United States Patent [19]

Rouyer

[11] **3,722,247**

[45] **Mar. 27, 1973**

[54] **CORRUGATION OF THIN SHEET**

[75] Inventor: **Georges Rouyer,** Paris, France

[73] Assignee: **Societe Nationale Industrielle Aerospatiale,** Paris, France

[22] Filed: **Apr. 5, 1971**

[21] Appl. No.: **131,048**

[30] **Foreign Application Priority Data**

Apr. 8, 1970 France.....7012767

[52] **U.S. Cl.**.....**72/106,** 72/180

[51] **Int. Cl.** **B21d 15/04**

[58] **Field of Search**.....72/50, 94, 104, 103, 49, 98, 72/180, 106, 105

[56] **References Cited**

UNITED STATES PATENTS

3,183,695	5/1965	Darner	72/180 X
2,940,502	6/1960	Martine	72/105
3,548,623	12/1970	Hess et al.	72/106
3,067,707	12/1962	Ellzey	72/50

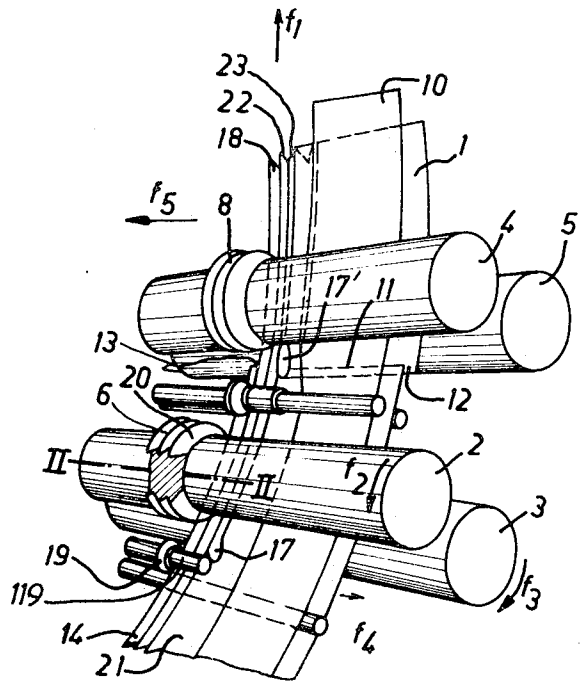
Primary Examiner—Milton S. Mehr

Attorney—Karl W. Flocks

[57] **ABSTRACT**

A machine for corrugating thin sheet metal comprising two rolls at a first work station, at least two rolls at a second work station, tracking lateral rollers, a corrugation-forming rake mounted on each roll, at least one clamping roll upstream of one work station, a shell of sheet metal being rotatable between the two rakes of each work station, each work station effecting through the pressure of the first-rake roller a bending of the metal to form a half-profile of the corrugation of each successive helix turn, the successive turns screwing helix-fashion into the rakes whereby to obtain a corrugated shell.

3 Claims, 4 Drawing Figures



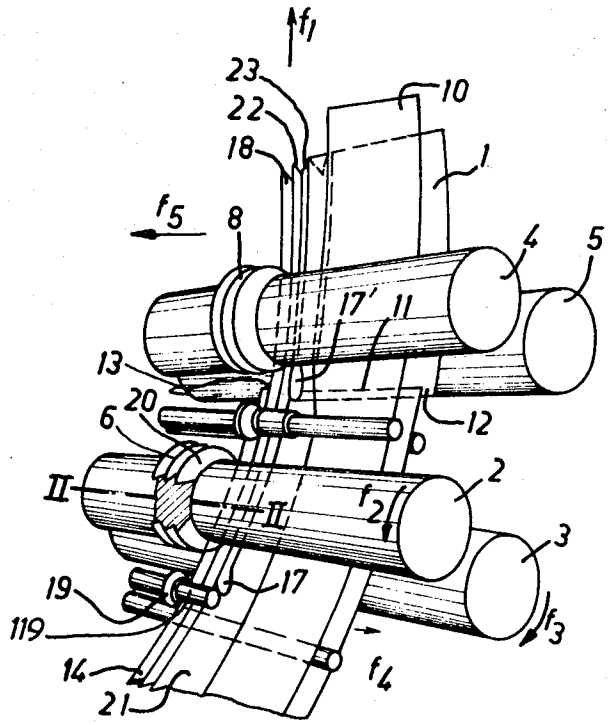
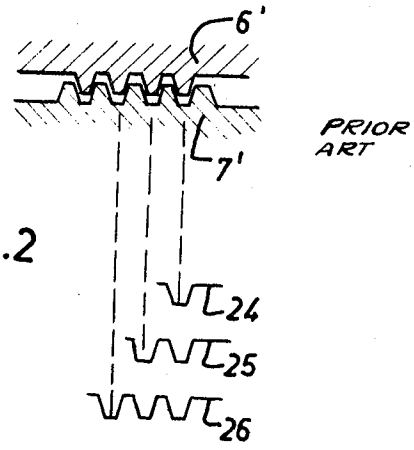


