transverse centerline of the working surface and preferably at right angles thereto and extends from the working surface 4 a short way into the body of the head where it joins an enlarged opening 8. Two narrow diverging openings 10, 12 extend from the opening 8 in directions away from the working surface and toward the side walls 14, 16 and terminate respectively in enlarged openings 18, 20 which are respectively disposed adjacent the opposite side walls 14, 16. Each of the narrow openings 6, 10, 12 and each of the openings 8, 18, 20 preferably extends entirely through the head C from the front to the rear thereof although, if desired, one or all of them may extend through the head only far enough to provide the required function. It will be seen that these openings substantially divide the head into four sections. The first of these, numbered 22, is of triangular shape and lies between the slots 10, 12, the second part 24 lies between the slot 10 and the side wall 14, the third part 26 lies between the slot 12 and the side wall 16, and the fourth part 27 overlies all of these parts and is integrally connected to all of them. In the embodiment shown, the part 27 is provided with openings by means of

which the head may be operably attached to a metal upsetting machine. It will be seen that the part 24, which may be referred to as a jaw, is integrally united to the main body part 27 through the section X—X, which lies between opening 18 and side wall 14, and that part 26, which may also be referred to as a jaw, is integrally united to part 27 by section Y—Y which lies between opening 20 and side wall 16. Each of the jaws 24, 26 includes a part of the lower or working surface 4 which is, as described, divided in half by the opening 6.

The shape of the working surface of the jaws is of importance in my invention. In general the working surface is convex, with the most extended part thereof being adjacent the opening 6 which lies between the working surfaces of the two jaws. Thus, the most extended part of the working surface of each jaw is spaced inwardly of the connection of the jaw to the head 27, i. e., the most extended part 28 of jaw 24 is spaced laterally inwardly of section X—X and the most extended part 29 of jaw 26 is spaced laterally inwardly of section Y—Y. It will be seen that when the working surface parts 28, 29 are pressed into engagement with a work piece to shrink the same, each jaw member will act as a lever, bending about some point in or adjacent the section X—X or Y—Y, whereby the jaws will move toward each other to the position shown in Fig. 5.

In order to provide best shrinking operation the shape of the working surface of each jaw must be a curve developed about the center or centers of movement of the jaw. I have found that best results are obtained if the working surface of each jaw member approximates the shape of an involute, and such shape is preferred in the formation of the working surfaces of jaws according to my invention and is shown in Fig. 10. The working surface of each jaw may be otherwise described by saying that it is generally arcuate and convex and that the shape thereof is such that the radius of curvature progressively decreases from the central or most extended part thereof, i. e., the part adjacent the central opening 6, outwardly, with the center of curvature remaining in the center-line G—G of the head. Such shape, in addition to the lever action of the jaws, causes each jaw surface to remain in contact with the work piece and to have a tendency to push inwardly on the work piece, i. e., toward the other jaw, when the jaws flex inwardly in the shrinking operation. In Fig. 8 of the drawings there is disclosed in enlarged view a shrinker head according to this invention and showing the shape of a typical working surface. Actual measurement of the distances A, B, C, D, E, at points 1, 2, 3, 4, 5, respectively, of a typical jaw which, in the head measured, were located at each one-eighth ($\frac{1}{8}$) inch point from the edge of the central opening 6 outwardly were:

A	0.0000
B	0.0001
C	0.00025
D	0.0009
E	0.00175

In practice I find that working surfaces of the described shape may be developed in various ways. In a preferred way the working surfaces of the two jaws are first ground at right angles to the center-line G—G of the head over a very small lateral distance producing the surface M—1 on each jaw. A shim which is only slightly narrower than the opening 6 is then placed

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therein, the jaws are drawn together against this shim and the working surfaces again ground at right angles to the center-line G—G, producing the surface M—2 on each jaw. This procedure is repeated using progressively thinner shims, thus producing the surfaces M—3, M—4, M—5, etc. The surface thus produced on each jaw will approximate the desired shape which is described above and is illustrated in Fig. 8. Such shape may also be produced by making the adjacent parts of the working surfaces of the two jaws perpendicular to the center-line G—G of the head and then rapidly and continuously forcing the working surface into engagement with a work piece for a considerable time, thus causing the working surfaces to wear to the desired and described shape. If produced in this way the working surfaces will be smooth curves and this is shown in Fig. 10.

