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Ruthner et al.

[11] **3,735,564**

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[54] **APPARATUS FOR MAKING A FILLED FLEXIBLE TUBING IN A CONTINUOUS OPERATION**

[75] Inventors: **Othmar Ruthner,** Vienna; **Peter Puxkandl; Guido Fastnacht,** both of Linz, all of Austria

[73] Assignee: **Vereinigte Osterreichische Eisen-Und Stahlwerke Aktiengesellschaft,** Linz, Austria

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[52] **U.S. Cl.** **53/177,** 53/373

[51] **Int. Cl.** **B65b 9/06**

[58] **Field of Search** ..... 53/28, 177–180, 53/229, 373; 93/1 C, 77 R; 156/203, 466

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Primary Examiner—Robert L. Spruill
Attorney—Kurt Kelman

[57] **ABSTRACT**

A tubular shaping device is provided and serves to receive a sheeting web having opposite edge portions and to shape said web to form a flexible tubing and to cause said edge portions to contact each other as said web is moved through said shaping device. A conveyor belt extends through said shaping device and is adapted to contact said web on that side which forms the outside of said flexible tubing in said shaping device and to move said web through said shaping device. A filling device has a discharge opening adjacent to said shaping device at a point at which said flexible tubing has been formed and which is disposed inside said flexible tubing. Joining means are provided to join said contacting edge portions at least in parts of their length.

22 Claims, 8 Drawing Figures

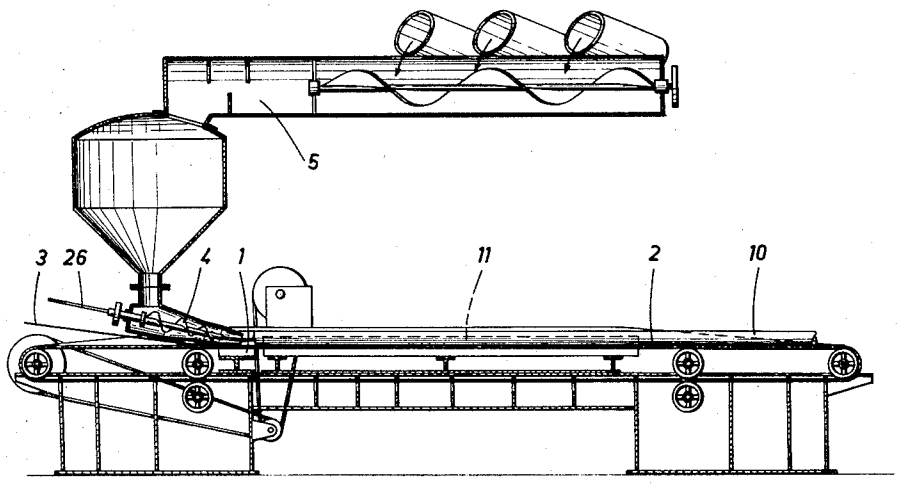
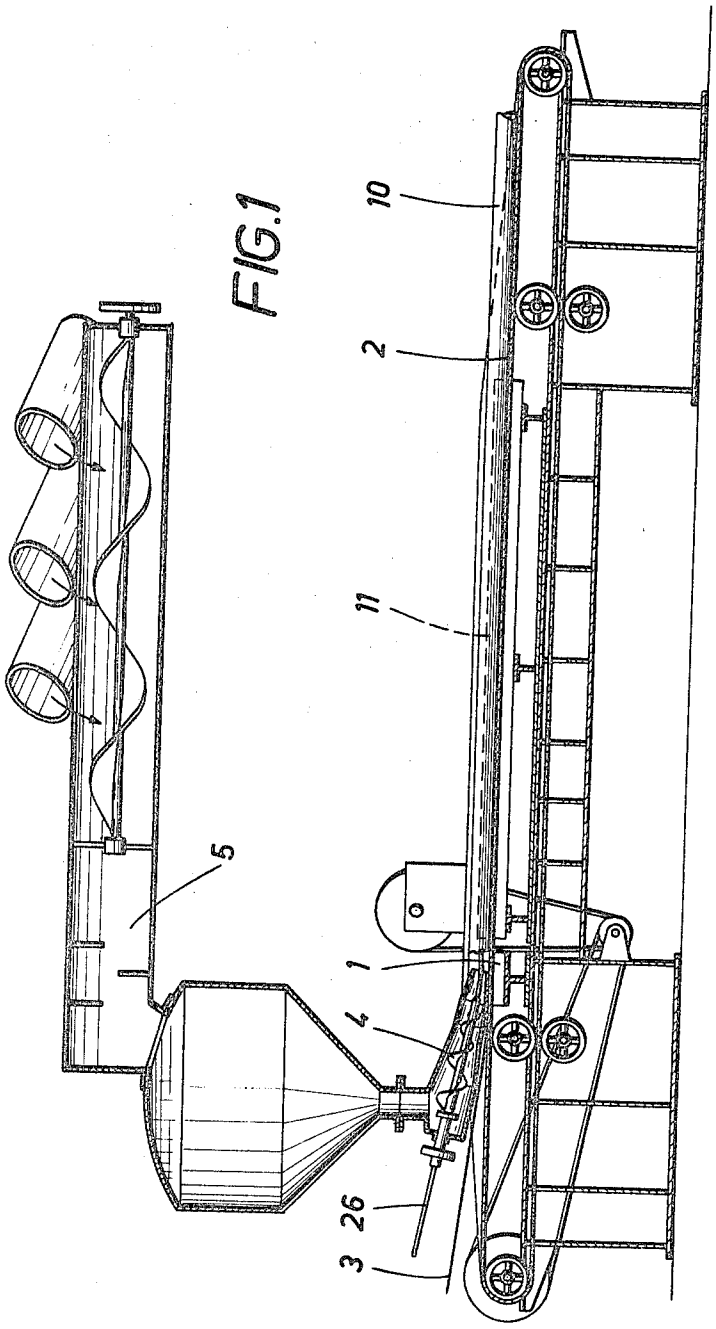


