

Aug. 11, 1953

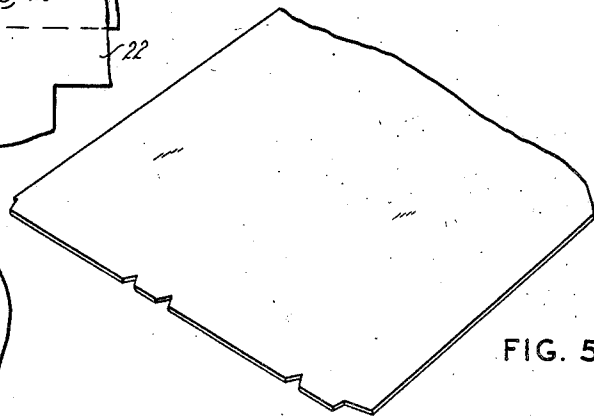
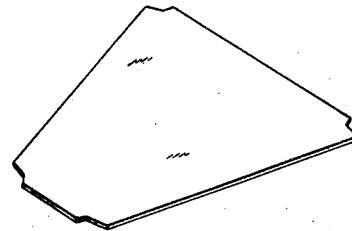
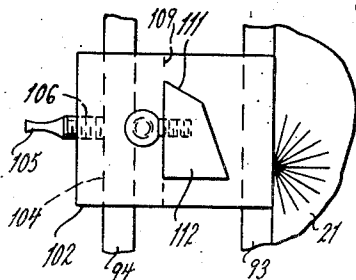
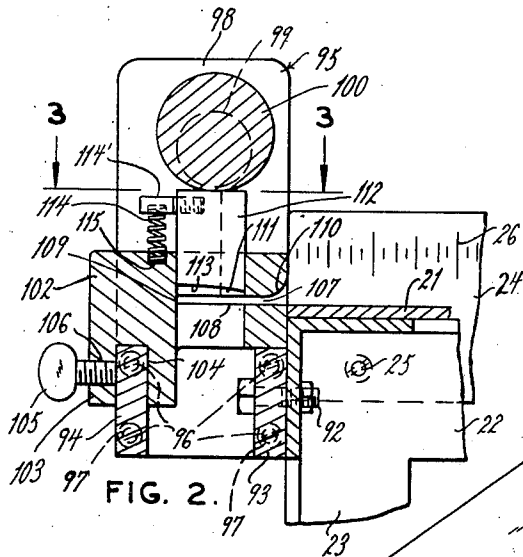
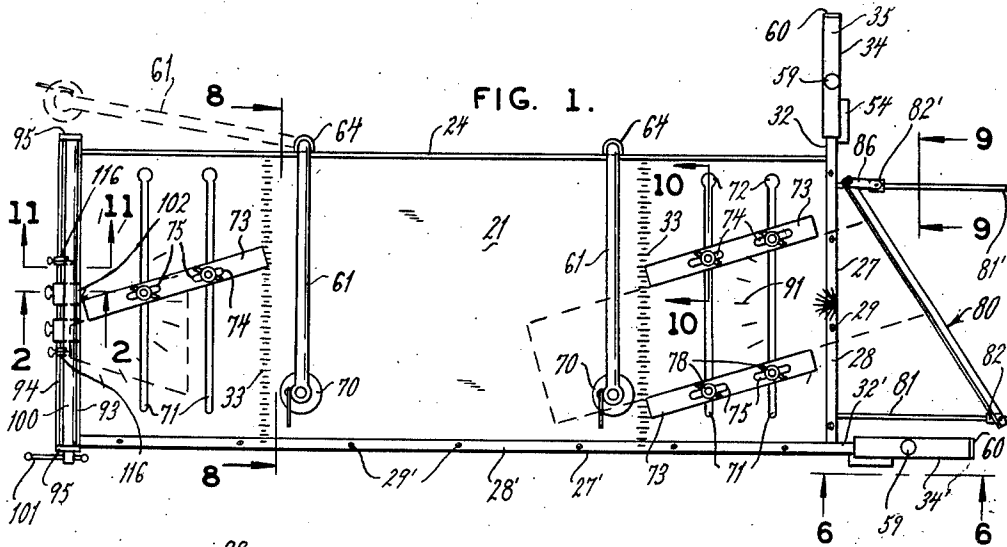
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2,648,381

