July 5, 1955

R. A. SANDBERG

2,712,340

APPARATUS FOR GROOVING SHEET METAL

Filed Feb. 8, 1950

3 Sheets-Sheet 1

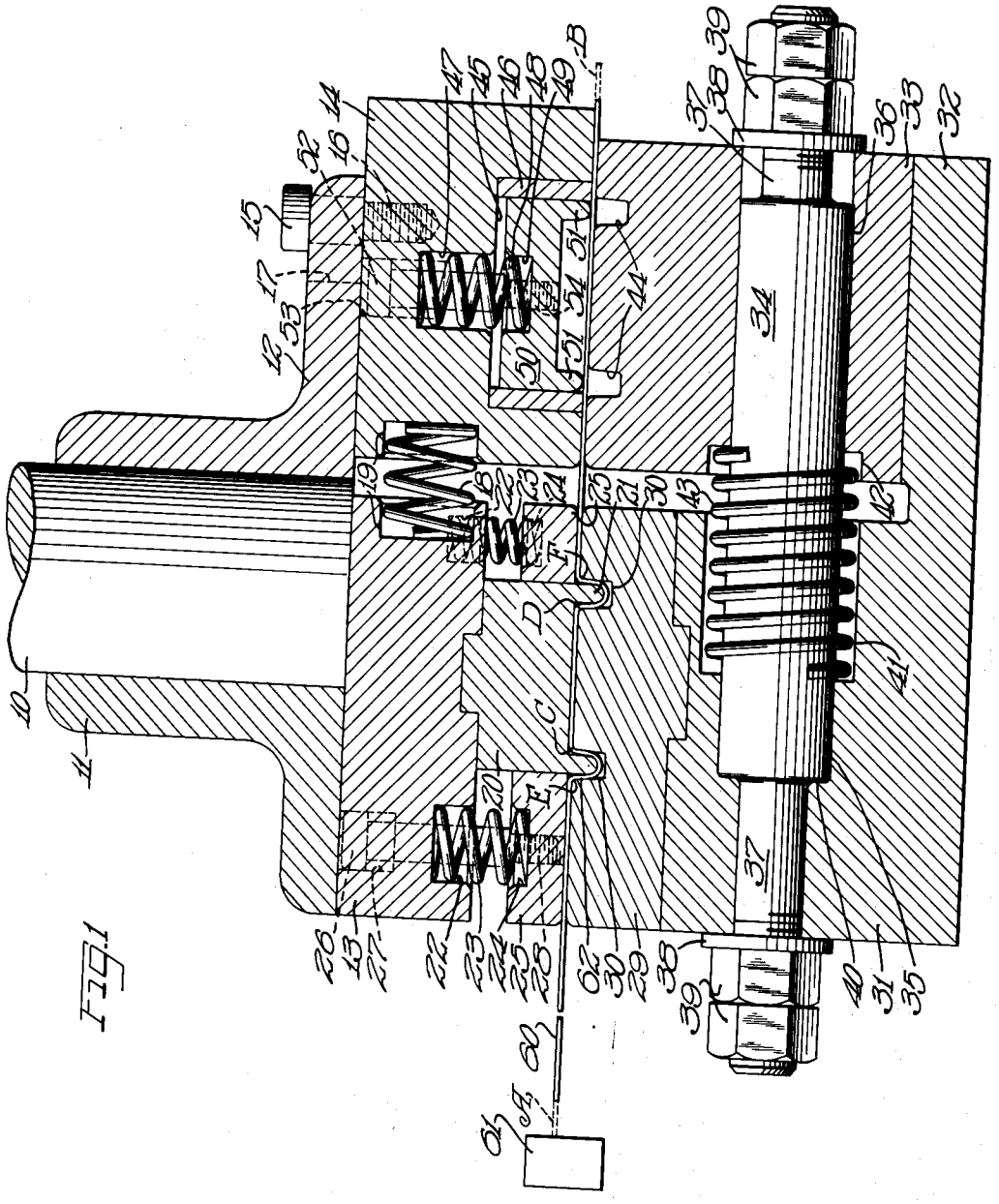


Fig. 1

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3 Sheets-Sheet 2

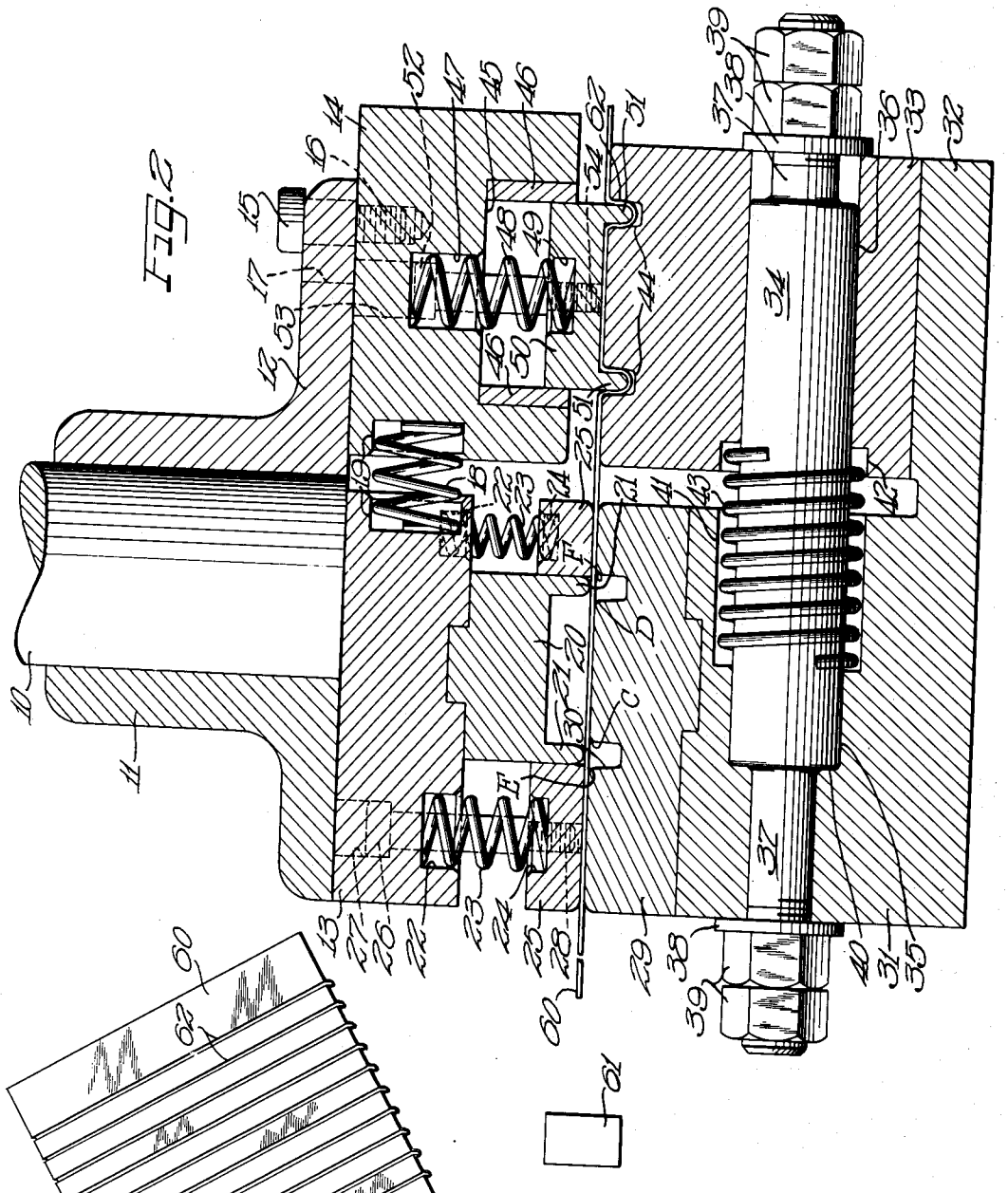


Fig. 2

Fig. 5

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3 Sheets-Sheet 3

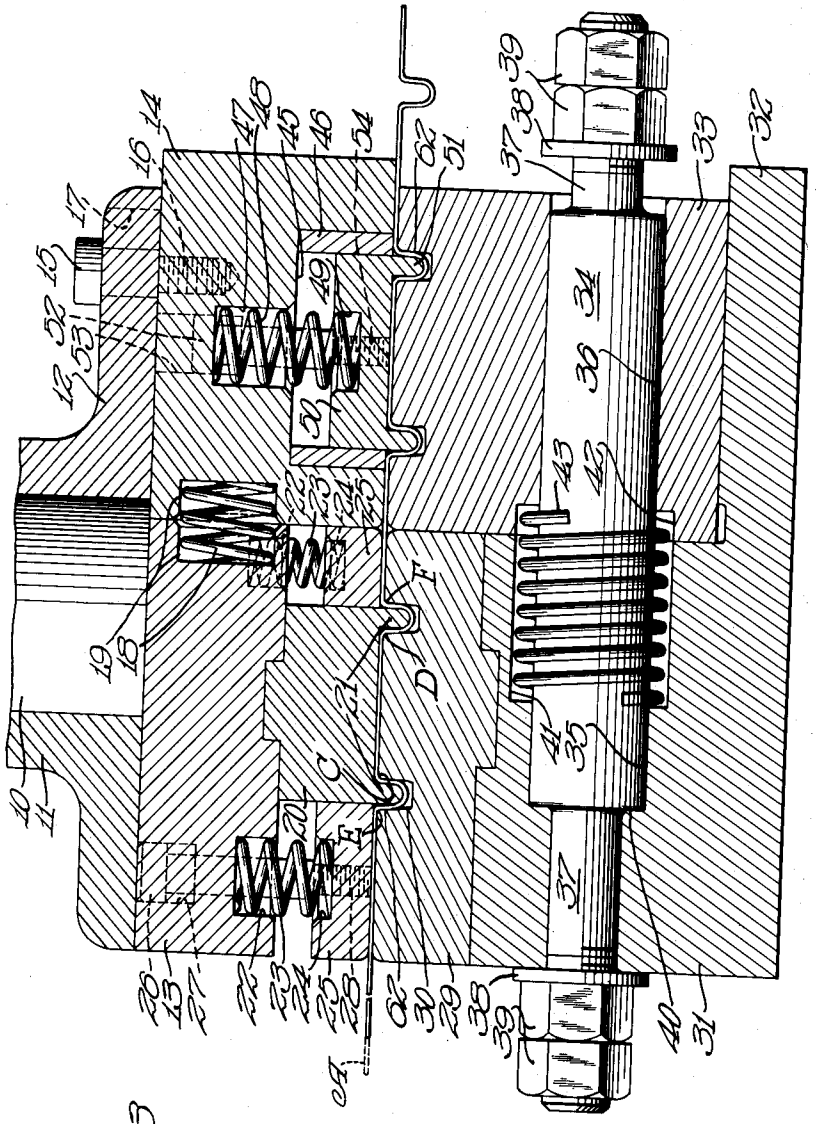


Fig. 3

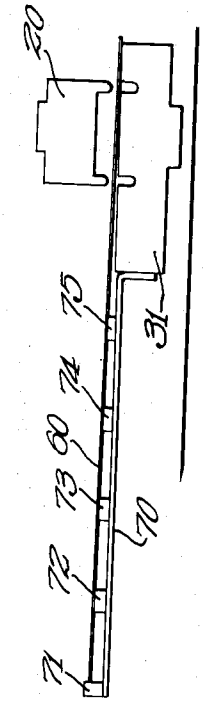


Fig. 4

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APPARATUS FOR GROOVING SHEET METAL

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Application February 8, 1950, Serial No. 143,009

7 Claims. (Cl. 153—76)

The present invention relates to a method of and apparatus for grooving sheet material. More particularly, the present invention relates to a method of forming a metal sheet with spaced parallel grooves without substantial stretching of the ungrooved portions of the sheet during the forming operation, and to apparatus for carrying out such method.

The accurate grooving of a metal sheet without any substantial stretching and/or transverse stressing of intermediate flat portions, or lands, of the sheet has long constituted a problem in the metal working art. The present invention now provides an improved method of grooving sheet metal without any substantial transverse stressing or deformation of the lands during the forming operation, and an apparatus for so grooving metal while at the same time accurately gauging the formation of a plurality of grooves across a metal sheet.

The method of the present invention contemplates the simultaneous formation of a plurality of grooves in a metal sheet with the metal for the grooves being provided by transversely inwardly gathering the sheet toward the grooves. In other words, the metal constituting the grooves is gathered from other portions of the metal sheet rather than being provided by stretching the portion of the sheet that is actually grooved. As a result of the gathering of the metal for the grooves, the sheet between the grooves is not substantially stretched or deformed.