FIG.1



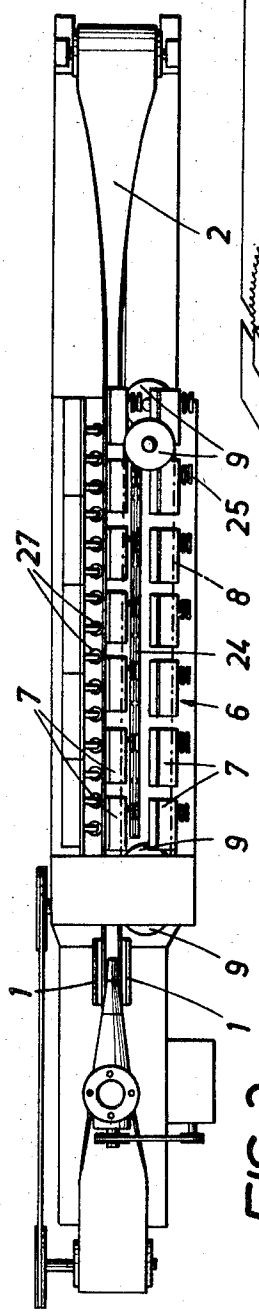


FIG.2

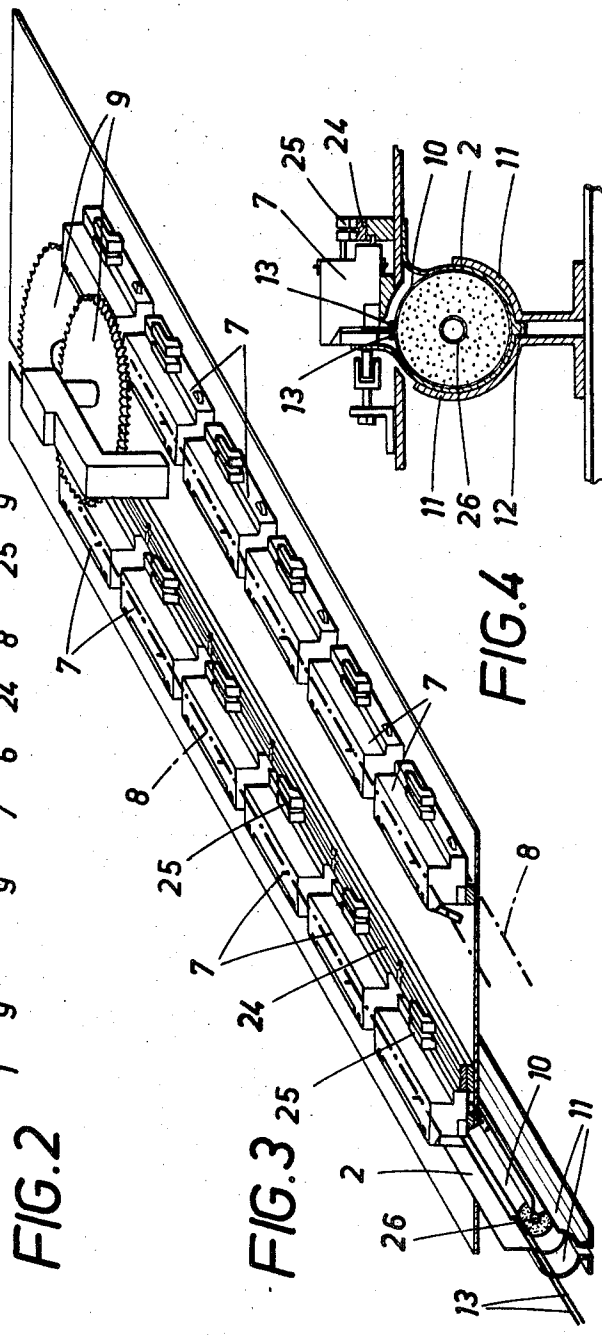


FIG.3

FIG.4

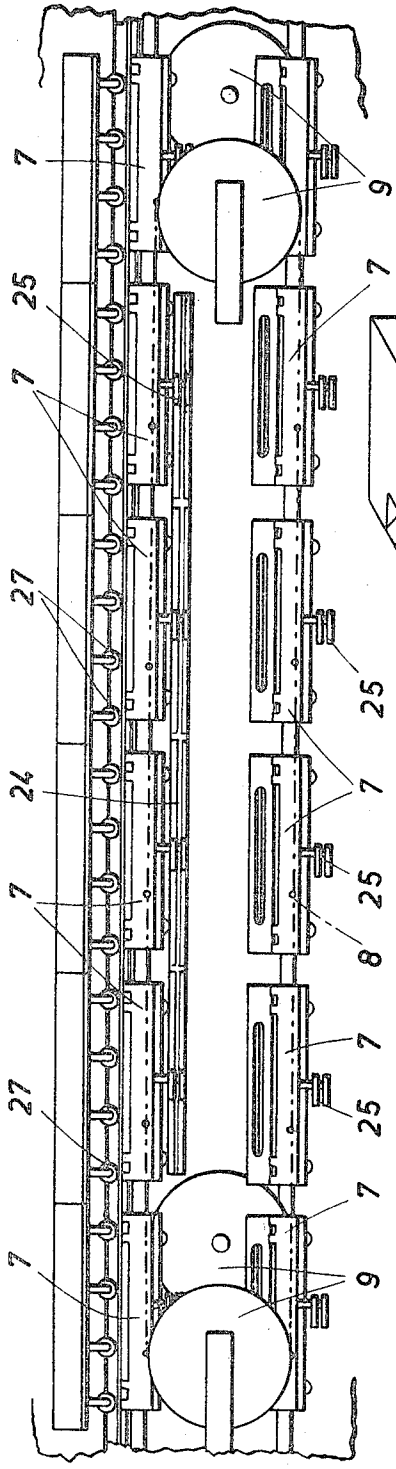


FIG. 5

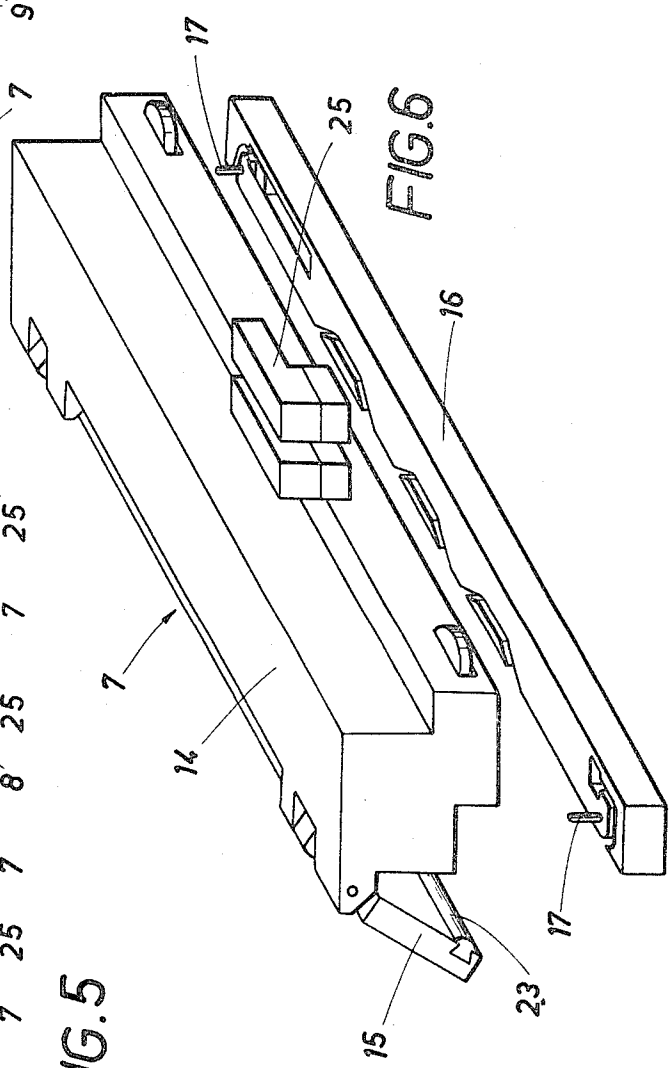


FIG. 6

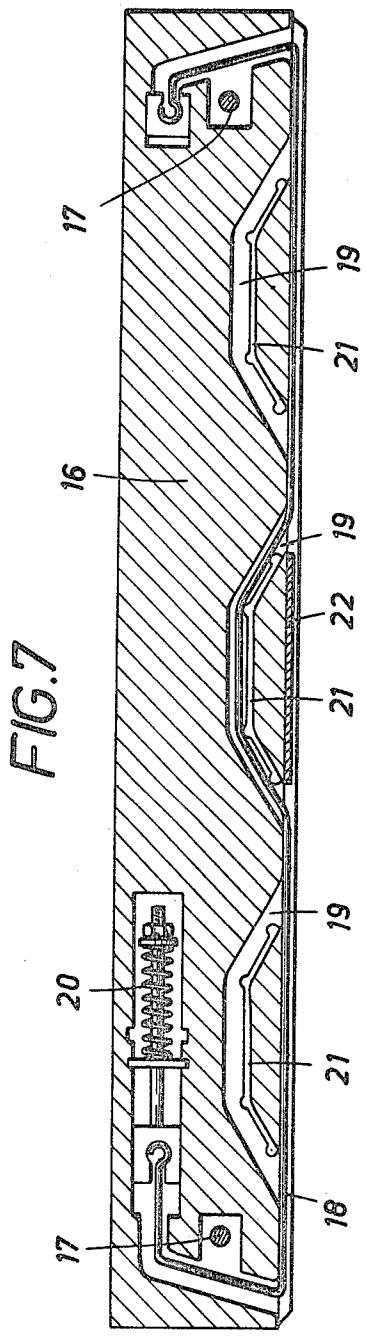


FIG.7

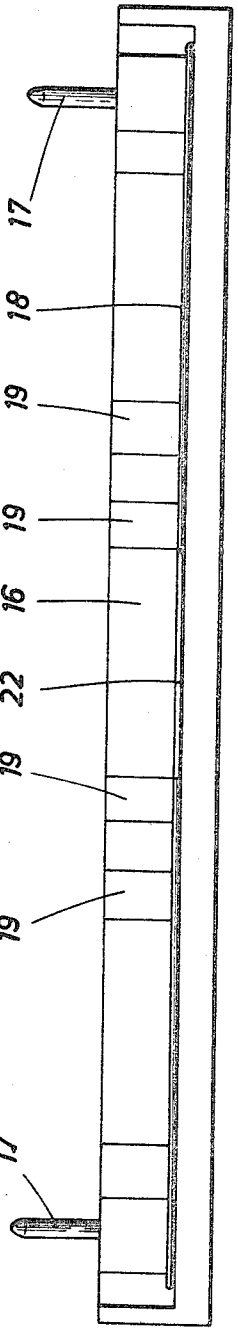


FIG.8

APPARATUS FOR MAKING A FILLED FLEXIBLE TUBING IN A CONTINUOUS OPERATION

This invention relates to apparatus for continuously making a filled flexible tubing by means of a tubular shaping device for shaping a continuously moving sheeting web into a flexible tubing, means consisting, e.g., of a welding device and serving to join the contacting edges of the tubularly bent web, a conveyor which comprises an endless belt which adjacent to the shaping device engages that surface of the web which lies on the outside of the flexible tubing, and a filling device.

The flexible tubing made in such apparatus is used mainly in plant-cultivating systems, particularly in hydroponic systems and for this purpose is filled with a substrate. In this connection, the term substrate covers all substances in which plants can be grown. The flexible tubing is usually made from plastics material sheeting, which is given such a cross-sectional shape as to meet the ecological requirements for the growth of the plant. The resulting flexible tubing accommodates mainly the roots of the plants and supplies water and nutrient solution thereto. To ensure a supply of water, nutrient solutions or air to the plants even through long flexible tubing having a length of many hundred meters and more, ducts may be provided in the flexible tubing.

In known apparatus for making small bags which are filled with granular, powdered, liquid or pasty material, a sheeting web withdrawn from a supply roll is wound about a mandrel to form a flexible tubing, which is sealed by a welding device and advanced by means of an endless conveyor belt. To fill the flexible tubing which is to be divided into bags, that apparatus comprises a metering screw, which extends through the hollow-cylindrical mandrel about which the flexible tubing is wound. Said screw has an end which is flush with the outlet opening of he mandrel.

