The present invention relates to sheet metal joints and to boxes using such joints, and it also relates to methods of making sheet metal joints and boxes. Over the years sheet metal parts have been joined together in many ways, as with rivets, spot-welds, and with integral projections extending from one metal sheet through a hole in another sheet and bent over to hold the sheets together. The present invention has as an object the provision of a new form of sheet metal joint having certain advantages over such joints known previously, and a related object is to provide a novel method of making sheet metal joints. A further object of the invention relates to providing a simplified and improved box joint and a novel method of making boxes whose walls are joined in the novel manner.

A feature of this invention is the great strength of the novel joints produced. An additional feature is the generous tolerances permissible in the joint forming operations. A further feature lies in a reduction in the number of operations involved in making boxes with joined walls. Other aspects of the invention and features of novelty will be apparent from the detailed description of an embodiment of the invention given below.

This illustrative embodiment will be seen to involve a four-walled box having one pair of walls formed with edge portions turned in along the inside surfaces of the other pair of walls. These in-turned edge portions may be referred to as inner sheet metal members or, more simply, as inner sheets or inner walls. Tongues are struck out of the inner sheets, these tongues projecting outward through holes in the overlying pair of walls. The inner sheet tongues leave spaces in the metal from which they are struck. The portions of the tongues that project from the inner sheet beyond the outer metal sheet are bent across the outer surface of that outer sheet, and are pressed hard enough to drive metal from the outer sheet into the spaces in the underlying or inner sheet from which the tongues were originally struck. Integral offset areas extending from the outer sheets are thus formed in the joint-forming operation. The portions of the inner-sheet tongues which formed the integral offsets then occupy the spaces in the outer wall left by metal shifted in forming the offset.

Only part of each of the inner-wall tongues described overlies an integral offset. The remainder of each inner-wall tongue is forced back into the space in the inner metal sheet from which it was struck initially. This is achieved through the provision of a further lance struck up from the outer sheet. This lancing operation forms relatively large holes for readily admitting the projecting tongues of the inner sheet metal elements.

The struck-up tongues of the outer sheet metal walls are driven against the base portions of the inner-wall tongues. Too much force finally drives the outer-wall tongues back into the holes left when they were formed initially, closing the holes provided for the inner-wall tongues, and the same operation drives the base portions of the inner-wall tongues back into the initial spaces in the inner metal sheet from which they were taken originally. The tongues in the finished joint are confined substantially to the same two levels or thicknesses of the metal sheets thus joined.

The struck-up outer-wall tongues and the base portions of the inner-wall tongues acquire great strength when they are driven back into the holes left in their original metal sheets. Each of the struck-up tongues acts as a tool whose location is fixed precisely in relation to the metal on which it is to act, operating accurately despite relatively inaccurate operation of the pressure applying tools.

In forming a box with these joints in the illustrative disclosure, the tongue-driving tools employed are the same ones which bend the second pair of walls up from the flat sheet-metal blank. The second pair of walls are bent into place by wiping dies, and those wiping dies continue their motion to wipe over the projecting tongues and drive them into final configuration.

The tongues struck up from the inner and outer sheets are arranged so as to extend from their base connections in the same direction relative to the holes left in their original sheets. In the box this is upward, away from the bottom of the box and toward the edges of the box. It is by virtue of the arrangement that the same wiping dies which fold the second pair of walls up into position are also effective in the very same stroke for completing the joints. Consequently, certain steps in handling of the box are avoided, such as might be required in making a box and then making joints of comparable strength.

The cost of making the box complete with the novel joints is not appreciably different from that of making the box without joints.

The holes in the outer wall are made larger in all directions than the cross section of the inner-wall tongues which extend outwardly through such holes during the forming operation. This is an important consideration since it enables practical joint-fabrication without imposing unduly close tolerances on various dies involved in the usual sequence of blanking, piercing and lancing, and bending stations. The application of the novel joint to the box described is highly advantageous but is not intended to be limited since the invention obviously has useful application to a wide variety of structures other than this form of sheet metal box.