In addition to the gathering of metal to form the grooves from the sheet itself, the method of the present invention includes a novel indexing or gauging step in which previously formed grooves of the metal sheet are employed to index the positioning of the sheet for a later grooving operation. In this manner, subsequently formed grooves are positioned in the plate in predetermined relation to earlier formed grooves, rather than with relation to an arbitrary gauge point.

The apparatus of the present invention includes cooperating dies and gauges carried by stamping means, such as a press ram or the like. Resilient means are provided for accommodating relative lateral movement of the gauges with respect to the dies in a direction transverse to the length of the sheet and of the grooves. The die is of such design as to simultaneously form a plurality of grooves in the plate, and the gauge, by transverse movement, accommodates the gathering of metal from the plate itself to form the grooves, while at the same time engaging the previously formed grooves to index the positions of later formed grooves.

It is, therefore, an important object of the present invention to provide an improved method for the grooving of a metal sheet without substantial stretching of the metal of the sheet.

Another important object of the present invention is to provide an improved apparatus for the formation of grooves in a metal sheet including means for forming a plurality of grooves in the metal sheet and means for gauging the positioning of the grooves transversely of the sheet, the gauging means accommodating transverse

movement of the sheet to permit the gathering of sheet material from which the grooves are formed.

It is a further important object of the present invention to provide an improved method for the grooving of a metal sheet including the steps of forming a plurality of grooves in the sheet, gathering metal of the sheet to form the grooves without substantial stretching of the sheet, and indexing the position of subsequently formed grooves from earlier formed grooves.

It is still another important object of the present invention to provide an improved apparatus for the grooving of the sheet metal including a forming die element and a gauging element resiliently movable with respect to the die element transversely of the sheet, the gauging element being movable toward the die element during a die forming operation to accommodate simultaneous gathering movement of sheet material for the die-formed grooves.

Other and further objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

On the drawings:

Figure 1 is a sectional view, with parts shown in elevation, illustrating an apparatus of the present invention carrying out an initial grooving operation;

Figure 2 is a sectional view, with parts shown in elevation, similar to Figure 1 illustrating the apparatus of Figure 1 in position prior to a second groove forming operation;

Figure 3 is a sectional view, with parts shown in elevation, similar to Figure 1, illustrating the apparatus of Figure 1 carrying out a later grooving operation.

Figure 4 is a schematic view of a modified form of the apparatus of the present invention; and

Figure 5 is a perspective view of a grooved sheet formed in accordance with a method of the present invention.

As shown on the drawings:

In Figure 1, reference numeral **10** refers generally to a ram, such as employed in conventional hydraulic presses and the like. The ram **10** carries at its lower free end a ram block **11** provided with an upper collar into which the lower end of the ram **10** extends and having a lower outwardly extending flange **12**.

The ram block **11** supports from its under surface an upper die block **13**, fixedly secured to the ram block by suitable means. An upper gauge block **14** is also supported from the under surface of the ram block flange **12**, and is secured in sliding contact with the block **12** by means of guide pins **15**, each threaded into the block **14** and slidable within an elongated slot **17** formed in the flange **12**.

The guide pin **15** is urged against that end of the slot **17** remote from the upper die block **13** by means of a helically coiled spring **18** confined between the blocks **13** and **14** within guide recesses **19** formed in adjacent faces thereof.

The upper die block **13** carries a centrally located, depending upper die **20** fixedly secured thereto and having downwardly projecting groove forming elements **21**. The lower surface of the upper die block **13** is recessed on each side of the die **20**, as at **22**, to receive a plurality of helical coil springs **23** that extend into corresponding, opposed recesses **24** in the upper faces of die guides or pressure pads **25**. An elongated, resiliently urged pressure pad **25** is thus provided adjacent each punch projection **21**. Displacement of the pressure pad from the upper die block **13** is prevented by means of a limit pin **26** having an enlarged head seated in an upper countersunk recess **27** in the die block **13** and a shank depending from the die block for threaded engagement with the pressure pad **25**, as at **28**. It will be understood that similar pins **26** are provided for each pressure pad **25**.

