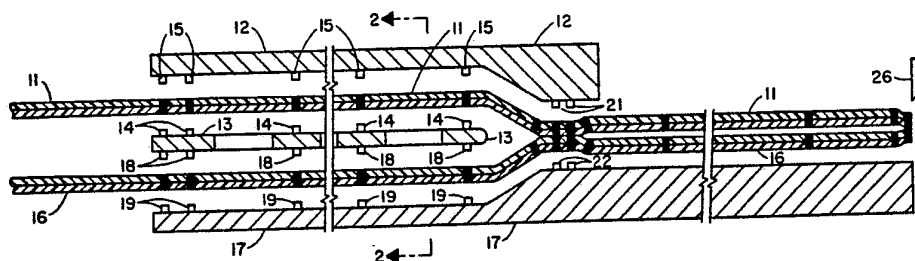




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>4</sup> : B29C 27/04, 27/02, 27/06 B29H 7/04, B32B 31/00, 3/12</p>	<p>A1</p>	<p>(11) International Publication Number: WO 85/ 03902 (43) International Publication Date: 12 September 1985 (12.09.85)</p>
<p>(21) International Application Number: PCT/US84/00317 (22) International Filing Date: 1 March 1984 (01.03.84) (71) Applicant (for all designated States except US): TERRACOPIA, INC. [US/US]; 2365 South Main, Salt Lake City, UT 84115 (US). (72) Inventors; and (75) Inventors/Applicants (for US only) : WALLACE, Volney [US/US]; Terra Box 1W, Dugway, UT 84022 (US). PINKHAM, Carlos, F., A. [US/US]; RFD No. 1, Northfield, VT 05663 (US). (74) Agent: CRELLIN, Terry, M.; Thorpe, North &amp; Western, 9662 South State Street, Sandy, UT 84070 (US). (81) Designated States: AT, AT (European patent), AU, BE (European patent), CH, CH (European patent), DE, DE (European patent), DK, FI, FR (European patent), GB, GB (European patent), JP, KP, LU, LU (European patent), NL, NL (European patent),</p>		<p>NO, SE, SE (European patent), US. <b>Published</b> <i>With international search report.</i></p>

(54) Title: METHOD OF MAKING DOUBLE WALLED, TUBULAR, THERMAL PROTECTIVE COVE RINGS



## (57) Abstract

A process or method for making a unique, double walled, tubular device which is divided into a plurality of substantially vertically extending compartments (42) which are adapted to be filled with water. The double walled, tubular device is made from first and second sheets (11 and 16) of thermoplastic material in which each sheet (11 and 16) has been folded back over itself along its longitudinal dimension. Each sheet (11 and 16) is then subjected to heat sealing treatments in which weld lines (41) are formed in the sheets (11 and 16) thereby forming the vertically extending compartments (42) in each sheet (11 and 16). The first and second sheets (11 and 16) are then superimposed one over the other and mutually respective pairs of additional welded lines (40) are formed so as to seal or weld the double layers of the two sheets (11 and 16) together at spaced positions along the longitudinal length of the superimposed sheets (11 and 16). Each of the weldlines (40) of mutually respective pairs thereof are closely spaced, side-by-side of each other. The respective pairs of weld lines (40) are spaced from other pairs such that a plurality of compartments (42) are included in each of the sheets (11 and 16) between the pairs of weld lines (40). The sheets (11 and 16) are cut transversely of their longitudinal dimension between each of the weld lines (40) in the respective pair of weld lines (40) to produce individual units of the unique, double walled, tubular device of the invention.

***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<b>AT</b> Austria	<b>GA</b> Gabon	<b>MR</b> Mauritania
<b>AU</b> Australia	<b>GB</b> United Kingdom	<b>MW</b> Malawi
<b>BB</b> Barbados	<b>HU</b> Hungary	<b>NL</b> Netherlands
<b>BE</b> Belgium	<b>IT</b> Italy	<b>NO</b> Norway
<b>BG</b> Bulgaria	<b>JP</b> Japan	<b>RO</b> Romania
<b>BR</b> Brazil	<b>KP</b> Democratic People's Republic of Korea	<b>SD</b> Sudan
<b>CF</b> Central African Republic	<b>KR</b> Republic of Korea	<b>SE</b> Sweden
<b>CG</b> Congo	<b>LI</b> Liechtenstein	<b>SN</b> Senegal
<b>CH</b> Switzerland	<b>LK</b> Sri Lanka	<b>SU</b> Soviet Union
<b>CM</b> Cameroon	<b>LU</b> Luxembourg	<b>TD</b> Chad
<b>DE</b> Germany, Federal Republic of	<b>MC</b> Monaco	<b>TG</b> Togo
<b>DK</b> Denmark	<b>MG</b> Madagascar	<b>US</b> United States of America
<b>FI</b> Finland	<b>ML</b> Mali	
<b>FR</b> France		

METHOD OF MAKING DOUBLE WALLED, TUBULAR, THERMAL PROTECTIVE COVERINGS  
BACKGROUND OF THE INVENTION

This application relates to an improved method of making a double walled tubular device which is divided into a plurality of substantially vertically extending compartments which are adapted to be filled with water. The double walled tubular device so made is self supporting and can be placed around a growing plant to provide thermal protection to the plant.

