May 19, 1942. J. JENSEN 2,283,258

METHOD OF AND MEANS FOR PRODUCING SHEET METAL JOINT LOCKS AND THE LIKE

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Fig. 1

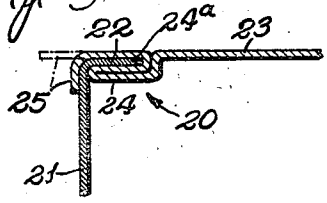



Fig. 2

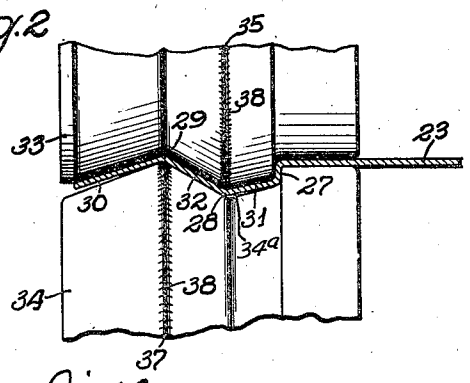



Fig. 3

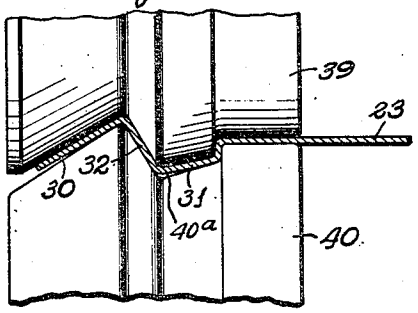



Fig. 4

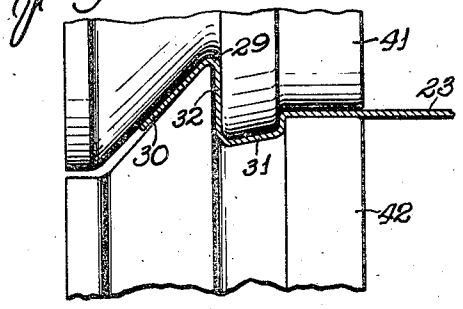



Fig. 5

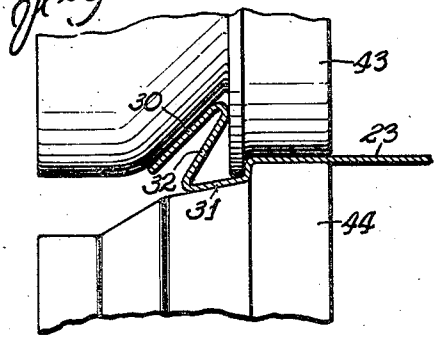



Fig. 6

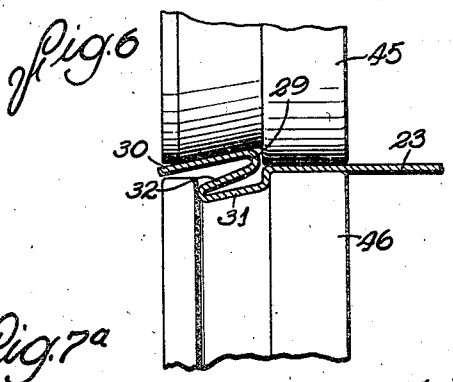



Fig. 7

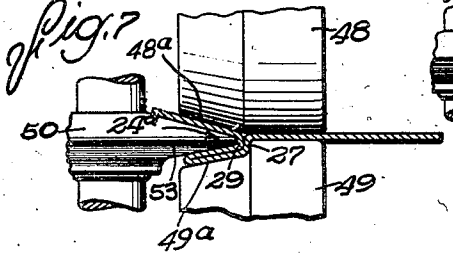
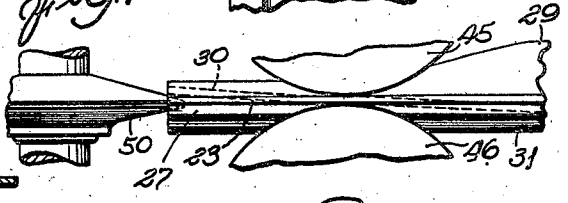



Fig. 7a




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Fig. 8

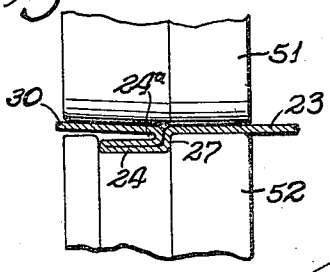



Fig. 9

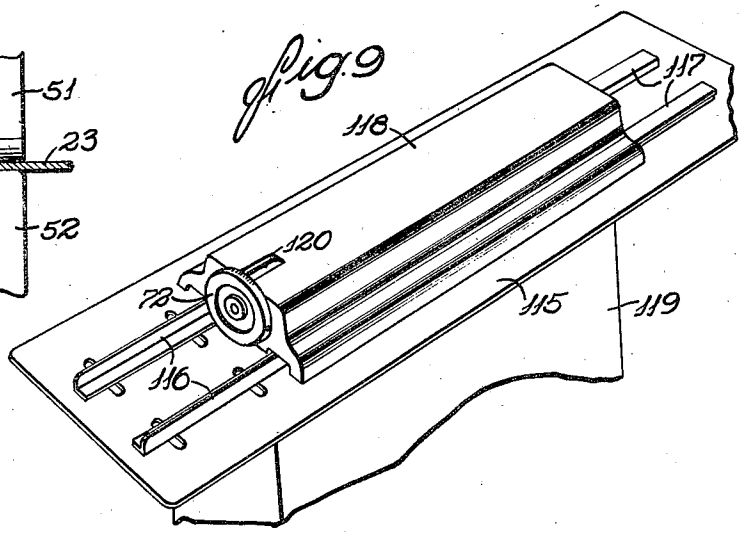
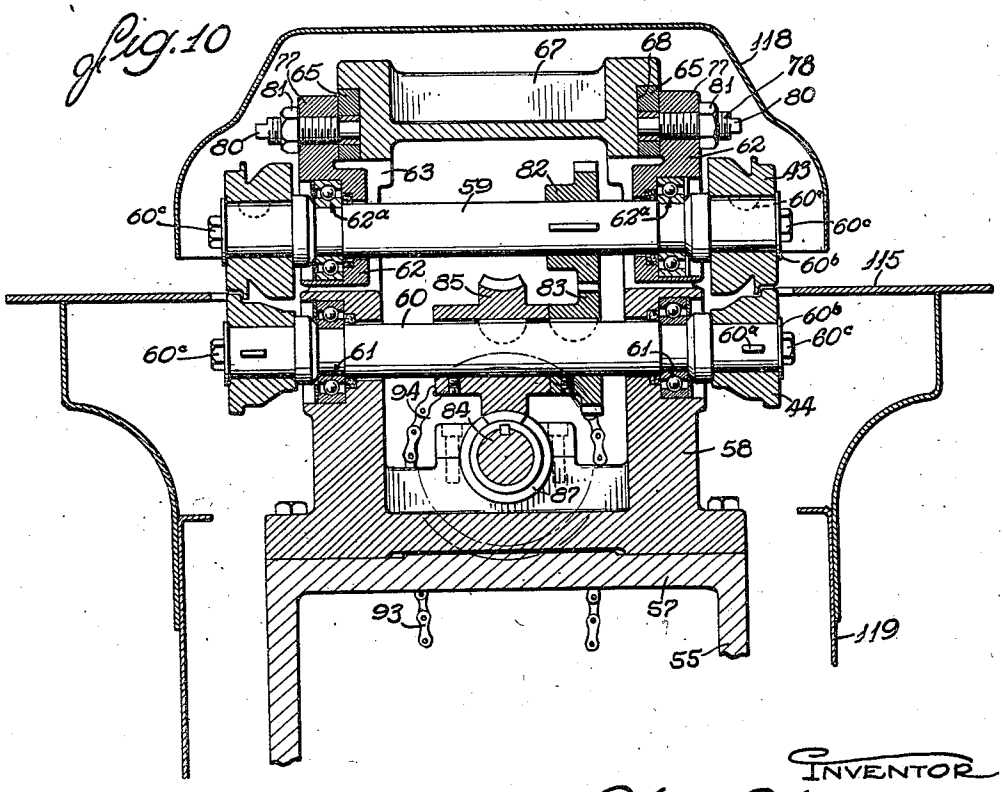