A lower die 29 is provided to underlie the die 20, the die 29 having forming recesses 30 therein to receive the groove forming projections 21 of the upper die 20. The lower die 29 is carried by a lower guide block 31 which is provided with a lower laterally projecting flange 32 underlying the upper gauge block 14 and adapted to slidably receive on the upper surface thereof a lower gauge block 33. The gauge block 33, is transversely slidable on the upper surface of the flange 32 of the lower die block 31 and is secured to the block 31 by means of one or more traverse pins 34 extending through registering bores 35 and 36 in the blocks 31 and 33, respectively. The pin 34 is provided with reduced end portions 37 which receive washers 38 and lock nuts 39. The pin 34 is also provided with a radial shoulder 40 that is held against a corresponding interior shoulder in the die block 31 upon tightening the left hand set of lock nuts 39.

The bores 35 and 36 in the blocks 31 and 33, respectively, are provided with facing countersunk recesses 41 and 42, respectively, and a helical spring 43 surrounds the pin 34 and is bottomed within the recesses. The compression spring 43 urges the block 33 from the block 31 along the surface of the flange 32 within the limit of movement permitted by the washer 38 and the nuts 39 on right hand end of the traverse pin 34.

The upper surface of the lower gauge block 33 is provided with gauging recesses 44 similar in contour and spacing to the recesses 30 of the lower die 29. In addition, the upper surface of the block 33 is transversely aligned with the upper surface of the die 29 and is coextensive in length therewith.

The upper gauge block 14 is provided with a central, longitudinal rectangular recess 45. Spaced parallel elongated gauge guides 46 are secured therein. A plurality of longitudinally spaced recesses 47 extend upwardly from the recess 45. The recesses 47 each receive the upper end of a helical spring 48, the lower end of which is confined within an opposing recess 49 formed in the upper surface of an upper gauge 50. The upper gauge 50 is provided with downwardly projecting gauging elements 51 identical with the die elements 21 in both contour and transverse spacing. The gauging projections 51 are adapted to be received by the gauging recesses 44, as best illustrated in Figures 2 and 3.

Movement of the gauge 50 from the gauge block under the influence of the spring 48 is limited by means of a limit pin having an enlarged head 52 positioned within a countersunk recess 53 in the gauge block 14 and having a lower threaded end 54 threadedly received by the gauge 50.

It will be seen that the apparatus hereinbefore described permits relative transverse movement between the die elements and the gauge elements. This relative movement is accommodated by the guide pins 15 entered in slots 17, the traverse pin 34 and the traverse spring 43, and the upper spring 18. Further, the pressure pads 25 are resiliently urged toward the lower die 29 by their springs 23 and the pressure pads 25 are capable of vertical movement relative to the die 20 during stamping movement of the press ram 10. In addition, the gauge elements 51 are resiliently urged by springs 48 into the gauge recesses 44 independently of stamping movement of the press ram 10. The gauge guides 46 closely guide the gauge 50 to prevent tilting movement of the gauge 50 upon transverse movement of the gauging element.

The method of the present invention, as carried out in apparatus such as described, contemplates first the positioning of a sheet 60 between the cooperating gauge and die members. The sheet is preferably indexed by means of an auxiliary gauge block 61. In feeding the sheet into the press, the operator places the front edge of the sheet, which is the left-hand edge, as shown in the drawings, against the gauge block 61 (Figure 1). At the start of operations the pressure pads 25 and the gauge 50 are in contact with the upper surface of the sheet 60 as it lies

supported upon the lower die 29 and the lower gauge block 33. For this purpose, the gauge 50 and the pressure pads 25 are spring-urged into contact with the upper sheet surface, while the gauge blocks 14 and 33 are laterally spaced from the die blocks 13 and 31 by the spring 18 and 43.

Upon further movement of the press ram, the die 20 is moved downwardly with the projections 21 entering the corresponding recesses 30 so that the sheet portions therebetween are deformed downwardly into the recesses to assume a grooved contour, as at 62. Finally the die 20 and the gauge block 14 contact the sheet 60.

