

July 1, 1969

R. A. MACKENZIE
STRETCH WRAPPING FIXTURE AND COMBINATION THEREOF WITH
DRAWING DIES AND PRESS

3,452,573

Filed June 14, 1967

Sheet 1 of 5

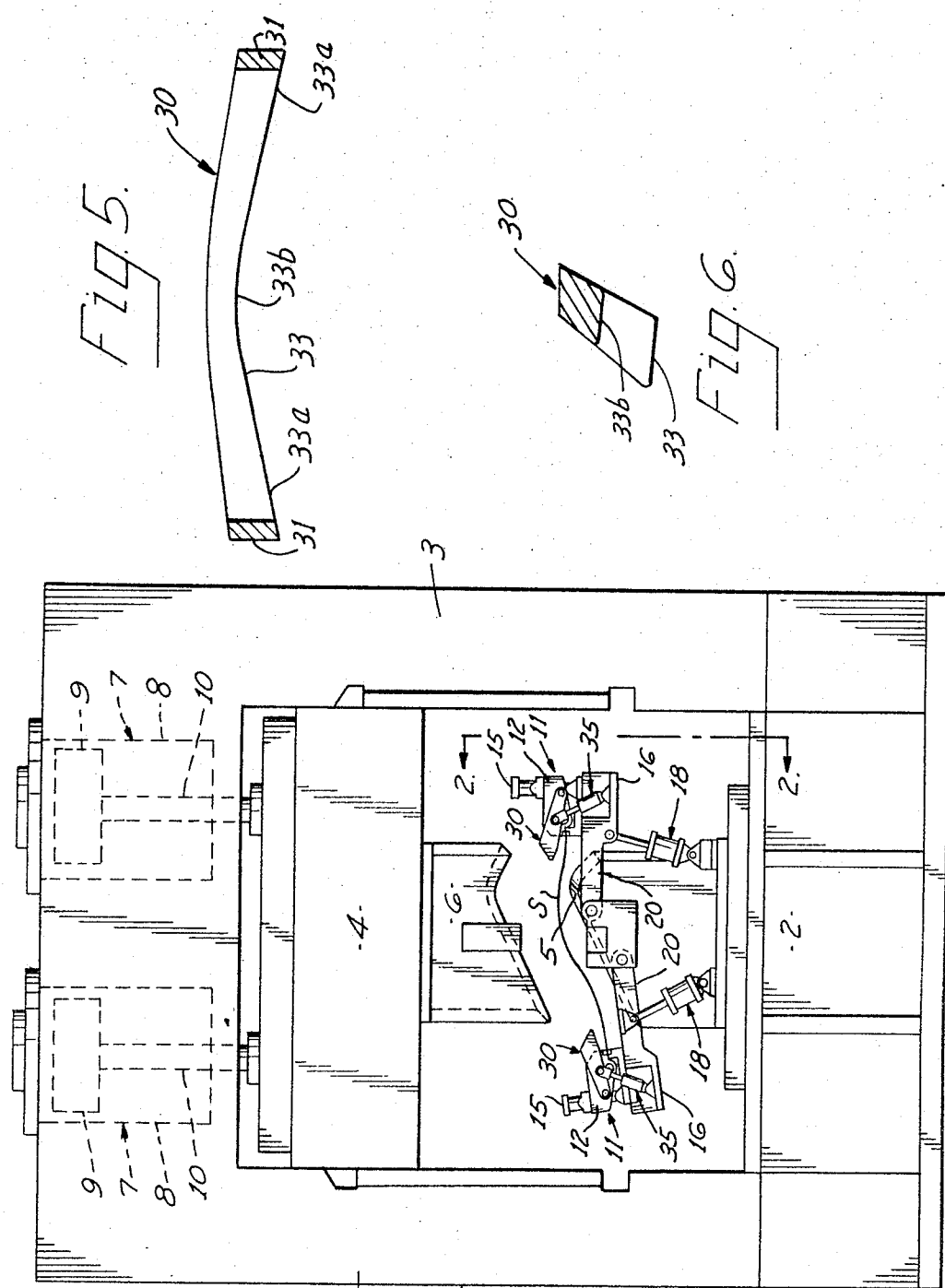


Fig. 1.

Fig. 5.

Fig. 6.