It is well known in the prior art that when water is deployed as a relatively air tight covering over a space to be protected, cold weather cannot freeze anything in that space until it first freezes the protective cover of water. The freezing of the protective cover of water is relatively slow inasmuch as water liberates heat on freezing, about 80 calories of heat per gram of ice formed. This release of heat is comparable to the release of heat by an equal weight of rock cooling from about 260 degrees Centigrade down to about zero degrees Centigrade. In contrast to hot rock, water releases its heat at zero degrees Centigrade as if it were a water burning furnace set to operate at and maintain a temperature of zero degrees Centigrade. Since heat loss from the system is proportional to the difference between the inside and outside temperature, this low temperature release of heat is far more effective than would be a hot rock under a hot cap.

There is a great need for protection of seedlings and young plants against late frosts in the spring thereby enabling an early start of vegetables and other seedlings. A plant which has a month's head start has an additional month at the end of the season when full development of the plant results in a maximal rate of food production.

Various means have been suggested in the prior art for utilizing water in the thermal protection of plants. It has been suggested to spray water directly on the plants as well as to somehow provide a water enclosure around or above the plants. In British Pat. No. 1,144,366, it is taught to build a trench up around the plants and then interpose between the plant and the sky a layer of water in a



-2-

translucent container. Alternatively, the British Patent suggests that a light admitting cover can be placed over the plant with bags full of water leaving on and over the light admitting cover.

5 U.S. Patent No. 3,206,892 teaches a protective device for plants containing an inflatable ballast tube partially filled with water and adapted to fit around a plant. The device may also contain a single walled tent or cover extending over the plant. The purpose of the water in the  
10 ballast tube is two fold. The water acts as a ballast to hold the device down, and the water assists in retaining heat in the ground under the ballast.

U.S. Patent No. 3,270,461 also teaches a thermal plant protective device having a water ballast tube at the bottom  
15 and which is closed at the top forming a single walled cover about most of the plant. Water is sprayed on the plant within the cover and runs down the inside of the cover into the ballast tube. Maximum thermal protection is acquired only by continuously spraying water within the cover.

20 A double walled insulative device in which elongate compartments are formed between the outside and inside walls is disclosed in U.S. Pat. No. 4,267,665. The outside and inside walls are said to be joined together by heat sealing, adhesives, or similar means to form compartments. The  
25 devices of U.S. Pat. No. 4,267,665 are very efficient in providing thermal protection to plants around which the devices are placed. The manufacture of such devices, however, can be a real problem, requiring much manual labor.

A principal objective of the present invention was to  
30 provide a method for economically mass producing a superior double walled tubular device which is divided into a plurality of substantially vertically extending compartments which are adapted to be filled with water, whereby the water-filled tubular device is self supporting and can be  
35 placed around a growing plant for thermally protecting the plant.

Another objective of the present invention was to provide an effective process for rapidly and efficiently



-3-

making a superior double walled tubular device from two sheets of thermoplastic material wherein (1) the respective sheets are folded along their longitudinal dimensions, (2) side-by-side, elongate compartments, which are open at one end, are formed in the respective folded sheets of material by forming spaced weld lines in the respective sheets, with the weld lines extending transversely across the folded sheets of material, (3) the two sheets of material containing the elongate compartments are superimposed one over the other such that the open ends of said compartments in each sheet are positioned adjacent to each other along one longitudinal side edge of the superimposed folded sheets of material, (4) respective pairs of relatively closely spaced weld lines are then formed at relatively widely spaced positions along the longitudinal length of the superimposed sheets of material, such that a plurality of compartments in each of the superimposed sheets are located between the relatively widely spaced pairs of weld lines, with each pair of closely spaced weld lines bonding the four layers of the superimposed folded sheets of material along the closely spaced pair of weld lines, and (5) the superimposed, folded, and bonded sheets of material are cut transversely across their width between the two closely spaced weld lines of each respective pair of closely spaced weld lines, to form individual double walled devices which can be shaped into a self sustaining tubular shape when the plurality of compartments formed therein are filled with water and the tubular shaped device can be placed around a plant to provide thermal protection for the encircled plant.

A further objective of the present invention was to provide a superior double walled tubular device produced by the novel method disclosed herein.

#### BRIEF DESCRIPTION OF THE INVENTION

The above objectives of the present invention are achieved by providing a novel, particularly effective and economical method of making a superior double walled tubular device, wherein the method comprises the following steps:



-4-

(a) a first sheet of thermoplastic, polymeric material, which has been folded back over itself along its longitudinal dimensions, is introduced or fed longitudinally to a first heat sealing station wherein repetitive, spaced, elongate, first weld lines are formed transversely across the folded back first sheet of material so as to form a plurality of side-by-side, elongate first compartments in the folded back first sheet between adjacent first weld lines therein, each of the first compartments being open at one end thereof and closed at the opposite end by the fold in the folded back, first sheet of material;

(b) a second sheet of thermoplastic, polymeric material, which has been folded back over itself along its longitudinal dimension, is introduced or fed longitudinally to a second heat sealing station wherein repetitive, spaced, elongate, second weld lines are formed transversely across the folded back second sheet of material so as to form a plurality of side-by-side, elongate second compartments in the folded back second sheet between adjacent second weld lines therein, each of the second compartments being open at one end thereof and closed at the opposite end by the fold in the folded back, second sheet of material;

(c) the portions of the first and second sheets of thermoplastic, polymeric material from steps (a) and (b) and which have the first and second weld lines formed therein, respectively, are superimposed one over the other such that the mutually respective weld lines formed in each of the superimposed portions of the first and second sheets of material lie substantially adjacent to each other and further so that the open ends of the mutually respective compartments in the superimposed portions of the first and second sheets of material lie substantially adjacent to each other, and the superimposed portions of the first and second sheets of material are introduced to a third heat sealing station;

(d) forming elongate pairs of third weld lines across the superimposed first and second sheets of material in the third heat sealing station, so as to seal and weld



-5-

together all the layers of the first and second sheets of material along the third weld lines, with the respective pairs of third weld lines being spaced along the longitudinal dimension of the superimposed portions of the first and second sheets of material such that a plurality of compartments are included in each of the superimposed portions of the first and second sheets of material between adjacent, spaced pairs of third weld lines, and with the two respective weld lines of each pair of third weld lines being spaced relatively closely adjacent to each other;

(e) cutting the first and second sheets of material from step (d) transversely across the width of the superimposed first and second sheets between the two relatively closely spaced weld lines of each pair of third weld lines; and

(f) repeating steps (a) through (e) in repetitive cycles.