As indicated in dotted outline at A and B (Figure 1), the front and rear edges of the sheet are moved toward each other during the die forming or grooving operation. Such movement of the front edge of the sheet (indicated at A) is accommodated by a sliding movement of the sheet beneath the left-hand spring-urged pressure pad 25, and a corresponding movement of the rear edge of the sheet (indicated at B) is accommodated by sliding movement of this portion of the sheet beneath the upper gauge block 14, the gauge 50, and the other pressure pad 25. Such movement of the rear edge of the sheet at B is possible since the gauge 50 is spring-urged against the sheet 60 and the upper gauge block 14 does not bear against the sheet surface until the die projections 21 are fully entered within the cooperating recesses 30, at which time no further movement of the far, or leading edge, is necessary. Thus, each of those portions of the pressure pads 25 and gauge 50 which contact the sheet 60 prior to and during the movement of the sheet to accommodate the gathering of metal for forming the grooves 62 is spring-urged. The strength of these springs is such that movement is accommodated without substantial stretching of the sheet 60.

Springs 48 exert only sufficient pressure to hold the sheet firmly against the gauge block 33, but not to the extent of deforming the sheet under the gauging projections 51 where the sheet is unsupported by the recesses 44. The length by which the sheet is shortened (the sum of the distances indicated by dotted lines at A and B) is that which is necessary to accommodate the formation of the grooves 62. Thus, the amount of additional material used to form a single groove in the sheet is equal to the distance A through which the sheet has drawn away from the gauge 61. By moving each of the front and rear edges of the sheet, the transverse grooving of the sheet is possible at a pair of spaced points without any substantial deformation or stretching of that portion of the sheet between the grooves. In other words, all of the material necessary to form the pair of grooves is accumulated from those portions of the plate, or sheet, that lie in front of and beyond the inner, or nearer together, edges C and D (Figure 1) of the pair of grooves 30.

As the next step in the method, press ram 10 is retracted to clear the sheet 60 for free movement between the cooperating gauge and die elements. Upon retraction of the press ram, the limit pins 26 and 52 prevent the displacement of the spring-urged members 25 and 50, respectively, from the assembly.

The sheet 60 is next indexed so that the grooves 62 previously formed therein are aligned with the recesses 44 of the lower gauge block 33 and drop thereinto. Upon again actuating the press ram 10, the assembly is lowered so that the projections 51 of the gauge 50 are urged by the springs 48 into the grooves 62 (Figure 2), thereby accurately securing the partially grooved sheet 60 for the next grooving operation. At the same time, the pressure pads 25 are spring-urged against the upper surface of the sheet 60 by their springs 23.

Upon further energization of the press ram 10, the projections 21 are again forced into the recesses 30 with the resulting formation of an additional pair of grooves 62 in the sheet 60. Concurrent movement of the portion

of the sheet beyond the die **30** (that is, to the right of the die **20** as shown in Figure 3) to gather the metal necessary for the grooving of the sheet without stretching of the metal is accommodated by compression of the springs **18** and **43**. Thus, the apparatus assumes the position shown in Figure 3. The free left-hand edge of the sheet **60** has again moved the distance represented by dotted lines at A toward the die element, while the right-hand edge of the sheet has been allowed to move a similar distance toward the die element by the lateral shifting movement of the assembly of guide blocks **14** and **33** and the gauge **50**. This lateral movement of the gauging elements is guided by the engagement of the guide pins **15** with the edges of the slots **17** and the sliding of the gauge block **33** upon the traverse pin **34**.

In this manner, the gauging elements not only accurately gauge the positioning of the sheet portions to be subsequently grooved, but they are laterally shifted during the grooving operation to gather metal for the grooves, thus eliminating the necessity for transversely stretching or otherwise distorting the sheet **60**.

The above-described method is most accurate since it allows positive spacing between the fixed punch projections **21** and approximately the same accuracy between each succeeding group of grooves since all gauging after the first hit is registered from the previously formed grooves and not the distant gauging point of the front edge of the sheet.

In Figure 4 there is shown schematically a modified gauging assembly for use with the die elements hereinbefore described and illustrated. In this instance, a supporting structure **70** is secured to the lower guide block **31**, the structure carrying on its upper surface a plurality of aligned equally spaced gauge blocks **71–75**, inclusive. The gauge blocks serve successively to index the left-hand edge of the sheet **60**. Upon the initial positioning of the sheet between the die members, the sheet edge is positioned against the first block **71**.

