# United States Patent

**Kalb et al.**

[15] **3,641,960**

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[54] **APPARATUS FOR JOINING SHEET METAL BANDS**


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[51] **Int. Cl.** ..... **B23p 11/00**

[58] **Field of Search** ..... 113/1.1, 1.2, 116 FF; 29/21.1, 29/509, 33



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[57] **ABSTRACT**

An apparatus for joining separate sheet metal bands to be passed in succession through a band-treating plant by punching interengaging cuts in overlapping end portions of the bands and comprising band-gripping rollers operative to first position the band end portions to be joined in relation to a transverse series of band cutting and deforming tools, to subsequently stretch the joint in order to effect interlocking engagement of the cuts, and to finally subject the joint to a pressure deforming the edges of the engaged cuts.


**7 Claims, 16 Drawing Figures**

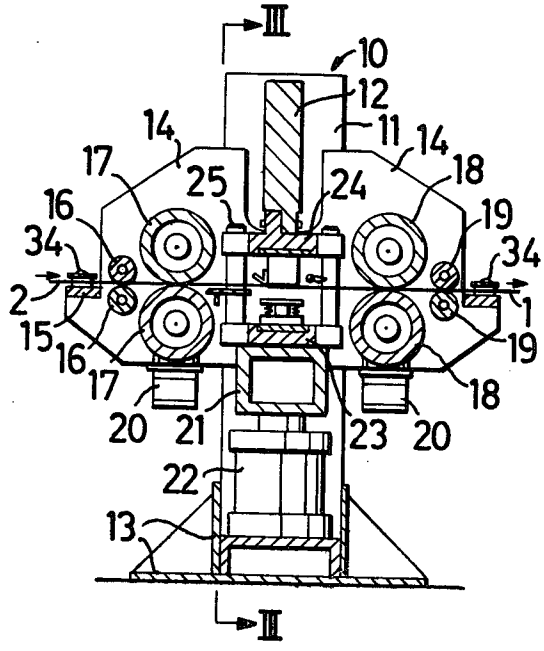

Fig.1

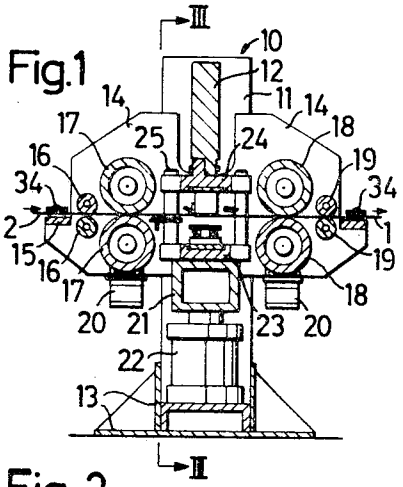


Fig. 2

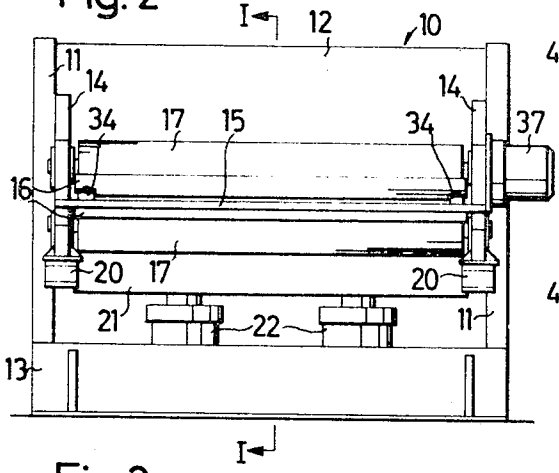


Fig.3

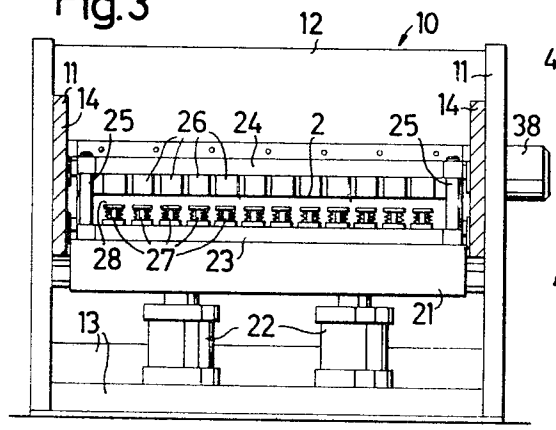


Fig.5

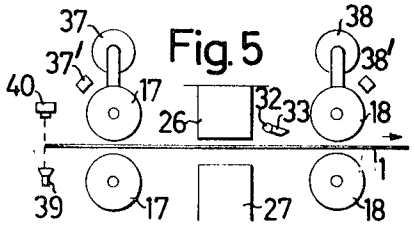


Fig.6

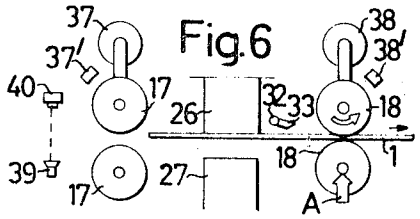


Fig.7

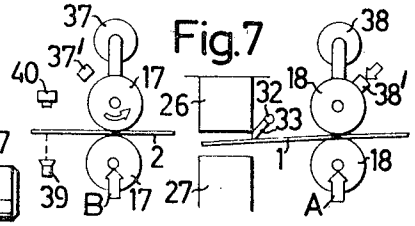


Fig.8

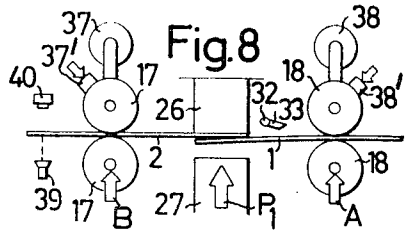


Fig.9

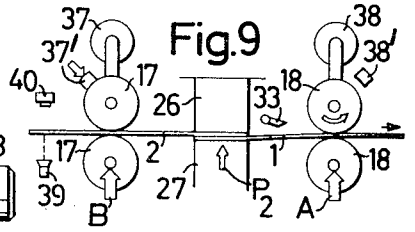


Fig.10

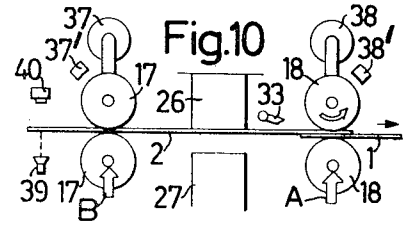

Fig.4

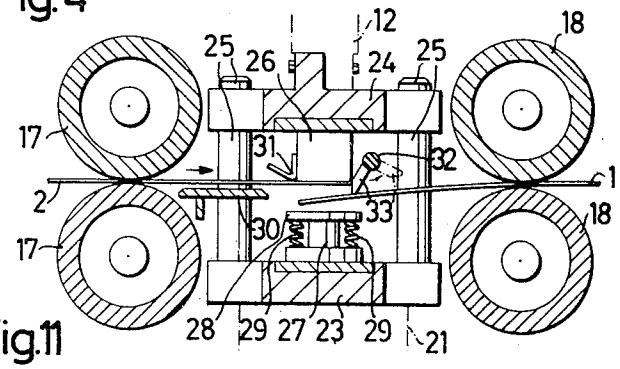


Fig.11

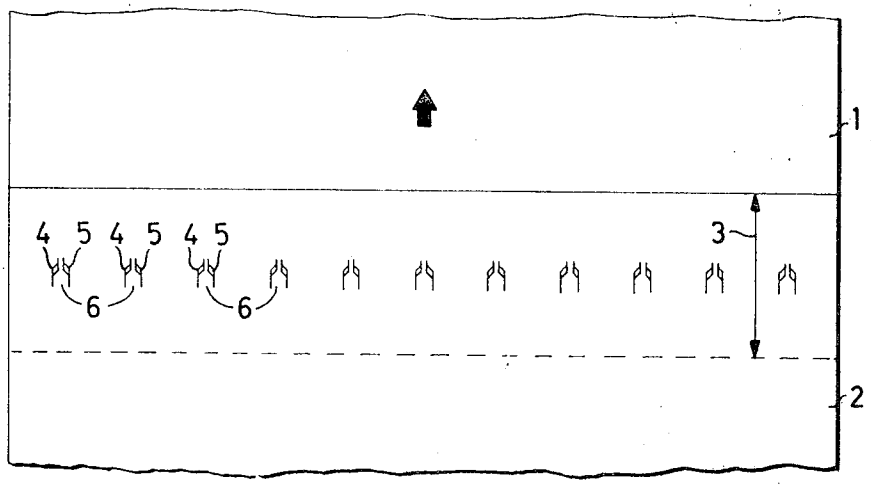


Fig.12

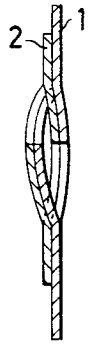


Fig.13

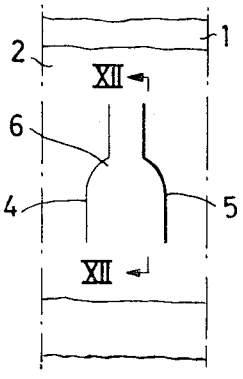


Fig.14


Fig.15

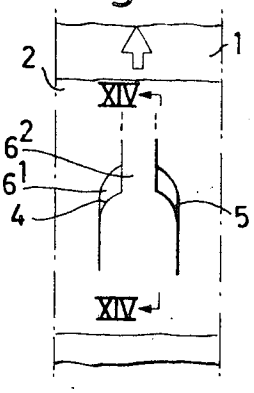


Fig.16

