March 9, 1954

A. S. BIORDI ET AL
APPARATUS FOR FORMING SHEET METAL
AND SHEET METAL FORMED THEREBY

2,671,492

Filed Jan. 20, 1951

9 Sheets-Sheet 1

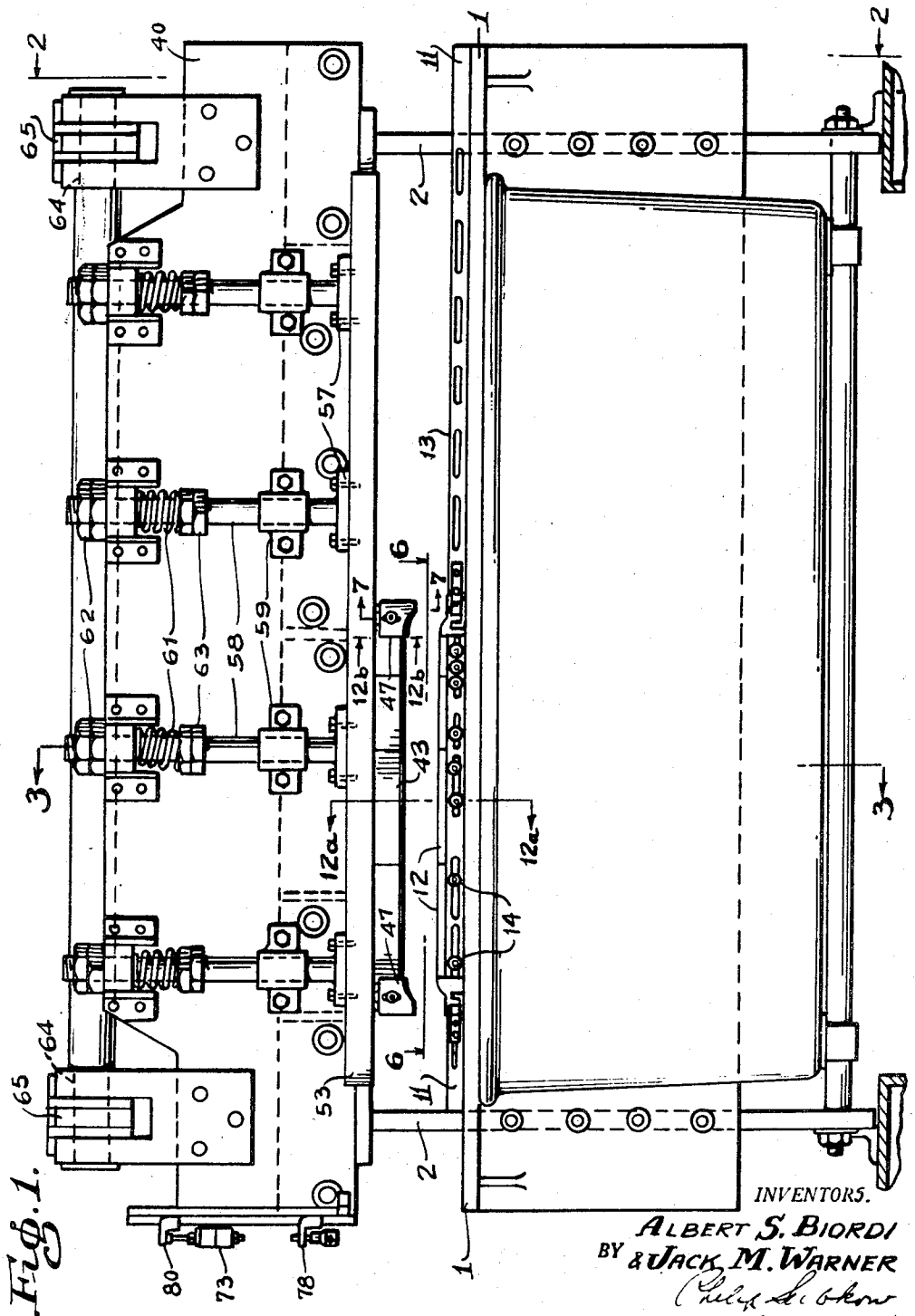

Fig. 1.

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Fig. 4.

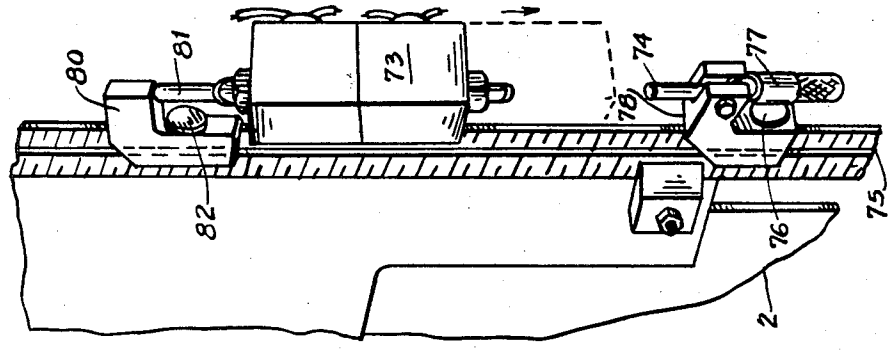


Fig. 3.

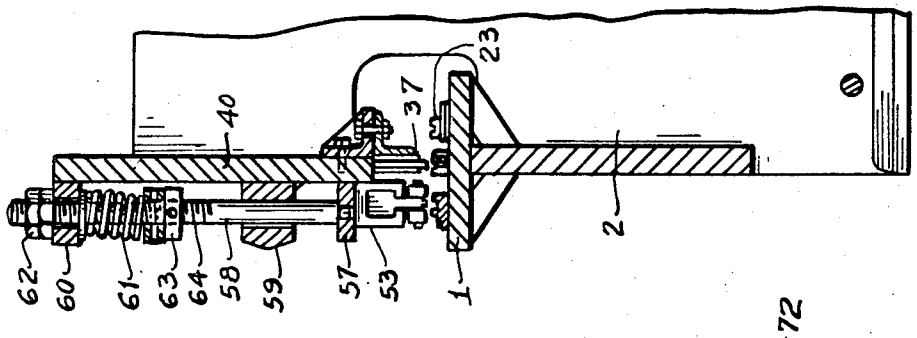
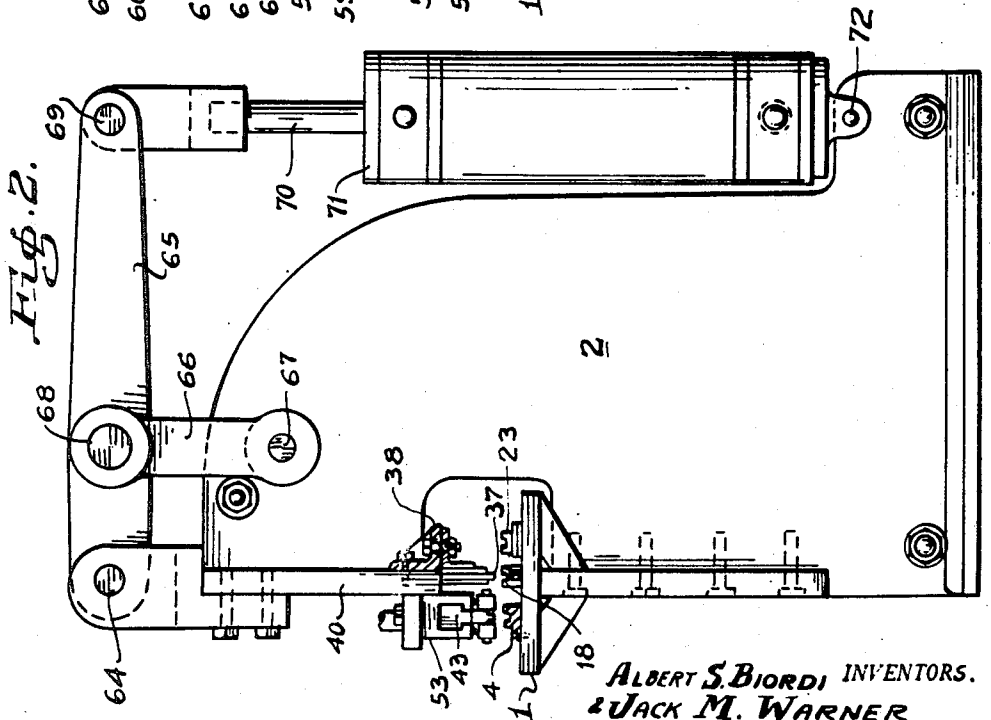


Fig. 2.



