March 21, 1967 R. STEINHARDT 3,309,907

FLATTENER FOR STRAIGHTENING CURVED SHEET MATERIAL

Filed June 22, 1964 2 Sheets-Sheet 1

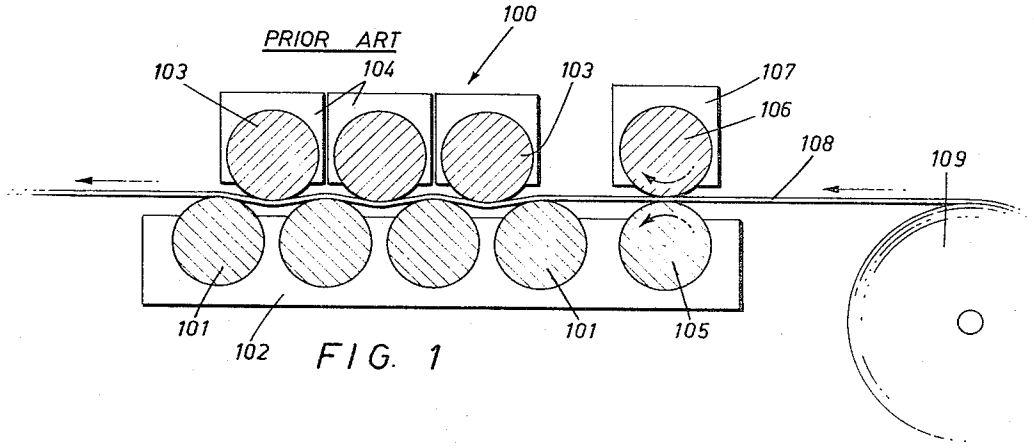

FIG. 1

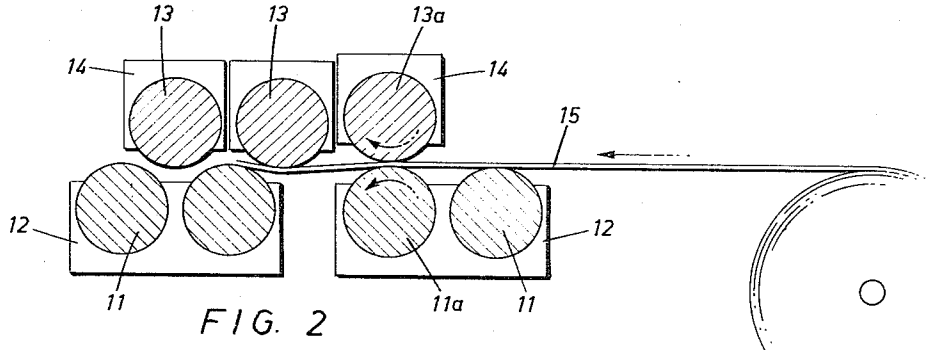

FIG. 2

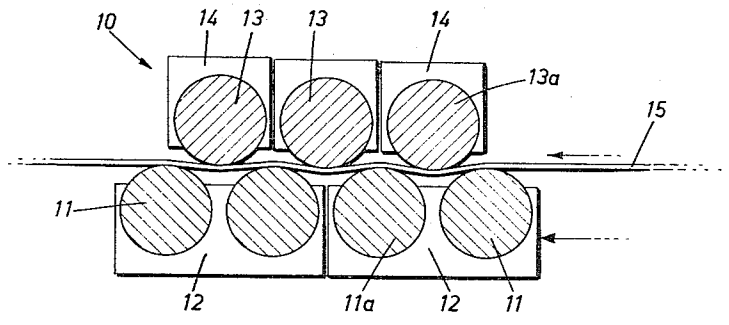

FIG. 3

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FLATTENER FOR STRAIGHTENING CURVED SHEET MATERIAL