METHOD OF CUTTING DUCT SECTIONS

Filed March 23, 1950

2 Sheets-Sheet 1



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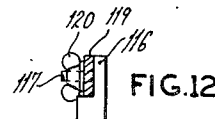
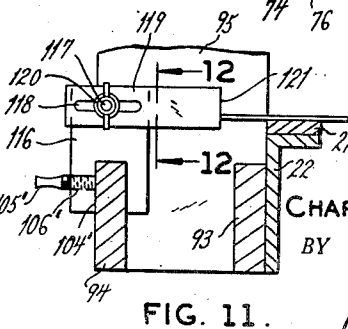
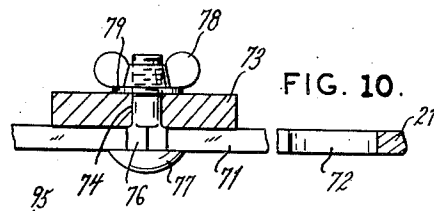
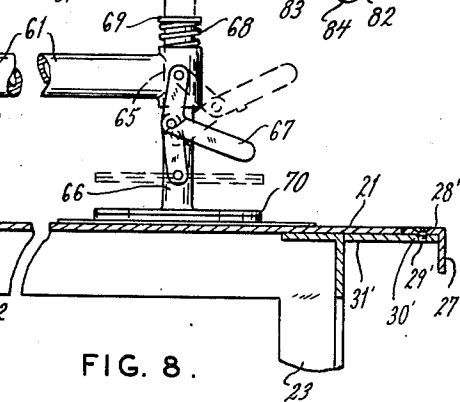
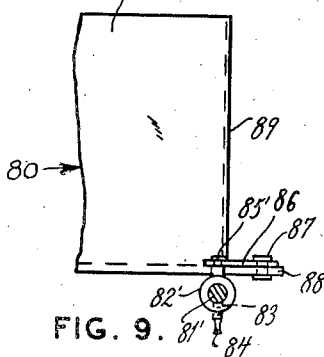
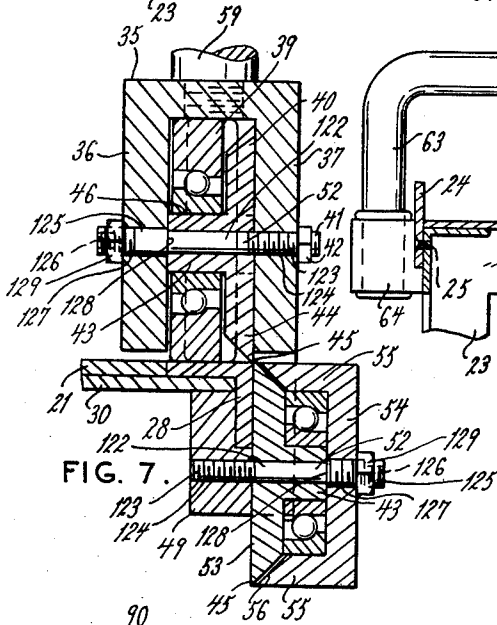
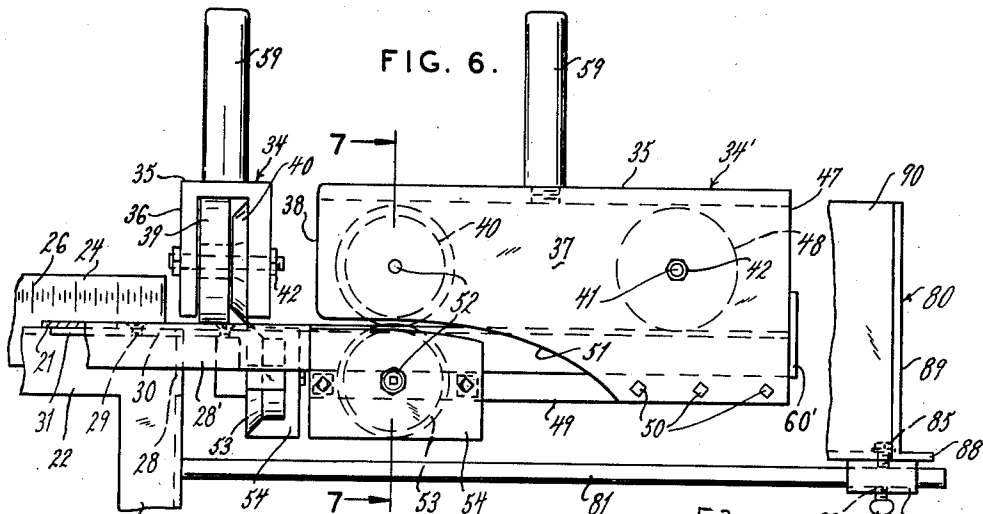
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2,648,381