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Fig. 4

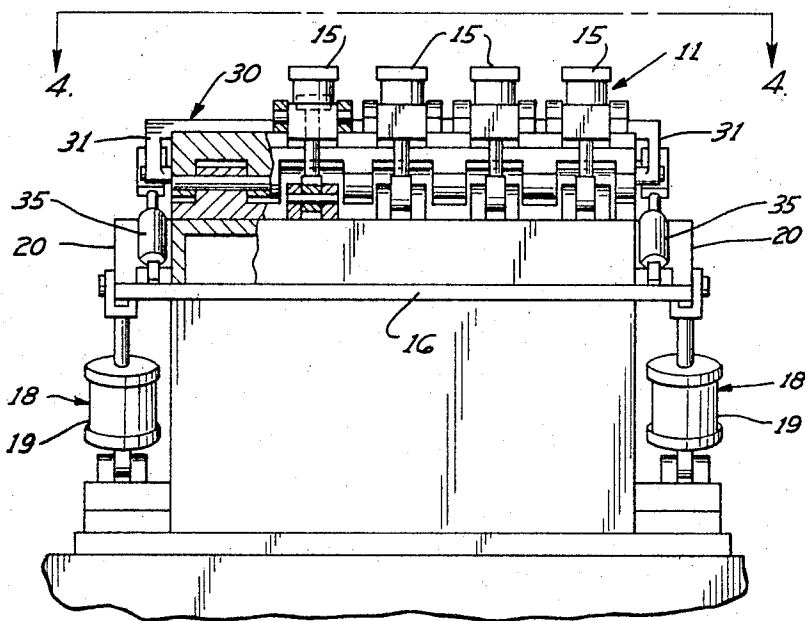
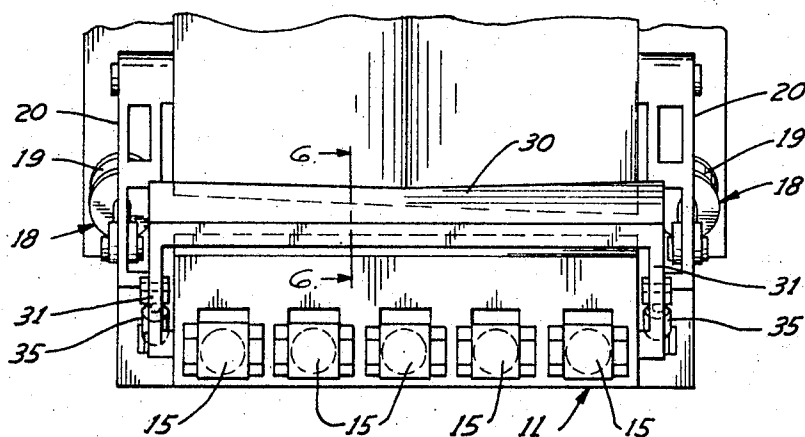


Fig. 2

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Fig. 3

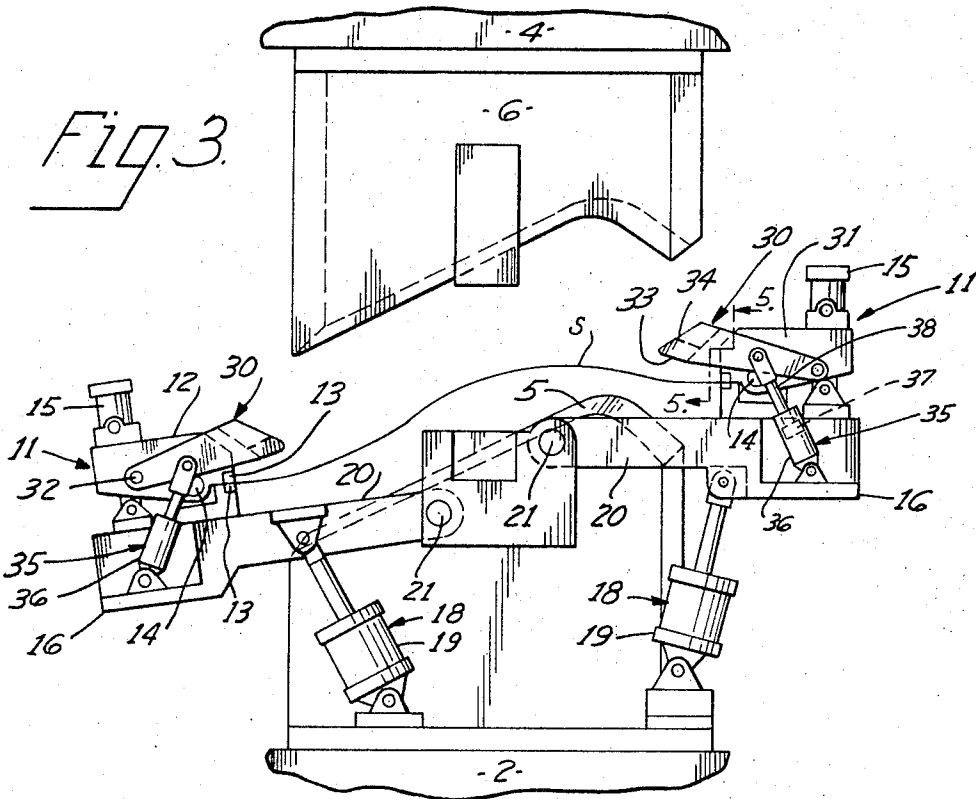
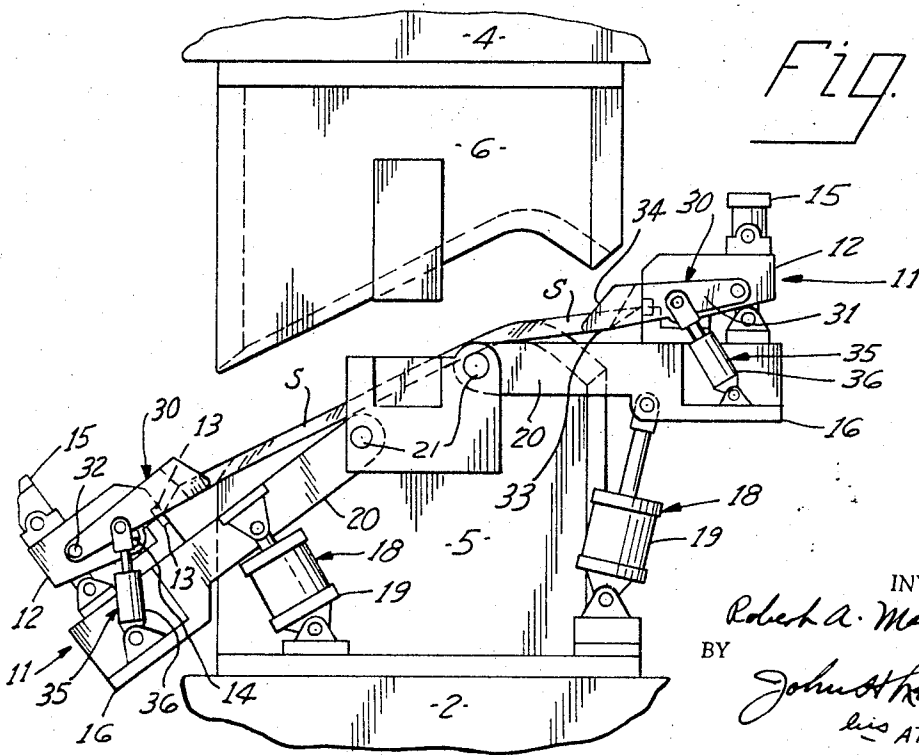