In the accompanying drawings in which an illustrative embodiment of the invention is shown:

Fig. 1 is a perspective of a box embodying features of the invention, the proportions of the joints being greatly enlarged relative to the dimensions of the walls of the box;

Fig. 2 is an enlarged fragmentary front view of a joint before the parts are bent into interlocking engagement;

Fig. 3 is a cross section of the joint along the line 3—3 in Fig. 2;

Figs. 4 and 5 are progressive cross sections of the parts of Fig. 3 in intermediate and final conditions, respectively, the plane of the section being the same as that of Fig. 3;

Fig. 6 is a cross section, further enlarged along line 6—6 of Fig. 5; and

Fig. 7 is a reduced cross sectional view of a metal box blank and forming dies preparatory to the final side-folding and joining operation, the plane of the section of this view being represented by the line 7—7 in Fig. 1.

Fig. 1 illustrates the invention as applied to a four-walled open box. This view shows a pair of end walls 10 having in-turned edge portions 12 and having outer side walls 14 all extending upward from the bottom 18. Near each corner of the box a mechanism joint is shown, formed of two tongues 12a and 14a, these numbers corresponding to the sheet metal elements from which they extend. As seen in Fig. 5, tongue 12a includes an end portion 12c and a further base portion 12d, the first portion being disposed over the outside surface.
of outer wall 14 yet being disposed in the level or thickness of that metal sheet, and the tongue portion 12c is disposed within the original level or thickness of inner metal sheet 12b in which it was initially formed. An integral off-set area 14b is formed of wall 14, this being very nearly of the same outline as tongue portion 12b. Off-set 14b is formed (as will be seen) by pressure applied by tongue portion 12b.

The edge of tongue portion 12b is seen to be intimately dug into the wall 14, immediately opposite the hole in panel 12 left by cutting tongue 12a of metal sheet 12; and similarly, the upper edge of tongue 14a and the lower edge of off-set 14b grip and dig into and lock the portion of tongue 12a at the line between portions 12b and 12c. This resulting interlocking arrangement prevents even the slightest motion of outer sheet 14 relative to inner sheet 12 if there were any tendency of the sheets to shift in the vertical direction.

As seen in Fig. 6, tongue portion 12b has pressed a small integral area 14b of wall 14 into the hole left in sheet 12 when tongue 12c was cut from the sheet. Off-set area 14b, pressed into that hole by tongue portion 12b leaves a corresponding recess at the level of sheet 14, and that recess is occupied by tongue portion 12b. Because of the interlock formed at the lateral edges of tongue portion 12b and off-set area 14b, no sliding motion of sheet 14 relative to sheet 12 is possible horizontally in the plane of those sheets.

Tongue 14a is driven into the space in its own sheet metal member from which it was originally formed, and similarly tongue portion 12c occupies substantially the original space in the inner sheet from which it was taken. This is not the case with tongue of this type, when such a tongue is cut out of its original sheet metal member and then driven back, there is great binding at the edges, and considerable force would be required to drive the tongue out of its original hole. These edge binding forces develop considerable resistance to any force tending to pull sheet metal member 14 from sheet metal member 12. Tongue 14a prevents tongue portion 12c from being pulled out of the position shown and tongue portion 12c itself is edge-locked in its original sheet.

It will be understood that if one were to attempt to separate sheets 12 and 14, it would be necessary to bend small integral area 14b from its position where it is overlapped by tongue portion 12c, or tongue portion 12b would have to be bent in an upright position; and in order to do this, all of the various edge binding forces would have to be overcome.

It has been noted that the proportions in Fig. 1 are distorted. Illustrative dimensions are: a box having a panel 10 of 4 1/2" wide and 3" deep, approximately, and an in-turned edge portion 12, 5/8" wide, utilizes a tapered lug 12a that is only 5/16" high by 5/16" wide at its upper edge and 5/16" wide at its base or point of connection to in-turned metal sheet 12; and in panel 14 that is 6" wide by 3" high, tongue 14a is 3/4" high, with an upper edge of 1 3/8", slightly tapered to have a broader base where it connects to its original sheet. In sheet metal of .054" thickness and only one such joint per corner, a box has been tested for Underwriters' Laboratories approval, and found to be strong enough to withstand severe warping of the walls without damage to the joints. The strength of the box compares favorably with a box having a number of spot-welds at each corner. The great strength of the new joint is maintained with remarkable uniformity, over a large number of boxes in mass production.