METHOD OF CUTTING DUCT SECTIONS

Filed March 23, 1950

2 Sheets-Sheet 2



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METHOD OF CUTTING DUCT SECTIONS

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3 Claims. (Cl. 164—17)

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This invention relates to improvements in methods for measuring, cutting and notching sheet metal for forming four-sided ducting, as used for heating and air-conditioning installations.

Straight sections of ducts for the purposes aforementioned are usually bent from individual sheets of metal. Such straight sections are normally interconnected by "transition" sections, that is, pieces of duct whose cross-sections vary along their length, required to carry over or under beams, to allow branching of the duct systems, to change cross-sectional area, and for other familiar purposes. These transitional sections are normally made from four flat pieces of sheet metal, one pair of which have some curved edges and the other pair being rectilinear and bi-symmetric but normally cut at oblique angles. The inherent variations in structure, form, length and proportion of the sheet metal pieces required for a single installation have heretofore been generally considered too great to achieve mass production. Instead, it has been the practice to "lay out" ducts individually, measuring and punch-marking the location of each shearing cut, bend and corner, shearing the material on square shears, and cutting corners and notching the material for bends by hand.

It should be explained that, according to conventional practice, the corners of ducts must be notched before they are formed so that material may be bent back at each end of the duct to form flanges for the connection of adjacent duct sections. Further, where a linear seam is required along a duct (as in forming a straight duct section after bending a sheet with three parallel rectangular bends) the corners to be fed into a seaming machine, such as a "Pittsburgh" machine, must be first notched to permit acceptance into and forming by such machine.

It is an object of this invention to create methods for the quick and inexpensive manufacture of uniform interchangeable four-sided ducts, both straight and transitional sections.

Another object is to provide means and mechanisms for measuring, shearing, laying out and notching duct sheet.

Another object is to provide adjustable stops and abutments to serve in shearing duct sheet at oblique angles as well as at right angles, and also in notching duct sheet at oblique angles.

Another object is to provide a rectangular measuring table equipped with adjustable guide

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stops and with rolling shear means operable along the entire length of two adjacent sides thereof.

Another object is to provide novel shearing roll cutters operable along two adjacent edges of a rectangular table and adapted to shear sheets of any length.

Another object is to provide a duct making device with a removable plurality of adjustably spaced cam-operated notching cutters.

Additional objects include equipping such duct making device with linear and protractor scales to cooperate with the several tools incorporated in such device.

A further object is to provide a method and means for mechanically notching bi-symmetric duct sheets to locate their corners and bends.

In the drawings:

Fig. 1 is a plan view of a duct jig embodying my invention.

Fig. 2 is a fragmentary detail taken in section on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary detail view in plan taken along line 3—3 of Fig. 2.

Fig. 4 is a perspective view of a polygonal side element of a 4-piece section of transition ducting, sheared and notched according to a possible set-up of my invention shown in Fig. 1.

Fig. 5 is a fragmentary perspective view of one end of a sheet sheared and notched to form a section of one-piece rectangular ducting.

Fig. 6 is a fragmentary detail view in elevation taken along line 6—6 of Fig. 1.

Fig. 7 is a sectional view taken along line 7—7 of Fig. 6.