Fig. 7



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Fig. 8

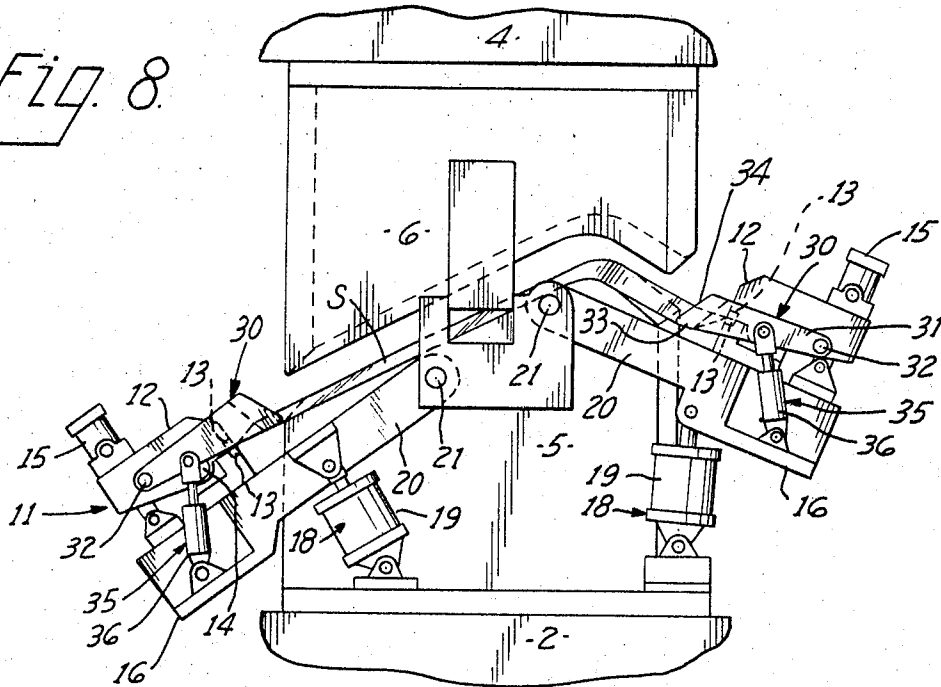
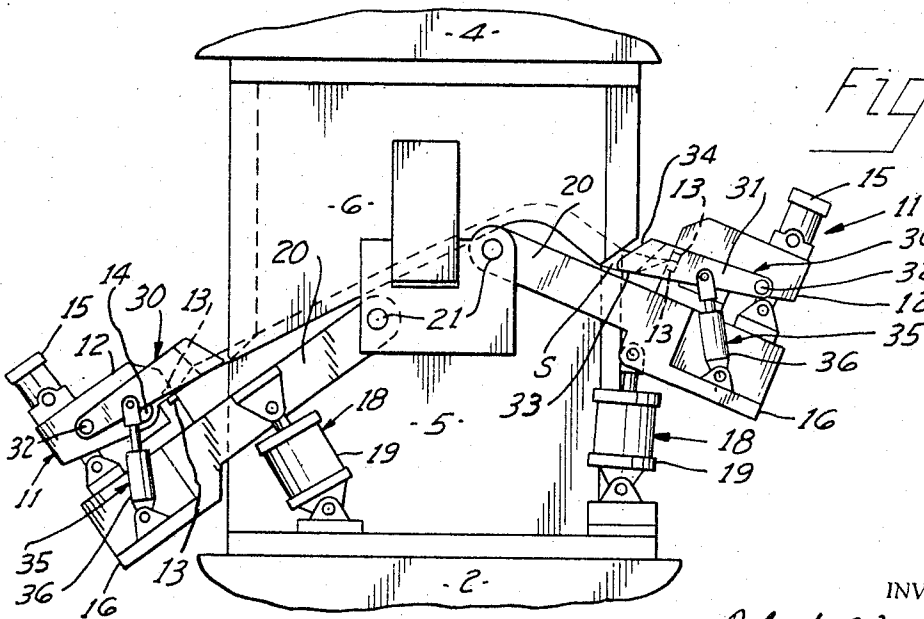