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2,671,492

Filed Jan. 20, 1951

9 Sheets-Sheet 3

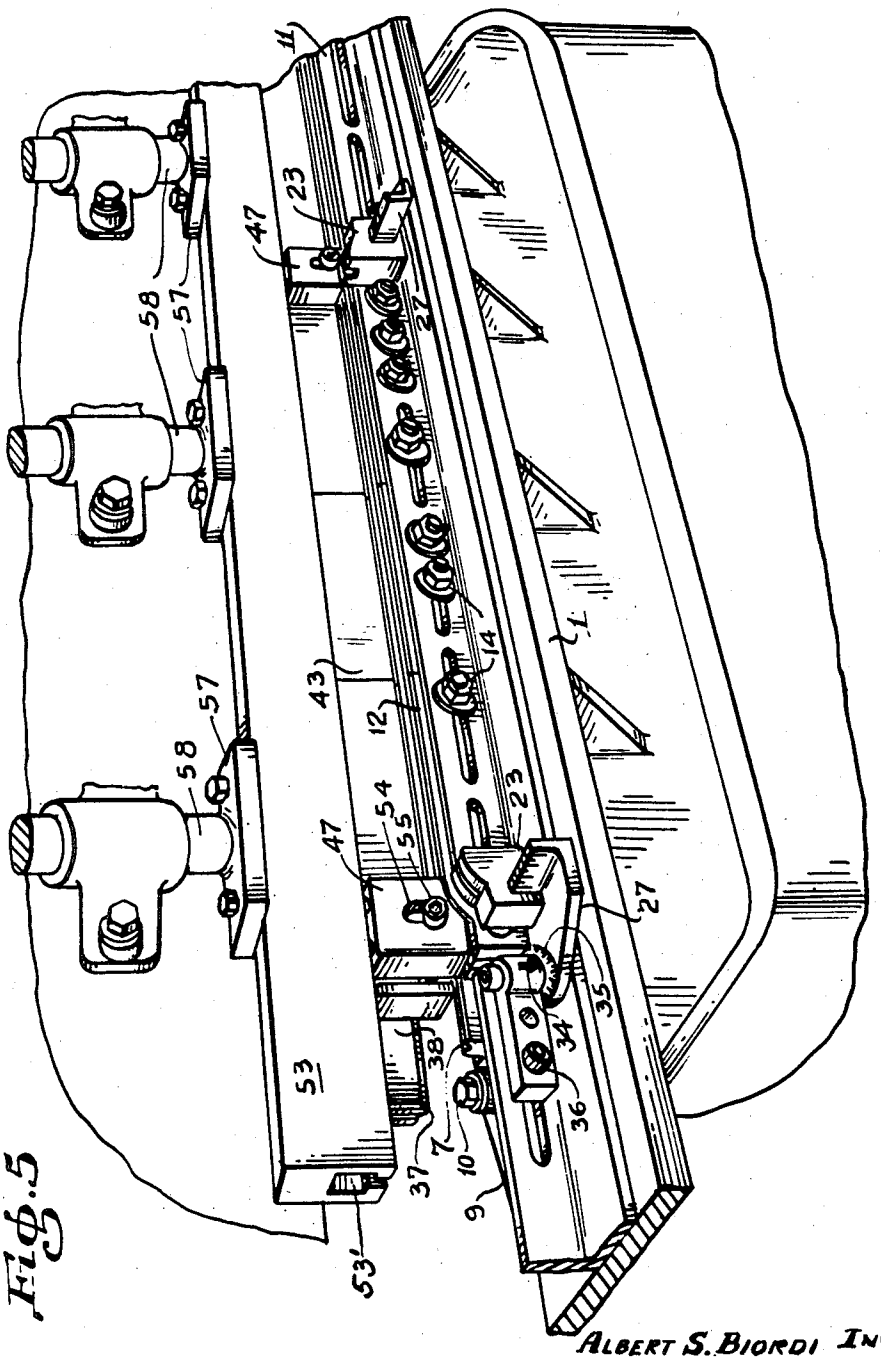

Fig. 5

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APPARATUS FOR FORMING SHEET METAL AND SHEET METAL FORMED THEREBY

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9 Sheets-Sheet 4

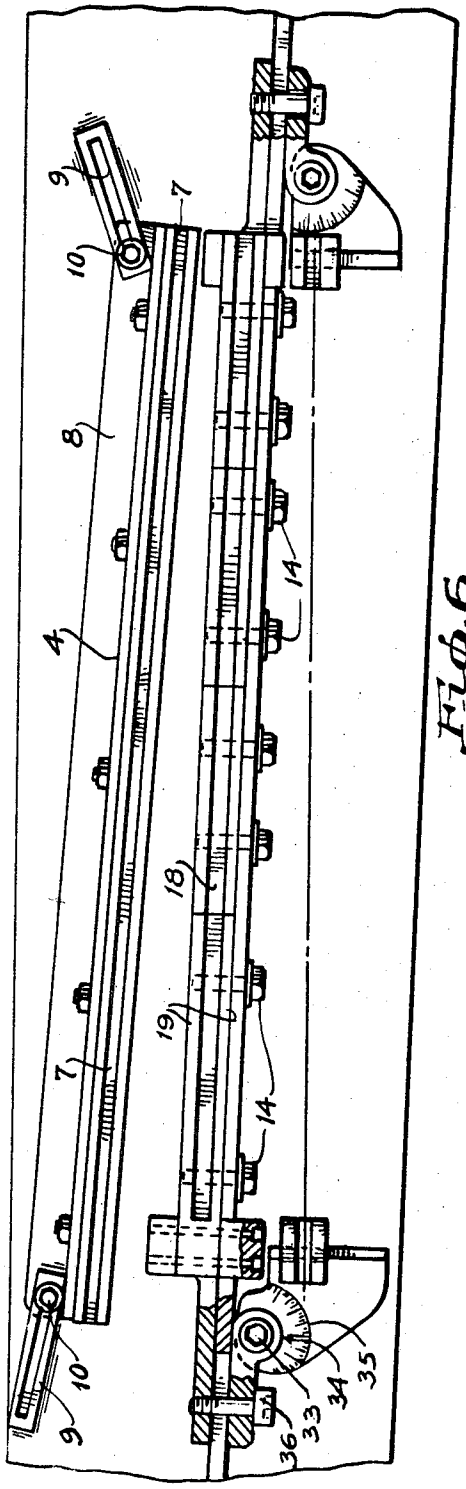

Fig. 6.

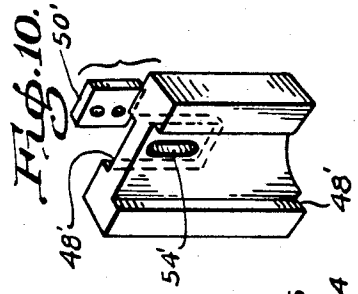

Fig. 10.

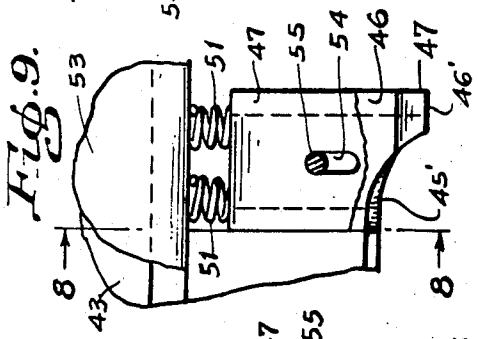

Fig. 9.

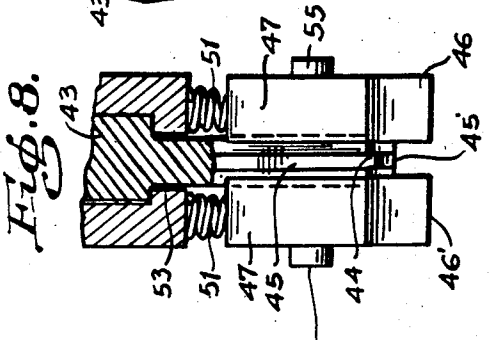

Fig. 8.

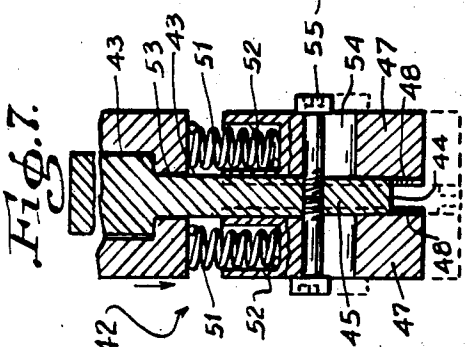

Fig. 7.