# APPARATUS FOR JOINING SHEET METAL BANDS

When preparing sheet metal from the rolling mill for various industrial purposes it is commonly known to pass long lengths thereof in a continuous flow through a treating plant where the sheet metal is subjected to cleaning, polishing, coating or other improving treatment. Usually it is then necessary or at least desirable to join the ends of the several lengths of sheet metal band following each other through the treating plant, because this plant frequently includes tortuous passages, through which it may be rather difficult to introduce a free band end.

Such joining of successive lengths of sheet metal band may be accomplished by spot welding or, sometimes, seam welding. However, such relatively simple welding operations cannot be successfully used unless the overlapping metal surfaces are tolerably clean, i.e., free from scales, grease and other impurities which may considerably increase the electrical contact resistance and hence impair the welding bond. Sheet metal bands coming more or less directly from the rolling mill rarely meet this requirement, and cleaning the band ends to be joined is usually an undesirable complication.

Other welding methods, such as arc welding, gas welding and butt welding may be used. However, these other methods are very expensive and mostly very time consuming and, consequently, they can only be contemplated when it is absolutely necessary to avoid an overlap joint, such as when the sheet metal bands are to be formed into a tube or otherwise profiled.

As an alternative to welding it has also been suggested to join the ends of successive sheet metal bands to be passed through a band-treating plant by subjecting the overlapping end portions thereof to a local cutting and deforming operation so as to form tongues or tabs and corresponding openings therein capable of interlocking engagement. These tabs and openings have been punched at locations distributed over the entire width of the bands, and the double tabs have then been bent out of the openings and folded back over the one or the other side of the overlapping band portions. In some cases the tabs are cut out to primarily extend in the running direction of the sheet metal bands and subsequently folded backwards over one side of the joint to form a kind of hooks. However, such hooks can very easily be detached and do not form a reliable connection, especially not if the sheet metal bands have to pass a tortuous path in the treating plant.

In another form of mechanical sheet metal joint of substantially the same type the tabs are cut out to primarily extend in the transverse direction of the two overlapping bands and then folded over in such a manner that some of the hooks thus formed will be directed towards the left border of the bands and the other hooks towards the right border thereof. This will give a more reliable joint.

However, in both cases the bent tabs or hooks will locally double the thickness of the joint which in turn is already twice as thick as each single band, and the projections formed by the hooks will have sharp edges to that they can easily damage certain elements of the treating plant, such as conducting rollers, surface treating tools and the like. In addition the locking tabs or hooks are difficult to produce, especially when the thickness of the sheet metal bands exceeds about two-hundredths of an inch or about 0.5 millimeter, and they cannot at all be used when the sheet metal is brittle, because the hooks then easily break and fall away when being formed.