Fig. 8 is a fragmentary view, partly in elevation and partly in section, taken along line 8—8 of Fig. 1.

Fig. 9 is a fragmentary elevation taken along line 9—9 of Fig. 1.

Fig. 10 is a fragmentary sectional view taken along line 10—10 of Fig. 1.

Fig. 11 is a fragmentary view, partly in elevation and partly in section, along line 11—11 of Fig. 1.

Fig. 12 is a fragmentary view, partly in elevation and partly in section, taken along line 12—12 of Fig. 11.

In the embodiment illustrated, steel table plate 21, which is of sufficient size to accommodate metal sheets used for ducts, is supported by angle iron frame 22 and legs 23. Rising from the back edge of table plate 21 is abutment strip 24, secured to frame 22 by screws 25 and scribed with linear scale 26, whose graduations relate to

the outer edge 27 of shear guide angle 28. Said shear guide angle's upper horizontal surface is on the same plane as table plate 21 and is in effect an extension thereof, being butted against its edge and secured by countersunk screws 29 to the outstanding edge 30 of tie plate 31, welded beneath table plate 21 outward of supporting frame 22. However, said shear guide angle 28 continues rearward of table plate 21 to form right hand shear base 32, as shown in Fig. 1.

The forward edge is similarly constructed, commencing with forward outer edge 27' of shear guide angle 28', which is similarly affixed by countersunk screws 29' to the forward outstanding edge 30' of a forward extending tie plate 31' welded beneath the forward edge of the table plate 21. Shear guide angle 28' extends beyond the right edge of table plate 21 to form forward shear base 32'. Graduated from forward outer edge 27' and extending rearward are linear scales 33, scribed in the surface of table plate 21.

Operable from said shear bases 32 and 32' and along shear guide angles 28 and 28' respectively are the right hand rolling shear 34 and the forward rolling shear 34', shown in detail in Figs. 6 and 7. Each of these shears has a carrier 35 shaped generally like an inverted channel, having a straight inner flange 36 of uniform depth. The outer flange 37 of frame 35 varies in depth, however. At the forward end 38 of said carrier, outer flange 37 is of the same depth as inner flange 36, but aft of said forward end 38 its depth increases for the purposes and in the manner hereinafter described.

Housed between carrier flanges 36 and 37 near forward end 38 of each of the shear carriers 35, so as to protrude but slightly below said flanges, is forward roller 39 and upper shearing disc 40, rotatably mounted on thread-ended pin 52, which has provision for lateral adjustment hereinafter described and is mounted normal to flanges 36 and 37. Shearing disc 40 has at its inner side (that is, inward with relation to table plate 21) a tubular stem portion 43 whose bore is sufficiently greater than the diameter of stem 122 to permit free rotation thereon, and at its outer side a tapered blade 44, whose diameter is a maximum at its outer or cutting edge 45, the diameter of said edge being equal to the outer diameter of roller 39, or nearly as great. The bore 46 of forward roller 39 is such as to permit easy rotation about the outer surface of the tubular stem portion 43 of said shearing disc 40.

Between flanges 36 and 37 near the aft end 47 of carrier 35 is housed aft roller 48, being of the same diameter but having greater width than forward roller 39, and being rotatably mounted on a bolt 41 (secured by a nut 42) through a bore normal to said flanges and at the same height as the axis of the forward roller 39 and shearing disc 40, so that forward roller 39 and aft roller 48 are substantially in alignment with each other.

Inasmuch as the cutting or shearing of the sheet metal is to be done from the forward end of carrier 35 by shearing disc 40 and a mating shearing disc 53 whose axis is below the surface of table plate 21, the outer flange 37 of carrier 35 is enlarged downward at the aft end 47 of the carrier 35, sufficiently so that when rollers 39 and 48 rest on guide angle 28, said aft end of outer flange 37 will extend below said guide angle 28. A rigid mating angle 49, adapted to engage slidably the inner face of the guide angle 28 and cause its outer face slidably to engage the

aft end of said outer flange 37, is affixed on the inward side of said aft end of outer flange 37 by bolts 50. Forward of the point of affixation, the lower edge of said outer flange sweeps upward and forward to form a guideway 51 which merges gradually into the horizontal at a point beneath the axis of the upper shearing disc 40.