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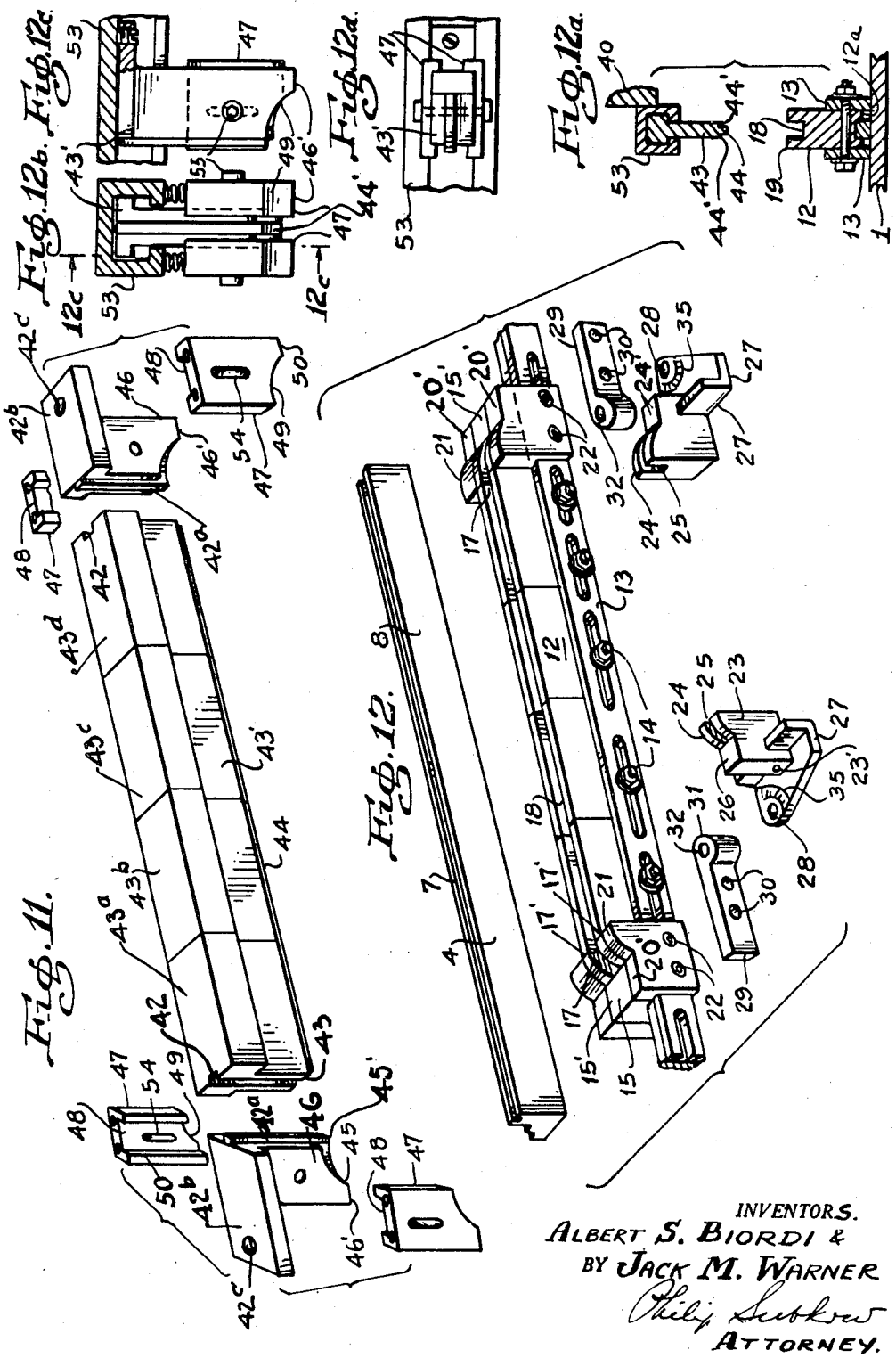
9 Sheets-Sheet 5



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APPARATUS FOR FORMING SHEET METAL AND SHEET METAL FORMED THEREBY

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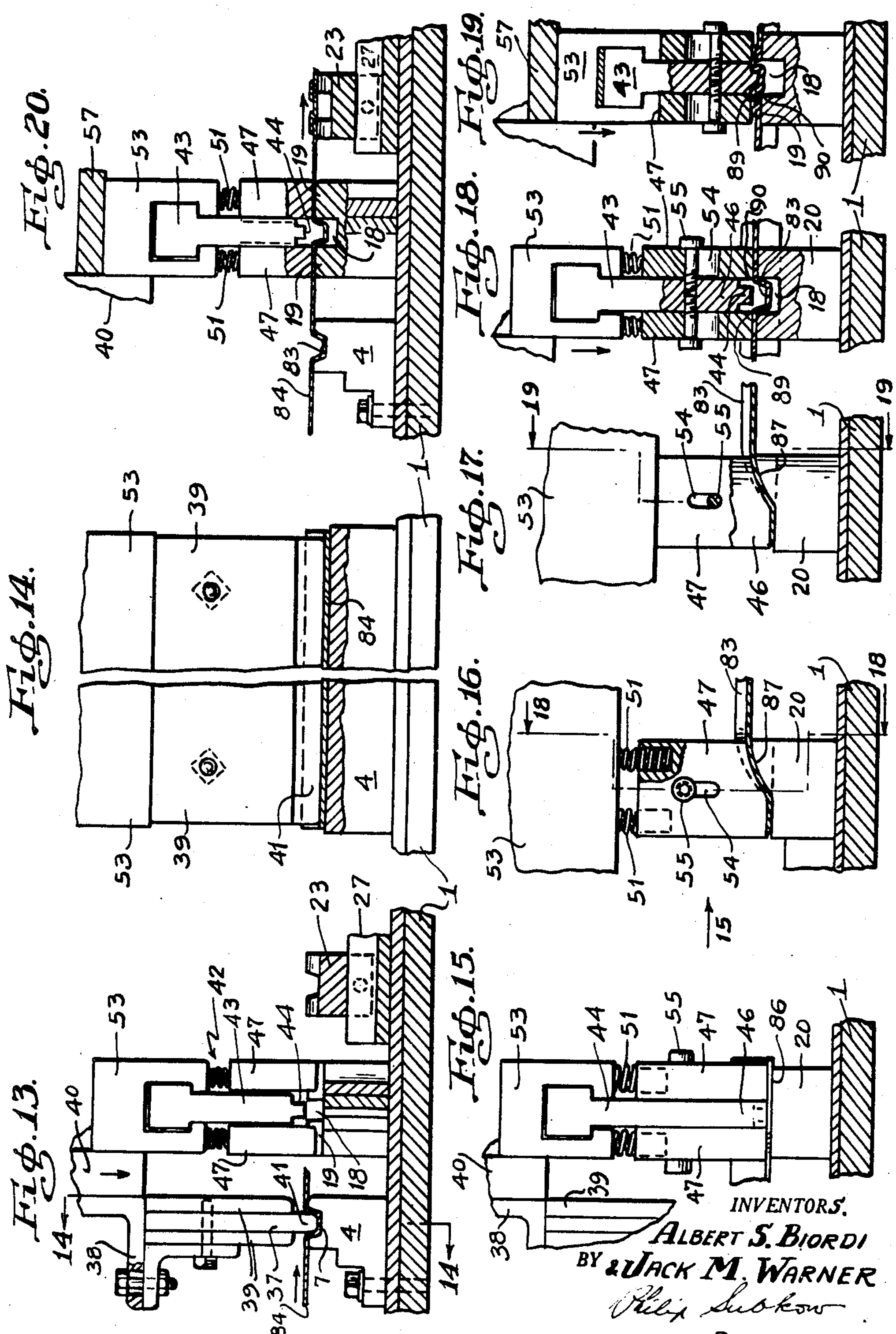
9 Sheets-Sheet 6