In a particular preferred embodiment of the invention, the first and second sheets of thermoplastic material are obtained in continuous rolls which have been either prefolded on the rolls or the material is folded as it is withdrawn from the roll. In either situation, it is preferable to have the sheets of material folded in what is generally referred to in the plastics industry as a "J" fold. That is the one longitudinal side of the sheet of material is folded over the sheet towards the other longitudinal side but with the side edge of the one side of the sheet being spaced slightly from the side edge of the other side rather than side edges being folded together. Advantageously, the folded back side edge is spaced by about one-eighth to one and one-half inches or more from the other side edge. The sheets of thermoplastic material are advantageously drawn continuously from the rolls thereof and the steps of the method as outlined above are continuously repeated, with subsequent portions of the first and second sheets of thermoplastic material being withdrawn from the rolls of continuous material during each repeated cycle of the process.



-6-

The process or method of the present invention produces a unique, novel, double walled, tubular device which can readily be placed around plant. The plurality of vertically spaced compartments can be easily and readily filled with water, and when the compartments are filled with water and the device formed into a tubular position, the side walls of the device become self supporting. The device, when filled with water and placed around a plant, offers superior thermal protection for the plant from cold temperatures.

Additional objects and features of the invention will become apparent from the following detailed description, taken together with the accompanying drawings.

#### THE DRAWINGS

A preferred embodiment of the present invention representing the best mode presently contemplated of carrying out the invention is illustrated schematically in the accompanying drawings, in which:

FIG. 1 is a schematical cross section of one embodiment of simplified apparatus by which the process of the present invention can be operated;

FIG. 2 is a transverse cross section taken along line -2 of Fig. 1;

FIG. 3 is a partial pictorial view of the intermediate platen member of the apparatus of Fig. 1; and

FIG. 4 is a pictorial view of the double walled, tubular device which is made in accordance with the method or process of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

In accordance with the present invention, a process or method is provided for making a double walled, tubular device which is divided into a plurality of substantially vertically extending compartments which are adapted to be filled with water. The water filled tubular device is self supporting and can be placed around a growing plant for thermally protecting the plant from cold weather and temperatures as low as from -5 degrees C. to -12 degrees C.

The process comprises a series of steps which can be repeated in cyclic manner to result in a process or method



-7-

for making the thermal protection devices in a continuous manner. In the first step, a first sheet 11 of thermoplastic, polymeric material, which has been folded back over itself, is introduced into a first heat sealing station wherein repetitive, spaced, elongate, first weld lines are formed transversely across the folded back first sheet 11 of material.

As illustrated diagrammatically in Figs 1 and 2, the first sheet 11 of thermoplastic, polymeric material is folded back over itself along the longitudinal length of the sheet. The sheet 11 of material is advantageously withdrawn from a continuous roll thereof (the roll is not shown in the drawings). The plastic material can be purchased commercially in large rolls in which the plastic material is already folded upon itself on the roll. The sheet 11 of material, in such instances, has a cross section as shown in Fig. 2 as withdrawn from the roll. If the plastic material is purchased in a roll which is not folded, the sheet is first folded along its longitudinal dimensions as it is withdrawn from the roll, and the folded back sheet is then introduced into the first heat sealing station.

As shown in Fig. 1, the folded back first sheet 11 of thermoplastic, polymeric material is introduced or fed between first and second, broad, substantially flat platens. The first platen identified by the referenced numeral 12 is aligned in face-to-face alignment with the second platen which is identified by the reference numeral 13. The platens 12 and 13 define the first heat sealing station for the apparatus as schematically shown in Figs. 1 and 2. The first heat sealing station further comprises a plurality of spaced, elongate, first heat sealing elements 14. The heat sealing elements 14 extend along at least one of the respective facing surfaces of the platens 12 and 13. As illustrated, the heat sealing elements 14 are shown extending along the upper surface of the second platen 13. Mutually respective, elongate, compression pads 15 advantageously extend along the lower surface of the first platen 12 in alignment with mutually respective heat sealing



-8-

elements 14. The first heat sealing elements 14 are spaced apart in mutually parallel relationship with each other, with the heat sealing elements 14 extending across the entire width of the folded first sheet 11 of thermoplastic, polymeric material from the folded edge thereof when the folded first sheet 11 is positioned between the first and second platens 12 and 13 as is best shown in Fig. 2.

In the second step, a second sheet 16 of thermoplastic, polymeric material, which has been folded back over itself, is introduced into a second heat sealing station wherein repetitive, spaced, elongate, second weld lines are formed transversely across the folded back second sheet 16 of material. The second sheet 16 of material is similar to the first sheet 11. The second sheet 16 is folded back over itself along the longitudinal length of the sheet, and the sheet 16 is preferably withdrawn from a continuous roll in the same manner as described above with respect to first sheet 11.