Vertically beneath and parallel to said axis, thread-ended pin 52 is mounted in and expands outward from mating angle 49. Rotatably mounted on said pin as an axis is lower shearing disc 53, which is identical with upper shearing disc 40 but faces inward instead of outward. The location of said lower shearing disc 53 is such that its cutting edge 45 is laterally in contact with the corresponding cutting edge of the upper disc, and reaches a vertical height slightly above the lowest point of the cutting edge on said upper disc in relationship suitable for shearing.

A guard channel 54 whose flanges 55 extend inward and are tapered at their inner ends 56, fits closely adjacent the lower shearing disc 53, in respect of the relation of inner flange ends 56 to the cutting edge 45 and also in respect of the relation of the outer end of tubular stem portion 43 with the base of said channel 54. Free rotation is achieved by the interposition of ball bearing surrounding tubular stem portion 43 between said channel base and the blade 44. Said guard channel 54 is held in position by two nut-fitted studs mounted in mating angle 49 on each side of lower shearing disc 53 and penetrating bores through the base of channel 54 in registration with said studs. Aft of the axis of thread-ended pin 52, the upper flange of said guard channel 54 is curved backward and downward corresponding to the curvature of the adjacent portion of guideway 51.

An operating handle 59 is affixed to and projects upward from carrier 35.

The manner of using said rolling shears 34 and 34' will be at once apparent. Between cutting operations they are permitted to stand on shear bases 32 and 32' at the outward-extending ends of guide angles 28 and 28', their outward movement being limited by stops 60 and 60'. The interaction of said shears with other features of my invention require some additional explanation, however.

In order to secure large sheets of metal while they are being sheared, I provide toggle clamps 61, each of which comprise an arm 62 and elbow 63 swingably mounted in bracket 64 affixed to the rear of frame 22. At the forward end of arm 62 is a vertical bore 65 within which shaft 66 is operable reciprocatingly by toggle mechanism 67, its downward movement being resisted by the force of compression spring 68 against cap 69 at the top of shaft 66. At the lower end of shaft 66 is affixed clamp pad 70, which is adapted to clamp and hold sheet metal sheets against table plate 21. When not in use, said toggle clamps 61 may be swung out of the way, as shown in phantom in Fig. 1.

Table plate 21 is provided with a plurality of fore-and-aft slots 71 arranged in pairs, terminating at their aft end in enlarged circular holes 72. For each pair of slots is provided one or more abutment bars 73 of rectangular cross-section of a length substantially greater than the distance between a slot and its paired slot. Each of said abutment bars 73 is provided with two short vertical slots 74 along the longitudinal axis of said bars, the adjacent ends 75 of which

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slots 74 are no farther separated than the distance between the parallel slots 71 in connection with which they are used. Said slots 71 and 74 are of such width as readily to accommodate and permit sliding motion of carriage-head bolts 76, but smaller than the heads 77 thereof. As shown in Figs. 1 and 10, the heads 77 of said carriage-head bolts are inserted downward through enlarged holes 72 upon loosening (but not removing) wing nuts 78, which can be tightened against washers 79 to fix said abutment bars 73 on the surface of table plate 21 in any desired fore-and-aft and angular position, within the limits of movement permitted by said slots 71 and 74.

One use for abutment bars 73 is to set them parallel to the forward edge of table plate 21 at a distance determined from linear scales 33, and to thus utilize them as an abutment and guide for cutting long sheets into desired widths with the forward shear 34'. Another use is illustrated at the right side of Fig. 1, in conjunction with angular abutment 80, which will now be described.

Said angular abutment comprises two substantially parallel horizontal rods 81 and 81' extending laterally from the frame 22. On rods 81 and 81' are sliding sleeves 82 and 82' respectively, each having on its under side a tapped hole 83 and thumb screw 84; on their upper sides are vertical pins 85 and 85' respectively. On pin 85' is attached one end of a short link 86, whose other end bears vertical pin 87. Said pin 87 is attached through the horizontal flange 88 of angle 89, whose upturned vertical flange 90 faces table plate 21 and, as shown in Fig. 6, extends from slightly below to slightly above the plane of said plate.