Following the formation of the first pair of grooves by the stamping operation, the adjacent edge of the sheet **60** is placed against the block **72**. Although the upper surface of the sheet and the blocks **72–75** are each parallel to the direction of travel of the sheet, the natural sag of the sheet material will permit the abutment of the front edge of the sheet against a vertical face of any one of the gauge blocks. Following the next grooving operation, the sheet is placed against the gauge block **73** for another stamping operation, followed by positioning of the sheet edge against the blocks **74** and **75** in turn. Although this method of gauging may be reasonably accurate and will also accommodate edgewise lateral movement of the plate to gather metal for the stamping, it will be appreciated that the accuracy of the gauging operation is dependent upon the skill and care of the workmen feeding the workpiece to the die elements. This personal element and skill of the workmen has been eliminated from the device hereinbefore described in connection with Figures 1–3, inclusive.

In Figure 5, there is illustrated a grooved sheet, or plate, of the present invention. The sheet **60** is provided with a plurality of spaced parallel grooves **62**. Due to the method and apparatus employed, substantially no stretching of the sheet is caused by the grooving operation.

In the forming of the grooves **62**, the metal of the grooves is considerably hardened, due to the cold working that occurs as the metal of the sheet is drawn over the edges of the grooves **30**, and particularly over the outer groove edges E and F (Figure 2). These edges have a small radius of curvature, usually about ⅛ of an inch, so that the metal is rather sharply bent as it is pulled over such edges. As a result, the metal is cold worked and hardened, and the metal of the grooves takes a definite "set." This is of considerable importance when the grooved sheet, or plate, is employed in the manufacture of a plate and tube type heat exchanger, or condenser,

which is the main purpose of the grooved sheet of this invention.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. In combination, a press ram mounting, a ram reciprocally carried by said mounting, a ram block carried by said ram, a first die member carried by said ram block for movement with said ram, a second die member fixed with respect to said ram mounting for cooperation with said first die member to form a groove in a metal plate positioned between said die members, a first gauge member carried by said ram block and laterally slidable relative thereto toward and away from said first die member, resilient means urging said first gauge member away from said ram block in the direction of reciprocation of said ram, means retaining said first gauge member with said ram block, a second gauge member carried by said ram mounting and laterally movable relative thereto, the gauge members being constructed and arranged to hold the plate against relative movement with respect thereto, resilient means confined between the corresponding die and gauge members for urging said gauge members laterally outwardly from said die members, and means engaging said gauge members for limiting laterally outward movement thereof for determining the gauging position of the gauge members, said resilient means confined between the die and gauge members accommodating lateral movement of said gauge members toward said die members during groove forming movement of said dies.

2. Apparatus for the grooving of a metal sheet comprising a lower die block, a die member carried by said lower block, an upper die block, a die member carried by said upper block for cooperation with said lower die member, the die members being constructed and arranged to form a plurality of grooves in a metal sheet interposed therebetween, an upper gauge member adjacent said upper die block, means guiding said upper gauge member for movement toward said upper die block, a lower gauge member slidable on said lower die block, a traverse pin extending through said lower die block and said lower gauge member for guiding movement of said lower gauge member relative to said lower die block, the gauge members being constructed and arranged to hold the sheet against relative movement in respect thereto, resilient means confined between said lower gauge member and said lower die block for accommodating sliding movement of said gauge members relative to said die block and urging said lower gauge member away from said lower die block, said traverse pin having an abutment thereon limiting outward movement of said lower gauge member from said lower die block, means urging said upper gauge member away from said upper die block, and means for engaging said upper gauge member for limiting outward movement thereof from said upper die block to position the upper gauge member for cooperation with the lower gauge member to establish a gauging position.

3. In combination, a fixed die and a movable die, one of said dies having a recess of fixed dimensions and the other of said dies having a projection of fixed dimensions for cooperation with said recess, and said dies being constructed and arranged for forming a groove in a plate disposed therebetween by movement of the movable die toward the fixed die, gauging means for interlocking with a grooved portion of the plate to position an ungrooved portion of said plate between said dies and including a movable gauging member, means mounting said movable gauging member for movement into engagement with said grooved portion of said sheet prior to each groove forming operation to lock said grooved portion relative to said gauging means, means mounting said gauging means for lateral movement toward and away from said dies, and gauge positioning means for

moving said gauging means laterally outwardly away from said dies after each groove forming operation to a predetermined gauging position, said gauge positioning means accommodating lateral inward movement of said gauging means during each groove forming operation.