FIG.1



PRIOR ART

FIG.2

INVENTOR

GEORGES ROUYER

BY KARL W FLOCKS

ATTORNEY

FIG.3

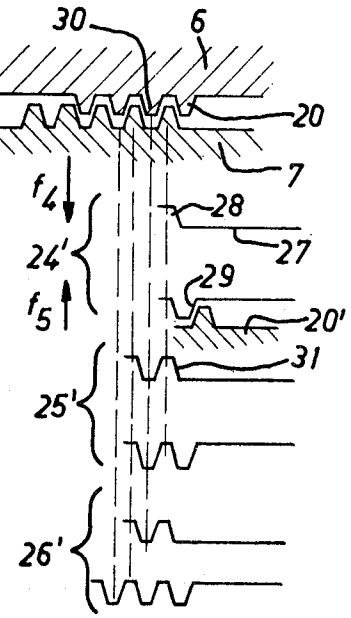
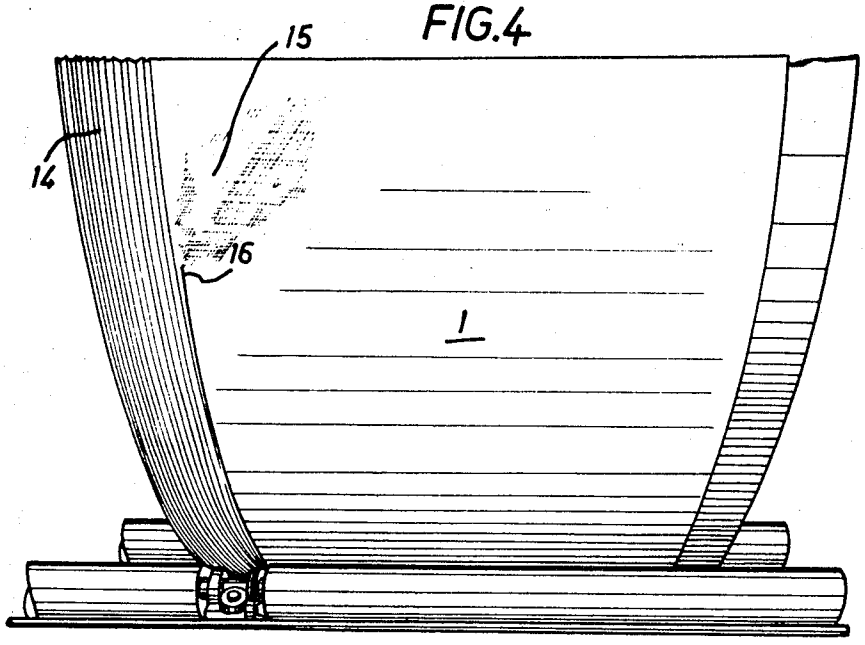


FIG.4



CORRUGATION OF THIN SHEET

The present invention relates to the corrugating of thin sheet and in particular thin sheet made of ductile materials which readily acquire a permanent set.

Already known is a method of corrugating thin sheet around a shell, in which the corrugating is done by two rollers or rakes which form a series of uniformly spaced helical corrugations, the bulge upon which the head corrugation is formed being bounded by the preceding trough, the forming roller, a restraining roller ahead of the bulge, and the effect of bent solid sheet on that side of the corrugation which is remote from said preceding trough.

The trough of the head corrugation, formed thus in the first rake imprint, returns after a full revolution of the shell into the second rake imprint and accordingly follows a helical path by a process of continuous screwing into the rake.

It is possible in this way to obtain corrugated cylindrical shells or conical structures. After these corrugated shells have been straightened out, sandwich-panel filler elements can be obtained for example, and because these corrugated elements have been fed through the rakes in a helical path it is possible to ensure the high precision to within a few minutes of arc in respect of angle or to within one-hundredth of a millimeter in respect of pitch, which precision is required when sandwich panels are fabricated by automatic welding operations on a buttress and later used as interchangeable prefabricated elements.

However, although this production method is satisfactory in the case of stainless steel strip 0.15mm thick for example, it has been found that when thin or medium thickness sheet is to be corrugated in this way, the metal becomes unduly stressed and flaws appear. Further, in the case of 0.15mm thick sheets of very ductile metals like titanium, which readily acquire a permanent set, the shell will not remain rigorously cylindrical and it has been found that, collectively, its cross-sections tend to taper off within the plastic range of the metal.

The present invention accordingly provides a method of corrugating by means of two work-stations, the first of which forms the first half-corrugation by drawing in the metal needed to form a half-pitch, and the other bends the metal in the opposite direction to form the other half-pitch and thereby complete the head corrugation, the latter then engaging into the helix pitch of the rake of the first work station whereby to fully assure the high precision required in the geometry of the corrugating process.

The description which follows with reference to the accompanying non-limitative exemplary drawings will give a clear understanding of how the invention can be carried into practice.

In the drawings:

FIG. 1 is a perspective view of a machine according to the invention for corrugating shells of thin sheet metal;

FIG. 2 is a sketch illustrating the prior art method of forming corrugated sheets, corrugation by corrugation;

FIG. 3 is a sketch illustrating the method according to this invention of forming corrugated sheets in successive half-corrugations at two work stations; and

FIG. 4 shows a sheet undergoing corrugation.

FIG. 1 shows a shell 1 of smooth thin sheet to be corrugated placed between two sets of rolls 2,3 and 4,5. The rolls 2 and 3 of the first work station carry roller supporting rakes 6 and 7 (the rake 7 not being visible). The rolls 4 and 5 carry rakes 8 and 9 (rake 9 not being visible).

Between rolls 2 and 4 and shell 1 is interposed a rigid cylindrical support 10.

Endless shell 1 is welded back upon itself at 11, and visible at 12 and 13 are the lateral offsets which, through the agency of tracking rolls, determine the degree of skew of the helical troughs 14.

FIG. 4 shows the formation of a bulge 15 at the point of initiation of the head corrugation 16. The same figure shows a shell in the process of being corrugated, the set of rollers having been omitted in order to show certain particularities of the method with greater clarity.

In FIG. 1 the shell 1 is driven in the direction of arrow f1 by rolls 2 and 4 rotating in the direction of arrow *f*2 and rolls 3 and 5 rotating in the direction of arrow f3.

Visible is a bulge 17 ahead of the rake 6 carried by roll 2. This bulge is relatively little developed and is bounded by the previously formed trough 18, the restraining roll 119, the first roller 20 of rake 6 and the effect of smooth bent sheet reinforced by the presence of support 10.

The region 21 of the sheet is level with apex 22 of trough 18. The effect of roller 20 at the first work station is to shape a half-corrugation by bending the sheet in the direction of arrow *f*4 (rightwardly of FIG. 1).

When the second work station is reached, the first roller of rake 9 (not visible in the figure) bends the sheet in the direction of arrow *f*5 (leftwardly of FIG. 1) to form the complementary half-corrugation of trough 23.

Guide rollers 19 restrained within corrugations 14 and 18 provide the working angle in relation to the forming rollers.

Reference will now be made to FIGS. 2 and 3 for a clearer understanding of the mechanism of the invention.

FIG. 2 shows in section along II—II of FIG. 1 the rakes 6′ and 7′ of a single prior art work station.

In the absence of a second work station, as was the case in the prior art, each revolution of shell 1 causes the trough helix to advance by one pitch. The graph 24 represents the formation of the full corrugation in the first turn taken from offset 13. It will be noted that all the smooth sheet required to form the corrugation is drawn in abruptly, thus causing cumulative elongation and internal stresses, which certain metals will withstand especially if the sheet is relatively thick.

The graph 25 represents the profile of the corrugation after a full revolution of the shell, and the graph 26 after two revolutions.

In FIG. 3, on the contrary, may be seen the rakes 6 and 7 of the first work station of rolls 2 and 3, in accordance with the present invention.

Graph 27 shows what happens when the first roller 20 engages with the offset 13 in the shell and how it forms half-corrugation 28 by bending the sheet downwardly in the direction of arrow f4.

At the second work station, during the same revolution of the shell, roller **20'** of rake **9** mounted on roll **5** bends the sheet upwards once more in the direction of arrow *f*5 to form half-corrugation **29** and thereby complete the trough **18** of the first turn in helix **14**.

Stage **24'** in the formation of the first trough is thus effected in two phases and the metal is bent without cumulative elongation and crowding in an entirely rational manner in order to avoid any permanent set from the metallurgical standpoint.

In this way observance is ensured of the 2 percent elongation not to be exceeded with certain materials, especially those containing a heavy proportion of titanium.

After a complete revolution of the shell, the trough **18** positions itself beneath the trough **30** of rake **6** whereby the precise geometry of the latter, in conjunction with the female counter-spline, ensures accurate geometry of the skew path of the helix of troughs **14** in accordance with the invention. Simultaneously, roller **20** forms the half-trough **31**, and thereafter the roller **20'** of rake **9** completes the trough **23** which can be seen in the process of formation in FIG. **1**, behind the bulges **17** and **17'**.

Stage **25'** is accordingly completed and at the next revolution the two consecutive work stations perform the stage **26'** in the same way.

It will be appreciated that the method of producing successive half-corrugations, according to this invention, permits of adjusting with extreme precision the process of drawing in the metal of the smooth shell to be corrugated. The work effected by the rollers, which exert virtually no distortion on the sheet, is not accompanied by any notable surface wear, which, without the need to touch up the bearing surfaces, makes it possible to guarantee on the corrugated sheet the high precision of to within one-hundredth of a millimeter in respect of pitch and corrugation depth, and to within a few minutes of arc in respect of angles, which precision is essential for the subsequent fabrication and use of sandwich panels.

It goes without saying that changes and substitutions of parts may be made in the preferred exemplary embodiment of the invention hereinbefore described, without departing from the scope of the invention as set forth in the appended claims.

What is claimed is :

1. A method of corrugating sheet metal bent to form an endless shell, characterized in that it includes the steps of welding upon itself a thin sheet to be corrugated; staggering the welded end edges by providing a degree of offset therebetween; positioning the shell on a cylindrical support between two sets of rolls of two work stations; causing the shell to rotate, the first roller of a rake mounted on one of the rolls of the first work station producing the bending into a half-corrugation upon said offset by pressing against a roller provided on the other roll of the first work station; effecting a bending in the opposite direction to form the second half-corrugation of the first turn in a helical corrugation by means of two sets of rollers provided at the second work station; engaging, upon the second revolution of said support, said first turn into a second imprint of the first work station and obtaining thereby a continuous helical corrugation without exceeding an elongation of 2 percent at any point in the metal.

2. A method as claimed in claim **1**, wherein two bulges formed on the metal ahead of the respective bends in the head turn are bounded between the previous corrugation, the forming roller, a restraining roll and the solid sheet metal effect on that side of the sheet which is adjacent the rigid cylindrical support.

3. A method as claimed in claim **1**, further characterized by

restraining guide rollers within corrugations so as to provide a working angle in relation to a following set of corrugation forming rollers.

* * * * *