Fig. 9



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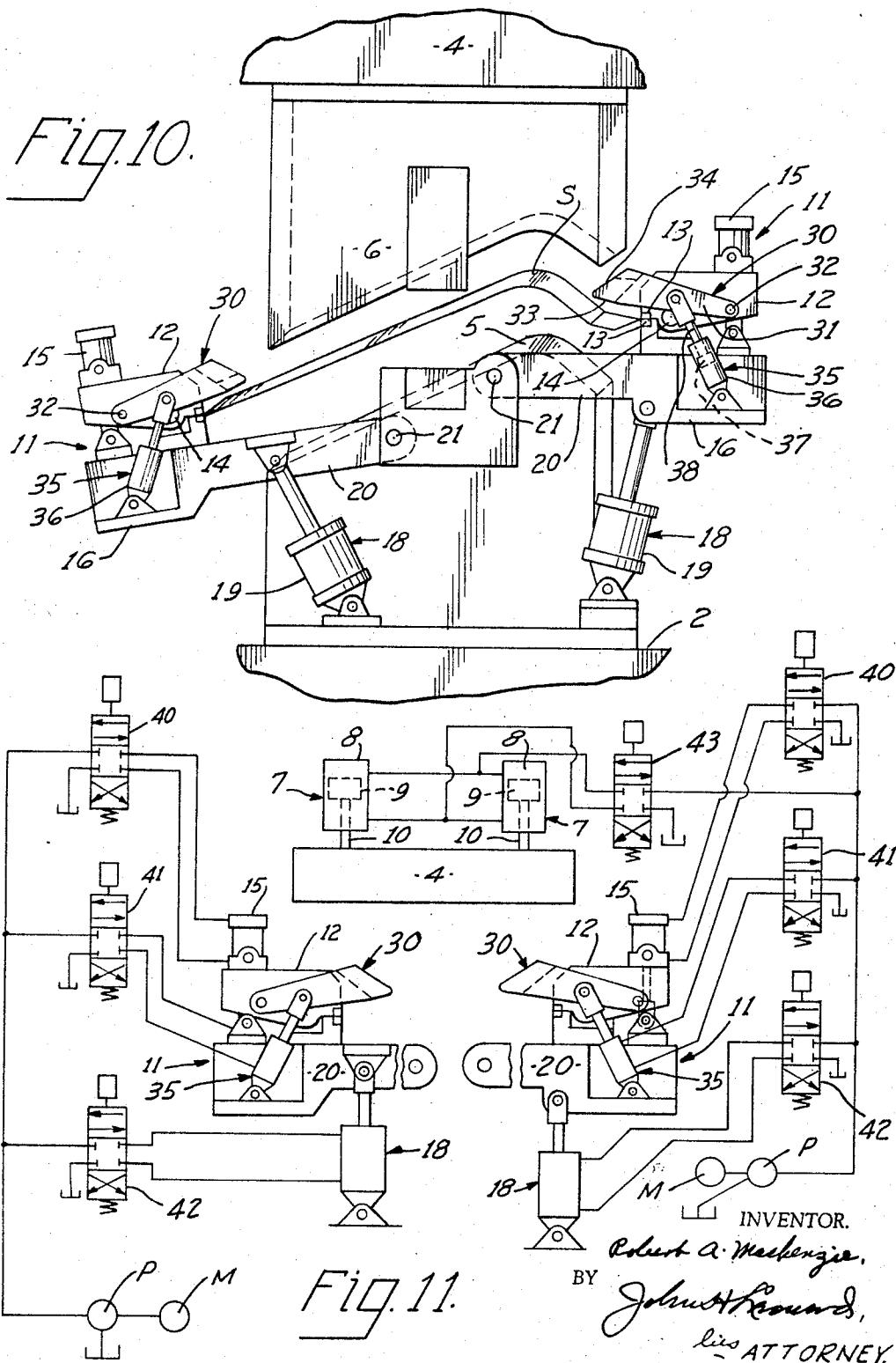
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3,452,573

STRETCH WRAPPING FIXTURE AND COMBINATION THEREOF WITH DRAWING DIES AND PRESS

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U.S. Cl. 72-296

12 Claims

ABSTRACT OF THE DISCLOSURE

The improvement herein resides in a supplemental stretch means cooperable with sheet stretching heads which are arranged for gripping two opposite margins of a sheet of metal for stretching it in one dimension while wrapping it onto a male die forming face which is convex transversely of the stretching dimension and wherein the gripping jaws of the heads are lineal transversely of the die face, so as to readily receive and grip two opposite planar margins of a sheet of metal to be stretched wrapped.

Due to the divergence of the convex die face cross section at the end of the face adjacent the jaws of a head from the lineal jaws, the sheet normally would be elongated to a greater degree at its lateral midportion than at its lateral margins during the stretch wrapping operation.

The supplemental stretch means cooperate with their associated head to impart to the sheet an elongation in addition to that imparted by the head alone during stretching and wrapping, particularly at the lateral margins of the sheet and to a progressively decrescent degree inwardly from the margins toward the lateral midportion of the sheet, so that elongation throughout the width of the sheet becomes equalized or approaches equalization to the degree to assure proper forming.

This invention relates to a stretch wrapping fixture and combination thereof with a drawing die press for performing stretch drawing operations, and is an improvement on the invention disclosed in U.S. Letters Patent No. 3,314,269, of Robert A. Mackenzie, issued Apr. 18, 1967, and in an application of Robert A. Mackenzie, Ser. No. 608,667, filed Jan. 11, 1967, now abandoned, and entitled Stretch Draw Unit with Ghost Line Eliminator.