Fig. 10




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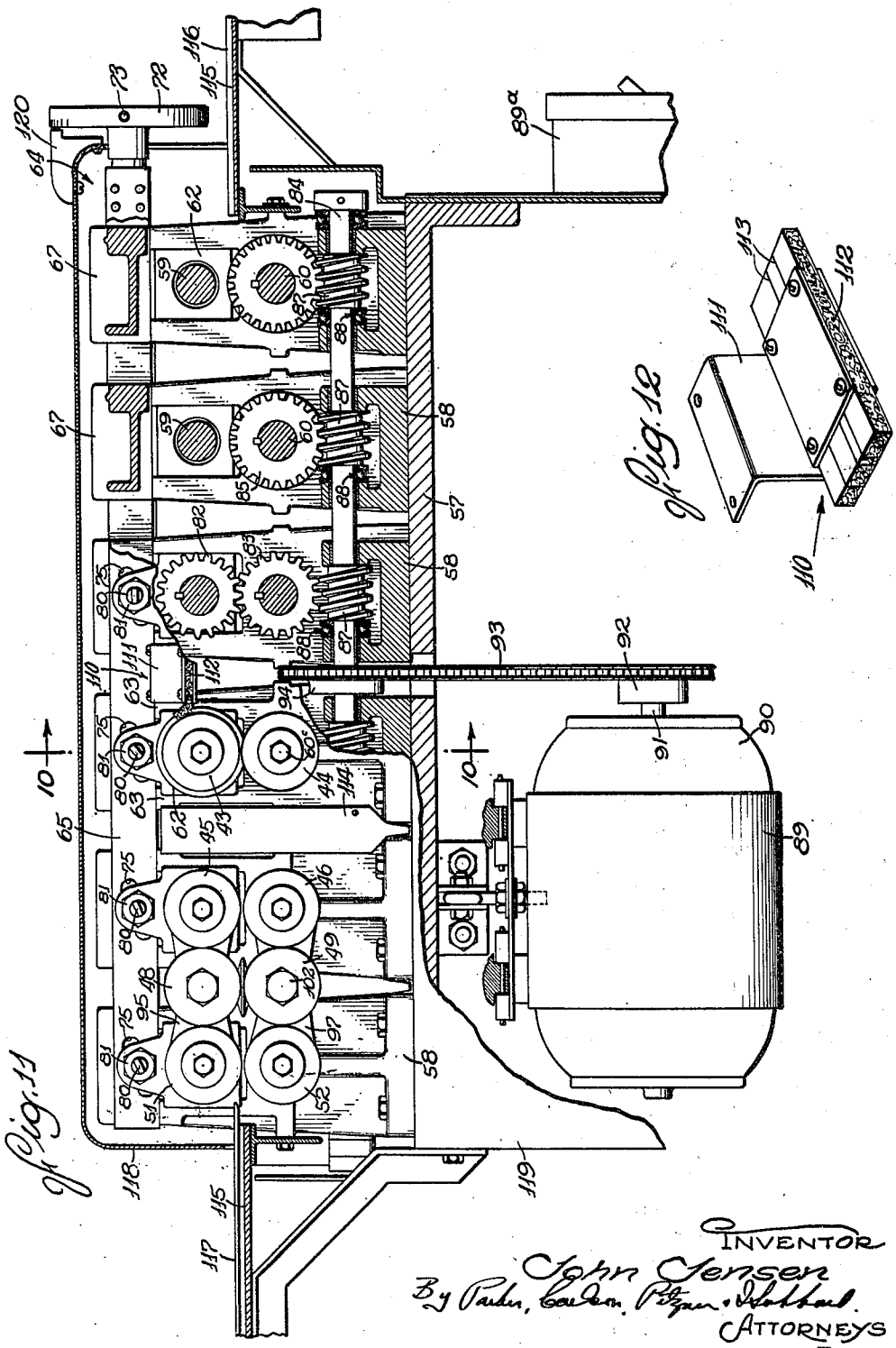


Fig. 11



Fig. 12

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METHOD OF AND MEANS FOR PRODUCING SHEET METAL JOINT LOCKS AND THE LIKE

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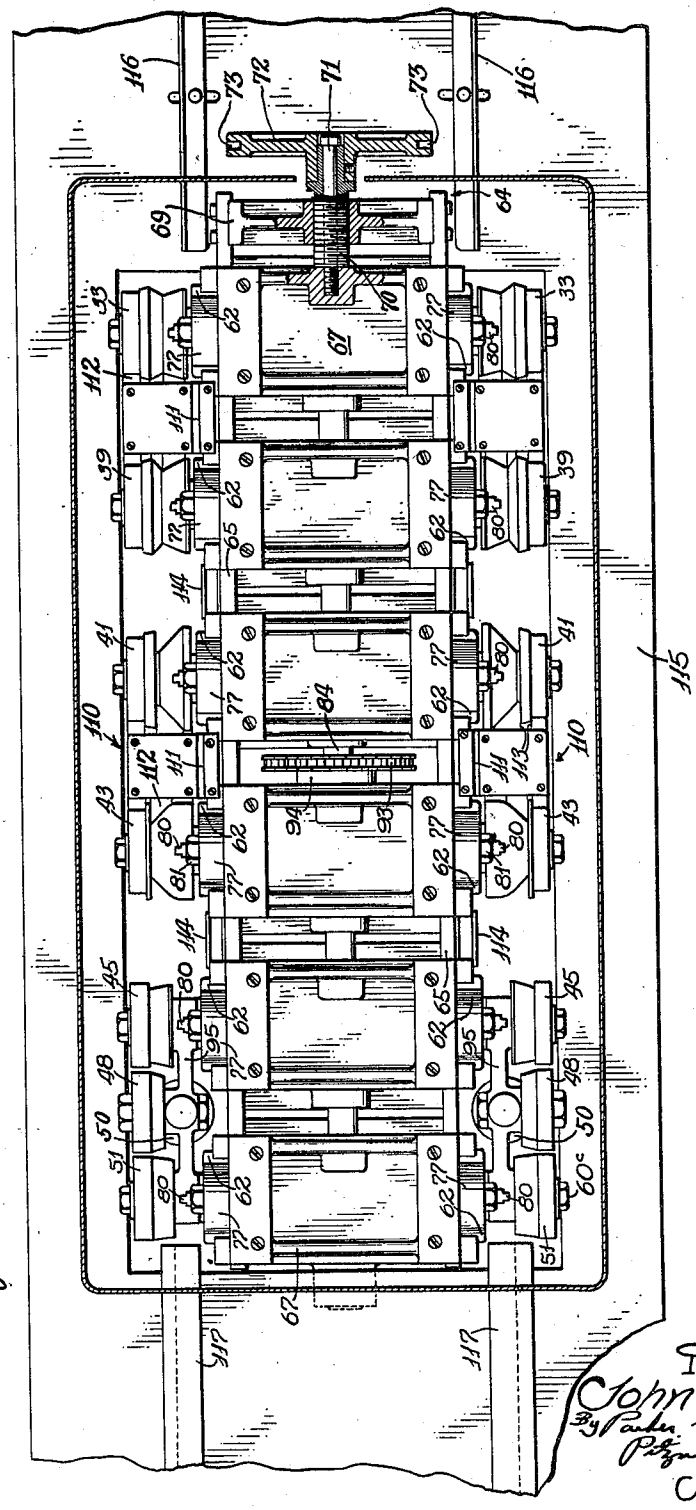


