United States Patent [19]

Demus

[11] **3,795,127**

[45] **Mar. 5, 1974**

[54] **METHOD AND APPARATUS FOR PRODUCING LONG FLAT METAL STRIP FROM A COILED METAL STRIP WITH UNIFORM STRAIGHT EDGES TO A HIGH DEGREE OF PRECISION**

[75] Inventor: **Andre Demus,** Imphy, France

[73] Assignee: **Creusot-Loire,** Paris, France

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[21] Appl. No.: **263,949**

[30] **Foreign Application Priority Data**

Aug. 11, 1971 France 71.29342

[52] **U.S. Cl.** **72/294,** 72/332, 72/308, 83/471.2

[51] **Int. Cl.** **B21d 43/28**

[58] **Field of Search** 72/294, 306, 308, 334, 378, 72/332; 83/425, 471.2, 675, 175

[56] **References Cited**

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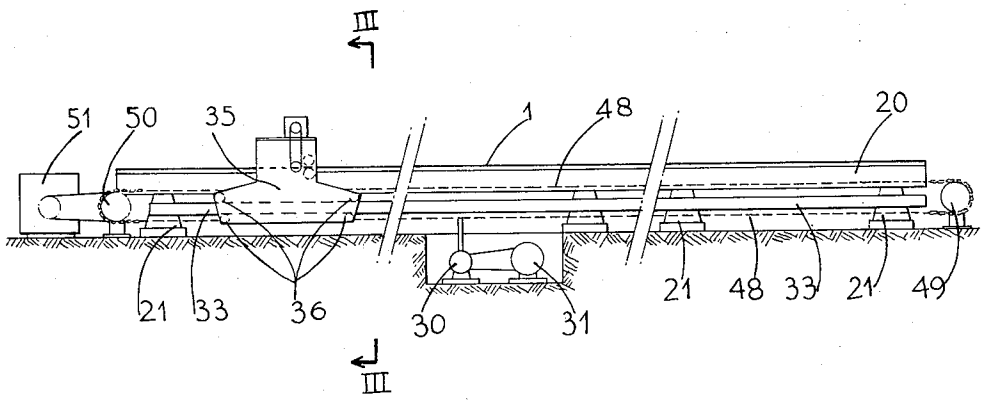
Primary Examiner—Charles W. Lanham
Assistant Examiner—M. J. Keenan

[57] **ABSTRACT**

A method and apparatus for producing long flat metal strip from a coiled metal strip so that the flat metal strip has uniform straight edges to a high degree of precision. The uncoiled strip is straightened by traction to a degree slightly beyond its elastic limit, laid flat unclamped on a bench, then immobilized on the bench and the edges trimmed by mobile shears movable on a longitudinal guide member lying parallel to the axis of the bench and the metal strip thereon.