Angular abutment 80 is of especially valuable use in cutting uniform bi-symmetric flat pieces at oblique angles for transition section faces, such as shown in Fig. 4. Having first utilized abutment bars 73 to cut the sheet metal to the necessary width, two such abutment bars are set up parallel to each other and spaced apart the width of the sheet strips in the fore-and-aft slots 71 adjacent the right end of table plate 21 at such degree of angularity to shear guide angle 28 as is required. The requisite angularity may be determined from a pattern or by reference to the protractor 91 scribed in the right edge of said table plate. The sheet strip to be cut is then fed between said abutment bars 73 slightly past shear guide angle 28, and trimmed with a forward movement of right hand rolling shear 34. The sheet strip is turned over, so that the edge formerly nearer the operator is now the farther edge, and then advanced between said abutment bars sufficiently so that a stroke of shear 34 would cut it to proper size. The angular abutment 80 is then adjusted by sliding the sleeves 82 until vertical flange 90 of the abutment is flush against the edge of the as yet uncut piece, and the thumb screws 84 tightened. The piece is then cut and removed, the strip again turned over and advanced against vertical flange 90 as an abutment, and cut, and the process repeated until as many pieces as desired have been cut or the strip is exhausted. The angular abutment 80 is in function a remote gage adjustably located as to space and angle from the rectilinear shear line formed by the path of the rolling shear 34.

Notching of the duct sheets is accomplished at the left edge of the device. Bolted to frame 22 along the left side and somewhat below the plane

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of table plate 21, by nut-fitted bolts 92, is inner notcher support bar 93, which is paralleled by outer notcher support bar 94. These extend the entire depth of table plate 21, and are held in alignment with reference to each other by end fittings 95 at their forward and aft ends, said end fittings being affixed by screws 96 penetrating them and entering tapped holes 97 in the ends of said bars 93 and 94. The upper portions 98 of said end fittings 95 contain large fore-and-aft horizontal bearing bores 99 which support the fore-and-aft ends of an eccentric-mounted rod 100, rotatable therein as a cam by applying torque by means of handle 101.

A plurality of notchers may be adjustably and removably affixed to outer notcher support bar 94, so as to bear upon both it and inner support bar 93. Such a notcher is shown in detail in Figs. 2 and 3. It comprises a block 102 adapted at its inner side to rest atop inner notcher support bar 93, and having at its outer side a depending portion 103 with a central square-cut keyway 104 of such size as to accommodate and bear upon outer notcher support bar 94, permitting the sliding of block 102 along said support bars except when restrained by turning and advancing thumb screw 105 through tapped hole 106 penetrating sideward into keyway 104, and tightening it against outer notcher support bar 94.

Notcher block 102 has a horizontal throat 107 cut from front to back adjacent to table plate 21 and of sufficient depth to accommodate the thickness of the sheet metal to be processed. The lower side 108 of said throat 107 is in the same plane as said table plate 21. The left margin or abutment 109 of said throat 107 serves as a stop for sheet metal inserted therein; and the insertion of such sheet metal into throat 107 is facilitated by the curved entrant portion 110.

Referring still to Figs. 2 and 3, block 102 is vertically penetrated by a die aperture 111 which, in its lateral location, extends along and inward from the line of left abutment 109. Within said die aperture 111 reciprocates punch 112 whose cross-section is similar to that of die aperture 111 although necessarily a bit smaller, and whose lower or cutting edge 113 shears in cooperation with the edge formed by the intersection of die aperture 111 with lower side 108 of throat 107. Punch 112 is depressed by the cam pressure of the eccentric rod 100 bearing against its upper surface, resulting from turning handle 101. When such pressure is released, it is raised to its original position above throat 107 by compression spring 114 pressing at its lower end against seat 115 in the upper surface of block 102, and lifting punch 112 by pressure of its upper end against key 114' affixed in and protruding sideward from the punch 112.