In the above-entitled patent and application there is disclosed a conventional draw press employing complementary drawing dies combined with stock gripping stretch heads which are operable by suitable power means to tension the sheet unidimensionally while wrapping it over a male die preparatory to, or during, the drawing of the stock between the complementary drawing dies. Generally, the gripping jaws are lineal endwise of the head and laterally of the sheet. The drawing face of the male die, however, is generally convex both in the tensioning dimension and transversely thereof. When the sheet under tension is stretch wrapped about the die, the portion at the lateral midportion of the sheet must be wrapped downwardly toward the base of the male die whereas the marginal portions of the sheet are not so wrapped. As a result, the midportion of the sheet must be elongated to extend along a greater length of the die face than the lateral margins of the sheet. Generally, the greater length is decrescent from the midportion toward the lateral margins. Consequently, in drawing and wrapping, if the sheet is elongated sufficiently so as to extend along the longer surface of the forming face at the lateral midportion of the face, those portions at the lateral margins of the face tend to be laid along the face with much less, if any, stretching. As a result, the lateral margins tend to draw

in laterally of the sheet and not only fail to thin out appreciably but, in fact, to thicken.

In many instances the margins tend to curl up even though under some tension above the elastic limit.

Heretofore it was thought that this "draw in" could be pulled back out entirely by the female die upon closure of the dies, but it was found that even though pulled out, the resultant panel lacked stiffness and had weak or flat spots.

In attempting to overcome this defect, the sheet was stretched by the lineal jaws to a degree to assure that the margins were stretched beyond the elastic limit and thinned down. This, however, caused overstretching of the sheet at the midportion and weakening or breaking of the sheet. The difference in elongation of the sheet from the midportion and to the margins appeared to be generally progressively decrescent, the degree of decrescence depending upon the convexity of the die face in transverse section, and also in greater convexity in longitudinal section as the midportion is approached. To provide the high quality product, it is desirable that the difference in elongation of the sheet from the margins to the midportion be maintained within a rather limited range, the optimum being equal elongation of the sheet throughout its entire width.

Curvilinear jaws conforming roughly to the cross section of the male die forming face near the ends thereof are impractical for high speed production, due to the difficulties of loading and unloading, and substantially lineal jaws between which the end margins of the sheet may be fed endwise of the gripping heads are dictated by these and other practical necessities.

The present invention has to do with a supplemental stretching means which initially cooperate with the lineal jaws and engage the sheet prior to, or at the initiation of the stretch wrapping of the sheet about the male die, so as to impose on the sheet, at least at its lateral margins, a movement and elongation of the metal of the sheet endwise of the sheet in addition to the elongation imposed by the lineal stretch heads themselves or by them and the die face. This is accomplished generally by arranging the supplemental stretch means to move with the head in a first or tensioning direction and concurrently move relative to the head flatwise of the sheet in a second direction of movement of the heads for wrapping the sheet onto the die. The supplemental stretch means has surface areas which engage the sheet close to the gripping jaw throat so that the additional movement of these surfaces relative to the head is imparted to the sheet and causes a part of the sheet near the jaws to be pushed in the second direction relative to the jaws to stretch or elongate the sheet at least near the lateral margins, and preferably from these margins at a progressively decrescent degree toward the midportion. This elongation is in addition to the stretching imparted by the heads themselves in the tensioning dimension.

Various specific objects and advantages of the invention will become apparent from the description wherein reference is made to the drawings, in which:

FIG. 1 is a front elevation of one type of conventional power driven drawing die press with the improved stretch wrapping fixture of the present invention combined therewith;

FIG. 2 is an enlarged fragmentary right side elevation, partly in section, of the fixture and part of the press shown in FIG. 1, as viewed from line 2-2 in FIG. 1;

FIG. 3 is an enlarged, somewhat diagrammatic, front elevation of the wrapping fixture and operating parts, showing their relation to the drawing dies, in the loading position of the dies and fixtures;

FIG. 4 is a fragmentary top plan view of one of the

stretch heads and supplemental stretching means as indicated in line 4—4 in FIG. 3;

FIG. 5 is a fragmentary right-hand elevation, partly in section, of the supplemental stretching means of one of the fixtures as taken on line 5—5 in FIG. 3;

FIG. 6 is an enlarged fragmentary sectional view of the supplemental stretch means taken on the line 6—6 in FIG. 4;

FIG. 7 is a view similar to FIG. 3 showing the relation of the dies and stretching fixtures during the initial part of the forming operation;

FIG. 8 is a view similar to FIG. 3 and showing the dies and fixtures toward the end of the forming operation;

FIG. 9 is a similar view showing the dies and fixtures at the completion of the forming operation;

FIG. 10 is a similar view showing the position of the dies and stretch fixtures in the unloading position;

FIG. 11 is a diagrammatic illustration showing the hydraulic circuitry which may be used for the operation of the stretch heads, supplemental stretch means, and press.

Referring to the drawings, the invention is shown in connection with a hydraulic press 1 having a bed 2 with upright corner guide members 3 arranged for guiding a power driven ram 4 for vertical reciprocation. A male die 5 having a forming face which is convex upwardly both lengthwise and transversely is supported on the bed 2, and a companion female die 6 is mounted on the ram 4. Conventional hold-down rings or devices are not employed, the stock being left free to draw in transversely of the tensioning dimension.

The invention is particularly desirable for combined stretching and die drawing of sheet metal automotive body stock and the like into asymmetrical shapes over a male die which is asymmetrical about an upright median plane extending transversely of the male die and of the tensioning dimension. The ram 4 is driven on its forming and return strokes by means of hydraulic piston and cylinder assemblages 7, including cylinders 8 with pistons 9 having rods 10 connected to the ram.

The stretch wrapping fixture generally includes two units 11 arranged on the bed 2 at the sides of the male die which are opposite each other in the tensioning dimension. Regardless of whether the tensioning dimension is the longer or shorter dimension of the work piece or die, it is considered the endwise dimension.