Fig. 13

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METHOD OF AND MEANS FOR PRODUCING SHEET METAL JOINT LOCKS AND THE LIKE

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Fig. 14

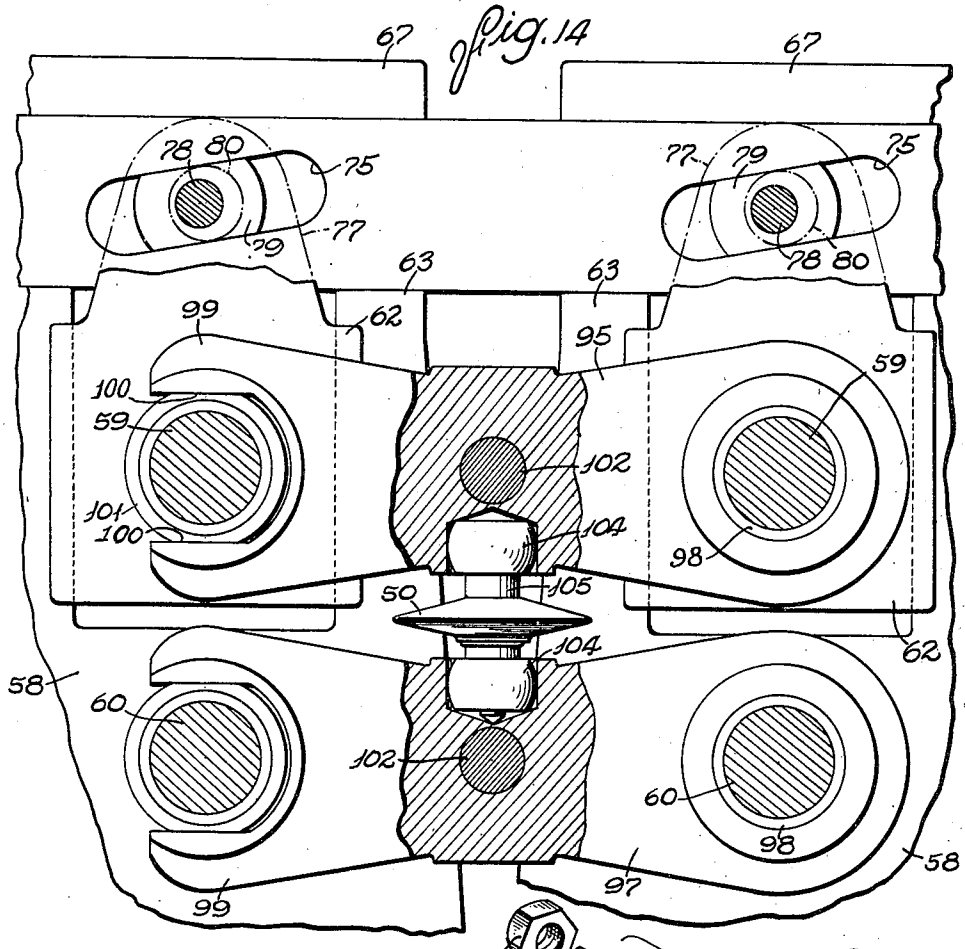
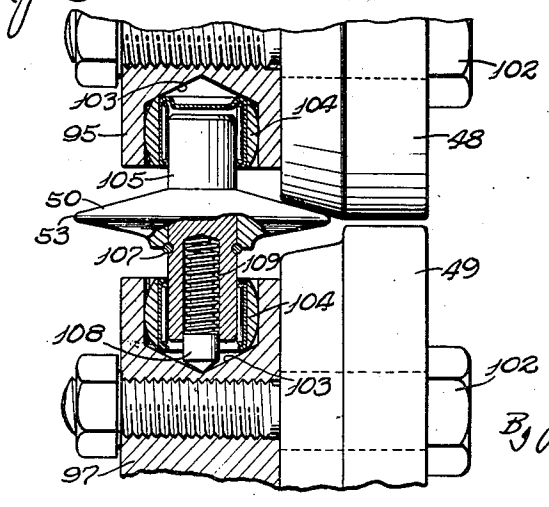



Fig. 15



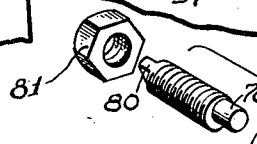
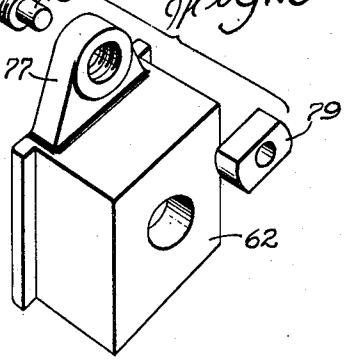




Fig. 16




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Patented May 19, 1942

2,283,258

# UNITED STATES PATENT OFFICE

2,283,258

## METHOD OF AND MEANS FOR PRODUCING SHEET METAL JOINT LOCKS AND THE LIKE

John Jensen, Rockford, Ill., assignor to Whitney Metal Tool Company, Rockford, Ill., a corporation of Illinois

Application October 8, 1938, Serial No. 233,917

15 Claims. (Cl. 153—28)

This invention relates primarily to improvements in the method of and means for producing the sheet metal joint lock sometimes referred to as the "Pittsburgh" lock. This lock is used where two sheet metal margins are to be united angularly, one margin being double folded longitudinally to provide a laterally opening mouth or socket and a projecting lip which may be bent over to lock within said socket a longitudinal edge flange on the other margin.

A general object of the invention is to provide an improved method of and means for producing this type of joint lock, which are simple, efficient and practical, which avoid undue strain on the metal undergoing shaping and minimize frictional resistances, and which insure uniformity in operation and product.

Another object is to provide an improved method of forming a joint lock of this type in which the parts forming the walls of the mouth or socket are gradually and smoothly brought into opposed spaced relation and are positively acted upon to maintain the spaced relationship permanently to facilitate reception of the sheet margin to be locked therebetween.

Another object of the invention is to provide a joint-lock forming machine which will efficiently handle a larger range of metal thicknesses or gauges than prior machines without requiring a change of forming rolls.