Spring 114, while of sufficient strength to raise punch 114 when not subject to the cam force referred to, nevertheless can be depressed by a relatively slight amount of force. Accordingly, on loosening thumb screw 105, entire notcher assemblies may be removed from under eccentric rod 100. Similarly additional notching cutters cutting notches of a variety of forms may be added and so spaced along outer notcher support bar 94 as to yield any desired notch spacing. Although in Fig. 1 I have shown an arrangement of notchers suitable for notching transition duct members, for notching straight sections of rectangular ducts, notchers are re-

quired as shown in Fig. 5. Of these, the intermediate three are simple V-notch cutters, to mark bend lines and permit the necessary bending at ends, while the end notches shown are developed in order to permit entry into such seam machines as the widely used "Pittsburgh" machine. Another function of said end notches is that sheets of greater width than desired may be first notched in the usual manner, that is, notching the left end, turning the sheet over right to left, and notching the other end. The notches cut by the most forward notcher are then used as a guide for shearing the sheet to the desired width, by pulling the sheet forward and centering it until said notches reach the forward shear guide angle 28', holding it with the toggle clamps 61 and shearing with rolling shear 34'.

Referring now to Figs. 1 and 11, stop base block 116, like notcher block 102, is equipped with a square-cut keyway 104', thumb screw 105' and tapped hole 106' extending sideward into said keyway. Secured near its upper end and approximately at the same height as table plate 21 is forward-extending stud 117, which penetrates the horizontal slot 118 in gage bar 119, adjustably secured thereto by wing nut 120. The inner surface 121 of said gage bar 119 extends from a point somewhat above to a point somewhat below the level of table plate 21, and thus serves as an abutment for sheets of metal placed on said table plate and moved to and beyond the left edge thereof.

Fig. 1 shows two such abutments in place with the jig set up for notching transition sheets. It is apparent that, for notching rectangular sheets as shown in Fig. 5, no such abutments are required, for the left abutments 109 of the throats 107 of the several notching cutters adequately serve this function.

The problem of notching the obliquely-cut, bi-symmetric transition sheets such as shown in Fig. 4, is somewhat different. Because of their oblique angles, abutment strip 24 at the rear of table plate 21 cannot be employed as a guide for notching them.

Reference has heretofore been made to the use of abutment bars 73, illustrated in Fig. 1, for shearing such sheets at the right end of the device. One such abutment bar is shown in Fig. 1 at the left end of the jig, in place for use as a notching guide for such bi-symmetric, obliquely-cut sheets, one of which being there shown in phantom lines. The angularity of such abutment bar 73 has been set to correspond with the angularity of the sides of the sheet to be notched. Two notcher blocks 102 are shown affixed so that one is adjacent either side of said abutment bar; and outward of each said notcher block is affixed a stop base block 116 with its gage bar 119 in place. On examination of Fig. 1, it will be apparent that the four corners of such obliquely-cut bi-symmetric sheets will be notched with precision in the following manner: keeping one side of the sheet up, it is fed (with its parallel sides at all times parallel to the left edge of table plate 21) first into the notcher on one side of the abutment bar 73 and then into the other, meantime turning it 180°. The sheet is then turned over so that the other side is up, and said steps repeated.

In the manner hereinabove described, my invention provides a simple and practical means and method whereby rectangular duct sheet may be squarely sheared along two adjacent edges,

gang-notched at one end, turned over and symmetrically gang-notched at the other, with speed and exactness as is required for the mass production of interchangeable ducts. The adjustments for varying size and proportion of the ducts are simple, and require no further comment. As for the automatic layout and notching of the transition sheets, the same device provides for shearing strips, shearing these into bi-symmetric rectilinear pieces, and notching each of their four corners precisely and speedily. The linear and protractor scales, the variable and adaptable abutment means, the rolling shears, adjustable notchers and all other parts cooperate to achieve these unique results.

Again mentioning the shear means provided, unique results have been achieved by their ability to shear sheets along the entire length and width of the table plate 21. Unlike shears of the type mounted on a yoke or bight accommodating a limited width of sheet, the present shear means may be used for shearing sheets of any width, regardless of the distance from the edge of the uncut sheet; and subject only to the limitation of width of the table plate 21.

