

SPECIFICATION

Ultrasonic seam welding apparatus

This invention relates to an ultrasonic seam welding apparatus for seam welding workpieces of sheet state, which are piled in plurality one above the other for being held in forced contact between a horn coupled to an ultrasonic resonator and a presser roller, by means of feeding the workpieces while imparting to the same ultrasonic oscillation.

As an apparatus in this category U.S. Patent No. 3,734,805 discloses one in which workpieces are held in forced contact between a working surface formed on top of a horn oscillating in a longitudinal direction thereof and the external peripheral surface of a driven feed roller for being seam welded while being fed by the rotation of the roller. In this apparatus heat naturally generated by the compressive force repeatedly applied on the workpieces by the horn advantageously enhances the energy efficiency. Another advantage of this type apparatus is that no load in a lateral direction is applied to a horn assembly including the horn therein. An inherent weak point of this apparatus lies however in that some pieces of the piled workpieces forced to the horn are relatively inferior in the feeding to those on the opposite side, which is liable to produce wrinkles in the welded portion. U.S. Patent No. 3,955,740 discloses on the other hand an apparatus, wherein a horn having a large diametered portion in it is parallelly disposed to the rotational axis of an anvil wheel roller for being rotated so that workpieces are held in forced contact between the external peripheral surface of the large diametered portion of the horn and the external peripheral surface of the anvil wheel to be seam welded. This type apparatus is disadvantageous in that the energy efficiency is inferior to a case where the horn is perpendicularly contacted to workpieces because of the oscillating direction of the working surface of the horn, i.e., the external peripheral surface of the large diametered portion of the horn, in this case being parallel to the workpieces under the process, while good feeding effect is being advantageously ensured by the light and smooth following rotation of the anvil wheel to the workpieces which are fed by the horn. A further disclosure can be seen in this U.S. Patent No. 3,955,740, in which the axial oscillation of the horn is converted at the large diametered portion thereof to the radial direction before being transmitted to the workpieces. Even in this instance the energy efficiency is inevitably deteriorated in the course of the direction converting of the oscillation. In addition to the above, the horn is obliged to be under a power in the perpendicular direction to the axis of the horn for holding the workpieces in between with the anvil wheel, which necessitates (1) the build-up of the horn assembly supporting means to be solid and stout and (2) to disadvantageously narrow the bosom or depth of the processing area, that is the distance of the actual processing place away from

the column of the machine frame, because the horn is hard to be projected from the machine frame very long due to its cantilever structure.

According to the present invention there is provided an ultrasonic seam welding apparatus including, a machine frame, a converter-horn assembly which includes a horn oscillatable in a direction parallel to a longitudinal axis of said assembly by an electroacoustic converter and which is supported by said machine frame rotatably about said longitudinal axis, driving means for rotating said converter-horn assembly, a roller rotatably disposed on said machine frame, and urging means for urging said roller toward said horn, characterised in that said horn is provided with a circular flat working surface substantially perpendicular to, and concentric with, said longitudinal axis, and said roller is opposed at the peripheral surface thereof to said circular flat working surface at a position offset from said longitudinal axis in a radial direction of said working surface to hold two or more sheet-like thermoplastic workpieces between said peripheral surface and said circular flat working surface in forced contact therewith under an urging force of said urging means.

Preferably, in the apparatus of the invention, the roller is also rotated by driving means to obtain a further improved feeding of the workpieces. A separate drive means may be provided for the roller, or the drive for the converter-horn assembly may be used also to drive the roller.

An elastic ring-shaped member such as an O-ring made of rubber is preferably disposed on at least one lateral side of the peripheral surface of the roller, which ensures a straight linear feeding of the workpieces.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is an elevational view of an embodiment of an ultrasonic welding apparatus of this invention;

Fig. 2 is a perspective view of an essential part of the embodiment in Fig. 1; and

Fig. 3 is an elevational, partly sectional, view of an essential part of another embodiment of an ultrasonic seam welding apparatus of this invention.

With reference to Figs. 1 and 2 an embodiment of this invention will be described hereunder.

A work table 1 constituting a part of a machine frame 16 is provided with a bed 2 secured thereon. An arm 3 is integrally formed with the bed 2 in a posture hanging thereover. An electric motor 4 is secured to the bed 2 from the lower side thereof. A pulley 5 is connected to the electric motor 4 by way of a belt 6 for being able to rotate a main shaft 7 retained in the arm 3. On the leftward end in Fig. 1 of the main shaft 7 another pulley 8 is secured, which is operatively connected via another belt 9 to a presser roller 11 disposed beneath a head portion 10 of the arm 3.