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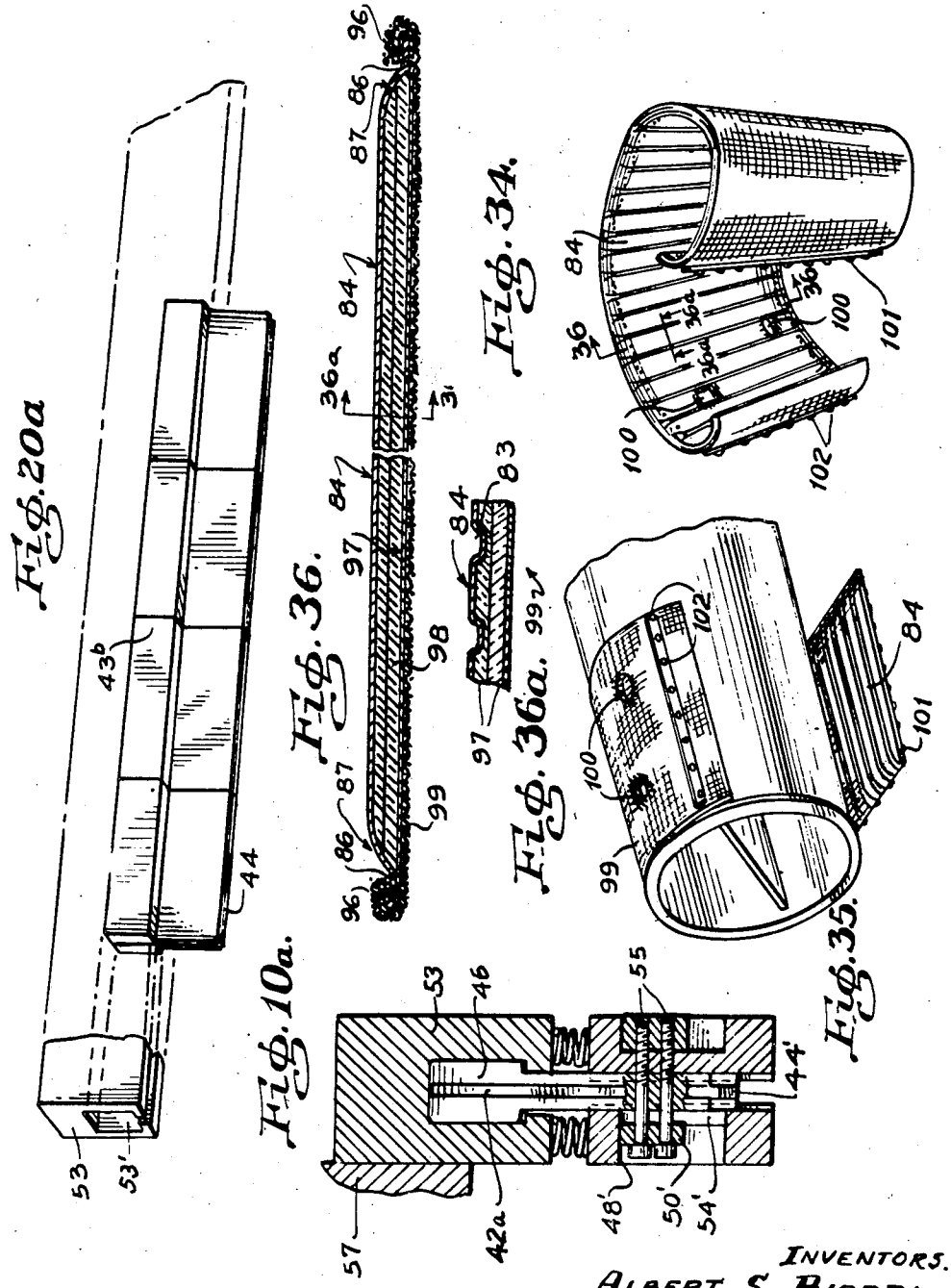
9 Sheets-Sheet 7



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2,671,492

Filed Jan. 20, 1951

9 Sheets-Sheet 8

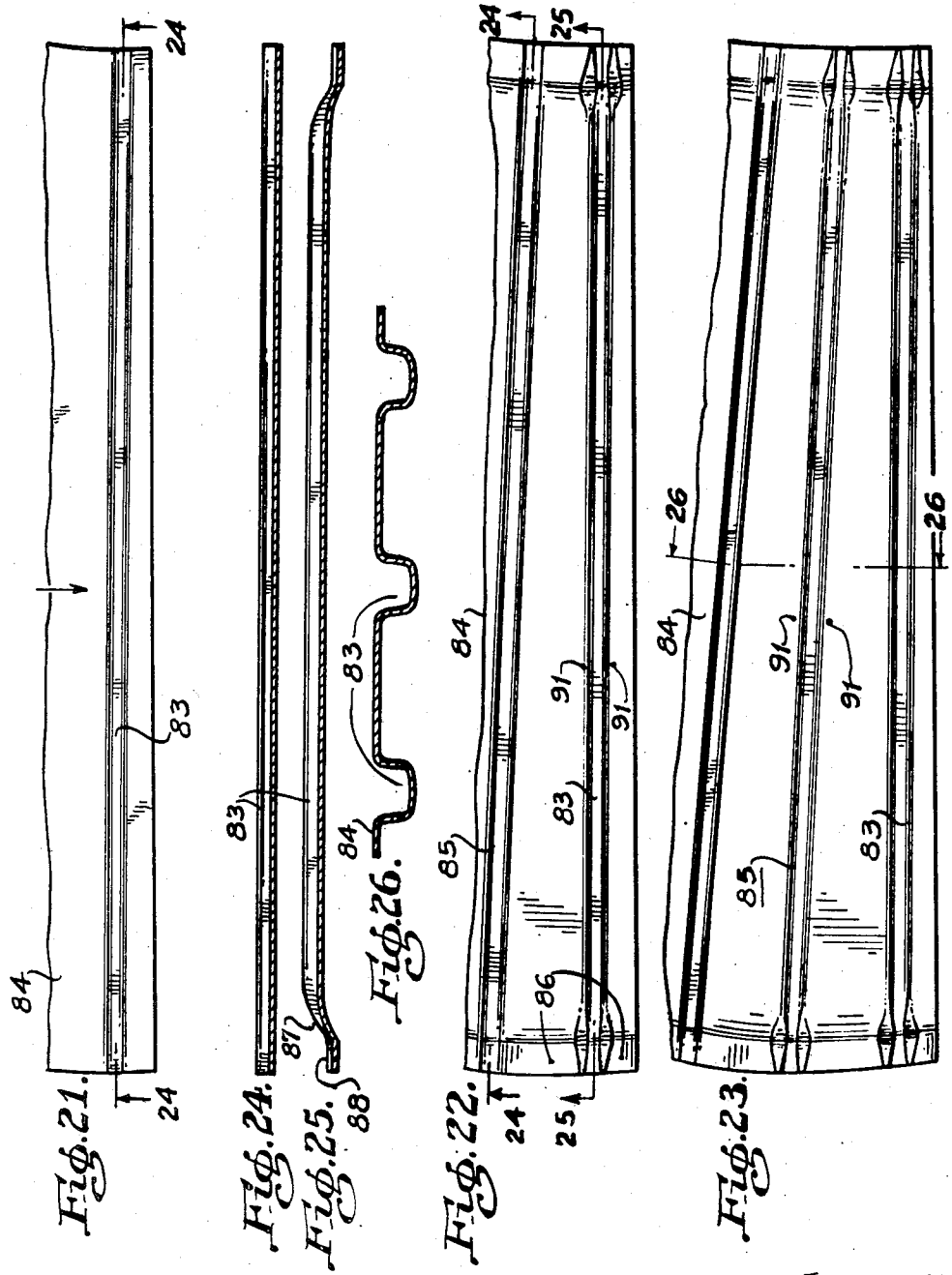

Fig. 21.

Fig. 24.

Fig. 25.

Fig. 26.

Fig. 22.

Fig. 23.

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March 9, 1954

A. S. BIORDI ET AL

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APPARATUS FOR FORMING SHEET METAL AND SHEET METAL FORMED THEREBY

Filed Jan. 20, 1951

9 Sheets-Sheet 9

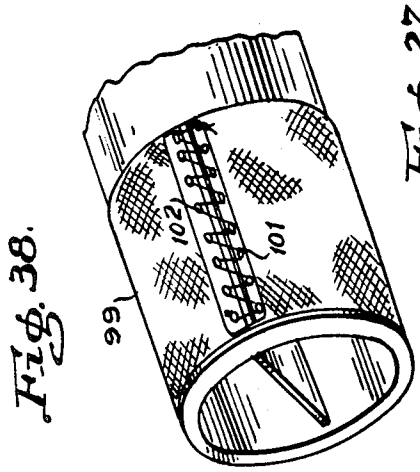

Fig. 38.