A further object of the invention is to provide a machine of this type which is adapted for simultaneously shaping two separate sheet metal members and in which the metal forming means is quickly replaceable to adapt the machine for various shaping operations.

An additional object is to provide improved, simple driving means for the forming rolls of the machine.

Still another object resides in the provision of improved means for adjusting the forming rolls.

A still further object is to provide an improved idler roll construction for use in one step of the joint-forming process.

Yet another object resides in the provision of novel means adapted for keeping the forming rolls of the machine free from oil and the like which might otherwise be transferred to the surface of the sheet metal undergoing shaping and cause an objectionable condition deleterious to finishing mediums such as paint that may subsequently be applied.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a fragmentary cross-sectional view through a sheet metal joint embodying a joint lock of the type contemplated by the present invention.

Figs. 2 to 7, inclusive, are fragmentary cross sectional views of a metal sheet margin showing consecutive steps in the forming process and the peripheral interrelationships of the several forming rolls used therefor.

Fig. 7a is a fragmentary side edge elevational view of the advancing end portion of the sheet margin as it passes from the rolls of Fig. 6, to the rolls of Fig. 7.

Fig. 8 is a fragmentary end elevational view of the sheet margin and the peripheral relationship of the final forming rolls.

Fig. 9 is a perspective view of a machine embodying the principles of the present invention.

Fig. 10 is a transverse vertical sectional view of the machine taken substantially along line 10—10 of Fig. 11.

Fig. 11 is a partially sectional side elevational view of the machine.

Fig. 12 is a perspective view of one of the roll wipers of the machine.

Fig. 13 is a top plan view of the machine, partly in section.

Fig. 14 is a fragmentary, partially sectional side elevational view of the idler forming roll structure.

Fig. 15 is a fragmentary transverse vertical sectional view through the idler roll assembly.

Fig. 16 is a perspective assembly view of one of the journal blocks utilized for the upper forming roll shafts of the present machine.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail, the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

A sheet metal joint 20 which embodies a joint lock of the type contemplated by this invention is shown, by way of example, in Fig. 1. Such a joint finds extensive utility, particularly in the construction of sheet metal ducts of the kind employed in heating, ventilating or air conditioning systems, etc. It is commonly used to unite two angularly related metallic sheets or

walls respectively designated 21 and 23. The sheet 21 is angularly bent longitudinally to form a marginal flange 22. The other sheet 23 is offset and otherwise shaped to provide a joint lock including a base fold 24 and a socket fold 24a within which the flange 22 is received. After assembly of the flange 22 within the socket 24a, an extension or locking lip 25, which initially projects beyond the lock socket as indicated in broken outline, is bent over against the outer face of the sheet 21 across the base of the flange 22. In this manner the two sheets 21 and 23 are connected together relatively snugly and permanently.

In forming the joint lock, a relatively wide marginal portion of the sheet 23 is offset out of the plane of the main body of the sheet, and this offset portion is shaped to form the lock by a series of forming rolls in a plurality of progressive forming steps. In accordance with the present invention, the rolls cooperate to form two reverse bends in the offset portion of the sheet, simultaneously producing the base fold 24, which is ultimately closed with opposing wall portions flat against each other and the socket fold 24a, which is preferably maintained open at all times throughout the forming operation.

Referring now to Figs. 2 to 8, inclusive, the sheet 23 is initially offset longitudinally from the plane of the main body of the sheet to define a relatively wide marginal portion with a narrow, substantially right angular shoulder 27. Simultaneously, the offset marginal portion is creased and bent along two spaced parallel longitudinal lines, as indicated at 28 and 29, to form two reverse bends comprising three connected flat plane sections, namely, an outer section 30, an inner section 31 and an intermediate or connecting section 32. These sections, as initially formed, are progressively of greater width from the inner to the outer section to provide for shrinkage in width during folding and to assure that the outer section 30 will finally project sufficiently to provide for the locking lip 25. Moreover, the sections are initially bent into angular relative relationships wherein the inner section 31 is obtusely related to the body of the sheet and the outer and intermediate sections 30 and 32 are obtusely related to each other and to the inner section. The initial creasing and bending is effected by a pair of cooperative, forming rolls 33 and 34 mounted on parallel axes.

To produce the creases or bends 28 and 29, the rolls 33 and 34 have creasing ridges 35 and 37, respectively, which project in opposite directions. The rolls 33 and 34 serve also as initial feed rolls and one or both of the creasing ridges may therefore be provided with means such as surface roughening or knurling 38 to facilitate gripping and onward feeding of the metal sheet.

After leaving the initial forming and feeding rolls, the sheet metal margin 23 passes successively through two additional preliminary forming steps between cooperative pairs of rolls 39 and 40 (Fig. 3), and 41 and 42 (Fig. 4). Between these rolls the angles between the outer and intermediate marginal sections 30 and 32 are gradually reduced from the initial obtuse relationship to an accentuated angular relationship. In passing between the second pair of rolls 39 and 40 the bending started by the initial pair of rolls is carried forward. Then between the third pair of rolls 41 and 42, the intermediate section 32 is brought to a substantially right angular relationship to the main body of the sheet, and the outer section 30 is bent in toward the intermediate section. At the same time the bend at the crease 29 is rounded off.

As a fourth step, the marginal portion of the sheet 23 passes between a pair of rolls 43 and 44 (Fig. 5) where the formation of the base and socket folds 24 and 24a becomes more evident. Here the outer and intermediate sections 30 and 32 are brought closer together and the intermediate section is tilted over toward the inner section 31.

Thereafter, the margin of the sheet 23 passes successively through three final forming steps wherein the outer and intermediate sections 30 and 32 are brought closer together, and the intermediate section 32 is bent against the inner section 31. To this end, the sheet margin passes on between a fifth pair of forming rolls 45 and 46 (Fig. 6) where the folding of the sections is brought close to completion. Then the sheet margin passes between a group of three rolls (Fig. 7) including two parallel-axis gripping rolls 48 and 49 and a transverse-axis roll 50. Here the inner and intermediate sections 31 and 32 are pressed together to close the base fold 24 and to open somewhat the socket fold 24a. Meanwhile, the obtuse angular relationship of the inner section 31 to the main body of the sheet is preferably maintained substantially the same as from the beginning of the forming operation. Lastly the sheet margin passes between a pair of finishing rolls 51 and 52 (Fig. 8) where the joint lock is given its final form, the inner and intermediate sections 31 and 32, which form the base fold 24 being brought substantially into parallelism with the main sheet body and the outer section 30 being bent back toward spaced parallelism with the other sections, to form the open socket fold 24a.

In practice it is important to have the mouth or socket 24a sufficiently open to facilitate reception of the mating flange 22 of the sheet margin to be connected. Such an open condition is assured herein by the action of the transverse-axis roll 50 which is of generally flattened shape and has the opposite faces thereof tapered wedge-fashion toward a blunt peripheral edge 53 to enter the mouth of the partially formed lock socket. As the roll 50 enters the mouth or socket 24a it forces the opposite portions of the socket fold gapingly apart against complementary outwardly tapered forming surfaces 48a and 49a on the parallel-axis rolls 48 and 49, respectively. Coincidentally, the peripheral edge 53 engages the inner angle of the socket fold formed by the crease 29 to force the latter into permanent open shape and lodge it against the offset-shoulder 27. This insures that the inner end of the socket fold will be smoothly rounded and definitely and uniformly shaped while the temporary enlargement of the mouth or socket facilitates the accurate final shaping of the lock by the rolls 51 and 52. Because of the permanent open shape of the inner angle of the socket fold 24a, even though the lips of the fold may subsequently be pinched closed accidentally or by fitting the associated sheet to a radius, such inner angle will retain its open shape and either cause the fold to spring open or permit easy opening thereof by means of a suitable tool when necessary.