Within the head portion 10 of the arm 3 a presser bar 12 is slidably retained in an up-and-

down or vertical direction. On the lower end of the presser bar 12 a roller holder 12a for rotatably supporting the presser roller 11 is secured. In the middle of the presser bar 12 a stopper 13 is fixedly attached. Between the stopper 13 and the upper wall of the arm 3 a compression spring 14 is installed for constantly urging the presser bar 12 downwardly. On the lower surface of the stopper 13 a cam portion of a lift lever 15 is abutted; while the lift lever 15 is held at a lifted position as illustrated in Fig. 1 the presser bar 12 is locked upward in a released position wherein the belt 9 stretched between the pulley 8 and the presser roller 11 is slackened. When the lift lever 15 is depressed downwards as shown in Fig. 2 the presser bar 12 is urged downwards by the action of the compression spring 14, causing the presser roller 11 to be abutted under pressure onto a later described horn 21.

On the lower side of the bed 2 the downwardly suspended machine frame 16 is secured; a pair of supports 17 of L-shape are secured on one side of the machine frame 16. Between the pair of the supports 17 a housing or casing 19 for accommodating a converter-horn assembly 18 is rotatably retained via not-shown bearings about the axis in an up-and-down or vertical direction thereof. Within the housing 19 an electroacoustic converter 20 is secured as an integral body. Upon supplying of high frequency current the electroacoustic converter 20 is given ultrasonic oscillation in the vertical direction.

The upper portion of the electroacoustic converter 20 is solidly or integrally connected to the cylindrically formed horn 21, whose upper end surface is made into a flat working or workpiece engaging surface 22 of annular shape, being perpendicular to the oscillating direction of the horn 21. This flat surface 22 is so designated as to be aligned at the same level with the top surface of the bed 2 through a circular aperture 23 formed in the work table 1 and the bed 2, and at the same time as to be opposed to the presser roller 11 at a portion offset away from the rotational axis of the flat surface 22 in the radial direction. And at the abutting portion of the presser roller 11 and the flat surface 22, the rotational direction of both is made identical or coincident so that workpieces 32 may be fed linearly in the backward direction as described later.

On the lower side of the converter-horn assembly 18 a pair of collecting rings 25, 26 are, with an insulating material 24 sandwiched in-between, secured so that they may be integrally rotatable with the housing 19. To the collecting rings 25, 26 and a pair of elastic contactors 27, 28 respectively secured at one end thereof to the machine frame 16 are connected, one of the contactors 27, 28 being connected to the plus terminal or pole and the other to the minus pole of a not-shown high frequency current generating system. Each of the collecting rings 25, 26 is respectively connected to each corresponding pole of the electroacoustic converter 20.

At the bottom of the converter-horn assembly

18 a pulley 29 is integrally secured. On the lower portion of the machine frame 16 another electric motor 30 is secured. The pulley 29 is connected to the motor 30 by way of a belt 31.

When the sheet-like workpieces 32 of thermoplastic resin material piled one above the other are seam welded, the presser roller 11 is held at the upper position by lifting up the lift lever 15 to the illustrated position in Fig. 1, the workpieces 32 consisting of at least two sheets piled are placed between the presser roller 11 and the horn 21, the lift lever 15 is depressed, after a process starting position has been determined for firmly sandwiching the workpieces 32 between the presser roller 11 and the horn 21. By switching ON of a starting switch (not shown) high frequency current is supplied from the not-shown high frequency current generating system via the contactors 27, 28 and the collecting rings 25, 26 to the electroacoustic converter 20 for imparting to the horn 21 ultrasonic oscillation in the vertical direction. The workpieces 32 are seam welded by the oscillation. At this time the electric motor 4 and the electric motor 30 are simultaneously energized, so that the presser roller 11 is counterclockwise rotated as illustrated in Fig. 2 with an arrow by the motor 4 and the horn 21 is clockwise rotated by the motor 30. Therefore the workpieces 32 are as shown in Fig. 2 continuously seam welded while being fed backwardly.

In this embodiment the presser roller 11 and the horn 21 are respectively driven by motors (4, 30). However, it is also possible to change the presser roller 11 into an idler roller to be rotated as a follower, through the feeding movement of the workpieces 32, of the horn 21 which is rotatably driven by its motor 30. Another alteration of making the horn 21 a solid cylindrical body instead of a hollow cylindrical body is of course permissible.

Another embodiment of this invention is illustrated in Fig. 3, wherein the presser roller 11 is provided with a V-groove formed on the external peripheral surface thereof, being offset to the left side. Upon forming this V-groove the external diameter of the presser roller 11 on the left side thereof becomes slightly smaller than that of the remaining portion that is an actual pressing surface. In this annular V-groove an elastic ring-shaped member 33 is put, which is practically on an O-ring with a circular sectional shape made of high anti-heat and anti-friction rubber material, particularly preferably fluorine-contained rubber. The external diameter of this elastic ring-shaped member 33, i.e., the O-ring is, made larger than that of the presser roller 11 by hundreds of μ . This second embodiment is entirely identical to the first embodiment except this portion including the V-groove and the O-ring.