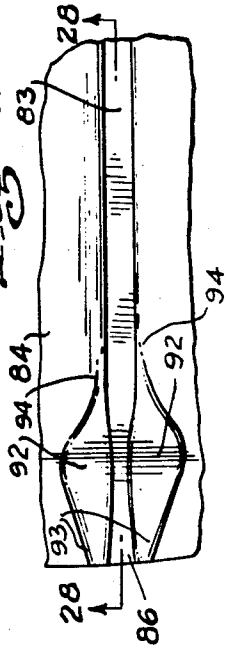

Fig. 27.

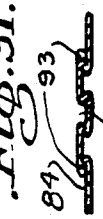

Fig. 31.

Fig. 30.

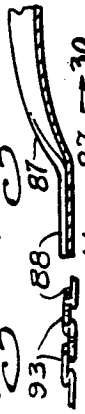

Fig. 32.

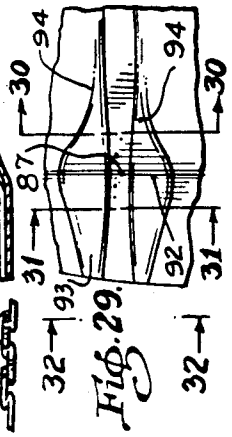

Fig. 29.

Fig. 28.

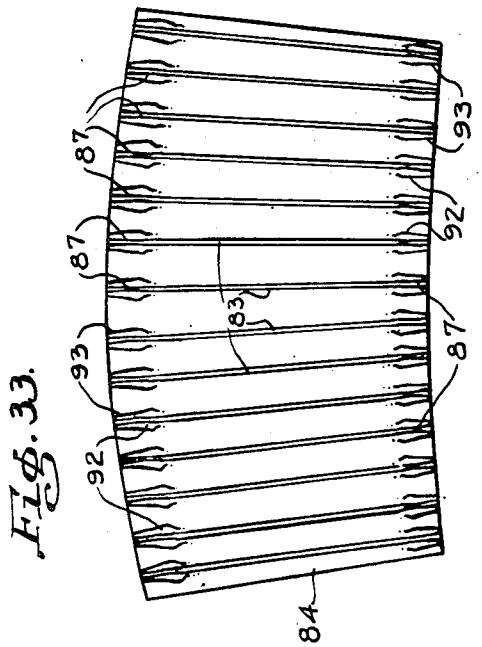

Fig. 33.

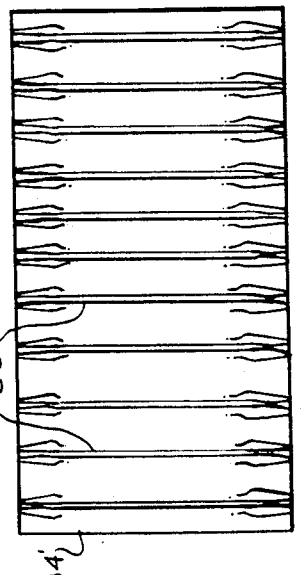

Fig. 37.

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Patented Mar. 9, 1954

2,671,492

UNITED STATES PATENT OFFICE

2,671,492

APPARATUS FOR FORMING SHEET METAL AND SHEET METAL FORMED THEREBY

Albert S. Biordi, Reseda, and Jack M. Warner, Torrance, Calif., assignors to The H. I. Thompson Company, Los Angeles, Calif., a corporation of California

Application January 20, 1951, Serial No. 207,044

16 Claims. (Cl. 153—76)

1

This invention relates to an insulation and acoustical blanket and to the foil employed in the manufacturing of the envelope for such insulation or acoustical blanket, and also to machinery for making such foil for such use.

Blankets now primarily employed for high temperature insulation for surfaces of jet and gas turbine engines are constructed of layers of batting of silica or glass fibers encased in a metallic foil envelope. The envelope formed of thin sheets of metal foil is used as a reflective surface to act as a radiation shield to cut down the loss of heat from the heated surfaces which are insulated by the blankets.

Since there is danger of fuel leaks from such jet engines, foils of sheet stainless steel, formerly sheet silica foil, are employed to form envelopes with sealed edges to seal the porous batting and prevent the accumulation of fuel in the batting which otherwise would create a severe fire hazard. Such envelopes also give added strength to the blanket, particularly when glass fiber or silica fiber is employed. This batting has relatively low mechanical strength so that the fibers tend to break and powder, thus reducing its insulating quality.

Such blankets are frequently formed to fit over curved surfaces, such as cylindrical or conical sections of jet engines and gas turbines, and the envelopes are thus of a form which approximates the geometric development of the surface to be covered.

In forming the foil envelopes for the blanket of this invention, we groove or corrugate the foil of the envelope which is to be placed closest to the surface to be insulated by the blanket, called the hot side. The grooves or corrugations are placed parallel to the generating element of the surface. Thus, for cylindrical surfaces, the grooves are parallel to each other and for conical surfaces they form an acute angle with each other related to the angle of the cone which is to be covered.

It is a feature of our invention that the edges of the corrugated blanket are so formed that the blanket is of substantially uniform thickness to its edges. This is accomplished by so forming the edge of the sheet that it may be overfolded to form a sealed edge without substantially compressing the fibers of the batting. This is accomplished by pleating the foil adjacent the ends of the groove and bending the adjacent foil along its longitudinal edge into an arcuate form to provide room for the batting when the longitudinal edges of the foil are overfolded.

2

By so forming the envelope we may overfold the longitudinal edge ends of the upper and lower foils of the envelope without, as is the case with prior art blankets, compressing the edges of the batting.

We have also devised a machine for corrugating the foil and forming the edges of the foil for the above purpose. We provide a grooving die and means for forming successive grooves at the desired angular relation to each other. We also provide means for pleating the edges of the sheet at the ends of the grooves, and provide means for forming the adjacent portions of the foil to form an arcuate edge to the sheet.

For such purpose we have devised a grooving, pleating, and forming press containing a grooving die in which a foil groove is formed and an indexing slot means to receive the grooved foil and to hold the sheet to form the desired angle between successive grooves so that they shall be along the generating lines of the developed surfaces. We also provide an edge-holding and pleating die to form the arcuate ends referred to above.

These and other objects of our invention will be described in connection with the drawings, in which

Fig. 1 is a vertical front view of the forming press of our invention;

Fig. 2 is a section taken on line 2—2 of Fig. 1;

Fig. 3 is a section taken on line 3—3 of Fig. 1;

Fig. 4 is a detail of the control mechanism for control of the vertical movement of the male die;

Fig. 5 is a perspective of the die assembly;

Fig. 6 is a detail section taken on line 6—6 of Fig. 1, showing the positioning of the female dies and indexing slots;

Fig. 7 is a section taken on line 7—7 of Fig. 1;

Fig. 8 is a section taken on line 8—8 of Fig. 9;

Fig. 9 is a side view of Fig. 7;

Fig. 10 shows a perspective view of a modification of the holding die;

Fig. 10*a* is a view similar to Fig. 7, showing the positioning of the die of Fig. 10;

Fig. 11 is an exploded view of the male pleating die;

Fig. 12 is an exploded view of the female grooving, pleating, and indexing dies;

Fig. 12*a* is a sectional view taken on line 12*a*—12*a* of Fig. 1, showing the dies separated;

Fig. 12*b* is a section taken on line 12*b*—12*b* of Fig. 1;

Fig. 12*c* is a fragmentary side view of Fig. 12*b*;

Fig. 12*d* is a bottom view of Fig. 12*c*;

Fig. 13 is a somewhat schematic showing of

the mechanism in position in the first stage of the grooving operation;

Fig. 14 is a section taken on line 14—14 of Fig. 13;

Fig. 15 is a side view of Fig. 16;

Fig. 16 is a somewhat schematic and fragmentary view showing the second stage of the operation showing the engagement of the edge-holding mechanism;

Fig. 17 is a somewhat schematic showing of the engagement of the pleating die;

Fig. 18 is a section taken on line 18—18 of Fig. 16;

Fig. 19 is a section taken on line 19—19 of Fig. 17;

Fig. 20 is a somewhat schematic view showing the last stage of the cycle of operation of formation of the pleat and curved edge;

Fig. 20a is a modification of the male holding die shown in Fig. 11;

Fig. 21 is a plan view of a fragment of the foil showing the groove in its initial form;

Fig. 22 is the same foil showing the forming of the pleat and arcuate end;

Fig. 23 shows the position of the succeeding grooves;

Fig. 24 is a section taken on line 24—24 of Fig. 21;

Fig. 25 is a section taken on line 25—25 of Fig. 22;

Fig. 26 is a section taken on line 26—26 of Fig. 23;

Fig. 27 shows an enlarged detail of the pleated arcuate end of the grooved foil;

Fig. 28 is a section taken on line 28—28 of Fig. 27;

Fig. 29 is the same view as Fig. 27, but showing the position of the section lines of the succeeding figures;

Fig. 30 is a section taken on line 30—30 of Fig. 29;

Fig. 31 is a section taken on line 31—31 of Fig. 29;

Fig. 32 is an end view of Fig. 29;

Fig. 33 shows the developed corrugated foil for use in a blanket to cover a conical pipe;

Fig. 34 shows the blanket formed from the foil of Fig. 33 and curled for illustrative purposes;

Fig. 35 shows how the blanket may be positioned in a conical tail pipe of a jet plane;

Fig. 36 is a section taken on line 36—36 of Fig. 34;

Fig. 36a is a section taken perpendicularly to the section on line 36a—36a, i. e., on 36a of Fig. 36;

Fig. 37 shows a formed sheet such as may be employed in forming a blanket for a cylindrical pipe; and

Fig. 38 illustrates a blanket formed from such sheet and positioned on such a cylindrical pipe.