Referring once more to Fig. 7, in service, it will be found that wear occurs along the cutting edges 45 of upper shearing disc 40 and lower shearing disc 53. In order to take up the wear and provide for grinding back, as well as for adjustment for varying sheet metal thicknesses, thread-ended pins 52 are made in a novel manner hereinafter described. Each pin 52 has a central bearing stem 122 in which threads 123 are cut at one end, mating with a correspondingly tapped hole 124 in the carrier structure. At the opposite side of said bearing stem 122 is a diametrically enlarged thread-ended bearing portion 125 equipped with internal wrenching socket 126. Its bearing portion is seated in a drilled hole 127 in the carrier structure. The demarcation of said diametrically enlarged portion 125 from central bearing stem 122 forms shoulder 128, which is adapted to bear against the end of the cutting disc's tubular stem 43. From the drawing, it is apparent that by screwing said pins 52 by their internal wrenching sockets 126, the upper and lower shearing discs 40 and 53 may be advanced toward each other (no other adjustment being required) and secured by tightening lock nuts 129, provided the whole faces of disc cutters 40, 53 are ground down.

It should be understood that changes and modifications in the form, construction, arrangement, and combination of the several parts of the punching and cutting devices, including duct gages, may be made and substituted for those herein shown and described without departing from the nature and principle of the present invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. The method of shearing sheet metal strips into bisymmetrical oblique-angled pieces, comprising fixing to a table a pair of abutment bars parallel to each other at sufficient distance to accommodate and guide between them the strip to be sheared and at such angle to the table edge as is desired to be cut, advancing said strip across said table edge, shearing along said table edge, turning said strip over, replacing it between said parallel abutment bars, advancing it such distance that the said table edge marks the desired line of cut, affixing against the first-sheared edge a laterally- and angularly-adjustable gage,

shearing along said table edge, removing the piece so sheared, turning over the remainder of said strip, replacing it between said parallel abutment bars, advancing the last-sheared edge against said gage, and repeating the five steps last mentioned until said strip is utilized as fully as is possible.

2. The method of laying out and cutting sheet metal for forming straight sections of interchangeable rectangular ducts, comprising placing a sheet of sheet metal on a table and aligning it against a scaled rear abutment so that the excess length of said sheet overhangs an edge of said table, shearing along said edge, adjusting along the opposite edge of said table a plurality of notchers, including one notcher adapted to mark the width desired, inserting one edge of said sheet into said notchers, maintaining said sheet abutting against said scaled rear abutment, actuating said notchers, removing the said sheet therefrom, turning it over and inserting the opposite end into said notchers, maintaining said sheet abutting against said rear abutment, actuating said notchers, removing said sheet therefrom to a position wherein the two notchers marking the desired width of sheet align with the cutting line of a shear, and shearing said sheet along a line between said two notches.

3. The method of shearing a sheet metal strip into a number of like bi-symmetrical oblique-angled pieces, utilizing a work table having a rectilinear shear, an abutment bar adjustably mounted to the table surface, and a remote gage spaced outward from the line of shear, comprising the steps of securing the abutment bar to the table surface at the desired oblique angle to the line of shear, placing the sheet metal strip on the table with its first side down, its first edge against the abutment bar, and with one end of the strip projecting across and outward of the line of shear, shearing the projecting end from the strip and discarding said end, turning the strip over onto its second side and placing its second edge against

the abutment bar and advancing the strip across the line of shear such distance that the portion projecting beyond the line of shear is a bi-symmetrical oblique-angled piece of the size desired, affixing the remote gage against the newly sheared end and securing it in reference to the work table, again shearing the strip, removing the oblique-angled piece so sheared from the strip, turning the remainder of the strip onto its first side with its first edge against the abutment bar and advancing its newly sheared end against the remote gage, again shearing the strip and removing the piece so sheared, and continuing the steps of turning the strip over, aligning it with the abutment bar, advancing its newly sheared end against the remote gage, and shearing, until the desired number of pieces is formed or the strip is exhausted.

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