It will be noted that up to the time the partially formed joint lock is engaged by the transverse-axis roll 50, the outer fold section 30 is caused by the preceding forming rolls to slope

generally in one direction relative to the main body of the sheet 23; but that the roll 50 rather abruptly forces said outer section 30 to slope in a reverse direction. The roll 50 is disposed with its largest diameter substantially in a plane between the rolls 45 and 46 (Fig. 11), but due to the inherent resiliency of the folded metal it tends to spring apart and the advancing end of the outer section 30 moves upwardly after leaving the rolls 45, 46 (see Fig. 7a) sufficiently to ride onto the upper face of the roll 50. The tendency of the edge portion or section 30 to spring upwardly is augmented by the rounded character of the bottom of the socket fold produced by the forming rolls 41—42 and maintained by the forming rolls 43—44.

In the final operation performed between the finishing rolls 51 and 52, the outer section 30 and the closed base fold 24 are reversely bent toward each other and brought almost to parallel relation but with the base fold parallel with the sheet 23 and the outer section 30 preferably on a slightly flaring angle to facilitate subsequent insertion of the mating flange 22 of the sheet margin to be secured in the socket 24a.

To carry out the several forming operations outlined, several of the pairs of forming rolls are necessarily cooperatively contoured with relatively deep forming grooves and complementary projecting flanges or ridges. In consequence there will be a differential in the peripheral rotary speed at spaced points axially of such rolls which might have a tendency to strain and warp the metal of the fold sections 30, 31 and 32 if the latter were tightly gripped at all points during passage between the rolls. To minimize such warping strains between the rolls 33—34 and the rolls 39—40, for example, they have a sufficient clearance as indicated at 34a and 40a, respectively, (Figs. 2 and 3) to permit slippage where the crease or bend 28 passes therebetween. Moreover, although the outer fold section 30 may be gripped between the horizontal- and vertical-axis rolls 48 and 50; this section is preferably free from gripping between the other rolls which are for this purpose contoured with sufficient clearance in the opposed peripheral portions of the rolls between which the section passes. In other respects also there is a minimum of necessary contact between the opposed rolls. This limited contactual relationship reduces friction and assures that the resulting joint lock will be substantially free of waviness or warping due to metal strains imposed by the rolls.

Although it is possible to adjust the forming rolls to accommodate sheet metal of different gauges, the rolls have a definite gauge range limit beyond which they will not operate effectively if at all. This is due to the fact that while the peripheral spacing between the rolls can be varied, it is not practicable proportionately to vary the clearance between the opposed axially facing wall surfaces of the contours of the rolls such as between the rolls 41 and 42. In order to avoid the necessity of having two separate machines or of changing over the rolls in a single machine for shaping metal sheets of gauges in a range beyond the limits of a single set of rolls, two sets of forming rolls are, according to the present invention, preferably mounted in a single machine for use simultaneously or alternatively. This at least doubles the capacity of the machine. One of the sets of rolls may, for example, be adapted for operating upon sheet metal within a range of approximately 18 to 22 gauge, while the other set of rolls may be adapted for operating upon sheet metal within a range of about 24 to 28 gauge. Moreover, the rolls are preferably replaceably mounted so that sets of rolls of different gauges can be substituted or rolls for producing other shapes than the Pittsburgh lock can be utilized in the machine. Thus, it is possible to form two joint locks of the same or different gauge metal simultaneously or to form another shape simultaneously as a joint lock or still another shape is being formed.

In this machine both sets of rolls are preferably driven by a common drive mechanism, and all of the rolls are preferably adapted to be adjusted simultaneously by common adjusting means. The metal sheets to be formed are adapted to be accurately guided to the forming rolls and as the folded shapes emerge from the finishing rolls they pass through a truing or straightening device.

As shown in Figs. 9 to 13, inclusive, the machine includes a suitable stand or base framework 55 having an elongated bed 57. Mounted in alinement in spaced parallel relationship transversely of the bed 57 is a series of substantially similar U-shaped standards 58 (Fig. 10). Each of these standards is constructed to support the opposite end portions of a pair of vertically spaced, parallel rotatable upper and lower shafts 59 and 60, respectively, the outer ends of which project beyond the opposite outer sides of the standards for supporting cooperating pairs of the forming rolls on horizontal axes. Herein, there are six of the standards 58 for supporting the shafts of six pairs of forming rolls. The rolls are secured fixedly to the ends of the shafts for easy removal, as by means of keys 60a, and retaining washers 60b which are held in place by bolts 60c threaded axially into the ends of the shafts.

In each instance, the lower shaft 60 is mounted to rotate on a fixed axis in suitable bearings 61 (Fig. 10) located in the opposite legs of the supporting standard 58. The upper shaft 59 is carried adjacent its opposite ends by identical journal blocks 62 containing anti-friction bearings 62a. The journal blocks 62 are mounted for vertical sliding movement between spaced parallel guides 63 (Figs. 11 and 13) at the upper ends of the legs of the standards 58 to permit adjustment of the spacing between the shafts, and thus the spacing between the forming rolls.

In order to effect such adjustment of the forming rolls quickly and easily and with consistent uniformity, novel means is provided for simultaneously shifting all of the journal blocks to vary the spacing between all of the upper shafts 59 and their corresponding lower shafts 60 jointly. Herein the journal blocks 62 are connected to an adjusting frame 64 (Figs. 11, 13 and 14) which is slidably mounted above the standards 58 for controlled longitudinal reciprocal movement across the paths of the up and down movement of the journal blocks to raise or lower the latter. The adjusting frame 64 includes a pair of spaced parallel bars 65 which respectively extend horizontally across the tops of all of the guides 63 of the opposite legs of the standards 58 above the journal blocks 62. To hold the adjusting frame 64 in place against upward movement, suitably dimensioned keeper plates 67 (Figs. 10 and 13) are secured to the upper ends of the guides 63 and have rabbets 68 at their ends to provide slideways for the frame bars 65.

At one end, herein at the front end of the machine, the adjusting frame bars 65 are connected

by a cross bar 69 (Fig. 13) through which is threaded an adjustment screw 70. This screw is rotatably secured in a fixed axial position by suitable means such as a stud bolt 71 which extends axially therethrough and is fixedly threaded into the side of the adjacent keeper plate 67. At its outer end the adjustment screw 70 carries a hand wheel 72 by which it may be rotated in opposite directions to effect horizontal longitudinal reciprocation of the adjusting frame 64. A suitable tool (not shown) to afford greater leverage and assist in turning the hand wheel 72 may be inserted into spaced radial sockets 73 provided therefor in the rim of the wheel.