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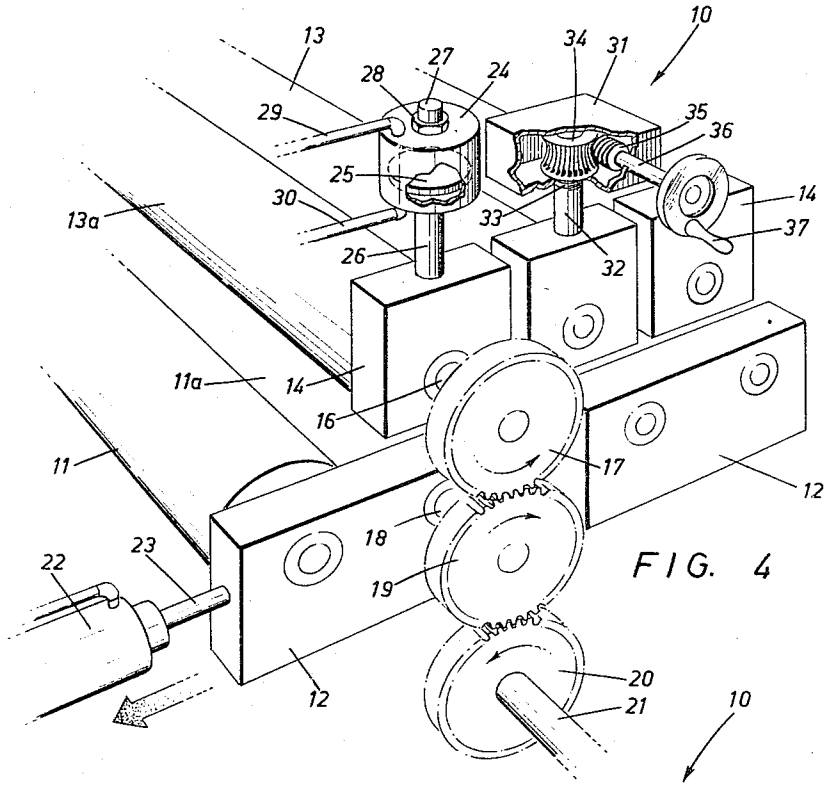

FIG. 4

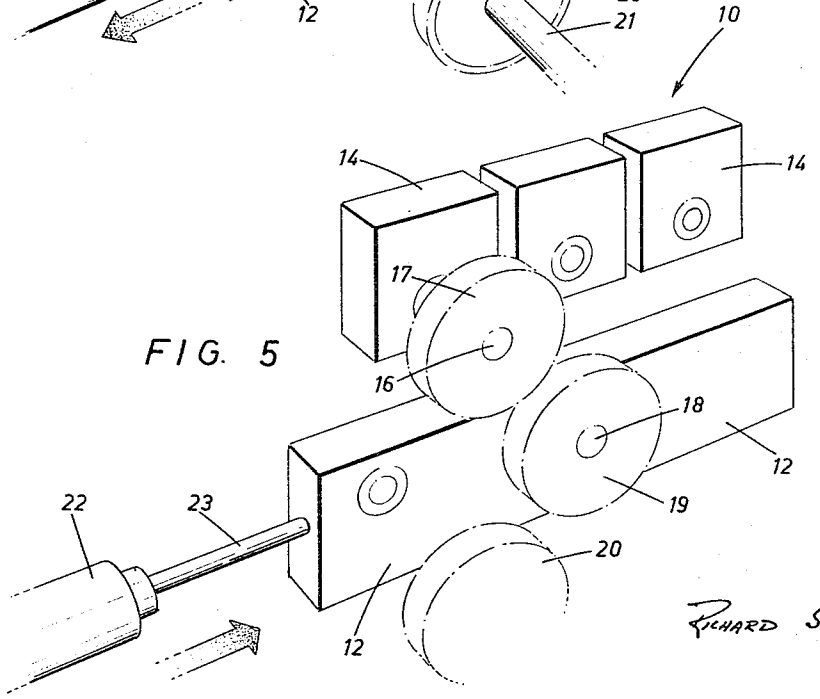

FIG. 5

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FLATTENER FOR STRAIGHTENING CURVED SHEET MATERIAL

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8 Claims. (Cl. 72—164)

This invention relates to a flattener for straightening curved sheet material such as a coiled metal strip.