Another known apparatus for making a flexible tubing comprises a shaping tube, through which a woven flexible strip is pulled and is thus shaped into a flexible tubing. To cause the edges of the strip to overlap the shaping tube is provided with an obliquely cut inlet opening, which is continued by a shaping slot, which is disposed adjacent to the lowest portion of the tube and extends only in part of the tube.

All these known apparatus have the disadvantage that they do not permit of making a flexible tubing which is filled with material introduced under pressure whereas only the use of such material ensures that the flexible tubing is self-supporting as is required for plant cultures. Besides, the edges of the tubularly bent web should not be joined by a continuous seam weld because the plants are inserted into the flexible tubing between those edge portions which are not joined. The usual welding devices cannot make such interrupted seam welds on continuously moved flexible tubing.

It is an object of the invention to eliminate these disadvantages and to provide an apparatus which serves for the continuous making of a filled flexible tubing which can be filled as it is formed from a continuously moving sheeting web and which apparatus enables a joining of longitudinally spaced apart portions of the contacting edge portions of the tubularly bent web.

In apparatus of the kind described first hereinbefore, the invention solves the above-mentioned object essentially in that the conveyor belt extends through the shaping device through which the sheeting web is advanced and the filling device has a discharge opening

disposed in the flexible tubing adjacent to the shaping device, whereas any welding device which is provided closely succeeds the shaping device. The sheeting web is continuously withdrawn from a supply roll and by the conveyor belt is moved through the shaping device, where the sheeting web is bent to form a flexible tubing. The filling material is supplied into the flexible tubing under pressure adjacent to the shaping device and within the latter applies to the inside wall of the flexible tubing, which is thus forced against the tubular shaping device and exactly assumes the desired shape. The flexible tubing which has thus been shaped and filled is welded immediately thereafter so that there is no need for special measures to hold the edges of an unjoined flexible tubing together. Otherwise, the flexible tubing formed from the sheeting web would gape under the pressure of the filling material as the flexible tubing leaves the shaping device.

In a particularly desirable embodiment of the invention, the shaping device consists of two confronting shaping shells, between which the two edge portions of the sheeting web protrude at the top to form a lip. The two shaping shells, which usually conform to a cylinder, present to the conveyor belt contacting them a lower frictional resistance than, e.g., a slotted tube but serve the same purpose. The lip of the flexible tubing protrudes upwardly between the two shaping shells and facilitates the joining of the two edge portions of the web.

To join longitudinally spaced apart edge portions of the web, the invention provides a welding device, which consists of a plurality of longitudinally spaced apart welding grippers, which are secured to an endless carrier, which is driven to move through a welding zone at the velocity at which the flexible tubing is advanced, and a plurality of welding grippers which in said welding zone grip and weld the web edge portions which contact to form a lip. The endless series of welding grippers are simple means for welding the edges of the web together in predetermined length portions. Because the welding grippers are driven at the velocity at which the flexible tubing is advanced, they assist in the advance of the flexible tubing so that the frictional forces which occur are reliably overcome.

In this connection it is desirable to provide two confronting backing shells, which conform to the flexible tubing and are disposed adjacent to the welding device and receive and support the conveyor belt and the flexible tubing during the welding operation. These backing shells conforming to the flexible tubing provide an additional safety that the flexible tubing will retain its shape as it is welded.

To ensure that the conveyor belt cannot twist in the shaping device and between the backing shells because such twisting would deflect the edge portions of the tubularly bent web from their straight configuration, it is a feature of the invention that the conveyor belt is provided on that surface which faces away from the flexible tubing with a guide rib or the like, which extends into the upper gaps between the shaping shells and between the backing shells.

In another embodiment of the invention the lip formed by the contacting edge portions is guided by and between two taut guide wires or the like, which are provided adjacent to the welding device and prevent a gaping of the web edge portions before they are welded. This arrangement ensures also a satisfactory operation of the welding grippers because the web edge

portions which are to be gripped by the welding grippers exactly assume a predetermined position.

In a further embodiment of the invention, the carrier consists of two parallel, longitudinally offset, endless chains or the like, to which the welding grippers are connected and which are trained around reversing sprockets and ensure a displacement of the welding grippers while the same remain parallel to themselves. That feature permits of a particularly space-saving arrangement because there is no need to give attention to the reversal of the individual welding grippers. Besides, that design ensures a good and rather exact control of the movement of the welding grippers connected to the two chains.

According to the invention, each welding gripper comprises a rigid body jaw and a movable jaw, which is hinged to said body jaw and in the inoperative position of the gripper is spring-urged upwardly against a stop whereas in the operative position of the gripper the hinged jaw is forced by means of stationary pressure rollers or the like spaced along the welding zone against the web edge portions disposed between the rigid jaw and the movable jaw. The pressure rollers act preferably on that edge portion of the conveyor belt which engages the movable jaws on the outside. The welding grippers are moved parallel to themselves against the edge portions of the tubularly bent web and the raised movable jaws extend over the edges of the web. That edge of the conveyor belt which extends upwardly between the backing shells contacts the movable jaws. As the operation proceeds, the movable jaws and the conveyor belt approach the pressure rollers, which firmly force the movable jaws against the rigid body jaw of the welding gripper so that the edge portions of the web are forced together as is required for welding.