The box of Fig. 1 is formed in a series of blanking, piercing and bending operations which are, in general, entirely conventional and are not illustrated. The sheet metal is formed and the tongues 12a and 14a are assembled as illustrated in Figs. 2 and 3. Off-set area 14b has not been formed, and is represented in Fig. 3 by the numeral 14b'. Tongue 12a is seen to project perpendicularly from sheet 12 through hole 14c left in sheet 14 by

the formation of tongue 14a. Hole 14c is seen to have its edge displaced by the distance 14b' from the upper edge of the hole 12d that was left in sheet 12 when tongue 12a was formed, and is supported on a male die 20 and is held against that die by

It is relatively simple and a relatively non-critical operation to assemble the sheets in the condition shown in Figs. 2 and 3, for there is a very great latitude permitted by the difference in size of the cross-section of tongue 12c, as viewed end-wise in Fig. 2, and the aperture which tongue 12a is to penetrate. Thus, the side-to-side tolerance is very great, the spaces A in Fig. 2 allowing a substantial latitude of error in arranging for tongue 12a to project through sheet 14. Similarly there is a considerable space between the upper edge 14c and the upper edge of tongue 14a for the tongue 12c to enter and be received.

The vertical clearances left between tongue 12a and the hole it is to enter are represented by spaces B and C in Fig. 3. This is a feature of immense importance in the practical application of this joint for it permits a wide range of variation and a comparatively great error in setting up of the tools without harmful effect in the assembling and joining operations and in the resulting joint. With the assembly shown in Figs. 2 and 3, the joint is made by applying a force to the lower surface of tongue 14a. It should be noted that the outer end of tongue 14a has a curled portion 14d. This curled tongue end engages the lower face of tongue 12a and acts as a localized tool which bends tongue 12a as tongue 14a is being bent. The bending operation is complete as shown in Fig. 4 with tongue 14a pressed against the outside surface of tongue 12a and tongue 12c pressed against edge 14c of metal sheet 14. As shown by a comparison of the views in Figs. 4 and 5 the joint is transformed preferably by sliding a tool up along the outer face of metal sheet 14 while furnishing backing for sheet 12, or a slant blow may be struck against the outer faces of tongues 14a and 12c. In box manufacture, either procedure can be followed in the same station where the sides of the box are bent up. During this final phase of the joint formation, tongue 14a drives tongue portion 12c into that portion of hole 12d from which that portion was originally taken, and tongue 14a is itself substantially returned to the portion of the sheet 14 from which it was taken; and tongue portion 12c forms an offset of tongue 14c extending integrally from the sheet metal wall 14. Tongue portion 12b is seen to have driven area 14b into the space left in metal sheet 12 when tongue portion 12c was originally formed, and, in turn, tongue portion 12b is seen to occupy the space left in sheet 14 by the formation of area 14b. The only mechanical working of tongue 14c that is imposed in forming offset 14c occurs during the very operation of forming the joint. There is no mechanical working of the metal at the edges of this offset preparatory to making the joint. Avoidance of such double mechanical working of the metal in making this offset is of substantial importance to the strength of the joint. Similarly, the only mechanical working of tongue portion 12b occurs during the formation of the joint. Tongues 12a and 14a are formed with a bend of generous radius at their connections to their respective sheets, and are thus protected from excessive mechanical working.

It has been said that this particular form of joint has special advantage in application to a box, of the general form shown in Fig. 1. The joint possesses all the requisite strength. The tongues are formed in the same stations where the other holes are formed and knuckled holes are formed in the box blank; and the joint can be formed in the very same operation required to bend the sides of the box into upright condition in the routine manufacture of such boxes. The folding operation is illustrated in Fig. 7. The box blank, whose portions bear the same reference numerals in Fig. 7 as the box shown in Fig. 1, is supported on a male die 20 and is held against that die by
by a pressure pad 22. A female die 24 is operated through a power stroke downward to wipe the side walls 14 into place against the intumescence edges portions 12 of the end walls 10. Tongues 12a are suitably positioned so that they penetrate holes 14c when the side walls 14 are bent into vertical position by the sliding female die 24. Tongues extend across the outside walls 14, that die strikes all of the tongues 14c simultaneously so as to transform the assembly through the succession of conditions shown in Figs. 3, 4 and finally 5. In Fig. 7, tongues 12a extend across the path of die 24, and in the finished joint, tongues 12a are directed away from the bottom of the box. The same direction of bending is effected when the joints are formed as is involved when the side walls are bent into vertical position.