When it is desired to shrink metal by means of the tool disclosed in Figs. 3, 4 and 5 the working surface thereof is rapidly and intermittently forced into engagement with the work piece by some means such as the machine disclosed in Figs. 19 and 20. Pressure of the working surface on the work piece will cause the jaws 24, 26 to bend about some point within or adjacent the sections X—X and Y—Y and move toward each other from their normal positions shown in Fig. 4 and in dotted lines in Fig. 5 to their deformed or stressed positions shown in full lines in Fig. 5, such movement being permitted by the normal separation of the two parts by the openings 6, 10, 12. The steel material of which the head is preferably formed is not stressed above its elastic limit when flexed in the described manner and when pressure on the head is released, allowing it to move out of engagement with the work piece, the jaws return to their normal separated positions. It will be apparent that the movement of the jaws toward each other while being forced against the surface of the work piece will cause the separated areas of the work piece which are engaged by the working surfaces of the pressure parts to be moved toward each other while at the same time the described shape of each working surface will insure that each such face will remain in contact with the work piece, preventing any wrinkling of the metal. If this operation is applied to edge A of the metal sheet of Fig. 1 but not to edge B thereof the sheet will be deformed in substantially its own plane to the shape illustrated in Fig. 2 because of the resultant shortening of edge A without corresponding shortening of edge B.

While it is possible to use the head C alone, in which case the work piece E must be mounted on a fixed support F, it is preferred, in order to achieve best results, to support the work piece on a fixed head H which is formed similarly to head C. The combination of an upper head C and a lower head H is disclosed in Figs. 6 and 7. The lower head H is rigidly supported below the upper head with its parts vertically aligned with the corresponding parts of the upper head, and when the upper head is raised, as shown in Fig. 6, the parts of both heads are in their normal unstressed, or undeformed, condition. Shrinking is effected by forcing the upper head C against the work piece and the lower head H, causing inward movement of each of the four jaws in the manner and with the result described.

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While the preferred configuration of the working surface of the head has been described, different shapes thereof may be employed, subject to the requirement that the working surfaces will remain in contact with the work piece as the jaws move inwardly. It will be seen however that in each embodiment of the invention the working surface is essentially outwardly convex and that the most outwardly-extended parts thereof, i. e., the lowest parts thereof in the case of the upper head and the highest parts thereof in the case of the lower head, are adjacent the opening 6 which divides the working surface of each head and are spaced inwardly of the connection of the respective jaw to the head.

It is preferred that the circular openings 8, 18, 20 be provided in the heads. These openings not only facilitate the making of the elongated openings but, in addition, the thickness and consequently the strength or rigidity of the sections X—X, Y—Y may be given any desired initial value by predetermined dimensioning of the openings 18, 20 which are adjacent these sections. However, if desired, some or all of the circular openings may be omitted without departing from the invention and in Fig. 17 there is shown a head having no such openings. It will be understood that either or both of the heads C, H may be so modified.

It has been found that best results are obtained in using this invention if the rigidity of the heads at the sections X—X, Y—Y is made approximately directly proportional to the thickness of the material being worked. It is, of course, impractical to vary the size of these sections after the head has been made. However, the invention provides means for varying the initial rigidity of these sections. One such means is disclosed in Fig. 11 and comprises grooves 30 which are formed in the side walls of the head within the sections X—X, Y—Y. It will be apparent that these grooves reduce the sections, thereby reducing the force required to cause the pressure parts to bend about these sections. Such grooves permit the head or heads to be used more efficiently on thinner metal. Another such means is disclosed in Fig. 18 and comprises an opening 40 extending transversely through the two jaws at right angles to the opening 6 therebetween and having tapped ends in the jaws in which threaded retaining members 42, 44 are screwed. A compression spring 46 is disposed within the hole 40 and bears at its ends against the retaining members 42, 44. It will be apparent that the compression spring resists movement of the jaws 24, 26 toward each other and that the degree of such resistance may be varied by moving the retaining members into or out of the tapped ends of the hole 40. The degree of compression of the spring 46 should be increased as thicker sheet metal is operated on and should be reduced as the thickness of the metal is decreased.