This invention is based on the conception that there is another way of interlocking overlapping sheet metal bands which, although not previously tried for joining broad bands to be successively treated in a continuously operating plant, could probably be used for such purpose and, if so, would be much superior to the methods now in use. This other way of locking together sheet metal band ends has been successfully used for many years in the packing industry for closing hoops or wrapping bands of sheet metal around various kinds of transport units, and also in this case overlapping band end portions, though representing the opposite end portions of a single band length, are joined by being punched. It has been



established by practical tests that this idea was basically right but also that special measures were required in order to adapt the known method to the new application. In addition, it was established that new and improved means were required to successfully accomplish the necessary steps of joining or interlocking the successive, broad sheet metal bands, because the conditions are in this case quite different from those prevailing when hoops of sheet metal strips are closed.

Accordingly, this invention is concerned with an apparatus for joining overlapping end portions of separate and successive, relatively broad sheet metal bands by locally cutting through and deforming the lap joint section between them in a manner to provide a transverse series of interengaging and interlocking groups of longitudinally extending, S- or Z-like cuts, the edges of which are displaced in the direction of thickness of the joint section so as to interengage, when a pull is exerted in the longitudinal or running direction of the sheet metal bands.

It is an object of the present invention to provide an apparatus of the kind just referred to, which is capable of accomplishing the necessary steps for reliably interlocking overlapping end portions of sheet metal bands in a manner to prevent inadvertent unlocking or disconnection thereof during the passage of the bands through a treating plant in continuous succession.

Another object of the invention is to provide an apparatus of the kind referred to which is capable of joining together the rear end portion of a preceding sheet metal band and the foremost end portion of a succeeding sheet metal band in a mutually overlapping position in such a manner that the total thickness of the joint will not considerably exceed the sum of the two band thicknesses, thereby avoiding such excessively protruding local projections in the joint which are liable to cause troubles during the subsequent continuous treatment of the jointed bands.

It is a further object of the invention to provide an apparatus of the kind here in question which includes means not only for punching the necessary groups of cuts in the overlapping sheet metal band end portions but also for effecting the proper engagement of the edges of the cuts by positively subjecting the overlapping band end portions to a relative displacement in the longitudinal direction of the bands, and for subsequently providing a lasting interengagement by subjecting the joint thus formed to an additional material-deforming operation.

A still further object of the invention is to provide an apparatus of the kind referred to hereinbefore, which is reliable in use, relatively simple and robust in construction and capable of carrying out the necessary operations in a rational manner and within a relatively short time interval, so that undesirably long interruptions in the band feed through the apparatus can be avoided.

Further objects and features of the invention will become apparent from the following description of a preferred embodiment thereof, which has been illustrated for the purpose of elucidation in the accompanying drawings, wherein

FIG. 1 is a sectional elevation of a band-joining apparatus according to the invention, the section being taken in the direction of running of the sheet metal bands to be joined and substantially along the line I—I in FIG. 2,

FIG. 2 is a front elevation of the apparatus as seen from the left in FIG. 1, i.e., from that side where the sheet metal bands are fed into the same,

FIG. 3 is a sectional elevation taken along the line III—III in FIG. 1, certain details being removed for clarity,

FIG. 4 is a partial sectional elevation showing the main parts of the apparatus as in FIG. 1 but on an enlarged scale,

FIGS. 5 to 10, inclusive, illustrate in a very simplified and diagrammatic manner the various operating steps of the apparatus shown in FIGS. 1 to 4,

FIG. 11 shows in plan view a joint between two sheet metal band end portions, which has been produced by an apparatus of the kind here described,

FIG. 12 is a partial longitudinal section through a lap joint section which has just been punched, the section being taken along the line XII—XII in FIG. 13,

FIG. 13 is a partial plan view of a pair of cuts punched in a lap joint section as a first step in joining the two sheet metal layers thereof together,

FIG. 14 is a partial longitudinal section taken along the line XIV—XIV in FIG. 15 and illustrating the next step in interlocking the two punched sheet metal layers,

FIG. 15 is a partial plan view resembling that of FIG. 13 but showing the sheet metal layers of the lap joint section longitudinally displaced in a manner to effect their interengagement, and

FIG. 16 is a partial section similar to that of FIG. 14 but illustrating the joint in a rolled or compressed and completed stage, as it will leave an apparatus embodying the present invention.