As shown in Fig. 1, the folded back second sheet 16 of thermoplastic, polymeric material is introduced or fed between the second platen 13 and a third, broad, substantially flat platen 17 which is aligned in face-to-face alignment with the lower surface of the second platen 13. The platens 13 and 17 define the second heat sealing station for the apparatus as schematically shown in Figs. 1 and 2. The second heat sealing station further comprises a plurality of spaced, elongate, second heat sealing elements 18. The heat sealing elements 18 extend along at least one of the respective facing surfaces of the platens 13 and 17. As illustrated, the heat sealing elements 18 are shown extending along the lower surface of the second platen 13. Mutually respective, elongate, compressions pads 19 advantageously extend along the upper surface of the third platen 17 in alignment with mutually respective heat sealing elements 18. The second heat sealing elements 18 are spaced apart in mutually parallel relationship with each other, with the heat sealing elements 18 extending across the entire width of the folded second sheet 16 of



-9-

thermoplastic, polymeric material from the folded edge thereof when the folded second sheet 16 is positioned between the second and third platens 13 and 17 as is best shown in Fig. 2.

5           Repetitive, spaced, elongate weld lines are formed transversely across the folded back first and second sheets 11 and 16 so as to form elongate first and second compartments in the sheets 11 and 16, respectively. The elongate compartments are formed between the adjacent weld  
10 lines in the sheets 11 and 16 such that each of the individual compartments is open at one end thereof and closed at its other end by the fold in the respective folded back sheets 11 and 16.

          The elongate weld lines are formed in the portions of  
15 the sheets 11 and 16 during the residence time of those portions within the first and second heat sealing stations. Preferably, the first sheet 11 and the second sheet 16 of thermoplastic material are introduced into the first and second heat sealing stations simultaneously, and the  
20 formation of the weld lines in the respective sheets 11 and 16 are formed simultaneously. The simultaneous formation of the weld lines is advantageously formed in the apparatus as schematically shown in Figs. 1 and 2 by compressing the first, second, and third platens 12, 13 and 17 together in  
25 closely engaged face-to-face relationship such that (1) the first heat sealing elements 14 are compressed tightly together with the first sheet of material 11 between the first and second platens 12 and 13, and (2) the second heat sealing elements 18 are compressed tightly together with the  
30 second sheet 16 between the second and third platens 13 and 17. The compression pads 15 and 19 on the first and third platens 12 and 17, respectively, are helpful in assuring a tight compression between the sheets of thermoplastic material and the respective heat sealing elements 14 and 18.  
35           While the first, second and third platens 12, 13 and 17 are compressed together, the first and second heat sealing elements are heated to a temperature sufficient to effect fusion of the folded over layers of the first and second



-10-

5 sheets 11 and 16 of thermoplastic material, respectively,  
along the loci of contact between the respective first and  
second heat sealing elements 14 and 18 and the mutually  
corresponding first and second sheets 11 and 16 of  
10 thermoplastic material. The first and second sheets of  
folded over material are thus fused and bonded together  
along the elongate bond lines corresponding to the mutually  
respective loci of contact between the heat sealing elements  
and the sheets of thermoplastic material so as to form  
15 individual, elongate compartments in each of the portions of  
the first and second sheets 11 and 16 in the first and  
second heat sealing stations. The heating sealing elements  
14 and 18 advantageously comprise electrical resistive  
heating elements, and they are quickly heated by passing  
20 electrical current through the heating elements when the  
platens 12, 13 and 17 are compressed together. When using a  
superimposed set of platens, as shown diagrammatically in  
Figs. 1 and 2, the mutually corresponding pairs of heat  
sealing elements 14 and 18 can be combined as single  
25 element. In such an arrangement, although not shown in the  
drawings, elongate openings could be formed in the second  
platen 13 at the locations of the heat elements. The heat  
elements could then be stretched across the respective  
openings, and the individual heat elements would be exposed  
30 to both the upper sheet 11 of material and the lower sheet  
16 of material. Each individual heat element would thus be  
capable of simultaneously forming a weld line in the upper  
sheet 11 and the lower sheet 16.

Following the heat sealing and formation of the bond  
35 lines in the first and second sheets 11 and 16 of  
thermoplastic material, the compression is released between  
the first, second and third platens 12, 13 and 17 and the  
portions of the sheets 11 and 16 of thermoplastic material  
are advanced from the first and second heat sealing stations  
so that subsequent, unsealed portions of the first and  
40 second sheets of material are simultaneously advanced or fed  
to the first and second heat sealing stations between the  
first, second and third platens 12, 13 and 17.



-11-

The portions of the first and second sheets 11 and 16 of thermoplastic material which have the weld lines formed therein are fed forward to a third heat sealing station. The portions of the first and second sheets 11 and 16 are  
5 superimposed one over the other in the third heat sealing station or location such that mutually respective weld lines formed in each of the portions of the first and second sheets 11 and 16 coming from the first and second heat  
10 sealing stations lie substantially adjacent to each other and so that the open ends of the mutually respective compartments in the first and second sheets 11 and 16 lie substantially adjacent to each other.

Although it is advantageous to utilize a superimposed set of platens as shown in Figs. 1 and 2 and to  
15 simultaneously advance the first and second sheets 11 and 16 through the set of platens as discussed above, it is to be specifically recognized that other embodiments of apparatus could be used. Separate and distinct sets of platens could be used, and the sheets of material from the separate  
20 platens could be brought together in superimposed condition in the third heat sealing station. In another possible alternative, the first and second heat sealing stations could comprise separate and distinct nip rollers, with a heat sealing element being associated with each of the nip  
25 rollers. As the first and second sheets of material passed through the respective nip rollers, the spaced, repetitive weld lines would be formed. The sheets would then be superimposed and sent to the third heat sealing station which could also be a nip roller having a heat sealing  
30 element associated therewith.