When the lift lever 15 is depressed in this second embodiment the elastic ring-shaped member 33 is urged onto the workpieces 32 to be deformed due to its own elasticity until the presser roller 11 is contacted to the workpieces 32.

Consequently the workpieces 32 are sandwiched under pressure not only between the presser roller 11 and horn 21 but also between the elastic member 33 and the horn 21. As a result, even when that oscillation of the horn 21 makes the apparent coefficient of friction between the presser roller 11 and the horn 21 remarkably low, the coefficient of friction between the elastic member 33 and the workpieces 32 can be maintained at a stable level. The workpieces 32 can be fed due to this evident maintenance of the friction coefficient due to the elastic member 33 regularly in the tangent direction of the external peripheral surface of the roller 11, that is, in the perpendicular direction to the axis of the pressure roller 11 under good regulation. This elastic member 33 contributes greatly to the guiding of the workpieces 32, which relieves the installation of a guide device for the workpieces 32 as well as the operator of this apparatus from skillfulness for the guiding.

As to the sectional shape of the elastic member 33, elliptical, polygonal, etc. are permissible, not being limited to the circular in this embodiment.

This invention should not be interpreted to be limited only to the described embodiments. Many variations and modifications can be made, for those skilled in the art, within the scope of the appended claims.

30 CLAIMS

1. An ultrasonic seam welding apparatus including, a machine frame, a converter-horn assembly which includes a horn oscillatable in a direction parallel to a longitudinal axis of said assembly by an electroacoustic converter and which is supported by said machine frame rotatably about said longitudinal axis, driving means for rotating said converter-horn assembly, a roller rotatably disposed on said machine frame, and urging means for urging said roller toward said

horn, characterised in that said horn is provided with a circular flat working surface substantially perpendicular to, and concentric with, said longitudinal axis, and said roller is opposed at the peripheral surface thereof to said circular flat working surface at a position offset from said longitudinal axis in a radial direction of said working surface to hold two or more sheet-like thermoplastic workpieces between said peripheral surface and said circular flat working surface in forced contact therewith under an urging force of said urging means.

2. An ultrasonic seam welding apparatus claimed in claim 1, wherein said horn is of cylindrical shape and said circular flat working surface is provided with a circular opening at the centre thereof.

3. An ultrasonic seam welding apparatus claimed in claim 1 or 2 wherein said roller is rotated by driving means.

4. An ultrasonic seam welding apparatus claimed in claim 1, 2 or 3, wherein an elastic ring-shaped member having slightly larger external diameter than said roller is disposed on at least one lateral side of the peripheral surface of said roller.

5. An ultrasonic seam welding apparatus claimed in claim 4, wherein said elastic ring-shaped member in an O-ring made of rubber.

6. An ultrasonic seam welding apparatus claimed in claim 1, 2, 3, 4 or 5, wherein said urging means is a spring and said seam welding apparatus further includes manual operable means for holding said roller at a position away from the circular flat working surface of said horn against the urging force of said spring.

7. An ultrasonic seam welding apparatus substantially as hereinbefore described with reference to Figures 1 and 2 or Figures 1 and 3 of the accompanying drawings.

Consequently the workpieces 32 are sandwiched under pressure not only between the presser roller 11 and horn 21 but also between the elastic member 33 and the horn 21. As a result, even when the oscillation of the horn 21 makes the apparent coefficient of friction between the presser roller 11 and the horn 21 remarkably low, the coefficient of friction between the elastic member 33 and the workpieces 32 can be maintained at a stable level. The workpieces 32 can be fed due to this evident maintenance of the friction coefficient due to the elastic member 33 regularly in the tangent direction of the external peripheral surface of the roller 11, that is, in the perpendicular direction to the axis of the pressure roller 11 under good regulation. This elastic member 33 contributes greatly to the guiding of the workpieces 32, which relieves the installation of a guide device for the workpieces 32 as well as the operator of this apparatus from skillfulness for the guiding.

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2. An ultrasonic seam welding apparatus claimed in claim 1, wherein said horn is of cylindrical shape and said circular flat working surface is provided with a circular opening at the centre thereof.

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4. An ultrasonic seam welding apparatus claimed in claim 1, 2 or 3, wherein an elastic ring-shaped member having slightly larger external diameter than said roller is disposed on at least one lateral side of the peripheral surface of said roller.

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