The rigid body jaw of the welding gripper is desirably provided according to the invention with a plugged-in welding bar, which cooperates with the movable jaw and carries a heating wire, which extends along the bar and which may be selectively arranged to extend in certain ranges above or below that surface of the welding bar which faces the movable jaw. Depending on the requirements, the entire heating wire or only portions of its length may extend on the surface of the welding bar so that each welding gripper may be used to provide seam weld portions having different lengths and spaced different distances apart.

To prevent an excessive heating of the heating bar by a portion of the heating wire disposed below the surface, it is a feature of the invention that each portion of the heating wire which extends below the surface of the welding bar rests on a metal plate or the like disposed under the surface. The metal plate is electrically connected in parallel to the covered portion of the heating wire so that the cross-sectional area of the conducting path is much increased and the resistance is much reduced. As a result, a much smaller amount of heat due to resistance heating will be produced.

Because the heating wire is forced against those web edge portions which are to be welded, said pressure will be absent in any areas in which the heating wire extends below the surface so that the grip and pulling effect of the welding gripper on the web edge portions will be reduced in said areas. To ensure a uniform grip everywhere, regardless of the configuration of the heating wire, it is a feature of the invention to provide the surface of the welding bar with pressure plates having the same thickness as the heating wire in those areas in which the heating wire extends below the surface of the welding bar.

According to another feature of the invention, one end of the heating wire is rigidly connected to the welding bar and the other end is connected to the welding bar by a spring having an adjustable initial stress so that the changes in the length of the heating wire which are due to a change of the configuration of the wire and to thermal expansion will be compensated.

For consistent results, the duration of the welding operation must be selected in view of the thickness and nature of the sheeting web. The welding time could be changed by a change of the speed of travel of the conveyor belt and of the welding grippers. This is undesirable, however because in that case the speeds of the drive means for the welding grippers and the conveyor belt as well as of the drive means for the filling device would have to be variable. To eliminate this disadvantage it is a feature of the invention that the revolving welding grippers are supplied with electric power in the welding zone by busbar sections which can be individually and selectively energized. In this case the duration of the flow of current through each heating wire will depend on the number of busbar sections which are energized.

Finally, the invention contemplates the use of a device for introducing at least one additional flexible tubing, which forms a duct and is suitably perforated, together with the filling material into the flexible tubing formed from the sheeting web. That additional flexible tubing ensures the supply of the required nutrients to the plants even over long distances.

An embodiment of the invention is shown diagrammatically and by way of example on the drawing, in which

FIG. 1 is a diagrammatic longitudinal sectional view showing the apparatus according to the invention.

FIG. 2 is a top plan view showing the apparatus.

FIG. 3 is a fragmentary perspective view showing a portion of the welding device.

FIG. 4 is a transverse sectional view showing a filled flexible tubing adjacent to the welding device.

FIG. 5 is a top plan view showing the welding device.

FIG. 6 is an enlarged perspective view showing a welding gripper.

FIGS. 7 and 8 are, respectively, a sectional view and a side elevation showing a welding bar also on a larger scale.

The apparatus according to the invention comprises a shaping device, which is formed by two confronting shaping shells 1 and through which an endless conveyor belt 2 extends. A sheeting web 3 is continuously withdrawn from a supply reel or the like and is moved through the shaping device by the conveyor belt 2 and in the shaping device is bent to form a flexible tubing. The two edge portions of the web protrude upwardly between the two shaping shells 1 in the form of a lip, which is closed in portions of its length by a welding device. A filling device comprises a conveyor screw 4 and a feeder 5 and has adjacent to the shaping shells 1 a discharge opening disposed inside the flexible tubing before the same has been welding. The shaping device is closely succeeded by a welding device 6, which comprises a plurality of longitudinally spaced apart welding grippers 7, each of which is connected to two parallel,

transversely spaced, endless chains. The chains **8** are of equal length and are trained around offset parallel reversing sprockets **9** and ensure that the welding grippers **7** will remain parallel to themselves as they are displaced. In the welding zone, which extends parallel to the lip of the flexible tubing **10**, the welding grippers grip the contacting edge portions of the web and weld them together.