In order to first elucidate the type of interlocking engagement to be established in the apparatus embodying the present invention reference will now be had to FIGS. 11 and 12–15. In all figures numeral 1 has been used to designate the rear end portion of a preceding sheet metal band, while numeral 2 has been used to designate the foremost end portion of a succeeding sheet metal band. The two bands ordinarily have a uniform width of between 1 and 7 feet (0.3–2.1 meters) and a uniform thickness between one-hundredth and two-tenths of an inch (0.25–5.1 millimeters). The sheet metal bands are supposed to be manufactured by rolling, which means that they possess at least a certain ductility.

As a first step in the joining operation the two end portions of the sheet metal bands 1 and 2 are brought to overlap each other a short distance substantially as indicated at 3 in FIG. 11. Thereupon both the overlapping band end portions are subjected to a cutting and material-deforming punching operation at which a plurality of through cuts 4 and 5 are produced in them as shown in FIG. 13. At the same time the opposite edges of each cut are slightly displaced in the direction of thickness of the joint as shown in FIG. 12. The cuts are arranged in a single row or series extending in the crosswise direction over the two bands 1 and 2 and in most cases it is preferred to punch the cuts 4 and 5 in closely adjacent, cooperating pairs as shown, so as to form between each pair a relatively narrow and, hence, easily deformable strip portion 6. Each cut, as can be most clearly seen from FIGS. 11 and 13, generally extends in the longitudinal direction of the two sheet metal bands and comprises two mutually parallel but laterally displaced end portions interconnected by an intermediate portion forming an angle with the end portions. The two cuts 4 and 5 in each pair are mirror pictures of each other as shown.

It should be understood that the detailed configuration of the cuts may be varied within certain limits without losing their ability to form a reliable "lock" between the overlapping joint layers 1 and 2. Thus some or all of the pairs of cuts may be inverted as compared with what is shown in FIG. 11, provided that the strip portions 6 between each such pair of cuts is then pressed out in the opposite direction. Instead of having a curved intermediate portion as illustrated each cut may also have a straight intermediate portion merging into both the parallel end portions at any desired angle.

When all the cuts 4 and 5 have been punched and their edges displaced as shown in FIG. 12, a relative movement of the two joint layers in the longitudinal direction of the sheet metal bands is required to establish a locking interengagement as has been illustrated in FIGS. 14 and 15. In accordance with the present invention this relative movement is positively effected by the apparatus to be described later on.

Finally the "locks" are, also in accordance with the present invention, subjected to a positive compression as illustrated in FIG. 16, whereby an inadvertent disengagement is made entirely impossible. This feature is of utmost importance, because sheet metal bands passing a treating plant are not necessarily subjected to a constant pull comparable to the permanent tension applied to a wrapping band and, in addition, the joints between sheet metal bands passing through a band-treating plant will be subjected to much more strains then are the closing joint of hoops, which do not have to move through a more or less tortuous path.

The apparatus embodying the present invention is intended to join the ends of succeeding sheet metal bands in the manner hereinbefore described. As can be seen from FIGS. 1 to 4, the preferred form of such an apparatus includes a supporting structure which has been generally designated by numeral 10 and which takes the form of a vertical framework comprising two spaced end columns 11, an upper crossbeam 12 and a lower, transverse foot structure 13. To the inner side of each column 11 there is secured a winglike end wall 14 and these two end walls are at their respective ends interconnected by shelves 15.

As seen in the direction of feed of the sheet metal bands 1 and 2 through the apparatus, there are between the end walls 14 mounted a first pair of guiding rollers 16, a first pair of feeding rollers 17, a second pair of feeding rollers 18 and a second pair of guiding rollers 19. Each such pair of rollers comprises an upper and a lower roller arranged above and below the path of the sheet metal bands, respectively. The guiding rollers 16 and 19 are free-running and may be mounted in fixed bearings at a distance from each other in each pair that slightly exceeds twice the thickness of the sheet metal bands to be passed between them. The upper ones of the feeding rollers 17 and 18 are also mounted in fixed bearings, while the lower ones are mounted in vertically adjustable bearings actuated by hydraulic jacks 20, of which there is one at each end of each lower feeding roller. By means of the jacks 20 each lower feeding roller 17 or 18 may be elevated from a lowered position, in which it is vertically well spaced from the corresponding upper feeding roller, to a lifted position, in which, the sheet metal band is firmly gripped between the cooperating pair of rollers with a heavy but slightly yieldable pressure.