Each unit 11 comprises a stretch head 12 having a pair of pivoted jaws 13 rockable about pivots 14 by suitable piston and cylinder assemblages 15 so as to grip the associated margin of the sheet of stock for applying tension thereto during movement of the head in one direction along the tensioning dimension. Each head 12 is mounted on a carrier 16 which, if desired, may be in the form of a plate rigid with the main casting or body of the head 12, or may be an integral part thereof. For raising and lowering the head 12, a plurality of hydraulic piston and cylinder assemblages 18 are provided. Each assemblage comprises a cylinder 19 with the usual piston having its rod pivotally connected to a suitable bracket on the carrier 16, and its cylinder pivotally connected to a bracket in fixed position relative to the bed 2 of the press.

With the structure thus far described, it is apparent that the stretch heads 12 can be moved endwise toward and away from each other generally horizontally for tensioning a sheet of stock S endwise and concurrently can be moved vertically or flatwise of the sheet by the assemblages 18 to wrap the sheet on the male die.

To apply the proper stretching movements to the heads in the tensioning dimension and for moving the sheet flatwise in the wrapping direction, each head is mounted preferably in fixed position on a pair of link arms 20. The link arms are pivotally mounted at their inner ends on pivots 21 which are secured in fixed position relative to the male die 5. This may be accomplished by mounting the pivots directly on the male die, or on supports along-

side the male die, and arranging the link arms one at the front and one at the rear of the dies. The axes of the pivots 21 of the two heads at opposite ends of the dies are parallel to each other and are in fixed relation to the heads and to the male die.

As fully disclosed in the above identified application and patent, it is apparent that upon movement of the heads downwardly by their piston and cylinder assemblages 18, they are caused to swing concurrently relatively apart from each other or in the outboard direction away from the adjacent end of the die. The specific paths of the heads may be determined by the length of the link arms 20 and position of their pivots 21.

In the form illustrated, the heads 12 are arranged so that in the loading position, the blank must be arched upwardly slightly to be slid in place edgewise from the front of the press. This upward arching provides temporary rigidity for preventing the blank from sagging down against the face of the male die during loading.

In general, the structure hereinbefore described is conventional except possibly the mounting of the stretch heads 12 in a fixed non-rocking position on the outer ends of their link arms 20. However, if desired, such a rocking position could be provided.

The forming face of the male die 5 is curvilinear and convex, both in longitudinal and in transverse section. It is apparent that with a die of this character, the midportion of the wrapped sheet must extend upwardly from the left-hand end of the die over a crest near the right-hand end and then downwardly.

On the other hand, the margins of the wrapped sheet extend more nearly in a straight line from one end of the die to the other end. Since the jaws of the heads are lineal so that the sheet can readily be loaded edgewise, the amount of metal between the heads throughout their length fore and aft of the press is the same at all increments of width of the sheet. Since this is inherent in the lineally gripping jaws, necessarily, in the absence of additional stretch means, upon stretching the sheet by the heads and wrapping it on the die, the midportion of the sheet will have to be elongated to a much greater degree than the lateral margins, due to the greater length of die face at different increments of width of the die face.

In order to impose, at least at the margins of the sheet, and preferably progressively decrescently from the margins to the midportion, elongation of the sheet in a tensioning direction in addition to that imposed by the heads alone, so as to tend to approach, or reach equalization of the stretching and elongation of the sheet throughout its width, supplemental stretching means of the present invention are provided. Each supplemental stretching means is movable with its head in the direction of movement of the head for tensioning and is movable relative to its head in the wrapping direction.

In the form illustrated, the additional stretch means comprise a rigid bridge 30 which is mounted on the head 12 for movement therewith and for movement relative thereto. The bridge 30 has arms 31 at its front and rear ends, respectively, which are pivotally connected by pivots 32 to the head 12. The bridge 30 can swing upwardly out of alignment with the jaws 13 for loading and then downwardly toward and past the throat of the jaws about the axis of the pivot 32. The bridge 30 has an underface 33 having areas which are shaped to engage the sheet closely adjacent the jaws as the bridge 30 swings downwardly and to move, and move the engaged portion of the sheet, relative to the head downwardly. Thus the face 33 of the bridge 30 engages the sheet and pushes it downwardly relative to the head and thereby increases the tension and elongation of the sheet over what it would be were the bridge 30 omitted.

The bridge 30 is shaped so that surface areas 33a nears its ends, and consequently at the lateral margins of the sheet, in the direction of downward movement of the bridge, lead relative to other areas of the face 33, such as the area 33b at the midportion. Consequently, the bridge

first engages the lateral margins of the sheet and pushes these margins downwardly at a location closely adjacent the jaws, whereas the area 33b may not be engaged, or only lightly engaged with the sheet. The bridge continues downwardly relative to the jaws so that it first engages at the lateral margins of the sheet and then engages the sheet progressively inwardly from the lateral margins toward the midportion, though the movement of the midportion of the sheet relative to the jaws by the bridge may be negligible. Preferably the contour of the face 33 is essentially the same as the contour of the end portion of the female die, or of the convex cross section of the face of the male dies adjacent the end of the die so that, in effect, the transverse contour imparted to the sheet by the bridge approaches more nearly the transverse section of the die—a contour such as might be obtained by curvilinear jaws. However, there is an additional advantage over curvilinear jaws in that the sheet has been stretched to more nearly the same degree throughout its width.