The press is formed of a bed 1, suitably supported on ends 2. The bed carries the female grooving die 4, shown in Figs. 2, 5, and 6. This is formed of an elongated bar carrying a longitudinal groove 7 and a flange 8. Suitably slotted clamping bars placed on the flange and held to the base clamp the die to the bed. The angularity of the die and its position on the bed may thus be adjusted by moving the die with respect to the clamping bars on the bed.

Extending longitudinally of the bed (see Fig. 1) is a slotted horizontal vertical bar or flange 11 which is affixed to the bed by suitable bolts. A plurality of die blocks carry a groove 18 between the top flat surfaces of the die block 12. These

blocks are assembled side by side between clamping plates 13 with notch 12a on the flange 11 and held in place on the flange 11 by the bolts 14 which pass through suitably provided slots in the die blocks, clamping plates and the flange. An elongated female die is thus obtained. Mounted on the flange at each end of the assembled die blocks 12 is a pleating die 15 (see Figs. 2, 3, 6, and 12) having a curved groove 17, having a vertical section which is convex upwardly, which registers at one end with the groove 18 of the die block 12. Flanking the groove is a curved surface 17' of like curvature but disposed at a higher elevation than the base of the groove 17. The flat top face 15', formed as a flat extension of the pleating die 15, is at a lower level than the top face 19 of the die blocks 12 to meet the downwardly curved faces 16 of the block 15, between which faces the curved groove 17 is positioned. The position of the die blocks 12 and the pleating dies may be altered by moving them on the flange 11 to the desired location.

The holding dies 20 and 21 are mounted on each side of the female pleating die 15. They are coplanar and conform to the surfaces 15' and 17', respectively. The dies are assembled and held in place on the flange 1 by the pins 22 which pass through the dies and the flange 11. It will be observed that there are two pleating dies of the same construction, one at each end of the die block assembly, and that each of these dies 15 is flanked by holding dies.

The indexing dies 23 are grooved and formed in identical fashion to the pleating dies 15 with a curved face 24, like 16, curved groove 25, like 17, and flat face 26, like 15'. This die is mounted on a bracket 27. It is grooved to slidably fit over the flange 27' and is held by the set screw 23'. The bracket 27 carries a pivot hole 28. A hub plate 29 carrying bolt holes 30, a hub 31, and a bore 32 may be clamped to the flange 11 by means of suitable bolts, and a pin 33 passes through the bores 32 and 28. An index 34 and a protractor 35 may be provided to measure angular adjustment of the bracket 27 and the index die 23 about the axis of the pin 33. The position of the die longitudinally of the flange may be adjusted by positioning the bolts 36, and the angular relationship of the slots 25 with respect to the face of the flange 11 may be adjusted by rotation of the bracket 27 about the pin 33. The position of the index block along the flange 27' may also be adjusted by sliding the block along the flange. It will be observed that two such index block assemblies are provided, one adjacent each female pleating die 15.

The male grooving die 37 (Figs. 2, 3, 12a–b, and 13) is mounted on a bracket 38 between clamping blocks 39 on the vertical slide 40. The edge 41 of grooving die enters the groove of the female grooving die 7. The lateral position of the male grooving die in respect to the bed of the press is adjusted by positioning the male grooving die on the bracket 38 which extends along the length of the slide 40 and is provided with suitable transverse slots positioned at intervals. The slots being elongated, the angular position of the die 37 with respect to the face of the slide 40 may also be adjusted. The male grooving die 37 may thus be fixed parallel to and mating with the female grooving die 7.

The male holding die (see Figs. 2, 3, and 7 to 11, 12, 12b, 13, and 20a) is formed of a plurality of abutting blocks, shown as four, to-wit, 43a to 43c, inclusive, each provided with a T head 43

and a square-faced knife edge 44 and adjacent faces 44' between which the knife is positioned. The square-faced knife edge 44 of each block is such as to mate and register with the grooves 18 of the die blocks 12 and with adjacent faces 44' registering with faces 19 of the die block 12.

The end die blocks 43a and 43d have vertical slots 42 formed in their outer faces. The blocks are slid into the T slots 53' formed in the T slide 53. The pleating die 46 is formed with a T head extension bracket 42a carrying a suitable bore so as to fit into the T slot 53'. The vertical rib 42a is formed in the outer face of the pleating die 46 to enter and engage with the slots 42. By passing a stud through the bore 42c and suitably disposed bore in the T slot, the dies are fixed in the slot and hold the die blocks in a fixed position in the slot.

The pleating die 46 positioned at each end of the die 42 has a knife 44 similar to 45', the vertical section of which is convex upwardly, and forms a curved extension of the knife edge 44 to form the curved pleating knife 44 which is the pleating die 45 (see Figs. 8 and 9) and flat surfaces 46' positioned at the end of the knife so that it conforms with the surfaces 15 and 16 and the groove 17 of the female pleating die. Thus, when the pleating and holding dies are placed in the die blocks 12, the knife edge 44 enters the groove 18 and the knife edge 45' enters and conforms with the groove 17 which has a like curvature to the knife edge 45, and the flat surfaces 44' (see Figs. 18 and 19) rest on the surfaces 19 of the die block 12 and the surface 46' on the surfaces 15 and 16. The knives referred to above are not formed to have a cutting edge, but have a cross section which conforms with that of the mating female die.

The sides of the holding blocks 47 (see Figs. 7 8, 9, 11, 12) are grooved at 48 so that they slide over the slides 46 formed on both sides of the pleating dies. The holding blocks 47, at their lower ends, are curved at 49 to conform with the curved surfaces 21 of the holding dies 20. These holding blocks have a flat surface 50 which conforms with the flat surface 21 of the holding dies 20. Compression springs 51 are mounted in the bores 52 of the sliding holding blocks 47 and underneath the T slot 53 in which the T head 43 is mounted. The blocks 47 are provided with a slot 54 so that they can slide over a pin 55 which passes through the bore 56 in the slide 46.

Figs. 10 and 10a show a modification of the construction wherein a groove 48' is provided in the face of the holding die on the other side of the groove 48. An elongated slot 54' is provided and two pins 55 are employed to hold the plate 50' in the groove. This construction prevents any tipping of the die about the pin.

The T slide 53 is mounted longitudinally of slide 40 on brackets 57 positioned at the ends of the rods 58 which are carried in bearings 59 positioned on the slide 40. The rods are clamped in brackets 60 positioned on the slide 40 by means of heavy tension springs 61, bolts 62 and adjusting bolts 63 on threads 64 formed in the rods 58.

The slide 40 is reciprocated by the link 65 (see Fig. 2) which is pivoted on the slide at 64 and on the frame by means of the link 66 pivoted on the frame at 67 and on the link 65 at pivot 68. The link 65 is pivoted to the piston rod 70 at 69 and the cylinder 71 is pivoted on the frame at 72. At one end of the structure is a motion limit mechanism (see Figs. 1 and 4). A switch mechanism 73 is mounted at the end of the frame 2. A micrometer trip 74 is mounted on slide 78, which is slidably positioned on the ruler 75 positioned on the slide 40. An upper slide 80 carrying a pin 81 slidably positioned on the ruler 75 by set screw 82 is also provided. The position of the micrometer on the scale is fixed by the set screw 76 and the micrometer 77 makes a fine adjustment of the position of trip 74. The switch 73 is actuated on contact with either 81 or 74.