While heads comprising the slots 10, 12 are easily manufactured, it will be seen that the central section 22 of the head performs no active or useful function and it is contemplated that this section may be omitted and the head constituted only by a unitary structure comprising the normally separated jaws and a connection therebetween. Such structures are illustrated in Figs. 11, 12 and 13 of the drawings. In the device of Fig. 11 the triangular section 22 has been removed, leaving the jaws integrally united to a connecting part 50 through spaced sections X—X

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and Y—Y. In the device of Fig. 12, a circular opening replaces the triangular opening of Fig. 11, while in Fig. 13 a rectangular opening is shown.

Means are provided by the invention for transforming the sheet metal shrinking device hereinbefore described to a sheet metal stretching device, such means comprising means for holding the jaws from movement toward each other when the working surface is forced into engagement with a work piece which is to be stretched, whereby the head acts in the known manner of a peening hammer. In Fig. 14 there is illustrated a head of the type and construction of that of Fig. 12, having a single circular opening therethrough, within which a plug 60 has been inserted, completely filling the opening and preventing movement of the jaws toward each other. It will be obvious that this principle may be applied to any other embodiment of the invention. In Fig. 15 there is illustrated a head of the preferred form disclosed in Figs. 3, 4 and 5, the same having an opening 61 extending therethrough at right angles to the central opening 6 and preferably relatively near the working surface. A headed bolt 62 extends through this opening and has a nut threaded to one end thereof whereby the pressure parts of the head may be drawn together, as shown, causing the head to act as a solid, unitary device when the working surface thereof is brought into engagement with a work piece.

While all forms of the invention hereinbefore described have comprised an integral head, it is contemplated that devices according to the invention may be formed of a plurality of parts. One such device is disclosed in Fig. 16 and comprises the jaws 70, 72 which are connected to a cross-member 74 by rigid but yieldable strips 76 which correspond to the sections X—X and Y—Y of other embodiments and each of which is connected at one end to an outer side wall of one of the jaws at a point removed from the working surface thereof and at the other end to the connecting member 74. The parts are arranged in the same relation as in other embodiments of the invention and as the function and operation of the parts are the same as those of the corresponding parts of other embodiments they will not be further described.

A machine for upsetting metal by the use of devices according to my invention is disclosed in Figs. 19 and 20 of the drawings and comprises a machine having a fixed upper part 80 within which is mounted a vertically movable member 82 which carries an upper shrinking or stretching head C which in Figs. 19 and 20 is disclosed as constructed in accordance with the preferred embodiment of the invention but which may be formed in any other way within the scope thereof. Means such as the pulley 84 and eccentric 86 are provided for rapidly and continuously reciprocating the member 82 and the head C in such a manner that the working surface of the head is rapidly and intermittently forced into engagement with the work piece E. The machine also comprises a lower part 88 on which a lower shrinker head H is mounted which is preferably of the same construction as the upper head C. This head may be supported in a fixed position or may be supported on an intermediate member 90 having an inclined lower end which rests on the inclined upper surface of a wedge member 92 which may be moved laterally by an adjusting screw 94. By this means the intermediate member 90 and the lower head H may be adjusted to vary the clearance between the upper

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and lower heads. It is believed that the operation of this machine will be apparent and no further description thereof or of the operation of the heads in shrinking or stretching sheet metal will be given.