Between the two pairs of feeding rollers 17 and 18 there is a punching equipment which will be more closely described in connection with FIG. 4, and for actuating said punching equipment the apparatus comprises a vertically movable, transverse box beam 21, which is supported by a pair of hydraulic lifting jacks 22, the cylinders of which are standing on and secured to the foot structure 13. As can be seen more clearly from FIG. 4, the punching equipment comprises a lower table 23 resting on top of the box beam 21, and an upper holder 24 secured by bolts or the like to the lower end of the crossbeam 12. The table 23 is near its respective ends provided with upstanding guiding posts 25 which extend through and are guided in corresponding holes in the holder 24 to provide for a perfect registration between the holder and the table, when the latter is vertically moved by the jacks 22. On the bottom side of the holder 24 there is mounted a series of die members 26, one for each pair of cuts to be punched in the sheet metal bands 1 and 2 to be joined. On top of the table 23 there is provided a corresponding series of punches 27, each of which is adapted for cooperation with a related one of the upper die members 26. Each punch 27 is surrounded by a spring-loaded holding-up plate 28, which is actuated by a number of heavy springs 29.

As will be readily understood, each die member 26 and its related punch 27 are made of hard and wear-resistant material, such as hardened steel or sintered carbide, and formed to produce, when pressed against opposite sides of the lap joint section between the sheet metal bands 1 and 2, a pair of cuts 4 and 5 therein as illustrated in FIGS. 12 and 13. The detailed configuration of the tools 26 and 27 is well known per se and, therefore, it seems to be no need for describing them here. The holding-up plate 28 also is of a sort well known from conventional punching presses. Its primary purpose is to keep the two sheet metal layers of the joint section properly together and prevent their relative displacement during the punching operation. However, as will be understood from the following,

the holding-up plates will also assist when the interlocking engagement is established.

At the feeding-in side of the punching equipment there is provided a fixed shelf **30** which will prevent the free end portion of the sheet metal band **2** from sagging when entering. In front of each die member **26** there is also provided a V-shaped guiding member **31** adapted to prevent the foremost end of the sheet metal band **2** from being stopped by the die member itself. At the feeding-out side of the punching equipment there is mounted a shaft **32** having spaced fingers **33** extending radially therefrom. This shaft **32** may be rotated back and forth to swing the fingers **33** between an inoperative position shown in dash-and-dot lines and an operative position shown in full lines. In their operative positions the fingers **33** do not only depress the rear end portion of the sheet metal band **1** in order to make certain that the foremost end of the succeeding band **2** will be received above the same, but also serve as stop members for properly positioning the foremost end of the band **2** under the dies **26**.

It should be noted that in FIG. **3** the shelf **30** and the guiding members **31** have been omitted for the sake of clarity.

Returning again to FIGS. **1** and **2** it can be seen that each of the shelves **15** carries a pair of guiding wheels **34** freely rotatable about vertical spindles which are, preferably, adjustable towards and away from each other, so that the wheels can be accommodated to the width of the sheet metal bands to be passed through the apparatus and caused to cooperate with the side edges of said bands. As can be seen from FIGS. **2** and **3** the apparatus also comprises two driving motors **37** and **38** connected to each one of the upper feeding rollers **17** and **18**. These driving motors are mounted on the outer side of one of the end walls **14**, and each motor includes a braking arrangement (not shown) so as to permit alternative driving or braking of the related feeding roller.

The operation of the apparatus now described has been diagrammatically illustrated in FIGS. **5** to **10**, inclusive, and in these latter figures the before-mentioned brake included in each motor **37** and **38**, respectively, has been illustrated in the form of a braking shoe **37'** and **38'**, respectively, acting directly against the related feeding roller. It should be understood, however, that this is only a simplified manner of illustration. FIGS. **5–10** also indicate the provision of certain sensing and operation releasing means illustrated in the form of a lamp **39** throwing a beam of light upwards into a photocell **40** when there is no sheet metal band passing. It should be understood that the photocell is supposed to be incorporated in an electrical circuit adapted to automatically start the operation of the apparatus at a suitable time before the rear end of band **1** has reached the same. Any other suitable means may, of course, be substituted for the same purpose. The sensing and operation releasing means may be located in any suitable place in front of the feeding-in end or side of the apparatus.