Having erected and leveled the press so that the bed plate 1 of the press is level, the die blocks 12 and the holding and pleating dies 15 and 46 are assembled in the T slot 53 so that the female and male dies register. The nuts 63 are adjusted so that the T slot is level and uniform compression of the male and female die occurs across the longitudinal length thereof. The clamping blocks 9 are adjusted so that the angle which the center line of the die groove 7 of the grooving die 4 makes with the center line of the slot 18 of the assembled die block 12 is the required angle for the surface elements of the developed surface being grooved. Thus, it may be an acute angle for the form shown in Fig. 33 or parallel for form shown in Fig. 37. The brackets 27 are adjusted on the flange 11 so that one index die is adjacent each female pleating die and the index dies are longitudinally separated on the center line passing through the groove of the indexing die at a distance equal to the longitudinal separation of the female pleating die on the center line passing through the grooves. The brackets 27 are adjusted about their pins 32 and the blocks 23 are positioned on the flange 27', so that the center line of the grooves 25 of each of the index dies 23 at both ends of the die 12 are on one line, which bears the same angular relation to the center line of the grooves 18 which the center line of such grooves bears to the center line of the groove 7 of the die block 4. The distance between the outside parallel faces of the adjacent blocks 47 at each end of the die 43 is equal at least to the interval between the said center lines measured at the corresponding ends of the die 43.

The operation of this press will be described when employed in forming the corrugated elongated foil with cupped longitudinal ends which we have developed for use with insulating blankets. It will be understood that sheet metal of various thicknesses may be employed, depending upon the power of the press to form these sheets.

The cross sectional form of the grooves may be altered and the angular relationship thereof also altered, depending upon the function for which the sheet is designed.

Thus, sheet material, such as stainless steel sheet of about 0.002'' thickness (such sheets are herein referred to as foils 13) formed into an elongated sheet of width, preferably not less than the length of the male grooving die, is fed in a direction of the length of the sheet and transversely to the die. One end is positioned over the die 4 and a switch (not shown) may be manually actuated to start the hydraulic pump to actuate the piston in cylinder 71. The piston ascends, causing the slide 40 to descend, and the male die 37 enters the female grooving die 6 (see Fig. 13). When fully entered the pin 73 which has been previously adjusted for such purpose opens the circuit and cuts off pressure in the cylinder 7. When the circuit is again manually closed the pump is actuated to cause the piston 70 to descend and the slide thus ascends. The

maximum upper limit of the stroke is controlled by the position of the contact 81 which trips the notch 73.

A groove 83 is thus formed which extends across the width of the sheet 84 from edge to edge (see Figs. 21–24). The groove has a U-shaped cross section, as shown in Fig. 26. When the groove 83 is formed the sheet 84 is lifted from the grooving die 4. The sheet 84 is now advanced and the groove 83 is positioned in the die blocks 12, the groove fitting inside the grooves 18. On the next descent of the slide, a second groove 85, similar to 83, is formed in the female die 4. Simultaneously the holding and pleating dies 43 and 47 and the female dies 12 and 15 function in the following manner. When the slide descends the blocks 47 first contact the sheet 84 at 86, i. e., in the area of 84 (see Fig. 22) adjacent to and on both sides of the groove, which is thus clamped between the curved surface 49 of the block 47 and the curved surface 21 of the holding block 29 and between the flat surface 21' of the block 20 and the flat surface 50 of the block 47. Thus, at the corresponding longitudinal edges the sheets are curved downwardly into a portion at 87 (Fig. 25) curved transversely of the longitudinal edge of the sheets, and a flat, i. e., horizontal, flange portion at 88. As the slide 40 continues to descend, the springs 51 compress, holding the edges 86 on both sides of the groove 83 against displacement on the holding surfaces and thus smooth. However, since the portion of the sheet between the blocks 20, i. e., between the inner faces 89 and 90 of the blocks 47 (see Figs. 7, 8, and 18), is not restrained it tends to cup due to the curling of the curved flange formed when the holding dies meet. The transverse section of the cupped flange is thus convexed upwardly. As the slide 40 continues in its descent, the blade 44 and the curved blade 48' enter the groove 83 and force it into the groove 18 and the curved groove 17. The excess metal in the cupped portion is thus locally pleated between the meeting surfaces of 15 and 46. The form of the pleat is a box pleat, as illustrated in Fig. 31. Since there is a greater excess of metal at the curved surface 87 than at the horizontal surfaces of the flange positioned over 15' of the pleating die 15 or over 19 of the longitudinal holding die, the pleat is wider over the curved surface and becomes triangular in shape as it progresses outwardly in both directions away from the curved surface in the form of a generally diamond-shaped pleat. Thus (see Fig. 29) the pleat is wider at 92 and narrows down to disappear at 94 and narrows down to a narrow pleat at 94 where it intersects the edge. The result is a local constriction in the groove at the curved surface 87.

The sheet may now be advanced to form the succeeding grooves at equal predetermined intervals and angular relation throughout the length of said sheet by again setting the grooves formed in the grooving die 4 in the die block 12 which function thus as registering dies to regulate the advance of the sheet and the angular disposition of the succeeding grooves. If the grooves are positioned at an acute angle to each other, the advance of the sheet to position the grooves into the die blocks 12 will cause an angular rotation, i. e., shifting, of the entire longitudinal length of the sheet through an acute angle equal to that between the center lines of the die blocks 12. This is somewhat inconvenient and a slow operation. We have increased the speed of the operation by using the indexing dies 23 which are adjusted as described above by setting the curved grooved foil sheet after forming in the blocks 15 and 20 in the dies 23. The sheet is automatically advanced and rotated through the desired angle described above to place the groove formed in the die 4 in the die blocks 12 and 15. Thus, the die blocks 12 index the position of the first groove formed in the front edge of the sheet and the index blocks 23 position each succeeding groove in 12 and automatically index the sheet to form the groove at the desired spatial and angular relation to the preceding grooves.

It will be observed, because the width between the outer faces of the holding and forming blocks 47 are at least equal to the interval between the center line of the grooves of the female die blocks 12 and 4, that the sheet is continuously formed into a compound flat and curved flange along each longitudinal edge. The grooves will be on the surfaces which are developed, since they bear the necessary relation to each other equivalent to the generating lines of these surfaces. Thus, if the grooves are at an equal angle to each other, the sheet is rotated angularly as the groove is moved from the die groove 18 to the indexing die 23, the angle of rotation being equal to the angle between these die grooves.

The grooves form rigidifying reinforcements extending across the width and along the length of the sheet. The pleated ends cause local stiffening at the edges and at both sides of the cupped curved flanges to hold the shape of the curved flange during fabrication and further handling. A foil sheet such as one described above is flimsy and distorts easily and is easily cracked in handling by cold working. The fact that the curved surfaces between the pleats are smooth and substantially unwrinkled and therefore are not cold-worked between the pleats is a material factor in reducing the number of sheets that show cracks at these localities after fabrication into blankets. This is a matter of utmost importance, since even a minute crack will permit entry of fuel into the interior of the blanket when used as a blanket for the tail pipe of a jet engine. The fuel may gasify and ignite, causing an explosion within the confines of the blanket and a disastrous fire.

The use of the grooved sheet with curved end 87 will be illustrated by reference to its function in the fabrication of blankets with fibrous material such as fiber glass or siliceous fiber batting.

As is illustrated in Figs. 34–38, the blanket is formed by using a flat foil 97 and placing batts 98, which may be siliceous or glass fibers, and a batt 97 of either of the two or any number of such batts with intermediate foil sheets, as the nature of the blanket requires.

The sheet 83 is laid on top of the batt 97 with the bottom of the groove 86 against the batt and with the grooves extending in the direction of the generating line of the developed surface of the form to be covered by the blanket. All of the lateral edges 86 and the ends 96 and the edges of the foil 99 are tack-welded, seam-welded, and over-folded, and welded in similar manner to form a completely enclosed and sealed envelope for the fibrous batting. In so doing, the grooves 86 are pressed into the batting so that the batting puffs up and fills in between the grooves 86. At the lateral edges the curved portion 87 permits the batting to maintain its full thickness to the lateral edge. This is important

because the insulating quality of the blanket is diminished by the compression of the edges of the batting where, except for this cupping, the ends would be so compressed as to cause a crushing of and powdering of the fibers. The blankets between the cupped edges are flat and may be stacked one on top of the other smoothly.

It will be observed that the blanket can now be placed over the surface of which it was a development. By allowing for the depth and the number and spacing of grooves in laying out the sheet, when laid with the grooved foil against the surface to be insulated, the blanket and foil bend without wrinkling or cracking of the foil to contact the surface, the foil bending at the grooves which act as hinged joints extending the full width of the blanket.