Some of the minor but significant detailed features may be of interest. The upper edge of tongue 12b is offset somewhat below the upper edge of hole 12d, because of the sinusoid form of tongue 12a as it passes between offset 14b and tongue 14c. Tongue 12b has tapered edges. It is by virtue of the offset between the tongue parts 12a and 12b and the taper of the latter that the transverse dimension of tongue 12b is everywhere slightly narrower than that of offset area 14b. Offset 14b accordingly is joined to its sheet 14 not only at its base but also at its lateral portions extending from from said first pair of metal sheets at three edges and has only a connection to its original sheet at its base. The foregoing detailed description portrays the presently preferred embodiment of the invention. However, it will be recognized that various features of the invention have a range of useful application, and the general arrangement, and the details of the illustrative embodiment are subject to a latitude of variation. Consequently, the appended claims should be accorded a latitude of interpretation, consistent with the spirit and scope of the invention.

What is claimed is:

1. The method of joining two metal sheets together including the steps of striking a first relatively narrow and long tongue up from the first sheet to leave a first hole therein and with said tongue projecting outward thereof, striking a second relatively short and broad tongue up from the second metal sheet to leave a second hole there in, and forming a curved end on said second tongue, there after assembling the sheets in overlying relationship with the tongue of the first sheet extending through the hole in the second sheet and with the curved end on said second tongue extending toward the first tongue, driving the curved end tongue against the first tongue, and driving a projecting portion of the first tongue against the second sheet, and forcing both said tongues to occupy the thicknesses of said sheets, respectively.

2. The method of making a metal box which includes the steps of forming a sheet-metal blank with opposed pairs of walls, forming upstanding relatively narrow tongues in laterally extending portions of one pair of walls so as to leave holes in such laterally extending portions and with the tongues extending integrally therefrom, forming second relatively wide tongues in the second pair of walls, leaving corresponding apertures in the second pair of walls, with the apertures in position to receive the upstanding tongues when the blank is later bent into box form, and to provide a wall portion overlying the holes in said first-mentioned tongues, forming a curved end on each of said second-mentioned tongues, with the curved ends of said second-mentioned tongues extending toward said first-mentioned tongues bending said first-mentioned pair of walls into upright position, and bending the second set of walls so as to have the first-mentioned tongues project through the holes in the second pair of walls, driving the curved ends of said second set of tongues against the first set of tongues and thereafter driving both sets of tongues substantially into the thickness of the overlying walls from which the lances were struck.

3. The method of joining two metal sheets together including the steps of striking a first tongue up from a first sheet to leave a first hole therein and with said tongue projecting outward thereof, striking a second tongue up from the second metal sheet to leave a second hole therein and forming a curved end on said second tongue, assembling the sheets in overlying relationship with both tongues projecting from the same sides of the assembled sheets and with the tongue of the first sheet extending through the hole in the second sheet and with said curved end on said second tongue extending toward the first tongue, driving the curved end of the second tongue against the first tongue, driving a projecting portion of the first tongue against the second sheet, and forcing both tongues to occupy the thicknesses of said sheets with part of the first tongue occupying the thickness of the second sheet adjacent said hole therein and part of the second sheet that underlies said part of said first tongue occupying part of said hole in the first sheet from which said first tongue was struck.

4. The method of making a sheet-metal box which includes the steps of forming a blank of sheet metal with a rectangular bottom, an opposed first pair of walls, lateral portions extending from said first pair of walls, and an opposed second pair of walls, striking relatively narrow integral tongues up from said lateral portions extending from said first walls so as to project outwardly when said walls and said lateral portions are bent into box form, driving second relatively wide tongues up from the second pair of walls so as to project outwardly when said second walls are bent into box form, the holes left by striking up said wide tongues being located to admit said relatively narrow tongues when the blank is bent into box form, bending said first pair of walls into upright position relative to said bottom and bending said lateral portions at right angles thereto, said relatively narrow tongues thereby projecting outwardly, bending said second pair of walls into upright position, and forming said second bottom and thereby causing said relatively narrow outwardly projecting tongues to project through the holes left by striking up said second tongues and causing said relatively wide tongues to project outwardly, and driving both the narrow and wide tongues in the restoring direction relative to the holes from which they were struck, the driving operation being sufficiently intense to force said second tongues and opposed portions of said first tongues respectively back into the holes and substantially into the metal thickness from which they were struck and to drive additional portions of said first tongues against said hole-covering areas of said second walls intensely enough to offset said hole-covering areas into the hole portions covered thereby and at the same time driving said additional portions of said relatively narrow tongues substantially into the thickness of the second walls to occupy the space left vacant by offsetting of said areas as aforesaid.