5 Claims, 3 Drawing Figures



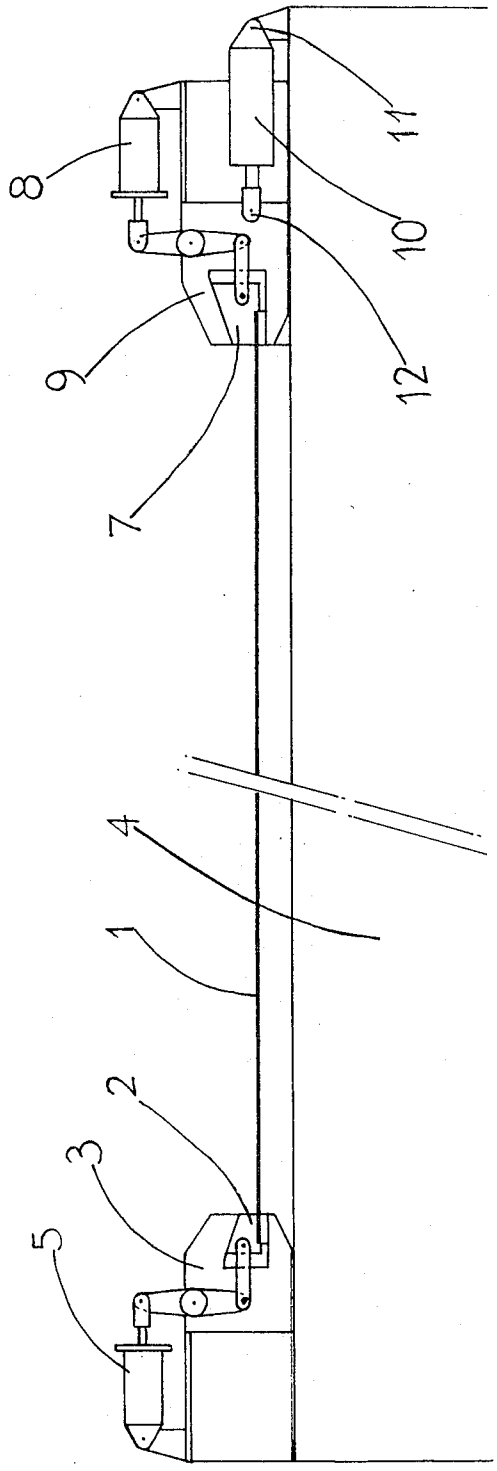


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FIG:2

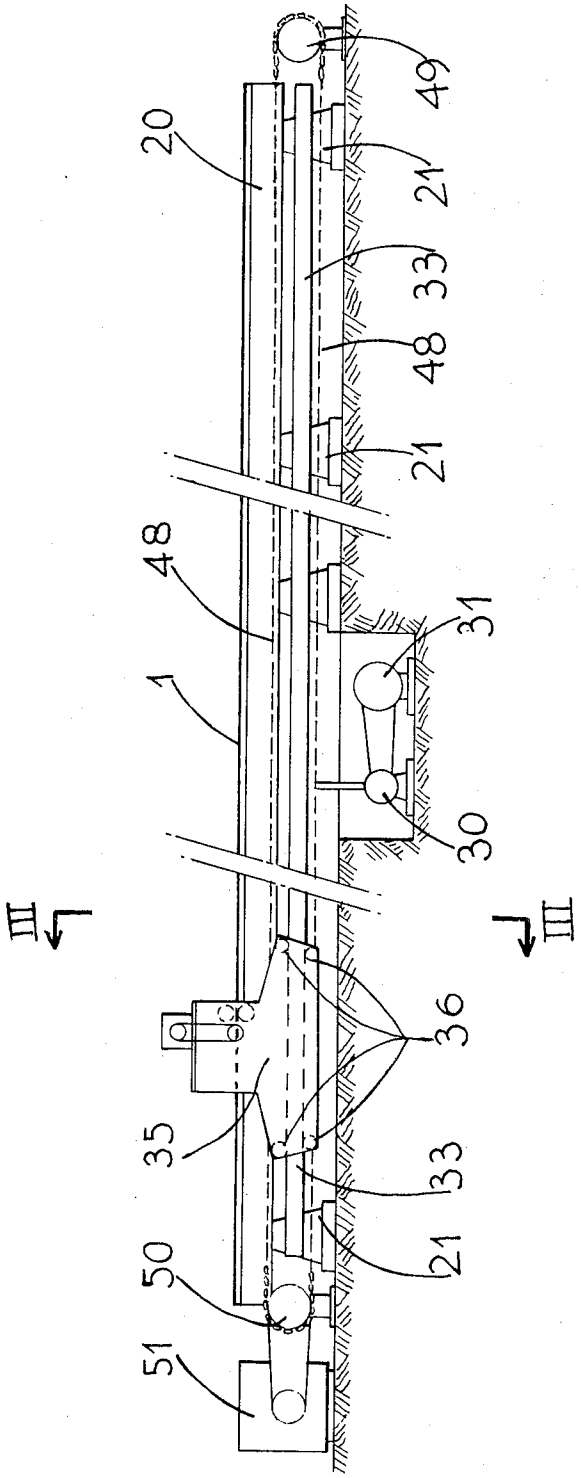
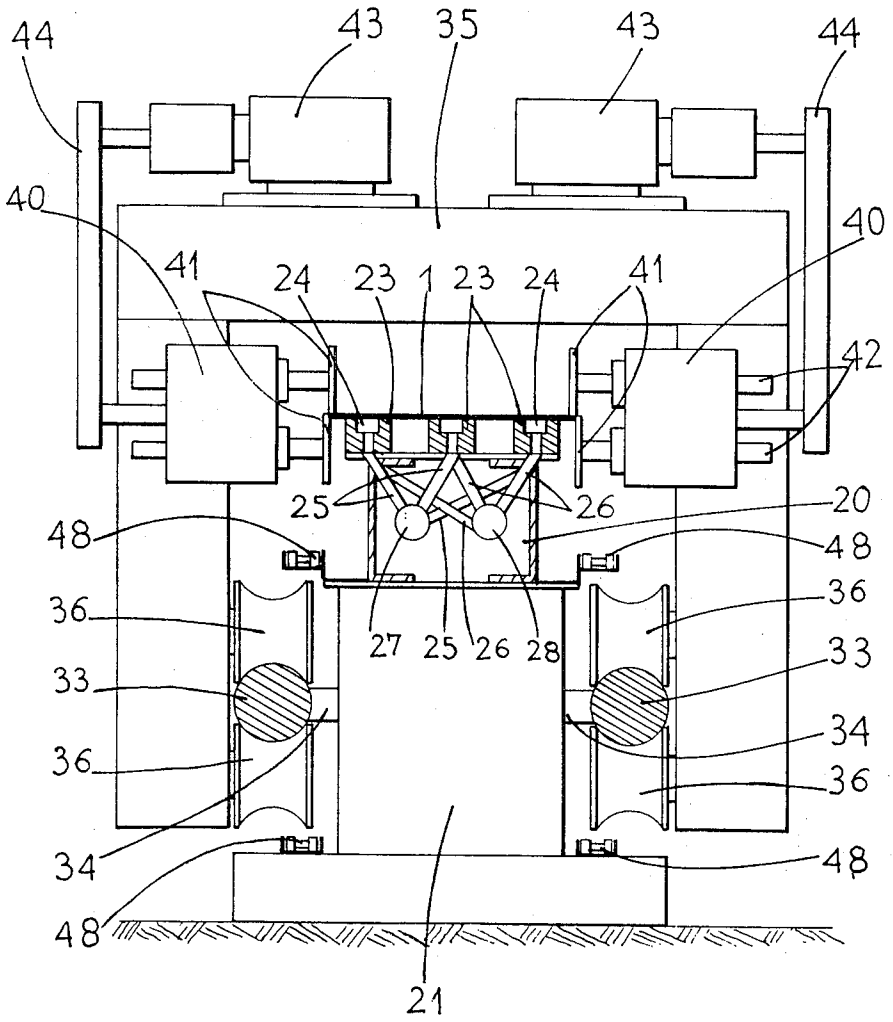