FIG. **5** illustrates, how the sheet metal band **1** is running freely through the apparatus from left to right, when the apparatus is inoperative. It also illustrates that the rear end of band **1** has just passed the line between the lamp **39** and the photocell **40**, so that the light beam from the lamp will reach the photocell and, hence, put the apparatus into action. It should be kept in mind that the sheet metal band **1** is ordinarily pulled through the apparatus by feeding means included in the band-treating plant, so that the feeding rollers **17** and **18** of the apparatus are either running completely free or are at standstill.

When the rear end of the sheet metal band **1** has passed the photocell **40** the jacks **20** of the lower roller **18** will become energized to lift said roller as indicated by the arrow A in FIG. **6**. At the same time the driving motor **38** will be started to feed a predetermined length of the sheet metal band **1** at a controlled rate until the rear end of the band **1** is properly positioned under the dies **26**. When this is done, the motor **38** is stopped and the roller **18** is blocked by means of the braking shoe **38'**. Now the shaft **32** is rotated in the clockwise direction so that the fingers **33** will depress the rear end portion of the band **1** as shown in FIG. **7**. In the meantime the foremost end of a new sheet metal band **2** has been inserted between the feeding rollers **17** which have also been closed, as indicated by the arrow B in FIG. **7**, and the driving motor **37** of which has been started to feed the new band **2** into contact with the fingers **33**. Now the motor **37** is also stopped, the upper roller **17** is blocked by means of its braking shoe **37'** as shown in FIG. **8**, the fingers **33** are swung back to their inoperative position, and the punching operation is performed, the punches **27** then being pressed upwards with a heavy pressure as indicated by the big arrow $P_1$ to produce the cuts and deformations illustrated in FIGS. **12** and **13**.

When the punching operation is accomplished, the upward pressure on the punches **27** is reduced but not entirely removed as illustrated in FIG. **9** by the small arrow $P_2$, and while the rollers **17** are still braked and forced together to hold the succeeding band **2** in a firm grip, the rollers **18** are released and the motor **38** is started, so that the preceding band **1** will be subjected to a heavy pull as illustrated in FIG. **9**. As a result of this, an engagement-establishing relative displacement between the two overlapping sheet metal portions will take place, substantially as illustrated in FIGS. **14** and **15**. The slight upward pressure $P_2$ on the punches **27** does not prevent the band **1** from being moved but makes certain that the holding-up plates **28** are still active and provide for a proper interengagement of the edges of the cuts produced in the overlapping band portions. Subsequently the punches **27** are lowered to their inoperative position and the rollers **17** are released, so that the rollers **18** can pull the jointed sheet metal bands forwards. This means that the overlap joint will pass between the compressed rollers **18** as illustrated in FIG. **10** and be subjected to a rolling action and a flattening pressure, whereby the completed joint will leave the apparatus in a condition substantially as illustrated in FIG. **16**. This final and heavy compression of the joint will result in a local deformation of the interengaging parts of each single "lock" which is highly advantageous not only because it will smooth out the joint section but also positively prevent the "locks" from being inadvertently disengaged. In fact the completed joint will thereby be capable to withstand considerable forces opposite to the normal pull.

When the joint has passed between the rollers **18** all the elements of the apparatus are restored to their initial positions (as shown in FIG. **5**) and both the motors **37** and **38** are again inoperative. The described cycle of operations is then repeated, when the rear end of the sheet metal band **2** is to be joined to still another succeeding band.

It should be understood that the number of "locks" and consequently the number of dies and punches has to be selected in a manner to fit the character and width of the sheet metal bands to be joined. The dimensions of the cuts produced in the overlapping sheet metal portions and the distance between each pair of cuts should in turn be accommodated to the thickness of the sheet metal bands, so that "locks" of a larger size are used in thick sheet metal bands and vice versa.

As can be easily understood, the feeding rollers **18** in the form of apparatus hereinbefore described must be very sturdy because they have to perform the heaviest work, while the feeding rollers **17** have a more easy task. This means that the rollers **17** must not be identical with the rollers **18** as shown but can be somewhat weaker in structure.