The horizontal rectilinear motion of the adjusting frame 64 in opposite directions is translated into vertical shaft-adjusting movement of the journal blocks 62 through the medium of a pin and cam slot arrangement. For example, each of the frame bars 65 may have a series of identical diagonal slots 75 (Figs. 11 and 14) which are inclined in a front to rear direction and correspond in number and location to the journal blocks in each set. Each of the journal blocks has an integral upstanding ear or lug 77 (Fig. 16) which carries means such as follower pin or stud 78 threaded therethrough and coacting with a wear shoe 79 to ride within the associated cam slot 75 (Fig. 14). Thus, when the adjusting frame 64 is shifted forwardly (longitudinally to the right as seen in Figs. 11 and 14), the shoes 79 will be forced down the cam slots 75 and cause the journal blocks 62 and the shafts and forming rolls carried thereby to be lowered. The reverse movement of the adjusting frame will cause the shoes 79 to ride up the cam slots 75 and raise the journal blocks and associated shafts and rolls. Since the journal blocks 62 support the roll shafts 59 near their opposite ends and close to the forming rolls thereon, the vertical adjustment of the shafts will be effected by the adjusting frame identically and accurately at both ends of the shafts and avoid any possibility of tilting of the shafts to throw them out of parallel relation to the lower shafts 60.

In addition to the joint vertical adjustment of all of the journal blocks 62 as has been described, it is also advantageous to have each journal block separately adjustable. To this end the studs 78 have the ends thereof which engage the wear shoes 79 formed eccentrically (Figs. 14 and 16) so that upon rotation of any stud the associated shoe 79 and journal block 62 will move relatively and thereby shift the position of the journal block vertically with respect to the adjacent adjusting frame bar 65. To facilitate adjustment of the eccentric studs 78 the outer ends thereof may be shaped as at 80 (Figs. 10 and 16) to receive a suitable actuating tool. The adjusted position of each stud may be maintained permanently by tightening a lock nut 81 threaded thereon. Through this arrangement all of the forming rolls carried by the respective shafts 59 and 60 can be maintained accurately adjusted individually and collectively for optimum efficiency.

All of the roll shafts 59 and 60 are preferably connected for rotation in unison. Accordingly, each pair of the shafts 59—60 is geared together (Figs. 10 and 11) for joint rotation in opposite directions by meshing gears 82 and 83, respectively, keyed thereto. All of the pairs of shafts are driven simultaneously by means acting through the lower shafts 60, herein including a single drive shaft 84 which is journaled on the bases of the standards 58 and extends on the longitudinal median line of the machine transversely below the lower shafts 60. Each of the lower shafts 60 carries a worm gear 85 which meshes with a corresponding worm 87 on the drive shaft 84. To relieve rear ends of the worms 87 of thrust friction, suitable thrust bearings 88 are interposed between such ends and the adjacent journals of the shaft 84.

Power for driving the shaft 84 is supplied by an electric motor 89 (Fig. 11) which may be adjustably mounted in any preferred manner under the bed 57. A manual electrical control switch for the motor may be mounted at a convenient place as in a box 89a at the front end of the machine. At is forward end the motor 89 carries a speed reducer 90 which has a power shaft 91 including a driving sprocket 92. A sprocket chain 93 passes up through the bed 57 from the sprocket 92 to a driven sprocket 94 (Figs. 10 and 11) fast upon the drive shaft 84 preferably between the center pair of standards 58. It will be noted that this driving arrangement is substantially simpler than in prior machines of this character and to a large extent eliminates the complicated gear trains heretofore employed.

As shown herein (Figs. 11, 13, 14, and 15), the three coactive rolls 48, 49 and 50 may be idlers mounted between the fifth pair of driven forming rolls 45—46 and the finishing rolls 51—52 which, it will be observed, are substantially smaller in their axial dimension than the other driven rolls. This permits a pair of similar, elongated idler-roll supporting brackets 95 and 97 to be mounted at their opposite ends upon the upper pair of shafts 59 and the lower pair of shafts 60, respectively, the ends of the brackets constituting spacers (see Fig. 13) between the adjacent shaft bearings and the inner ends of the rolls. Herein, each of the brackets is apertured at one end to fit around a bearing sleeve 98 to receive one of the supporting shafts rotatably therethrough. At its opposite end, each of the brackets is constructed to permit adjustment transversely of the supporting shaft. For this purpose the bracket is formed to provide a pair of opposed parallel-faced jaws constituting a clevis 99 for slidably engaging diametrically opposite flattened faces 100 upon a shaft-encircling bearing member 101. Thus, both of the brackets will tolerate possible variations in the relative positions of the respective supporting shafts 59 or 60 therefor, and the upper bracket 95 will automatically assume a relatively adjusted position when either of the shafts 59 is shifted by adjustment of its journal block 62. Moreover, this bracket arrangement permits the idler roll assembly to be easily removed when necessary simply by removing the companion driven rolls from the ends of the shafts.

The parallel-axis idler rolls 48 and 49 are supported rotatably by the upper and lower brackets 95 and 97, respectively through the medium of suitable stud shaft bolts 102 on vertically alined axes in peripheral alinement with the driven forming rolls. In the vertical axial plane of the stud shaft axes, the opposed sides of the brackets 95 and 97 have coaxial bores 103 to receive self-centering bearings 104 for the opposite ends of an axle 105 supporting the tapered idler roll 50. The axle 105 and the idler roll 50 may be assembled slidably, with the roll held in a predetermined vertical position on the axle by a locating ring 107 or the like. Means such as a spring-

urged plunger 108, which is axially slidable in a bore 109 in the lower end of the axle 105, tends to urge the axle longitudinally upwardly and thus carry the upper tapered face of the roll 50 toward abutment with the complementary tapered portion of the upper idler roll 48 in any adjusted position of the latter. Thus, the idler roll 50 is supported in a manner to be self-adjusting in conformity with adjustments that may be made in its companion idler rolls.

It is desirable to keep the forming rolls free of oil or grease so that the latter will not be transmitted to the surfaces, and particularly the outer surface, of the formed sheet metal. Paint will not adhere to any oily surface. Therefore, where the integral protection on the sheet surfaces such as galvanize, chips off of the metal during the forming process and a film of lubricant takes its place and is not properly removed, subsequent painting will be of no protective avail but will blister and peel off and expose the unprotected areas to deterioration. Consequently means is preferably furnished for keeping the forming rolls clean, herein comprising suitable roll wipers 110 (Figs. 11, 12 and 13). These wipers may have suitable angular brackets 111 which are mounted horizontally between at least certain of the forming rolls as by attaching them to the standards 58. Each bracket carries absorbent wiping means such as a felt pad 112 clamped thereto with its ends adapted to project into contact with the peripheries of the forming rolls to be wiped. Preferably the roll contacting ends of the wiping pad are slitted as at 113 to enable more ready adaptation to and engagement of the contoured areas of the particular rolls to be wiped.

As a further protection to the metal undergoing shaping, means such as splash plates 114 (Figs. 11 and 13) may be secured across the spaces intervening between the legs of the standards 58. This will avoid possible difficulty due to lubricant being thrown by the gears or other moving mechanisms of the machine.

In the operation of the machine, a metal sheet is placed upon a supporting table 115 (Figs. 9, 10, 11 and 13) on the machine with the margin of the sheet which is to be formed into the joint lock slidably abutting a suitable, adjustable guide 116. Then the forward end of the margin is brought into engagement with the initial forming and feeding rolls 33—34 where it is gripped, initially offset, creased and bent, and fed onward. Between the succeeding rolls the margin is formed and folded as hereinbefore described and eventually passes from the finishing rolls 51—52 under a truing or straightening device such as an undercut bar 117 at the discharge end of the table 115. The bar 117 will counteract any tendency of the formed lock-margin of the sheet to issue curved or bent because of deformation strains to which the margin may be subjected between the rolls.