Two confronting backing shells **11**, which conform to the flexible tubing, are provided adjacent to the welding device **6** and receive and carry the conveyor belt **2** and the flexible tubing **10** during the welding operation. On its surface remote from the flexible tubing **10**, the conveyor belt **2** is provided with a guide rib **12**, which extends in the direction of travel of the belt and which extends into the lower gaps between the shaping shells **1** and between the backing shells **11**. This is clearly apparent from FIG. **4**.

To ensure that the web edge portions do not gape under the pressure of the filling material as they leave the shaping device, two taut guide wires **13** extend adjacent to the welding device **6**. The web edge portions are exactly guided between said wires, which prevent a gaping of the web edge portions before they have been welded.

FIG. **6** shows a welding gripper **7**, which comprises a rigid body jaw **14** and a movable jaw **15**, which is hinged to the body jaw **14** and which by a spring, not shown, is forced upwardly against a stop. By means of contact pins **17**, a welding bar **16** is plugged into the rigid body jaw **14** of the welding gripper **7**. The bar **16** carries a heating wire **18**, which may selectively extend on the surface of the welding bar or in grooves **19** so that the lengths of the seam weld portions and the distances between them may be varied. An example of a configuration of the heating wire is shown in FIGS. **7** and **8** and enables the formation of two seam weld portions with one welding gripper.

To enable a compensation of length changes which are due to thermal expansion or to a change of the configuration of the heating wire, the heating wire is connected to the welding bar by a spring **20** having an adjustable initial stress. If the length of the heating wire is increased, e.g., as a result of a temperature rise, the spring **20** will contract and the wire will remain taut.

The grooves **19** contain metal plates **21**, which are electrically connected in parallel to those portions of the heating wire which extend in said grooves so that the electrical resistance in these areas is much reduced. This will result in a reduction of the heat which is produced by resistance heating so that a detrimental overheating of the welding bars is avoided.

Because the welding grippers **7** grip the web edge portions not only to weld them but also in order to exert a pull on the flexible tubing **10**, pressure plates **22** are provided in those portions of the welding bar in which the heating wire **18** extends below the surface. These pressure plates **22** are forces against a rubber strip **23** carried by the movable jaw **15**. The web edge portions are gripped between the rubber strip **23** and the pressure plates **22**.

To supply electric power to the welding grippers, a busbar **24** is provided, from which the heating wires **18** of the several welding grippers are fed by current collectors **25**. To enable a selection of the welding time in view of the nature and thickness of the sheeting web, the busbar **24** consists of a plurality of sections, which can be individually and selectively energized. Hence, the welding time depends on the number of busbar sections which are energized so that different welding times may be obtained at a given speed of travel of the welding grippers.

To ensure a supply of nutrients to the plants inserted into the flexible tubing even if the latter is very long, a duct-forming flexible tubing **26** having perforations may be introduced into the outer flexible tubing as the latter is filled.

Adjacent to the shaping shells **1**, the filling material is introduced under pressure by the feeder **5** and the conveyor screw **4** into the flexible tubing **10** formed by the bent web. The filling material forces the web **3** against the shaping shells **1** so that the flexible tubing **10** has consistently the shape determined by the shaping shells. As the flexible tubing advances, the web edge portions protruding upwardly between the two shaping shells and forming a lip are engaged by the two guide wires **13** so that the web edge portions cannot gape. The web edge portions which are thus retained are held in contact with each other, are subsequently gripped and welded together by the welding grippers **7**, which also assist the advance imparted to the flexible tubing by the conveyor belt **2**.

When a welding gripper approaches the web edge portions, that edge portion of the conveyor belt which protrudes upwardly between the backing shells **11** engages the outside surface of the raised movable jaw **15** of the welding gripper and forces said movable jaw against the welding bar **16**. To ensure the proper welding pressure, stationary pressure rollers **27** are spaced along the conveyor belt adjacent to the welding device. These rollers engage the conveyor belt to force the movable jaw **15** firmly against the welding bar **16**. When the flexible tubing **10** leaves the welding device, the welding grippers are moved away from the flexible tubing while remaining parallel to themselves, the movable jaws leave the range of the pressure rollers **27** and under their spring bias are swung up to the stop. Because the several welding grippers are moved in an endless series, the flexible tubing which has been continuously shaped from a sheeting web and has been filled with substrate by a filling device can be continually welded and the distances between successive seam weld portions may be selected to meet the requirements imposed by the size of the plants to be grown.