As stated hereinbefore, the tool provided by the invention may be used by itself to effect the shrinking or stretching of a piece of sheet metal E which is carried by a rigid support F, and by the present invention there is provided a hand tool which may be used in this manner. This tool is disclosed in Figs. 21 and 22 and comprises a head 100 which is constructed and operable in the manner taught by the invention and which may take the form of any embodiment herein described or other embodiment within the scope of the invention. A handle 102, or other means, is attached to the head and provides means for manually operating the same in the manner of a hammer, whereby the working surface 104 of the head may be rapidly and intermittently brought into forceful contact with the work piece E, which is mounted on a rigid support F, thereby effecting the shrinking thereof in the described manner. If desired, the head 100 may be additionally weighted by a part 106, which is integrally or otherwise joined thereto, preferably on the opposite side of the handle from the working surface.

It will be seen that the shrinking tool or head which is provided by this invention may be manufactured easily and cheaply and may be of unitary construction. Further, this tool may be used by itself or with other tools to effect metal shrinking or stretching. Further, the devices provided by the invention may be adjusted to provide maximum efficiency for all thicknesses of work. While the specification and claims refer in certain places to vertical reciprocation or up-and-down movement, or to upper and lower positions, it will be understood that these terms place no limitation on the invention, being merely illustrative of one mode of operation or position of parts, and that devices and parts thereof according to the invention may be so positioned and operated that the shrinking or stretching heads are positioned horizontally on opposite sides of the work piece, or otherwise.

While there are here described and illustrated a number of different embodiments of the invention, other embodiments as well as modifications of those disclosed will occur to those skilled in the art. All of these may be made and practiced without departing in any way from the spirit or scope of the invention, for the limits of which reference must be had to the appended claims.

While there are here described and illustrated a number of different embodiments of the invention, other embodiments as well as modifications of those disclosed will occur to those skilled in the art. All of these may be made and practiced without departing in any way from the spirit or scope of the invention, for the limits of which reference must be had to the appended claims.

I claim:

1. A metal shrinking tool comprising an integral metallic head having jaw members integral therewith, said jaws being connected to the head by spaced sections which are of such area that they may be flexed to permit the jaw members to move toward and away from each other, said jaw members having normally spaced, closely adjacent work-engaging surfaces at their free ends which are spaced laterally inwardly of the connections of the respective jaw members to the head where-

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by the jaw members move toward each other by flexure of said connecting sections when the work-engaging surfaces are forced into engagement with a work piece, each of said work-engaging surfaces being convex and arcuate with its radius of curvature lying in a plane intermediate the two connecting sections and being greatest at the part of the work-engaging surface adjacent the other and progressively decreasing outwardly therefrom whereby the adjacent parts of the work-engaging surfaces remain in contact with the work piece and parts outward thereof come into contact with the work piece as the work-engaging surfaces moves toward each other during the shrinking operation.

2. A metal shrinking tool according to claim 1, comprising in addition a compression spring disposed between said jaw members and constantly urging them apart, and means for varying the compression of said spring to thereby vary the force resisting movement of the jaw members toward each other.

3. A metal shrinking tool comprising an integral metallic head having side walls and an end surface, there being a narrow slot extending into the head midway and across said end surface to provide two separated work-engaging surfaces, and there also being two narrow diverging slots extending from the inner end of the first slot obliquely in opposite directions toward the side walls and respectively terminating adjacent the side walls, said slots defining two normally-spaced

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jaw members each including substantially one-half of the working surface and being integrally connected to the head by spaced sections located respectively between the ends of the diverging slots and the side walls which are of such cross-sectional area that they may be flexed to permit the heads to be moved toward and away from each other, the work-engaging surface of each jaw member being convex and arcuate with its radius of curvature lying in a plane intermediate the two connecting sections and being greatest at the part of the work-engaging surface adjacent the other and progressively decreasing outwardly therefrom whereby the adjacent parts of the work-engaging surfaces remain in contact with the work piece and the parts outward thereof come into contact with the work piece as the work-engaging surfaces move toward each other during the shrinking operation.

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