A removable hood or cover 118 may normally enclose the upper part of the machine which projects above the table 114, and the part of the machine which lies below the table 114 may be enclosed by a skirt or casing 119. If desired the hood 118 may carry a bar 120 adjacent to a calibrated portion of the periphery of the adjustment wheel 72 to serve as a means for gauging adjustment of the forming rolls.

From the foregoing it will be apparent that the present invention provides an improved method of forming joint locks and a simplified, compact and highly accurate and efficient machine for practicing the method. The two sets of adjustable and replaceable forming rolls adapt the machine for use upon sheet metal of a wide variety of gauges and for various metal shaping uses. Substantial protection is afforded against the transmission of oil or grease to the formed sheet metal shapes. Among the other advantages of the invention are the joint or separate adjustment of the forming rolls which assures uniformity of results, and the simple, powerful driving mechanism which reduces the number of operating parts and assures uniform, steady operation.

I claim as my invention:

1. A machine for making a sheet metal joint lock comprising, in combination, an initial pair of horizontal-axis feeding and forming rolls for simultaneously offsetting a substantially longitudinal marginal portion of a metal sheet and creasing and bending such portion along two spaced parallel longitudinal lines to produce three angularly related longitudinal sections consisting of an inner section, an outer section, and a connecting section; a plurality of additional pairs or horizontal-axis forming rolls for accentuating the angles between said sections and for progressively tilting the intermediate section toward the inner section whereby to form base and socket folds; a set of idler rolls including a pair of opposed tapered surface rolls and a complementary wedge-tapered blunt edge roll adapted to enter said socket fold for gapingly forcing the socket fold sections apart and pressing the same against said tapered surface rolls, thereby flattening said intermediate section against said inner section and rounding the bend between said outer and intermediate sections to assure an open mouth between the latter sections; and a pair of horizontal-axis finishing rolls located to act upon said sections after the latter leave said idler rolls for bringing all of said sections into substantially parallel relation.

2. The method of forming a joint lock of the Pittsburgh type which includes the steps of reversely bending the margin of a metal sheet along parallel longitudinal lines into base and socket folds, closing the base fold and simultaneously bending the opposite portions of the socket fold into divergent relationship and forcing the inner angle thereof into permanent open shape so that even though the lips of the socket fold are subsequently moved toward closed position the inner angle will retain its open shape and facilitate insertion of a mating member thereinto, and reversely bending the divergent portions of the socket to approximately parallel relation.

3. A machine of the character described for shaping the edge of a sheet metal blank into an open-mouth Pittsburgh type joint lock comprising, in combination, a series of forming rolls for receiving and progressively bending a longitudinal marginal portion of a sheet metal blank into the return bent socket shape of the lock, said rolls including a pair of parallel-axis rolls having opposed outwardly tapering forming surfaces to receive the partially formed return bent socket portion of the sheet therebetween, and a relatively flattened perpendicular axis roll having its opposite faces tapered wedge-fashion toward its periphery substantially complementary to the taper of said parallel-axis rolls and adapted to enter the mouth of the partially formed socket to force the opposite sides thereof divergently

open, the periphery of said perpendicular axis roll being blunt and adapted to engage the inner angle of the mouth to force the latter into permanent open shape so that even though the lips of the socket may subsequently be pinched closed such inner angle will retain its open shape.

4. Apparatus for forming a sheet metal joint lock comprising, in combination, a plurality of cooperative pairs of parallel-axis forming rolls mounted for successively receiving a marginal portion of a metal sheet and progressively bending such marginal portion along spaced parallel longitudinal lines into a base fold and a socket fold, a group of final shaping rolls comprising a wedge-tapered roll for entering and wedging said socket roll gapingly open and a pair of rolls having shaping surfaces complementary to the tapering faces of said wedge-tapered roll cooperative with the latter to close the base fold at a diagonal angle relative to the plane of the sheet body, and finishing rolls fashioned to bend the base fold substantially into parallelism with said plane.

5. Apparatus for producing a Pittsburgh joint lock comprising, in combination, a series of forming rolls and means for driving the rolls, said series including rolls for initially offsetting a marginal portion of a metal sheet and creasing the offset marginal portion along spaced parallel longitudinal lines to form outer, intermediate and inner sections, a succeeding pair of rolls of the series having opposed cylindrical peripheral surfaces cooperating to grip the body of the sheet adjacent to the offset and including one roll having a relatively deep annular groove defined by a perpendicular shoulder and a frusto conical forming surface tapering inwardly toward the shoulder to push against the outer surface of said outer section for bending the latter toward the intermediate section, the second of said pair of rolls having a substantially complementary frusto conical annular projection extending into said groove to engage the inner surface of said outer section adjacent to the base of the groove and having an inwardly facing perpendicular surface opposing said shoulder whereby to engage and bend the intermediate section into a substantially perpendicular plane relative to the body of the sheet, said frusto conical forming surface and the opposed surface of said projection being spaced apart sufficiently throughout their major extent to avoid gripping of said outer section therebetween, and final shaping rolls for bending the intermediate section toward abutment against the inner section and for bending the outer section into substantially spaced parallel relation to the intermediate section.

6. In combination in a machine for producing a Pittsburgh joint lock, a series of parallel axis rolls mounted in cooperative pairs for successively receiving and forming the margin of a metal sheet, and means for driving said rolls simultaneously to draw the sheet margin longitudinally through the rolls, the first of said pairs of rolls offsetting the marginal sheet portion from the main body of the sheet and creasing and bending said marginal portion along longitudinal spaced parallel lines into outer, intermediate and inner sections, another pair of rolls receiving the sheet margin after such creasing and bending and having a circumferential groove and a complementary circumferential projection respectively defined by substantially complementary opposed frusto conical forming surfaces to receive the outer section therebetween and forming surfaces perpendicular to the body of the sheet to act upon the intermediate section, and a plurality of subsequently operative pairs of rolls including annular grooves of successively diminishing depth and increased inward spacing relative to the sheet margin and defined by frusto conical forming surfaces of successively diminishing pitch for successively pushing against the outer surface of the outer section to bend it closer to the intermediate section and to bend the intermediate section closer to the inner section, and rolls for completing the joint lock including a generally wedge shaped roll for entering between the inner and intermediate section to assure a spaced open-socket condition between these sections and to force the intermediate and inner sections closely together to form the base of the joint lock.

7. A Pittsburgh joint lock machine comprising, in combination, a plurality of pairs of horizontal axis rolls mounted in series to successively receive the margin of a metal sheet to be formed therebetween, means for driving said rolls simultaneously, the first of said rolls having contours acting to offset the marginal sheet portion from the main body of the sheet and to crease and bend the marginal portion along parallel lines to form angularly related outer, intermediate and inner sections, a plurality of successive pairs of rolls including annular shaping grooves of successively diminishing depth and greater spacing measured from the outer ends of the rolls defined by inwardly tapered frusto conical forming surfaces of successively diminishing pitch for engaging the outer surface of said outer section and pushing it toward the intermediate section and thereby easing the intermediate section toward the inner section, a pair of horizontal rolls thereafter receiving the sheet therebetween and having outwardly tapering annular forming surfaces respectively to receive the outer faces of the inner and outer sections, a vertical axis roll having a substantially wedge-shape radial cross section with tapered surfaces complementary to the outward taper of said last mentioned pair of rolls and engaging the inner faces of the outer and intermediate sections to force the latter section gapingly apart and bend the intermediate section into abutment with the inner section, and a pair of horizontal axis finishing rolls contoured to bend the gapingly related sections into substantially parallel relation.