Prior art types of flatteners generally comprise two pinch rolls, which can be driven through suitable gearing by an electric motor, for example, and a number of flattening rolls which are arranged in two rows with the flattening rolls in one row being spaced from and offset with respect to the flattening rolls in the other row, so as to define a generally sinusoidal sheet material receiving path therebetween. The flattening rolls are not driven but are freely rotatable. The flattening rolls, as their name implies, serve to flatten the curved sheet material. The pinch rolls serve to initially drive the sheet material between the offset flattening rolls, but, generally speaking, serve no good purpose after the sheet material has been threaded through the flattener and taken up by some other device which pulls the sheet material through the flattener. In order words, once the flattener is in operation, the pinch rolls become superfluous.

In accordance with this invention, there is provided a flattener which is designed in such a manner that once the flattener is in operation, one of the pinch rolls may be moved, so that the pinch rolls become flattening rolls and serve a useful purpose.

A flattener embodying this invention comprises a plurality of rotatable rollers which are spaced apart from and offset with respect to each other so as to define a sheet material receiving path between successive rollers, means for moving one of the rollers substantially directly above and into alignment and pinch roll relationship with another one of the rollers, and means for rotating at least one of the aligned rollers.

This invention will become more apparent from the following detailed description of preferred embodiments of this invention taken in conjunction with the appended drawings, in which

FIGURE 1 is a schematic side elevation, in section, of a prior art type of flattener,

FIGURES 2 and 3 are schematic side elevations, in section, of a flattener embodying this invention, each showing a different position of the rollers thereof, and

FIGURES 4 and 5 are perspective views, in greater detail, showing parts of the flatteners of FIGURES 2 and 3 respectively.

Turning first to the prior art type of flattener **100** illustrated in FIGURE 1, four lower rollers **101** are shown, these being journalled at both ends thereof in bearings (not shown) in frames **102**, only one of which is shown. Positioned above lower rollers **101** and offset with respect thereto are three upper rollers **103** journalled at both ends in bearings (not shown) in separate frames **104**, only one of which is shown for each roller **103**.

Journalled at both ends in bearings (not shown) in frames **102** is a roller **105** which is in alignment and pinch roll relationship with a roller **106**, the latter being journalled at both ends thereof in bearings (not shown) in frames **107** (only one shown).

Rollers **102** and **103** are freely rotatable but are not driven. Rollers **105** and **106**, however, are driven in the directions shown in FIGURE 1 by an electric motor (not shown) and through suitable gearing.

The strip or sheet **108** of material to be flattened is unwound from a reel **109** of the material and is passed between pinch rollers **105** and **106**, which drive the strip of material between the flattening rollers **101** and **103**. Once the left-hand end of strip **108** emerging from flattener **100** has been taken up by some device which pulls strip **108** through the flattener, pinch rollers **105** and **106** become superfluous.

Referring now to FIGURE 3, there is shown a flattener **10** which consists of a plurality of lower rollers **11** and **11***a* positioned side-by-side and in spaced apart relationship with each other. The axes of rotation of rollers **11** and **11***a* are parallel and lie in a common horizontal plane. The lower rollers are journalled at both ends in bearings (not shown) in two sets of separate frames **12** positioned at either end of rollers **11** and **11***a*.

Positioned above rollers **11** and **11***a* are a plurality of upper rollers **13** and **13***a* which also are positioned side-by-side and in spaced apart relationship with each other. The axes of rotation of rollers **13** and **13***a* are parallel and are parallel to the axes of rotation of rollers **11** and **11***a*, but the axes of rotation of rollers **13** and **13***a* may not lie in a common horizontal plane, since it is common in flatteners for the first upper roller **13***a* encountered by the strip or sheet of material being flattened to be closer to the lower rollers than are subsequent upper rollers **13**, so that the strip of material is subjected to greater stressing at the beginning of the flattening operation, and the degree of stressing decreases progressively as the strip of material passes through the flattener, this latter effect being achieved by positioning successive upper rollers **13** progressively further from the sets of lower rollers with which the upper rollers are associated.

Each roller **13** and **13***a* is journalled at both ends in bearings (not shown) in frames **14** (only one of which is shown per roller).