5. The method in accordance with claim 4 wherein the holes left by striking up said tongues are more remote from said bottom than the connection of said tongues to said sheet-metal blank, and wherein said driving step as aforesaid is effected by a least one cutting stroke along the outside surface of the box in the direction away from said bottom.

6. The method of making a sheet-metal box which includes the steps of forming a blank of sheet-metal with a rectangular bottom, an opposed first pair of walls, and an opposed second pair of walls, with portions extending integrally from said first pair of walls, a portion of each of said second pair of walls to be engaged by one of said lateral portions of said first pair
of walls as a pair of companion face-to-face contacting portions in the completed box, striking integral upstanding tongues out of said lateral portions and out of said portions of said second walls and leaving holes therein, the tongues all projecting generally in the same direction relative to one surface of the sheet-metal and relative to the bottom of the completed box, the tongue that extends from one of each pair of said companion portion being relatively narrow and the tongue that extends from the other one of each said pair of companion portions being relatively wide, both tongues and the corresponding holes of each of said pairs of companion portions being located so that each narrow tongue will enter and project through the hole left by the related wide tongue when said lateral portions and said pairs of walls are bent into box form, and each hole left in one of a pair of said contacting portions by striking up a said relatively narrow tongue being located to be partly covered by a small area of the other of said pair of contacting portions, bending said first walls so as to be erect on said bottom and bending said lateral portions at right angles to said first walls, bending said second walls so that said companion portions thereof make face-to-face contact with said lateral portions of said first walls, the relatively narrow tongues projecting through the holes left by striking up the relatively wide tongues and said wide tongues projecting in the same general direction as said relatively narrow tongues, and driving both the relatively narrow tongue and the relatively wide tongue of each said pair of portions substantially into the thicknesses of such pair of portions with part of each relatively narrow tongue being driven against the corresponding small hole-covering area with sufficient intensity to offset said small area into the part of the hole covered thereby and into the thickness of the metal in which such hole is formed, said part of each narrow tongue being driven into the space originally occupied by said offset small area, each of said relatively wide tongues being intensely driven against opposed portions of said relatively narrow tongues so as to drive both the wide tongues and the corresponding portions of the relatively narrow tongues back substantially into the metal thickness from which they were struck and into edge-locking relation therewith.

7. A four-walled sheet-metal box including a rectangular bottom and an opposed first pair of walls and an opposed second pair of walls, lateral portions extending integrally from said first walls and at right angles thereto and each lateral portion underlying a corresponding portion of one of said second walls at each corner of the box, said portions at each corner having respective integral tongues struck therefrom, one of said tongues at each corner being relatively wide and being edge-locked in the hole from which it was struck and the other of said tongues at each corner being relatively narrow and having a part thereof underlying said relatively wide tongue, said part being disposed in the corresponding part of the hole from which it was struck and being edge-locked therein, an additional part of each of said relatively narrow tongues overlying a corresponding integral small area of the related one of said portions adjacent the end of the corresponding relatively wide tongue, each said additional part of said relatively narrow tongues being disposed to occupy the thickness of said portion from which the related second tongue extends and each said small area being disposed to occupy the thickness of said portion from which said first tongue extends, both said tongues at each corner of the box extending integrally from their respective portions in substantially the same direction.

8. A sheet-metal box in accordance with claim 7, wherein said relatively wide tongues are integral portions of said second walls and said relatively narrow tongues are integral portions of said lateral portions of said first walls, and wherein said relatively wide and narrow tongues extending in the upward direction relative to the bottom of the box.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,647</td>
<td>Pratt</td>
<td>Aug. 14, 1891</td>
</tr>
<tr>
<td>454,636</td>
<td>Brown</td>
<td>June 23, 1891</td>
</tr>
<tr>
<td>518,767</td>
<td>Plecker</td>
<td>Apr. 24, 1894</td>
</tr>
<tr>
<td>597,056</td>
<td>Dieckmann</td>
<td>June 11, 1898</td>
</tr>
<tr>
<td>1,557,066</td>
<td>Krantz</td>
<td>Oct. 13, 1925</td>
</tr>
<tr>
<td>2,426,670</td>
<td>Cooley</td>
<td>Sept. 2, 1947</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>338,139</td>
<td>France</td>
<td>Mar. 11, 1904</td>
</tr>
</tbody>
</table>