What is claimed is:

1. Apparatus for a continuous manufacture of a filled flexible tubing, which comprises

1. a tubular shaping device for receiving a sheeting web having opposite edge portions, and for shaping said web to form a flexible tubing and to cause said edge portions to contact each other as said web is moved through said shaping device, the shaping device comprising
   a. two confronting shaping shells having top edges defining a top gap and lower edges defining a lower gap, the edge portions being adapted to protrude upwardly through the top gap to form a lip;
2. a conveyor belt extending through said shaping device and having a web contacting side to contact said web on that side which forms the outside of said flexible tubing in said shaping device, and a side opposite to said web-contacting side and formed on said opposite side with guide means ex-

tending into said lower gap, the conveyor belt moving said web through said shaping device;

3. a filling device having a discharge opening adjacent to said shaping device at a point at which said flexible tubing has been formed and which is disposed inside said flexible tubing; and

4. joining means for joining said contacting edge portions at least in parts of their length.

2. Apparatus as set forth in claim **1,** in which said guide means comprise a rib extending along said conveyor belt.

3. Apparatus as set forth in claim **1,** which comprises means for introducing adjacent to said discharge opening an additional, duct-forming flexible tubing into the flexible tubing formed from said web.

4. Apparatus as set forth in claim **1,** in which said joining means comprise a welding device.

5. Apparatus as set forth in claim **4,** in which said welding device closely succeeds said shaping device.

6. Apparatus as set forth in claim **5,** in which said welding device comprises

an endless carrier arranged to be moved at the same speed as said conveyor belt in an endless path which comprises a welding zone, and

a plurality of welding grippers carried by and spaced along said carrier and arranged to grip and weld together said contacting edge portions in said welding zone.

7. Apparatus as set forth in claim **6,** in which

said conveyor belt extends through said welding zone and is adapted to move said flexible tubing through said welding zone and

two confronting backing shells are disposed adjacent to said welding zone and adapted to conform to said flexible tubing formed by said shaping device and to receive and support said conveyor belt and said flexible tubing as they move through said welding zone.

8. Apparatus as set forth in claim **6,** which comprises guide means extending adjacent to said welding zone and adapted to be disposed on opposite sides of said contacting edge portions to prevent them from gaping before they have been welded together.

9. Apparatus as set forth in claim **8,** in which said guide means comprise two taut guide wires, which are adapted to be disposed on opposite sides of said contacting edge portions.

10. Apparatus as set forth in claim **6,** in which

said carrier comprises two parallel, longitudinally offset, endless carrier elements,

each of said welding grippers is secured to both said endless carrier elements, and

said endless carrier elements are trained around reversing pulleys and constrain said grippers to remain parallel to themselves as they are moved by said carrier.

11. Apparatus as set forth in claim **10,** in which each of said endless carrier elements consists of a chain.

12. Apparatus as set forth in claim **5,** in which

each welding gripper comprises a rigid body jaw and a movable jaw hinged to said body jaw,

said body jaw and movable jaw are adapted to be disposed on opposite sides of said contacting edge portions in said welding zone, and

stationary pressure means are provided in said welding zone and arranged to force said movable jaw of each gripper in said welding zone against the associated body jaw to grip said contacting edge portions.

13. Apparatus as set forth in claim **12,** in which each of said grippers comprises

spring means urging said movable jaw away from said body jaw and

stop means limiting the movement of said movable jaw under the action of said spring means.

14. Apparatus as set forth in claim **12,** in which said pressure means comprise pressure rollers.

15. Apparatus as set forth in claim **12,** in which

said conveyor belt extend through said welding zone and has an edge portion engaging said movable jaw of each gripper in said welding zone on the side remote from the associated body jaw and

said pressure means engage said edge portion of said conveyor belt.

16. Apparatus as set forth in claim **12,** in which

said body jaw comprises a detachable welding bar, which has a surface facing said movable jaw and a heating wire connected to and extending along said welding bar throughout the length of said bar and extending on said surface at least along part of said heating bar, and in said part being engageable by said movable jaw under the action of said pressure means,

said heating bar having at least one length portion adapted to accommodate said heating wire in a position in which it is recessed from said surface of said bar.

17. Apparatus as set forth in claim **16,** in which

said heating bar is recessed from said surface of said bar in said one length portion and

a conductor having a substantial cross-sectional area contacts said heating wire in said one length portion.

18. Apparatus as set forth in claim **17,** in which said conductor comprises a metal plate.

19. Apparatus as set forth in claim **16,** in which

said heating bar is recessed from said surface of said bar in said one length portion and

said bar is provided in said one length portion with a pressure plate which protrudes from said surface of said bar to an extent which is equal to the thickness of said heating wire.

20. Apparatus as set forth in claim **16,** in which

said heating wire has one end which is rigidly connected to said welding bar and

a spring connects the other end of said heating wire to said welding bar.

21. Apparatus as set forth in claim **20,** which comprises means for adjusting the initial stress of said spring.

22. Apparatus as set forth in claim **6,** which comprises longitudinally spaced busbar sections which are disposed in said welding zone and are individually and selectively energizable to supply electric power to said welding grippers in said welding zone.

* * * * *