The bridge 30 has an upper face 34 so shaped, as best illustrated in FIG. 9, that the face of the bridge can approach very closely to the end of the male die when the female die is in the fully closed position. The bridge 30 is swung about the axes of the pivots 32 relative to the jaws 13 by reversible hydraulic piston and cylinder assemblies 35, one at each end of the bridge. Each assembly includes a cylinder 36 pivotally connected to the link arm 20 and a piston 37 having a rod 38 pivotally connected to the adjacent arm 31 of the bridge 30. In order to operate the apparatus in the desired sequence, the hydraulic circuitry illustrated in FIG. 11 is employed. As therein illustrated, hydraulic fluid under pressure is supplied by a pump P driven by a motor M. The jaw opening and closing reversible piston and cylinder assemblies 15 are supplied from the pump P through a solenoid operated stop and reversing valve 40.

The reversible assemblies 35 for the bridge 30 are connected to the pump through a solenoid operated stop and reversing valve 41.

The reversible assemblies 18 for rocking the link arm 20 are connected to the pump P through a solenoid operated stop and reversing valve 42.

It is to be noted that each of the assemblies 18 and 35 of the right hand unit 11 is controllable independently of its counterpart in the left hand unit 11.

The ram piston and cylinder assemblies 7 are connected to the pump through a solenoid operated stop and reversing valve 43.

If automatic control of the operating cycle is desired, such can be obtained by conventional limit switches connected to the solenoids of the valves.

The cycling employed depends to some degree on the shape of the part to be formed. For example, the part illustrated is an automobile engine compartment hood which has less convexity at the left end portion than at the right end portion and which has a relatively abrupt bend at the right end portion which is the forward portion of the hood. The drawing dies 5 and 6 are correspondingly shaped.

In such a case, the following procedure, for example, is effective:

The left hand assemblage 18 is first operated so as to render the sheet taut and cause it to engage the crest of the die near the right end of the die and then approach the relatively flat portion of the die to the left of the crest. Only about a 10% elongation is obtained during the initial part of this operation, and the sheet may be below or only slightly exceeding the elastic limit. The right hand assemblage 35 is then operated as the left hand head continues lowering, so that the bridge 30 at the right moves from starting to final position relative to its associated head and jaws. This action of the right hand bridge 30 folds the lateral margins of the sheet more nearly to the cross section of the die. At the same time it tensions the stock endwise at the lateral margins and to a progressively lesser degree from the margins to the

lateral midportion. The tension and stretch is substantially equalized throughout the width of the sheet, whether near or above the elastic limit. The right hand assemblage 18 then starts to pull down the arm 20 and thus the right hand head 12 in cooperation with the left hand head 12 stretch the sheet into the yield range and wrap it onto the male die which is so stretched.

The lowering of the bridge 30 relative to the right hand head causes the sheet to stretch throughout its entire width so that gathering of loose unstressed material at the margins is eliminated.

The degree of approach to equalization of permanent elongation across the width of the sheet depends upon the type of metal in the sheet. For ordinary cold rolled sheet, which can be stretched 20%, the stretch may be as much as 6% less at the edges than at the midportion. With metals in which the yield point and ultimate strength are relatively close together, the percent of variation becomes less.

The optimum in all cases is equalized permanent stretch throughout the width of the sheet. In any event, it should not be permitted that part of the width of the sheet be tensioned above the elastic limit while some other part of the width is below the elastic limit or untensioned. The sheet must not be permitted to gather and thicken above its original thickness at any portion due to variation in tension, but should be stretched across its entire width concurrently at all times.

Since, contrary to earlier practice, the margins are initially being stretched and continue so to be so that they, though free from laterally applied holding or tensioning force, do not become slack, the midportion can be stretched over the end of the die while well within its permissible and safe stretching range. The midportion, therefore, does not have to be overstretched in order to obtain enough movement at the margins to pull out the gather and stretch the margins to the proper degree.

With some dies, the bridge 30 of one or the other of the heads may be left inoperative. With other dies, the bridge 30 of one head may have sheet engaging surfaces different from those of the bridge 30 of the other head, due to different cross sections of the die at its different ends. Likewise, the bridges and heads may be operated in some instances concurrently and in other instances at different times, depending upon the timing of the engagement of the die and sheet adjacent to the particular bridge.

During the stretch wrapping, the female die is moved downwardly by the ram. The stretch wrapping is substantially completed and the sheet stretched throughout its width before the sheet is engaged by the female die, so that all the female die needs to do is to impart the final and limited draw for forming character lines and conforming the margins of the sheet to the male die. This latter requires little movement of the margins by the female die because of the prior tensioning and prepositioning of the margins by the bridge 30.

Since no part of the sheet need be stretched to an excessive degree for assuring ample stretching at the margins, the sheet retains ample stretchability and drawability so that it can be stretch drawn while remaining well within the permissive range, and finally drawn to final shape of the dies without danger of over or understretching or of stretching one part of the width appreciably more than another part.

Again, it is to be noted that when the sheet is being formed between the dies, normally the gripped margins of the sheet would pull upwardly against the movable die jaw, this tending to open the jaws and reducing the gripping effect. Due to the equalizer, however, the sheet is pulled downwardly against the lower of the die jaws.

The exact timing of the movement of the equalizer and the die head depends to some extent upon the shape of the dies and the particular metal being drawn. For ordinary steel, the equalizer bridge 30 completes about three-fourths of its movement after the sheet has been drawn against the crest of the male die and before an

appreciable part has been laid onto the male die at the end adjacent the head. Thus, the bridge may complete about three-fourths of its movement when the associated head has reached the point only slightly beyond that necessary to pull the sheet tightly against the crest of the die. The bridge completes its movement as the head moves from past the initial contact position of the sheet toward the final position of the head. Further, it has been found that for many parts the equalization of tension across the width of the sheet makes it unnecessary to employ a female die, especially if sharp character lines are not required, and even when such are required a very rudimentary female die may be used capable of engaging the sheet only adjacent the margins and at the specific areas of the character lines.