FIG:3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METHOD AND APPARATUS FOR PRODUCING LONG FLAT METAL STRIP FROM A COILED METAL STRIP WITH UNIFORM STRAIGHT EDGES TO A HIGH DEGREE OF PRECISION

The present invention relates to a method and apparatus for the manufacture from a coiled metal strip of very long metal strip with straight edges to a high degree of precision. As an example, it is particularly applicable to the problems encountered in the construction of high capacity storage or transport tanks for liquefied gases, such as the methane tankers for the sea-transport of liquid methane at very low temperature.

Such tanks are constructed by welding long metal strips with a very low expansion coefficient and the construction specifications demand very exact precision for the straightness of the edges of the strip, the tolerance being of the order of ± 0.5 mm per metre, non-accumulative; whatever may be the length of a strip, no point on the edge of that strip may be distant by more than 0.5 mm from the ideal straight line joining the two ends of this edge, and the inclination of the edge relative to this line is at most equal to 0.5 mm per metre on either side. At present the strip has to be 30 metres long, but the development in the size of methane tankers means that we may now consider having in future to use strips up to 50 metres long. Such precision, over such a length, obviously cannot be obtained by longitudinal shearing prior to coiling at the end of the rolling-mill.

It is known that thin sheet, supplied in the coil, always exhibits when uncoiled out flat a distortion known as "sword edge", the two borders being curved in the same direction. The tolerance usually allowed is a maximum deflection of 1 mm per metre, but this deflection accumulates along the whole length of the strip and it will be seen that, for strip of the order of at least 30 metres, the total offset from one end to the other will be very large. Cutting a vertically rectilinear strip, with a non-accumulative tolerance of ± 0.5 mm per metre relative to the perfect straight, out of such a curved strip. will lead to substantial wastage. Now the metal used for the construction of tanks for liquid gases is generally a metal with a high nickel content and, consequently is an expensive metal; substantial wastage would rapidly increase the overall net cost of construction.