It will be seen from FIGURE 3 that the axes of rotation of successive upper and lower rollers are positioned at the apices of zig-zag path, i.e., the upper rollers each are positioned between two adjacent lower rollers. On account of this, and because the upper rollers are spaced apart from the lower rollers, a generally sinusoidal strip material receiving path is defined between successive ones of the rollers, the amplitude of this path preferably being largest at the right-hand end of the flattener of FIGURE 3 and diminishing progressively towards the left-hand end of the flattener, as explained hereinbefore. A strip **15** of material being flattened is shown passing through the flattener along this path and in the direction given by the arrow.

When rollers **11**, **11***a*, **13** and **13***a* are in the position thereof shown in FIGURE 3, each upper roller preferably is spaced equidistant from adjacent upper rollers, each lower roller preferably is spaced equidistant from adjacent lower rollers, and the upper rollers preferably are positioned half-way between the lower rollers with which they cooperate.

Normally rollers **11**, **11***a*, **13** and **13***a* in the position thereof shown in FIGURE 3 are not driven but do rotate freely.

Whereas FIGURE 3 shows a flattener embodying this invention in normal operating condition, FIGURE 2 shows the flattener of FIGURE 3 at start-up. It will be seen from FIGURE 2 that one of the sets of frames **12** has been moved to the right from the position thereof in FIGURE 3, so that roller **11***a* is aligned with and is in pinch roll relationship with roller **13***a* directly above it, and to this end roller **13***a* and its frames **14** have been moved upwardly.

In the position of the apparatus shown in FIGURE 2, rollers **11***a* and **13***a* are driven in the direction shown by the arrows and serve as pinch rollers.

One suitable form of mechanism for moving roller **11***a* between the positions thereof in FIGURES 2 and 3, one suitable form of mechanism for shifting roller **13***a* between the positions thereof in FIGURES 2 and 3, and means for adjusting the positions of the other rollers **13** relative to the other rollers **11** are shown in FIGURES 4 and 5.

Referring to FIGURES 4 and 5, the shaft **16** of roller **13***a* projects through its frame **14** and has a gear **17** fixed thereto. Similarly, the shaft **18** of roller **11***a* projects through its frame **12** and has a gear **19** fixed thereto. A gear **20** is fixed to a shaft **21** which, in turn, is driven by any suitable means such as an electric motor (not shown), for example.

The means for moving frames **12** carrying roller **11***a* consist of a hydraulic cylinder **22**, which is fixed in position, and which has a movable piston (not shown) therein which is secured to a connecting rod **23** that projects through cylinder **22** and is coupled to frame **12**, it being understood, of course, that such cylinders are provided for the frames **12** at both ends of roller **11***a*.

The means for shifting roller **13***a* upwardly and downwardly between the positions thereof shown best in FIGURES 2 and 3 consist of a cylinder **24** which is fixed in position, a piston **25** positioned within cylinder **24**, and a shaft **26** which is secured to frame **14** of roller **13***a* and on which piston **25** is fixed. Shaft **26** has a threaded end **27** which passes through cylinder **24** and a lock-nut **28** is threaded thereon. Conduits **29** and **30** are provided for conducting fluid under pressure to the chambers within cylinder **24** above and below piston **25** respectively. Means (not shown) are provided for exhausting fluid from these chambers when required. It will be understood, of course, that the device hereinbefore described is duplicated for the frame **14** at the end of roller **13***a* which is not shown in FIGURE 4.

The means for adjusting the spacing between upper rollers **13** and lower rollers **11** comprise a housing **31** which is fixed in position, a shaft **32** which is fixed to frame **14** and which has a threaded end **33**, a gear **34** positioned within housing **31** and supported by a thrust bearing (not shown) from the bottom wall of housing **31** and threadably engaging threaded end **33** of shaft **32**, a worm gear **35** which rotates gear **34**, a shaft **36** secured to worm gear **35** and a handle **37** also secured to shaft **36** and adapted to rotate the same upon rotation of the handle. It will be appreciated, of course, that a similar device to that hereinbefore described will be provided at the opposite end of roller **13** to that shown in FIGURE 4. Furthermore, such devices will be provided for all of rollers **13** so as to permit the spacing between rollers **13** and their cooperating rollers **11** to be adjusted independently of each other.