If so desired the shaft **32** with the fingers **33** thereon may be utilized as a sensing member in such a manner that, when the fingers **33** are hit by the foremost end of the succeeding sheet metal band **2** and thereby caused to swing in the counterclockwise direction, the corresponding rotation of the shaft **32** may release the sequence of operations of the apparatus illustrated in FIGS. **8**, **9** and **10**.

The advantages of the present invention, as well as certain changes and modifications of the disclosed embodiment thereof, will be readily apparent to those skilled in the art. It is the applicant's intention to cover all those changes and modifications which could be made to the embodiment of the

invention herein chosen for the purposes of the disclosure without departing from the spirit and scope of the invention.

What is claimed is:

1. An apparatus for joining overlapping end portions of separate sheet metal strips, said apparatus comprising:

1. a stationary punching press comprising a plurality of punch means in said press and disposed across the width of the strip, each of said punch means being operative when actuated to form, across the width of the overlapping end portions of the strips, adjacent pairs of separate cuts having laterally offset ends extending in the longitudinal directions of the strips, thus defining between each pair of cuts a depressed web portion having a narrower end, a wider end and an angled intermediate portion therebetween, both ends remaining attached to the punched sheet metal strips,
2. resiliently yieldable means associated with said plurality of punch means for firmly pressing together the overlapping strip end portions within the operating area of said tools,
3. a first pair of cooperating rollers located at the inlet side of said punching press,
4. first jack means for positively varying the mutual distance between said first rollers and for temporarily forcing them together to thereby cause them to grip the sheet metal strips passing therebetween,
5. first means for alternately driving and braking at least one of said first rollers to cause said first rollers to alternately serve as a feeding-in and positioning mechanism for the foremost end portion of a succeeding sheet metal strip and as a retainer for said joining process,
6. a second pair of cooperating rollers located at the outlet side of said punching press, and operative to pull the preceding strip at the end of the punching cycle and while the succeeding strip is still retained by said first rollers to effect positive engagement of said depressed web portions extending across the width of said end portions of said strips,
7. second means for positively varying the mutual distance between said second rollers and for temporarily forcing them together to thereby cause them to grip the sheet metal strips passing therebetween and to also subject the lap-joint between such strips to a deforming pressure, and
8. second means for alternately driving and braking at least one of said second rollers to cause said second rollers to serve firstly as a positioning mechanism for the rearmost end portion of a preceding sheet metal strip, secondly as a puller of said strip, and thirdly as a roller press for compressing the locks formed between the strip end portions.

2. An apparatus according to claim 1 including deflecting means between said press and said second rollers for temporarily deflecting the rear end of the preceding sheet metal strip during the introduction of the foremost end of the succeeding sheet metal strip into said press by operation of said first rollers to assure correct overlapping of the two strip ends to be simultaneously punched.

3. An apparatus according to claim 2, wherein the reciprocatable punch members of said punching press are mounted on a common, vertically reciprocatable table below the path of the sheet metal strips through said press, and wherein the opposing die members of said punching tools are secured to a common fixed carrier above said path, said resiliently yieldable means being associated with said lower punch members, said punching press comprising hydraulic jack means operative to vertically reciprocate said table.

4. An apparatus according to claim 1, wherein said second means includes sensing means comprising a lamp and a photocell disposed in the beam of said lamp, and associated control circuit means operative to control the alternate driving and braking of at least one of said second rollers.

5. An apparatus according to claim 1 including guide means operative to align the sheet metal strips which are fed into and out of said stationary punching press.

6. An apparatus according to claim 5 wherein said guide means comprises a first pair of laterally opposed, horizontally disposed wheels and a first pair of guiding rollers located at the inlet side of said first pair of cooperating rollers, a first pair of upstanding guiding posts disposed between said first pair of cooperating rollers and the inlet side of said punching press, a second pair of laterally opposed, horizontally disposed wheels and a second pair of guiding rollers located at the outlet side of said second pair of cooperating rollers, and a second pair of upstanding guiding posts disposed between said second pair of cooperating rollers and the outlet side of said punching press.

7. An apparatus according to claim 6 wherein each wheel in each of said first and second pairs of laterally opposed, horizontally disposed wheels is adjustable in its position relative to the other paired wheel.

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