In addition, it must be noted that when the starting material is a strip with a sword-edge distortion, even if cutting is carried out perfectly straightly, the wastage will not be equally distributed on each side, and the stresses of the original strip will not be released symmetrically. As a result, the strip obtained will be newly distorted, with deflections greater than the tolerance of ± 0.5 mm per metre.

A process is known for straightening swordedge curved strip, consisting of subjecting the strip, uncoiled in the flat, to a longitudinal, tractional force slightly greater than its limit of elasticity. The permanent distortion resulting from this traction straightens the strip, making it symmetrical about a rectilinear axes, but generally leads to a slight width reduction in the central portion by contraction of cross-section, the two edges then exhibiting symmetrical curves, with a convexity facing the axis of the strip. It is not yet possible to effect longitudinal shearing with the precision imposed by passing the band into shears, for the strip could only be guided by contacting an edge which would itself be curved beyond the required tolerance.

According to the invention, the uncoiled strip is first straightened flat by traction to a degree slightly beyond its limit of elasticity and the strip is next laid flat, unclamped on a bench, then immobilized on this bench and the edges trimmed by mobile shears guided on a longitudinal member attached to the bench.

The invention also relates to the apparatus for carrying out the above method, this apparatus including a straightening bench capable of receiving the uncoiled metal strip and having a pair of devices for securing the opposite ends of the strip, at least one of these securing devices being connected to a traction device; the apparatus also includes a longitudinal shearing bench including a pair of sets of shearing means and means for raising the strip uniformly over its entire surface from the shearing bench, means for immobilizing the strip on the shearing bench, longitudinal guiding means parallel to the axis of the bench, at least one set of shearing means being each side of the shearing bench and transversely adjustable along and connected to longitudinal guide means, and drive means for longitudinal displacement of the shearing means.

One embodiment of the invention will now be described, given by way of example only, with reference to the attached drawings, in which:

FIG. 1 is a simplified elevation of a tensioning straightening bench;

FIG. 2 is a simplified elevation of a shearing bench; and

FIG. 3 is a cross-section along the line III—III of FIG. 2.

With reference to FIG. 1, representing the tensioned straightening device, strip 1 is held at one end in the self-closing jaws 2 of a unit 3 rigidly connected to the frame 4 of the machine. Unit 3 also supports a ram device 5 for opening jaws 2. At the other end, a similar device with self-closing jaws 7 and opening rams 8 is mounted on a unit 9; however, this unit 9 is slidable on frame 4. A ram system 10, connected at 11 to frame 4 and at 12 to unit 9, applies a longitudinal, tractional force. Of course, the anchoring points 11 of ram 10 to frame 4 are multiple and uniformly distributed over the bench to allow different lengths of metal strip to be worked.

Referring now to FIGS. 2 and 3, the shearing bench consists of a longitudinal beam 20 supported on a series of blocks 21. The resting plane of strip 1 is formed by the upper surfaces of a series of parallel, longitudinal beams 23 resting on beam 20. Each longitudinal beam 23 has orifices 24 uniformly spaced along the whole length of the beam and alternately connected, by conduits 25 or 26, to a common longitudinal conduit 27 or 28, respectively. Conduit 27 is connected to a compressor 30 driven by a motor 31. Conduit 28 is connected to a vacuum pump driven by a motor not illustrated in the drawing, but which, simplified, would have the same appearance as the compressor and its drive motor in FIG. 2.

On each side, the bench includes a guiderail of circular cross-section 33, which is perfectly rectilinear and parallel to the bench axis. Each guide-rail 33 is connected to blocks 21 by supports 34. The mobile shearing device consists of a frame 35, the lateral surfaces of which are held captive on each lateral rail 33 by means of free-running rollers 36. Each side frame 35 supports a set of shears 40 with two circular blades 41. Each set of shears 40 is transversely adjustable on slide bars 42

and is linked to a reduction drive motor **43** by a transmission **44.**

On each side, mobile frame **35** is connected to the upper run of an endless chain **48** wound on a return drum **49** and a motive drum **50** driven by a motive device **51.**