Returning, however, to the apparatus shown, schematically in Figs. 1-3, the third or final heat sealing station is comprised at least in part by extensions of the first and third platens 12 and 17. AS illustrated, the  
35 first and third platens 12 and 17 extend beyond the second platen 13 in the direction of movement of the sheets of material 11 and 16 through the system of platens. This allows the sheets 11 and 16 of thermoplastic material to be



-12-

brought together in superimposed condition as they are drawn forward from the first and second heat sealing stations. As shown, the first and second sheets 11 and 16, as they are withdrawn from the first and second heat sealing stations, are superimposed one over the other so that mutually respective bond lines formed in each of the portions of the sheets lie substantially adjacent to each other, with the folded side edges of the sheets being mutually adjacent to each other at one of the longitudinal side edges of the superimposed sheets, and with the open ends of the compartments formed in each of the superimposed sheets being aligned along the opposite side edge of the superimposed sheets.

The final or third heat sealing station comprises the extensions of the first and third platens 12 and 17. These extending end portions of the platens 12 and 17 can have somewhat thickened cross-sectional depths as shown in Fig. 1 to make up for the thickness of the second platen 13 which does not extend between the end portions of the first and second platens 12 and 17. The third or final heat sealing station has a pair of elongate third heat sealing elements 21 which are spaced in mutually parallel relationship with each other and substantially parallel with the first and second heat sealing elements 14 and 18 of the first and second heat sealing stations. The third heat sealing elements 21 are adapted to be brought into compressed contact with the superimposed first and second sheets 11 and 16 and effect fusion of the folded over layers of the first and second sheets as well as fusion of the first and second sheets 11 and 16 to each other along the loci of contact between the third heat sealing elements 21 and the superimposed sheets of material as the platens 12, 13, and 17 are compressed together. A pair of compression pads 22 are provided to aid in assuring a tight compression between the sheets of thermoplastic material and the heat sealing elements 21. The heat sealing elements 21 advantageously comprise electrical resistive heating elements which are quickly heated by passing electrical current through the



-13-

heating elements when the platens 12, 13 and 17 are compressed together.

The arrangement of the platens 12, 13 and 17 as illustrated in Figs. 1 and 2 allows the platens to move together simultaneously such that the heat sealing of compartments in the first and second sheets 11 and 16 and the bonding of the first and second sheets together at relatively widely spaced intervals can be done in synchronous manner during the simultaneous, repetitive movements of the platens 12, 13 and 17. As the bond lines are being formed in the particular portions of the separate sheets 11 and 16 in the first and second heat sealing stations to form the individual compartments therein, the final weld lines or bonds which fuse the first sheet to the second sheet are being formed simultaneously by the heat sealing elements 21 of the third heat sealing station. The sheets 11 and 16 are then moved forward and the simultaneous heat sealing functions are repeated. As the sheets 11 and 16 exit from the third heat sealing station, the first and second sheets 11 and 16 are cut or slit transversly across their width between the two spaced weld lines formed in the third heat sealing station.

The heat sealing elements 21 are spaced from the trailing heat elements 14 and 18 of the first and second heat sealing stations by a distance somewhat equivalent to the distance between the respective heat sealing elements 14 and 18 of the first and second heat sealing stations. Thus, as the sheets of material 11 and 16 are fed forward from the first and second heat sealing stations to the third heat sealing station, the trailing bond lines in sheets 11 and 16 coming from the first and second heat sealing stations can be advanced so that they are moved ahead of the heat sealing elements 21 in the third heat sealing stations by the width of one of the compartments in the bonded sheets. The heat sealing elements 21 would form a final compartment following the trailing bond lines as well as fuse the first and second sheets 11 and 16 together. The first compartments in the subsequent portions of the sheets 11 and 16 of material



-14-

would then be formed between the heat sealing elements 21 and the forward most heat sealing elements 14 and 18 of the first and second heat sealing stations.

In a preferred embodiment of the invention, as illustrated diagrammatically in Figs. 1 and 2, the initial heat sealing elements 14 and 18 on the left hand side of the first and second heat sealing stations, i.e., the trailing heat sealing elements, are spaced relatively closely as a pair, such as by  $1/2$  or  $3/4$  of an inch. The other heat sealing elements 14 and 18 are spaced about 3 to 4 inches, typically. The pair of third heat sealing elements 21 are spaced about 3 to 4 inches, typically, from the final heat sealing elements 14 and 18 of the first and second heat sealing stations. The pair of third heat sealing elements are spaced apart by less than  $1/2$  of an inch, typically about  $3/8$  of an inch. When the sheets 11 and 16 of material are advanced in the apparatus as shown diagrammatically in Figs. 1 and 2, the pair of closely spaced trailing weld lines formed by the pair of closely spaced heat sealing elements 14 and 18 at the left hand side of the first and second heat sealing stations are moved forward to a position in which the pair of third heat sealing elements 21 will contact the sheets 11 and 16 of material equal spaced between the pair of closely spaced, trailing weld lines. This will form a double seal at the beginning and end of each tubular units as the sheets 11 and 16 of material are severed or cut transversely across their widths between the two spaced weld lines formed by the heat sealing elements 21 in the third heat sealing station.