In order to describe the operation of a flattener **10** embodying this invention, it will be assumed that the flattener is in its normal operating position, as shown in FIGURES 3 and 5, but with no strip **15** of material passing between the upper and lower rollers. In this position gears **17**, **19** and **20** are disengaged, and the motor which drives gear **20** through shaft **21** is stationary. Lock nuts **28** are threaded on shafts **27** to a position such that roller **13***a* is at a desired height above its two cooperating lower rollers for a flattening operation.

When it is desired to flatten strip **15** of material, fluid under pressure is introduced through lines **30** to the chambers in cylinders **24** below pistons **25**, so as to raise roller **13***a* to a sufficient extent that it will not be struck by roller **11***a* when the latter is moved in to pinch roll relationship with roller **13***a*. When this has been done, hydraulic fluid under pressure is introduced into cylinders **22** to move frames **12** carrying roller **11***a* horizontally from the position shown in FIGURES 3 and 5 to the position shown in FIGURES 2 and 4. When frames **12** carrying roller **11***a* reach the position thereof shown in

FIGURE 4, gears **17**, **19** and **20** mesh with each other, and roller **13***a* is directly above roller **11***a* and in pinch roll relationship therewith. The fluid in cylinders **24** beneath pistons **25** then may be exhausted to permit roller **13***a* to rest upon roller **11***a*, and positive pressure may be applied by conducting fluid under pressure to the chambers in cylinders **24** above piston **25** through lines **29**. The motor connected to shaft **21** is started and rotates gears **17**, **19** and **20** in the directions shown in FIGURES 2 and 4. Rollers **13***a* and **11***a* consequently are driven and serve as pinch rollers for strip **15** which is passed therebetween and is driven between successive rollers **13** and **11** by the pinch rollers.

Once strip **15** has passed through flattener **10** and has been taken up by some device which pulls strip **15** through flattener **10**, it is no longer necessary for rollers **11***a* and **13***a* to remain in pinch roll relationship or to be driven. Consequently, the motor which drives gear **20** can be stopped, the hydraulic fluid in cylinders **22** exhausted, and the pistons therein actuated to move frames **12** carrying roller **11***a* to the position of FIGURES 3 and 5, where rollers **13***a* and **11***a*, together with the roller **11** ahead of roller **11***a*, serve a flattening function.

It will be seen from the foregoing that a flattener embodying this invention operates in the same way as the prior art type of flattener insofar as the flattening operation is concerned, but eliminates two pinch rollers **105** and **106** of the prior art type of apparatus.

It will be appreciated that the height of roller **13***a* relevant to the lower rollers may be adjusted by the position of lock nuts **28**, and that the positions of rollers **13** relevant to their cooperating lower rollers may be adjusted by rotation of handles **37**.

While rollers **11**, **11***a*, **13** and **13***a* normally are not driven when they are in the position shown in FIGURES 3 and 5, it will be appreciated that it would not depart from this invention to drive these rollers in this position thereof, if such were desirable.

It also should be appreciated that many different types of mechanisms may be employed to perform the various functions of shifting the rollers as hereinbefore described, and that the rollers other than roller **11***a* may be shifted if desired. Thus, it would not depart from this invention to provide a single frame **12** for all of the lower rollers and to shift all of the lower rollers so that all of the upper rollers come into pinch roll relationship with the lower rollers. Alternatively, one or more of the upper rollers may be shifted relevant to the lower rollers to establish the pinch roll relationship.

While this invention has been described in connection with a flattener having three upper rollers and four lower rollers, it will be appreciated that any number of rollers above three may be employed.

It will be appreciated that gears **17**, **19** and **20** are of the long tooth type. If, on account of the thickness of strip **15**, meshing between gears **17** and **19** in the position thereof shown in FIGURE 4 cannot be effected even with long toothed gears, it will be appreciated that a gear train may be provided between gears **17** and **19** so as to permit gear **17** to be driven by gear **19** through the gear train.