We may also provide openings 100 suitably sealed for passage of any structural projecting part and also provide lacing hooks 100' and 101 for mounting on the conical pipe, as in Fig. 35, or the cylindrical pipe, as in 38, or on any other structure of desired shape.

It will be observed that at the ends of the blanket where no extra precautions are taken to form a curved end at the seal, the blanket is over-folded when laced so that an extra thickness of blanket is provided for added insulating effect.

While we have described a particular embodiment of our invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

We claim:

1. A machine for grooving, pleating, and edge-forming foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved edge forming dies, the center line of said grooves of each of said curved grooved female dies being positioned on a line and spaced from the female grooving die, a male grooving die member mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming die, a male pleating die, entering between the holding die member and mating with the curved groove of said female edge forming die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, means to sequentially engage the female and male holding die members to subsequently enter and engage the male pleating die member into the mating female pleating die member.

2. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved female pleating die member, curved holding surfaces positioned in each side of said curved female grooved pleating die, the center line of said grooves of each of said edge forming pleating die being positioned on a line at an acute angle to the center line of said female grooving die member, male grooving die member mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming grooved pleating die, a male pleating die entering between the holding die members and mating with the edge forming grooved pleating die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member into said female grooving die member, and means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female pleating die member.

3. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved pleating die member, curved holding surfaces positioned in each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved female pleating die member, the center line of said grooves of each of said edge forming and pleating dies being positioned on a line and spaced from the female grooving die, male grooving die members mating with said grooving die, a male edge forming die comprising a pair of holding die mating with the holding die surfaces on each side of said female edge forming die, a male pleating die entering between the holding die members and mating with the female edge forming grooved pleating die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, and means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female pleating die member.

4. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said forming dies comprising a curved female grooved pleating die member, curved holding surfaces positioned in each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved female pleating die member, the center line of said grooves of each of said edge forming pleating dies being positioned on a line at an acute angle to the center line of said female grooving die member, a male grooving die member mating with said grooving die and male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming die, a male pleating die entering between the holding die members and mating with the edge forming groove die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die member, and means to sequentially engage the female and male holding die members and subsequently to enter and engage the male pleating die member in the mating female pleating die member.

5. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved pleating die member and curved holding surfaces positioned in each side of said curved female grooved die, the center lines of said grooves of each of said edge forming dies being positioned on a line and spaced from the

female grooving die, male grooving die member mating with said grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female pleating dies, a male pleating die entering between the holding die members and mating with the edge forming groove die, means for resiliently mounting said male holding die members, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female pleating die member.

6. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member, curved holding surfaces positioned on each side of said curved female grooved die, the center line of said grooves of each of said edge forming die being positioned on a line at an acute angle to the center line of said female grooving die member, male grooving die member mating with said grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming die, means for resiliently mounting said male holding die members, a male pleating die entering between the holding die members and mating with the grooved edge forming die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member in said female grooving die member, means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female pleating die member.

7. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved die member, the center line of said grooves of each of said edge forming dies being positioned on a line and spaced from the female grooving die, male grooving die member mating with said grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming die, means for resiliently mounting said male holding die members, a male pleating die entering between the holding die members and mating with the grooved edge forming die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male edge forming die member in the mating grooved female edge forming die member.

8. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved female die member, the center line of said grooves of each of said edge forming die being positioned on a line at an acute angle to the center line of said female grooving die member, a male grooving die member mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, means for resiliently mounting said male holding die members, a male edge forming die entering between the holding die members and mating with the female grooved edge forming die, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die member, and means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male edge forming die member in the mating female edge forming die member.

9. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved dies, the center line of said grooves and each of said edge forming dies being positioned on a line and spaced from the female grooving die, male grooving die members mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming dies and a male pleating die, entering between the holding die members and mating with the grooved edge forming female die, a pair of indexing dies, each of said dies having a grooved die member of curvature similar to the curved grooved female edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the grooved female edge forming dies, the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the female grooving die and the center line of the grooves of the female edge forming die and said indexing dies being longitudinally spaced on said center lines equal to the longitudinal spacing of the grooved female edge forming dies, on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die member, and means to sequentially engage the female and male holding die members to subsequently enter and engage the male pleating die member in the mating grooved female edge forming die members.

10. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies,

each of said edge forming dies comprising a curved female grooved die member, curved holding surfaces positioned on each side of said curved female grooved dies, the center line of said grooves of each of said edge forming dies being positioned on a line at an acute angle to the center line of said female grooving die member, a male grooving die member mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said female edge forming die and a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said dies having a grooved die member of curvature similar to the curved grooved female pleating die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the female grooving die and the center line of the grooves of the female edge forming die, said indexing dies being longitudinally spaced on their said center line equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member into said female grooving die member; and means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating grooved female edge forming die member.

11. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved die member, the center line of said grooves of each of said female edge forming dies being positioned on a line and spaced from the female grooving die, male grooving die members mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved grooved female edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the grooving die and the center line of the grooves of the edge forming dies and said indexing dies being longitudinally spaced on their said center line equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, and means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female edge forming die member.

12. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved grooved female die member, the center line of said grooves of each of said female edge forming dies being positioned on a line at an acute angle to the center line of said female grooving die member, male grooving die members mating with said female grooving die and male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved grooved female edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the female grooving die and the center line of the grooves of the female edge forming die, said indexing dies being longitudinally spaced on their center lines equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die member, and means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member into the mating female edge forming die member.

13. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, the center lines of said grooves of each of said female edge forming dies being positioned on a line and spaced from the female grooving die, a male grooving die member mating with said female grooving die and male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming dies, means for resiliently mounting said male holding die members, a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved grooved female edge forming

die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center line of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the grooving die and the center line of the grooves of the female edge forming die, said indexing dies being longitudinally spaced on their said center lines equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die members into said female grooving die members, and means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating grooved female edge forming die member.

14. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member, curved holding surfaces positioned on each side of said curved female grooved die, the center line of said grooves of each of said female edge forming die being positioned on a line at an acute angle to the center line of said female grooving die member, a male grooving die member mating with said grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, means for resiliently mounting said male holding die members, a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved grooved female edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the grooving die and the center line of the grooves of the female edge forming die and said indexing dies being longitudinally spaced on said center lines equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member into said female grooving die member, and means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating grooved female edge forming die member.

15. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said edge forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved female grooved die member, the center line of said grooves of each of said female edge forming dies being positioned on a line and spaced from the female grooving die, male grooving die members mating with said female grooving die, a male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, means for resiliently mounting said male holding die members, a male pleating die entering between the holding die members and mating with the grooved female edge forming die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved grooved female edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said indexing dies being on a line having an angle equal to the angle between the center line of the grooving die and the center line of the grooves of the female edge forming die, said indexing dies being longitudinally spaced on their said center lines equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member into said female grooving die member, and means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female edge forming die member.

16. A machine for grooving, pleating, and edge forming of foil, which comprises an elongated female grooving die, a pair of edge forming dies, each of said forming dies comprising a curved female grooved die member and curved holding surfaces positioned on each side of said curved female grooved die, a flat surface positioned at the extension of said curved holding surfaces and said curved female grooved die member, the center line of said grooves of each of said female edge forming die being positioned on a line at an acute angle to the center line of said female grooving die member, a male grooving die member mating with said female grooving die, male edge forming die comprising a pair of holding dies mating with the holding die surfaces on each side of said grooved female edge forming die, means for resiliently mounting said male holding die member, a male pleating die entering between the holding die members and mating with the female edge forming groove die, a pair of indexing dies, each of said indexing dies having a grooved die member of curvature similar to the curved female grooved edge forming die and having adjacent curved surfaces on each side of said groove of said indexing dies of a curvature like the curvature of the curved surfaces adjacent the curved groove of the female edge forming die, one of said indexing dies being adjacent each of the female edge forming dies and the center lines of the grooves of said in-

dexing dies being on a line having an angle equal to the angle between the center line of the grooving die and the center line of the grooves of the female edge forming die and said indexing dies being longitudinally spaced on said center lines equal to the longitudinal spacing of the female edge forming dies on the center line of the grooves of said female edge forming dies, means to position a sheet of material over said female die members, means for advancing and entering said male grooving die member into said female grooving die member, and means for advancing and retracting said male die members, said means including means to sequentially engage the female and male holding die members and subsequently enter and engage the male pleating die member in the mating female edge forming die member.

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