The compressive movement of the first, second and third platens 12, 13 and 17 of the apparatus as diagrammatically illustrated in Figs. 1 and 2 is advantageously provided by drawing a vacuum between the first and third platens. Compressive sealing means 24 can be attached around the perimeter edges of the platens 12, 13 and 17 to aid in holding the vacuum within the platens. Switching means not shown can be used with the apparatus which is activated when a preset vacuum is achieved between the platens. The



-15-

switching means would allow electrical current to flow in the resistive heat sealing elements when the switching means is activated. The switching means would remain in the active state for a present period of time and then

5 deactivate. The deactivation would terminate the vacuum as well as the electrical current in the resistive heaters. With the compression between the platens being released, the sheets 11 and 16 of material can then be advanced to the next cycle. To aid in drawing the platens together,

10 openings such as the rectangular openings 25 as best shown in Fig. 3 are provided in the intermediate or second platen 13. The openings 25 allow the vacuum to draw the outermost platens 12 and 17 evenly together, with the third platen 13 and the sheets 11 and 16 of thermoplastic material

15 compressed uniformly therebetween.

As shown in Fig. 1 the lower platen 17 can be extended out to form a support for the portion of the sheets 11 and 16 which extend from the heat sealing elements 21 and the third heat sealing station. A cutting knife 26 and a knife

20 edge can be provided at the far end of the extension of platen 17 for cutting the sheets 11 and 16 of material.

The sections cut from the sheets 11 and 16 are joined at their opposite longitudinal ends to form a double walled tubular device in accordance with the present invention.

25 One of the tubular devices produced from the process or method in accordance with the present invention is shown in Fig. 4, with the tubular device being formed into its generally round, tubular configuration for being placed around a plant. The weld lines 40 at each of the ends of

30 the tubular device are the welds formed by the heat sealing elements 21 of the third heat sealing station as discussed hereinbefore. The weld lines 41 are those formed by the heat sealing elements 14 and 18 of the first and second heat sealing stations as discussed hereinbefore. The elongate

35 compartments formed in the tubular device are shown at their open ends 42.

Any thermoplastic material may be used as the sheets 11 and 16, such as polyethylene, polypropylene, etc. It is



-16-

particularly advantageous to use polyethylene material, with the sheets having a thickness of about 5.5 mils. Ultra violet inhibitors and puncture resistant additives are preferably added to the thermoplastic material.

5 While the invention has been described in the best mode presently contemplated, the invention is not to be limited to those embodiments shown and described but is to be defined by the scope of the appended claims and equivalents thereof.

10



-17-

## CLAIMS

1. A method of making a double walled, tubular device which is divided into a plurality of substantially vertically extending compartments which are adapted to be filled with water, whereby the water-filled tubular device is self supporting and can be placed around a growing plant for thermally protecting the plant, said method comprising the steps of

(a) feeding a first sheet of thermoplastic, polymeric material which has been folded back over itself between first and second, broad, substantially, flat platens, with a plurality of spaced, elongated, first heat sealing elements extending along at least one of the respective facing surfaces of said first and second platens, said first heat sealing elements being spaced in mutually parallel relationship with each other, with the heat sealing elements extending across the entire width of the folded first sheet of thermoplastic, polymeric material from the folded edge thereof when said first sheet of material is positioned between said first and second platens;

(b) feeding a second sheet of thermoplastic polymeric material which has been folded back over itself between said second platen and a third broad, substantially flat platen, with a plurality of spaced, elongate second heat sealing elements extending along at least one of the respective facing surfaces of said second and third platens, said second heat sealing elements being spaced in mutually parallel relationship with each other, with the heat sealing elements extending across the entire width of the folded second sheet of thermoplastic, polymeric material from the folded edge thereof when said second sheet of material is positioned between said second and third platens;

(c) compressing the first, second and third platens together in closely engaged, face-to-face relationship such that (1) the first heat sealing elements are compressed tightly together with said first sheet of thermoplastic material between said first and second platens, and (2) the second heat sealing elements are



-18-

compressed tightly together with said second sheet of thermoplastic material between said second and third platens;

5 (d) while said first, second and third platens are compressed together, heating said first and second heat sealing elements to a temperature sufficient to effect fusion of the folded over layers of said first and second sheets of thermoplastic material, respectively, along the loci of contact between the respective first and second heat  
10 sealing elements and the corresponding first and second sheets of thermoplastic material, whereby the respective folded over first and second sheets of material are fused and bonded together along elongate bond lines corresponding to the mutually respective loci of contact between said heat  
15 sealing means and said first and second sheets of thermoplastic material, so as to form individual, elongate compartments in each of the first and second sheets of thermoplastic material between adjacent bond lines therein, each of said individual compartments being open at one end  
20 thereof and closed at its other end by the fold in the respective folded over first and second sheets of thermoplastic material;

(e) releasing the compression between the first, second and third platens and advancing the first, second,  
25 and third platens following the heat sealing and formation of said individual compartments in said first and second sheets of material in step (f) so that subsequent unsealed portions of said first and second sheets of material are simultaneously advanced or fed between the respective first,  
30 second, and third platens;

(f) feeding the portion of the first and second sheets of material having said bond lines sealed therein from step (e) forward to a final heat sealing station wherein said portions of the first and second sheets having  
35 said bond lines sealed therein are superimposed over each other so that mutually respective bond lines formed in each of the portions of the first and second sheets during step (d) lie substantially adjacent to each other, said final



heat sealing station having a pair of elongate third heat sealing elements which are spaced in mutually parallel relationship with each other with said third heat sealing elements being adapted to be brought into compressed contact with the superimposed first and second sheets and effect fusion of the folded over layers of said first and second sheets as well as fusion of the first and second sheets to each other along the loci of contact between the third heat sealing elements and said superimposed first and second sheets of thermoplastic material, said superimposed first and second sheets being fed forward such that the mutually respective, trailing pair of bond lines formed in the first and second sheets of material in the previous step (d) are positioned adjacent to said third heat sealing elements;

(g) bringing the third heat sealing elements into contact with the superimposed first and second sheets so as to seal the first and second sheets together along two spaced weld lines;

(h) separating the third heat sealing elements and cutting the first and second sheets transversely across their width between the two spaced weld lines formed in step (g); and

(i) repeating steps (a) through (h).