Attention is directed to the fact that the mounting of roller **13***a* is such that jamming of rollers **11***a* and **13***a* will be avoided in the event that roller **13***a* is not lifted before roller **11***a* is brought into pinch roll relationship therewith. In this event roller **11***a* merely will force roller **13***a* upwardly with shafts **36** sliding through cylinders **24**.

While preferred embodiments of this invention have been described in detail herein, those skilled in the art will appreciate that changes and modifications may be made therein without departing from the spirit and scope of this invention as set out in the appended claims.

What I claim as my invention is:

1. A flattener for straightening curved sheet material

such as a coiled metal strip, said flattener comprising: at least first, second and third rotatable rollers, said rollers being spaced apart from each other and being located in a first position relative to each other wherein the axes of rotation of said rollers are disposed substantially parallel to each other and are located at the apices of a triangle with the axis of rotation of said second roller being located intermediate and thereby laterally offset from the axes of rotation of said first and third rollers and also on one side of a line joining the axes of rotation of said first and third rollers; means for laterally shifting at least one of said first and second rollers relative to each other to a second position, in said second position said first and second rollers being in alignment and pinch roll relationship with each other with one of said first and second rollers being located substantially directly above the other of said first and second rollers with reference to said line; and means for rotating at least one of said first and second rollers.

2. A flattener according to claim 1, including means for moving at least one of said first and second rollers relative to each other in a direction substantially perpendicular to a line joining the axes of rotation of said first and third rollers when said first and third rollers are in said first position.

3. A flattener for straightening curved sheet material such as a coiled metal strip, said flattener comprising: a plurality of rotatable first rollers, said first rollers being positioned side-by-side with the axes of rotation of said first rollers being parallel to each other; a plurality of rotatable second rollers, said second rollers being positioned side-by-side with the axes of rotation of said second rollers being parallel to each other and parallel to the axes of rotation of said first rollers, said first rollers being spaced from said second rollers and all located on one side of a line joining the axes of rotation of said second rollers with the axis of rotation of each first roller being located between and hence laterally offset from the axes of rotation of the immediately adjacent pair of said second rollers, whereby a sheet material receiving path is defined between said first rollers and said second rollers; means for moving one of said first rollers laterally into alignment and pinch roll relationship with one of said second rollers at one end of said flattener; and means for rotating at least one of the aligned rollers.

4. A flattener for straightening curved sheet material such as a coiled metal strip, said flattener comprising; a plurality of first rollers, said first rollers being positioned side-by-side but in spaced-apart relationship with each other and with the axes of rotation of said first rollers being parallel to each other and lying in a substantially straight line; a plurality of second rollers, said second rollers being positioned side-by-side but in spaced-apart relationship with each other and with the axes of rotation of said second rollers being parallel to each other and the axes of rotation of said first rollers and lying in a substantially straight line, said first rollers being spaced from said second rollers and all located on one side of said line joining the axes of rotation of said second rollers with the axis of rotation of each first roller being located half way between and hence laterally offset from the axes of rotation of the immediately adjacent pair of said second rollers, successive ones of said rollers being positioned relative to each other to define a generally sinusoidal sheet material receiving path between said first rollers and said second rollers; means for moving one of said first rollers laterally into alignment and pinch roll relationship with one of said second rollers at one end of said flattener; and means for rotating at least one of the aligned rollers.

5. A flattener according to claim 4 including means for moving said one second roller relative to a line joining the axes of rotation of said first rollers in a direction such that the distance between said one second roller and said one first roller may be increased or decreased.

6. A flattener according to claim 4 including means for adjusting the spacing between said second rollers and said first rollers.

7. A flattener according to claim 4 wherein said means for rotating at least one of the aligned rollers comprises a driving gear and a driven gear, said driven gear being connected to drive said one of said aligned rollers, said driving gear meshing with said driven gear when said one of said first rollers and said one of said second rollers are in pinch roll relationship.

8. A flattener according to claim 6 wherein said means for rotating at least one of the aligned rollers comprises a driving gear and a driven gear, said driven gear being connected to drive said one of said aligned rollers, said driving gear meshing with said driven gear when said one of said first rollers and said one of said second rollers are in pinch roll relationship.

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