8. In combination in a sheet metal forming machine of the character described, a horizontally alined series of vertically spaced pairs of cooperative shafts having cooperative forming rolls at the opposite ends thereof, means for supporting the lower shafts of the series on stationary axes, shiftable journal blocks supporting the upper shafts adjacent to the opposite ends thereof and having upwardly projecting members, means for simultaneously vertically adjusting all of said journal blocks to predetermine the spacing between the shafts and rolls including a pair of bars lying transversely above the upper shafts respectively adjacent to the upwardly projecting members of the opposite journal blocks, means for slidably supporting said bars for movement in a fixed longitudinal path, means connecting said bars to said journal blocks for translating longitudinal movement of the bars into vertical movement of the journal blocks, and means connecting said adjustment bars for simultaneous actuation.

9. In combination in a sheet metal forming

machine of the character described, a plurality of upright standards mounted in spaced horizontal alinement, horizontal shafts journaled upon fixed axes in parallel horizontal alinement in said standards, vertically shiftable journal blocks supported by said standards above said fixed axis shafts, shafts journaled in said journal blocks in vertically spaced relation to the respective fixed axis shafts, and means for simultaneously adjusting the vertical positions of said journal blocks comprising an adjustment bar slidably supported in a horizontal plane by the tops of said standards for longitudinal movement transversely of the shaft axes and having connections with said journal blocks for translating longitudinal horizontal movement of the bar into vertical movement of the journal blocks.

10. In combination in a sheet metal forming machine of the character described, upright supporting means, horizontal shafts journaled in said supporting means upon fixed horizontally alined axes, vertically shiftable journal blocks carried by said supporting means respectively above each of said fixed axis shafts, shafts journaled in said journal blocks in vertically spaced relation to the respective fixed axis shafts, means for simultaneously adjusting the vertical positions of said journal blocks comprising an adjustment bar slidably supported in a horizontal plane above said journal blocks for longitudinal movement at right angles to the shaft axes and having connections with said journal blocks for translating longitudinal horizontal movement of the bar into vertical movement of the journal blocks, and means forming part of said connections for effecting relative independent adjustment between said journal blocks and said adjustment bar.

11. A machine of the character described including, in combination, a pair of cooperative forming rolls, shafts for said rolls, a movably supported journal member supporting one of said shafts for adjusting the spacing between said rolls, means for adjustably moving said journal member including an element having operative movement in a fixed plane at right angles to the path of movement of the journal member and including a diagonal slot, a shoe riding in said slot, a bolt connecting said journal member to said shoe having eccentric engagement with said shoe whereby to enable relative adjustment movement between the journal member and said adjusting element by rotation of said bolt, and means for locking said bolt in any adjusted position thereof, whereby operative movement of said adjusting element in opposite directions will cause said shoe to ride up or down in said slot and thus adjust the position of said journal block.

12. A joint lock forming machine of the character described comprising, in combination, a series of cooperating pairs of forming rolls arranged to act successively upon a marginal portion of a metal sheet fed longitudinally therebetween for transforming the same into socket and base folds, the first pairs of rolls having complementary contours shaped to offset said marginal portion from the body of the sheet and begin bending of said portion along spaced parallel longitudinal lines to provide angularly related outer and inner sections joined by an intermediate section, a subsequently operative pair of rolls having complementary contours arranged to bend the outer and intermediate sections into an acute angular relationship, succeeding pairs of rolls including annular grooves of successively diminishing depths defined by frusto conical forming surfaces of successively diminishing pitch disposed to engage and bear against the outer surface of the outer section to bend it closer to the intermediate section whereby to form the socket fold and to bend the intermediate section over in the space afforded by the grooves toward the inner section whereby to form the base fold, substantially wedge shaped means operative after said succeeding rolls to enter between said outer and intermediate sections and force the base fold closed while maintaining the socket fold gapingly open, and finishing means shaped to engage the outer faces of said outer and inner sections and bend the gapingly related sides of the socket fold into substantially parallel relation.

13. A machine for producing Pittsburgh joint locks comprising, in combination, a series of cooperative pairs of parallel-axis rolls alined for successively receiving and double folding a marginal portion of a metal sheet to form a base fold and a socket fold, and means for driving all of said rolls in unison, the first pairs of said series of rolls having opposed cylindrical peripheral surfaces adjacent one end for continuously firmly gripping the sheet along a strip paralleling the marginal portion to be double folded, the remaining peripheries of the first pairs of rolls having cooperative contours providing forming surfaces sloping in generally opposite directions relative to the roll axes and providing relatively sharply defined inner and outer grooves and projections arranged to receive said marginal portion of the sheet therebetween and bend it along spaced longitudinal lines into three sections generally conforming in width and angularity to the forming surfaces, said first pairs of rolls having the sloping forming surfaces nearest to the cylindrical gripping surfaces projecting entirely radially beyond the latter surfaces on one of the rolls and recessed within an annular depression in the opposed roll so as to offset the engaged inner section of the sheet margin from the body of the sheet and at the same time force such section to assume an angular relationship to said body sloping into the inner groove, said recessed forming surfaces of said pairs of rolls extending at a slightly sharper sloping angle than the opposed projecting forming surface so as to provide a divergence which gradually increases the width of the clearance between the surfaces down to the inner groove whereby said inner marginal section will be gripped by the surfaces only adjacent to the sheet body and is left free for slippage relative to the rolls adjacent to said inner groove.

14. A sheet metal shaping machine comprising, in combination, an elongated frame, an upper series of horizontally disposed parallel shafts spaced apart longitudinally of the frame and adapted to support a series of forming rolls, a lower series of roll supporting shafts correspondingly positioned along the frame so as to form with said upper series a plurality of pairs of shafts with the shafts of each pair disposed one above the other, one of said series of shafts being journaled in said frame, journal blocks for the shafts of the other series mounted in said frame for vertical movement and each having a bearing element thereon, a bar guided for movement longitudinally of the frame at one side of said journal blocks and having formed thereon a plurality of cam surfaces with which the bearing elements on the journal blocks engage, and

means for imparting incremental adjusting movements to said bar so as to shift said journal blocks by the interengagement of said bearing elements with their respective cam surfaces on the bar.

15. A sheet metal shaping machine comprising, in combination, an elongated frame, an upper series of horizontally disposed parallel shafts spaced apart longitudinally of the frame and adapted to support a series of forming rolls, a lower series of roll supporting shafts correspondingly positioned along the frame so as to form with said upper series a plurality of pairs of shafts with the shafts of each pair disposed one above the other, one of said series of shafts being journaled in said frame, journal blocks for the shafts of the other series mounted in said frame for vertical movement, a bar guided for movement longitudinally of the frame at one side of said journal blocks and having a plurality of longitudinally disposed slots therein, each of said journal blocks having an eccentrically mounted bearing element thereon engaging in one of said slots and adapted for individual adjustment, and said slots being inclined so as to engage said bearing elements with a cam action when the bar is shifted longitudinally whereby to impart vertical movements to said journal blocks in unison.

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