2. A method in accordance with Claim 1, wherein the steps (a) through (h) are continuously repeated.

3. A method in accordance with Claim 1 or 2 wherein each of the first and second sheets are folded over themselves such that the respective lateral edges of each folded sheet of material are spaced from each other as the respective sheet is folded flat.

4. A method of making a double walled tubular device which is divided into a plurality of substantially vertically extending compartments which are adapted to be filled with water, whereby the water-filled tubular device is self supporting and can be placed around a growing plant for thermally protecting the plant, said method comprising the steps of:



-20-

(a) feeding a first sheet of thermoplastic polymeric material which has been folded back over itself to a first heat sealing station wherein repetitive, spaced, elongate, first weld lines are formed transversely across the folded back first sheet of material so as to form elongate first compartments in the folded back first sheet between adjacent first weld lines therein, each of said first compartments being open at one end thereof and closed at its other end by the fold in said folded back first sheet of material;

(b) feeding a second sheet of thermoplastic, polymeric material which has been folded back over itself to a second heat sealing station wherein repetitive, spaced, elongate second weld lines are formed transversely across the folded back second sheet of material so as to form elongate second compartments in the folded back second sheet between adjacent second weld lines therein, each of said second compartments being open at one end thereof and closed at its other end by the fold in said folded back second sheet of material;

(c) feeding the portions of the first and second sheets of material having said first and second weld lines, respectively, therein from steps (a) and (b) forward to a third heat sealing station; wherein said portions of the first and second sheets of material having said first and second weld lines formed therein are superimposed over each other so that mutually respective weld lines formed in each of the portions of the first and second sheets of material during steps (a) and (b) lie substantially adjacent to each other and so that the open ends of the mutually respective compartments in said first and second sheets of material lie substantially adjacent to each other;

(d) as the superimposed first and second sheets of material pass through said third heat sealing station, repetitive, spaced, elongate pairs of third weld lines are formed across the superimposed first and second sheets of material so as to seal and weld together said first and second sheets of material along said third weld lines, with



-21-

the two respective weld lines of each pair of their weld lines being spaced closely adjacent to each other and with respective pairs of third weld lines being spaced along the longitudinal dimension of said first and second sheets such that a plurality of compartments in each of said first and second sheets of material are included between adjacent, spaced pairs of third weld lines;

(e) cutting the first and second sheets of material transversely across their width between the two closely spaced weld lines of each pair of third weld lines formed in steps (d) and (f) repeating steps (a) through (e).

5. A method in accordance with Claim 4, wherein the steps (a) through (e) are continuously repeated.

6. A method in accordance with Claim 4 or Claim 5 wherein each of the first and second sheets are folded over themselves such that the respective lateral edges of each folded sheet of material are spaced from each other as the respective sheet is folded flat.