4. In combination, a first die having a pair of projections extending therefrom in fixed spaced relation, a second die movable relative to said first die and having a pair of fixed recesses therein spaced to receive said projections, closing movement of said dies forming a pair of grooves in a portion of a plate therebetween with the spacing between the grooves equal to the fixed spacing between the projections and recesses of the dies, gauging members disposed adjacent said dies and constructed and arranged to engage a grooved portion of said plate to hold said grooved portion against movement with respect thereto, means for urging said gauging members laterally outwardly away from said dies, means engaging said gauging members for limiting outward movement thereof or determining the gauging position of the gauging members and for positioning an ungrooved portion of the plate between the dies in proper position for having a pair of grooves formed therein, said urging means accommodating movement of said gauging members and the grooved portion of the plate engaged thereby toward the dies to supply material for one groove to be formed in the ungrooved portion of the plate, and means accommodating movement of the plate on the other side of said ungrooved portion toward the dies to supply material for the other groove to be formed, whereby pairs of grooves are successively formed in the plate without stretching of the metal between the pair of grooves being formed.

5. In combination, a press ram mounting, a ram reciprocally carried by said mounting, a first die member carried by said ram for movement with said ram, a second die member fixed with respect to said ram mounting for cooperation with said first die member to form a groove in a metal plate positioned between said die members, a first gauge member carried by said ram and laterally slidable relative thereto toward and away from said first die member, resilient means urging said first gauge member away from said ram in the direction of reciprocation of said ram, means retaining said first gauge member with said ram, a second gauge member carried by said ram mounting and laterally movable relative thereto, the gauge members being constructed and arranged to hold the plate against relative movement with respect thereto, means for moving said gauge members laterally outwardly from said die members, and means engaging said gauge members for limiting laterally outward movement thereof for determining the gauging position of the gauge members, said gauge members being movable toward said die members during groove forming movement of said dies.

6. In combination, a press ram mounting, a ram reciprocally carried by said mounting, a first die member carried by said ram block for movement with said ram, said first die member having a pair of projections extending therefrom in fixed spaced relation, a second die member fixed with respect to said ram mounting and having a pair of fixed recesses therein spaced to receive said projections, closing movement of said die members forming a pair of grooves in a portion of a plate therebetween with the spacing between the grooves equal to the fixed space between the projections and recesses of the die members, a first gauge member carried by said ram and laterally movable relative thereto toward and away from said first die member, resilient means urging said first gauge member away from said ram in the direction of reciprocation of said ram, means retaining said first gauge member with said ram, a second gauge member carried by said ram mounting and laterally movable relative thereto, the gauge members being constructed and arranged to hold the plate against relative movement with respect thereto, resilient means for urging said gauge members laterally outwardly from said die members, means for limiting laterally outward movement of said gauge members for determining the gauging positions of the gauge members and for positioning an ungrooved portion of the plate between the die members in proper position for having a pair of grooves formed therein, said resilient means accommodating movement of said gauge members and the grooved portion of the plate engaged thereby toward the die members to supply material for one groove to be formed in the ungrooved portion of the plate, and means accommodating movement of the plate on the other side of said ungrooved portion toward the die members to supply material for the other groove to be formed, whereby pairs of grooves are successively formed in the plate without stretching of the metal between the pair of grooves being formed.

7. In combination, a fixed die and a movable die, one of said dies having a recess of fixed dimensions and the other of said dies having a projection of fixed dimensions, and said dies being constructed and arranged for forming a groove in a plate disposed therebetween by movement of the movable die toward the fixed die, gauging means for interlocking with a grooved portion of the plate to position an ungrooved portion of said plate between the dies and including a movable gauging member, means mounting said movable gauging member for movement into engagement with said grooved portion of said plate prior to each groove forming operation, resilient means urging said movable gauging member to a position relative to said movable die to engage said plate prior to said movable die to lock said grooved portion relative to said gauging means, means mounting said gauging means for lateral movement toward and away from said dies, and gauge positioning means for moving said gauging means laterally outwardly away from said dies after each groove forming operation to a predetermined gauging position, said gauge positioning means accommodating lateral inward movement of said gauging means during each groove forming operation, and said movable gauging member being automatically movable into and out of locking relation to the grooved portion of said plate in synchronism with the movement of said movable die.

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