Having thus described my invention, I claim:

1. A stretch head for a stretch draw unit; substantially lineal companion gripping jaws carried by the head and operable to receive therebetween and to grip, a substantially planar margin of a sheet of metal;
first power means connected to the head and operable for moving the head endwise of the sheet in a first direction for stretching the sheet endwise and in a second direction transversely of the first direction for wrapping the sheet facewise about a concavo-convex male die forming face;
the improvement comprising:
supplemental stretch means;
means supporting the supplemental stretch means for movement relative to the head and jaws predominantly in said second direction;
supplemental power means for moving the supplemental stretch means relative to the head and jaws in said second direction to a predetermined position; and
said supplemental stretch means having sheet engaging surface areas near the jaws which, at least near the opposite ends of the jaws, move in said second direction past the gripping surfaces of the jaws as the supplemental stretch means move to said predetermined position, for thereby imparting elongation to the sheet at its lateral margins in addition to the elongation of the sheet imposed by the stretch head.
2. The structure according to claim 1 wherein are provided:
means for controlling the first power means so as to cause the head to move to an initial position for causing initial tensioning of the sheet below its elastic limit and initial engagement of the sheet with the die; and
means for controlling the second power means for causing the supplemental stretch means to move to its predetermined position prior to movement of the head in said second direction beyond said initial position.
3. The structure according to claim 1 wherein the supplemental stretch means are connected to the head for movement therewith in the said first direction, and for movement relative thereto in said second direction.
4. The structure according to claim 3 wherein said supplemental stretch means are pivotally mounted on the head for rocking about an axis in fixed position relative to the head and extending endwise of the lineal jaws and are swingable downwardly about the pivotal axis for movement in said second direction relative to the head.
5. The structure according to claim 1 wherein the surfaces of the supplemental stretch means are arranged so that the additional elongation of the sheet in the tensioning dimension caused by said surfaces is decrescent from the lateral margins of the sheet at least partway toward the midportion.
6. The structure according to claim 5 wherein the

surfaces of the supplemental stretch means are arranged so that the resultant elongation of the sheet imparted by the combination of the head and supplemental stretch means is approximately equalized throughout the width of the sheet.

7. The structure according to claim 1 wherein the surface areas of the supplemental stretch forming means approximate in contour the transverse cross section of the adjacent end of the male die forming face aligned therewith, respectively, in the tensioning dimension.

8. The structure according to claim 1 wherein the surface areas of the supplemental stretch forming means comprise a continuous surface approximating the transverse contour of the male die forming face near the adjacent end of the male die.

9. The structure according to claim 8 wherein a companion female die is provided,

power means are provided for driving the female and male dies into drawing relation;

the supplemental stretch forming means includes a bridge member extending endwise of the jaws and having a face with contour approximating the contour, transversely of the dies, of the female die, and having a surface exposed toward the female die in the closing direction of the dies, shaped to substantially fit a complementary surface on the female die as the dies move to final drawing position.

10. The structure according to claim 1 further comprising a set of companion male and female power driven drawing dies; an additional stretch head and an additional first power means therefor; an additional supplemental stretch means and an additional supplemental power means therefor; the first mentioned stretch head and its associated first power means, and the first mentioned supplemental stretch means and its associated supplemental power means, being arranged at one end of the dies, and the additional stretch head and its additional first power means, and the additional supplemental stretch means and its additional supplemental power means, being arranged at opposite end of the dies; means for operating the first mentioned first power means and the additional first power means independently of each other; and means for operating the first mentioned supplemental power means and the additional supplemental power means independently of each other.

11. A stretch head and drawing die combination comprising,

a male die having a forming face which is convex in its endwise dimension and in its transverse dimension;

first and second pivot means;

means connecting the pivot means to the die with their respective axes parallel to each other and extending in the direction of one of said dimensions, and in fixed relation to each other and to the die,

stretch heads at those limits of the forming face which are opposite from each other in the direction of the other of said dimensions;

rigid link means of fixed length connected to the pivot means, respectively, each for swinging about the axis of its associated pivot means;

stretch heads secured on the link means, respectively, each head in spaced relation to the axis of the pivot means of its associated link means;

power means for swinging the heads; each about the axis of its associated link means;

a matching female die;

means for guiding the female die into drawing relation to the male die;

characterized in that each head is connected in fixed non-rotative position on its associated link means.

12. A method of forming a metal sheet to a predetermined shape by stretching the sheet unidimensionally into a range above its elastic limit and simultaneously

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wrapping it over a male die which is convex at least transversely of the stretching dimension, wherein the sheet is gripped at opposite ends by lineal jaws of stretch heads which are moved relative to each other and to the die to effect such stretching and wrapping of the sheet, characterized by additionally stretching the sheet by imposing on the sheet, at least at its lateral margins, a movement and elongation of the metal of the sheet in said stretching dimension in addition to the elongation imposed by movement of the lineal jaws of the stretch heads themselves and the die face.

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RONALD D. GREFE, *Primary Examiner.*

U.S. Cl. X.R.

72—297, 302, 305, 392, 395; 73—497; 310—15, 16

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,452,573

July 1, 1969

Robert A. Mackenzie

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 52, "a" should read -- at --. Column 6, line 7, "which" should read -- while the sheet --; line 73, "ordinarily" should read -- ordinary --.

Signed and sealed this 24th day of November 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents