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METHOD AND APPARATUS FOR CORRUGATING TUBES

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This invention relates to a method and apparatus for continuously corrugating tubes. More particularly, it relates to a method and apparatus especially suitable for continuously forming deep corrugations in a thin-wall tube and for avoiding substantial torsional stresses in the tube during the corrugating operation.

Tubes have been corrugated heretofore by apparatus having a hollow rotating head carrying a grooving tool. The tube is advanced continuously through the head along its rotation axis so that the tool is rotated about the advancing tube while in groove-forming engagement with the tube.

The grooving tool has taken various forms in such prior apparatus. For example, it may consist of a member at least partly surrounding the tube and having at its inner surface a concave working edge engaging the tube periphery to form a helical corrugation as the tube is advanced, as disclosed in British Patents Nos. 791,513 and 791,514 published Mar. 5, 1958. In another form, the grooving tool comprises a plurality of roller discs mounted on the head in spaced relation about the tube and rotatable on axes generally parallel to the head axis, whereby the disc peripheries engage the tube periphery to form therein a helical corrugation as the tube advances through the rotating head, as disclosed in U.S. Patent No. 2,817,363 dated Dec. 24, 1957.

Apparatus of this rotating head type as made heretofore have the disadvantage that the rotating head transmits a torque to the tube through the grooving tool as the latter impresses the corrugation. This torque creates objectionable stresses and strains in the tube and in many instances requires an anti-torque device, such as a caterpillar, for gripping the advancing tube adjacent the corrugating apparatus to prevent transmission of the torque through the tube to a preceding or subsequent operation thereon.

A further disadvantage of prior apparatus of this type is that it is unsuited for forming deep corrugations in thin-walled tubes, due to the fact that the corrugation groove is impressed suddenly to its full depth with a resulting tendency of the grooving tool to break or fracture the thin metal.

Still another disadvantage of such prior apparatus is that it is suitable for forming only a helical groove or corrugation on the tube, whereas it is sometimes desirable to corrugate the tube by forming annular grooves. Heretofore, annular corrugation of tubes has been effected by advancing the tube through a stationary frame which mounts four gear-like rollers driven synchronously about axes lying in a plane normal to the tube axis, each roller having a grooved periphery embracing one-quarter of the tube circumference. As disclosed in British Patent No. 711,305 published June 30, 1954, these four rollers have peripheral teeth which, as the rollers are driven, engage the tube periphery to impress the annular grooves while drawing the tube through the stationary frame. The latter type of apparatus, however, lacks many of the advantages of the rotating head type and is generally unsuitable for high-speed corrugating.

The principal object of the present invention is to provide a tube corrugating apparatus of the rotating head type which overcomes the above-noted disadvantages of

prior apparatus of this type. A further object is to provide an improved method of corrugating tubes.

According to the method of the present invention, the periphery of the tube to be corrugated is pressed radially inward simultaneously at a series of pressing locations spaced lengthwise along the tube and to depths which progressively increase from a first to a last location of the series. During these simultaneous multiple pressings, the tube is advanced lengthwise at constant speed in the direction from the first to the last of these pressing locations; and at the same time the pressing locations are rotated as a unit at constant speed around the advancing tube while maintaining these locations in positions to press successive turns of the groove simultaneously. In this way, each external groove making one turn around the tube is formed gradually to its final depth as the groove of initial depth is subjected in succession to the pressing operations at the subsequent pressing locations; and when each pressing location has completed its pressing action through one turn around the advancing tube, its next complete rotation around the tube will similarly press a succeeding increment of length of the advancing tube.

To maintain the pressing locations in the above-noted positions, they may be advanced lengthwise of the tube at the same speed as the tube advancement, whereby the grooves are pressed in annular form around the tube. Alternatively, the rotating pressing locations may be maintained in their above-mentioned positions by holding them fixed in the direction lengthwise of the tube advancement, whereby the grooves are pressed in spiral form around the tube with each turn forming a continuation of an adjacent turn.

In the preferred method, the tube advancing from the first series of pressing locations is pressed radially inward simultaneously at a second series of pressing locations spaced lengthwise along the tube, these last pressings being to progressively increasing depth from the first to the last location of the second series, that is, in the direction of the tube advancement. During these pressing operations at the second series of pressing locations, the latter are rotated as a unit at constant speed around the advancing tube in the direction opposite to the direction of rotation of the first-mentioned series and while maintaining the locations of the second series in positions to press successive turns of the grooves simultaneously. Thus, the grooves are pressed to still greater depth at the second series of pressing locations, and at the same time the latter serve to counteract the torsional stresses to which the advancing tube is subjected at the first series of pressing locations, since the two series are rotating in opposite directions.

An apparatus made according to the present invention comprises a head mounted for rotation about an axis, means for rotating the head at constant speed about this axis and means for advancing the tube lengthwise relative to the head at a constant speed and with the tube axis coinciding with the rotation axis. A series of tube pressing elements is carried by the head with these elements in positions to engage the periphery of the advancing tube simultaneously along a series of successive turns around the periphery as the head rotates. The apparatus also comprises means mounting the pressing elements on the rotating head in the aforesaid positions while spacing the respective elements from the rotation axis by radial distances which progressively decrease in the direction of the tube advancement, so that the pressing elements gradually press the grooves to a depth corresponding to the shortest of these radial distances.

Preferably, the mounting means for the pressing elements include a roller rotatable on the head about an axis generally parallel to the head axis, the pressing ele-