To effect longitudinal shearing, strip **1,** which has just undergone straightening by drawing, is firstly placed in longitudinal beams **23.** For this operation the shear-carrying carriage **35** is obviously returned to one end of the bench, while the shears are opened to allow the maximum free space for manipulation of the strip while it is being set on the bench. For its transfer from the drawing bench to the shearing bench, the strip has had to be coiled; when uncoiled on the shearing bench, the strip has necessarily had to be realigned to be exactly along the axis of the bench, and it is not certain that there do not remain in the entirely uncoiled strip local residual stresses due to the frictional forces of the strip on longitudinal beams **23.**

These possible stresses are eliminated by blowing through a portion of orifices **24** compressed air supplied by conduit **27** and the connection piping **25.** Strip **1** is thus raised and as though floating above longitudinal beams **23,** so that, when the supply of compressed air is discontinued, the strip falls back onto longitudinal beams **23** totally freely and without any stress remaining.

The strip thus resting freely on the bench is then connected rigidly to the bench, using the other series of orifices **24** as suckers by starting the vacuum-pump, which aspirates through conduit **28** and conduits **26.**

With strip **1** then immobilised on the bench, shears **40** are adjusted to the transversal position for the required final strip width and moved along the bench by movement of the supporting mobile frame assembly **35,** driven by motive device **51.**

It will be seen that the apparatus described above permits strictly rectilinear shearing, since it depends only on the straightness of guides **33,** which are entirely fixed and may therefore by made as rigid as necessary to ensure the required degree of precision. Moreover, shearing is carried out on a strip of sheet metal across which no stresses remain from setting on the bench, this same strip having previously been made symmetrical both dimensionally and with regard to internal stresses by the drawing under tension of the first operation.

Of course, the invention is not limited to the single embodiment which has been described as an example, but also covers other embodiments which could differ from it only in detail and enable the process as it has been disclosed to be carried out.

Thus the drawing bench and the shearing bench could also be imagined as combined in the same piece of apparatus; the securing and traction devices would then have to be fitted at the end of the shearing bench beam. Such an arrangement would have the substantial advantage of avoiding transport manipulation of the strip from one bench to the other, resulting in a saving in time and a reduction in the risk of damage.

Similarly, instead of using the compressed-air blowing and the sucker devices, firstly to raise the strip and free it of bench contact stresses, and then to strongly adhere it to the bench, equivalent means, for example magnetic means, could be used. Finally, the shears used could be of any usual known type, provided that their longitudinal displacement is controlled by a guide rigidly connected to the bench.

I claim:

1. Method for producing from a coiled strip a metal strip which has straight edges to a high degree of precision, comprising the steps of straightening the uncoiled strip in the flat by traction to a point slightly beyond its limit of elasticity, placing the strip flat, without constraint, on a bench, raising the strip uniformly over its entire surface from the bench on an air cushion, and then immobilising the strip on the bench, the edges of the strip then being trimmed off by longitudinal shearing with mobile shears guided along a longitudinal member fixed to the bench.

2. Apparatus for producing from a coiled strip a metal strip which has straight edges to a high degree of precision, comprising a straightening bench capable of receiving uncoiled metal strip and having a pair of devices for securing the opposite ends of the strip, at least one of the securing devices being connected to a traction device, and a longitudinal shearing bench including a pair of sets of shearing means, air cushion means for raising the strip uniformly over its entire surface from the shearing bench, means for immobilising the strip on the shearing bench, and longitudinal guiding means on and parallel to the axis of said shearing bench, a set of said shearing means being on each side of the shearing bench and transversely adjustable along and connected to said longitudinal guide means and drive means for longitudinal displacement of said shearing means.

3. Apparatus as claimed in claim **2,** said means for raising the strip on said shearing bench including a plurality of orifices uniformly distributed in the surface of said bench and a compressed air generator connected to said orifices for raising the strip uniformly over its entire surface from said shearing bench.

4. Apparatus as claimed in claim **2,** said means for immobilizing the strip on said shearing bench including a plurality of orifices uniformly distributed in the surface of said bench and a vacuum pump connected to said orifices for immobilising the strip on said shearing bench.

5. Apparatus as claimed in claim **2,** said means for immobilising the strip on said shearing bench being magnetic.

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CERTIFICATE OF CORRECTION

Patent No. 3,795,127 Dated March 5, 1974

Inventor(s) ANDRE DEMUS

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Foreign Application Priority Data [30]

August 11, 1972 France 71.29342

Add Atty.

William B. Kirkam, Jr.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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