7. The double walled, tubular device made in accordance with the method of any one of the preceding claims.



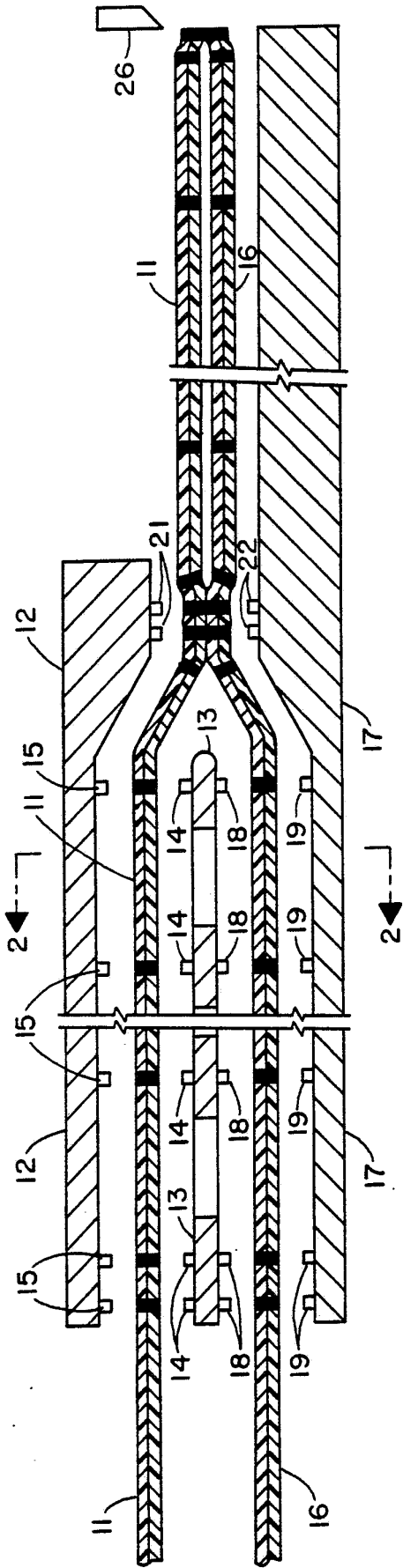


Fig. 1

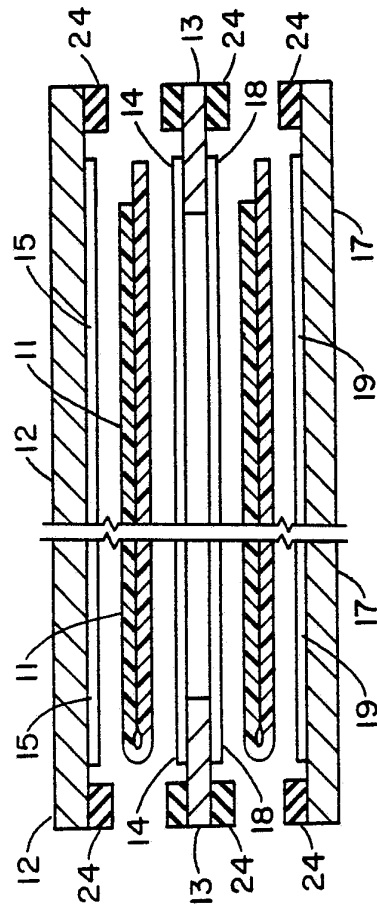


Fig. 2



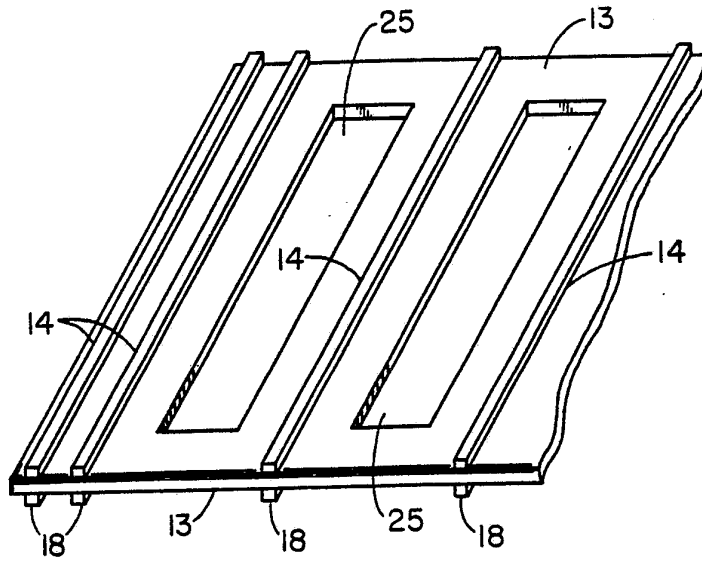


Fig. 3

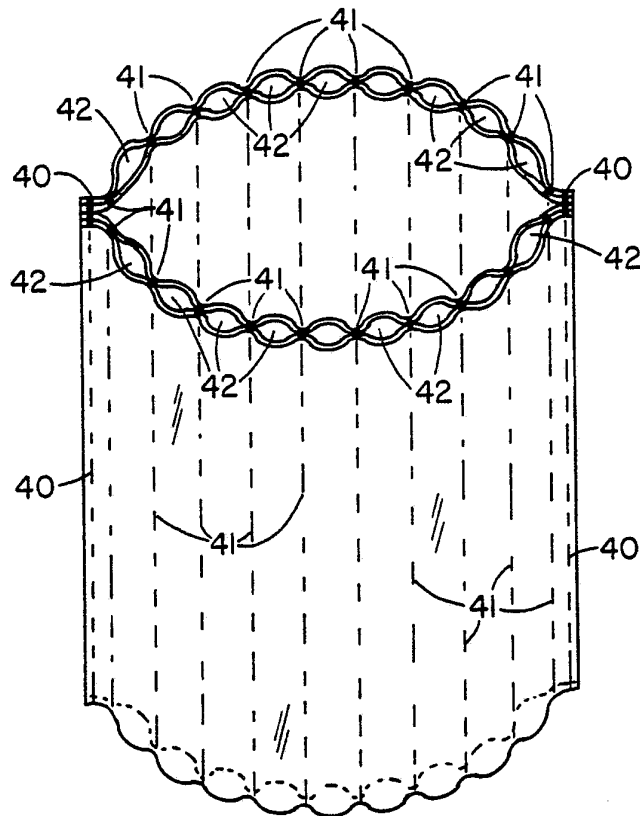


Fig. 4

# INTERNATIONAL SEARCH REPORT

International Application . . . PCT/US84/00317

<b>I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>3</sup></b>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
U.S. CL 156/273.5, 272.2, 274.4, 275.1, 290, 292 428/177		
IPC <sup>4</sup> B29C 27/04; B29C 27/02; B29C 27/06; B29H 7/04; B32B 31/00; B32B 3/2		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
US	156/200, 204, 227, 272.2, 273.3, 273.5, 274.4, 274.6, 275.1 156/290, 292, 308.1 428/178	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>14</sup></b>		
Category <sup>6</sup>	Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
A	US, A, 3437776, PUBLISHED 08 APRIL 1969, SCHAEFFER ET AL (SEE FIG. 1).	
Y	US, A, 3739522, PUBLISHED 19 JUNE 1973, GREENBAUM (SEE FIGS 3-6).	1-7
Y	US, A, 3872621, PUBLISHED 25 MARCH 1875, GREENBAUM (SEE FIG 5, 8-9).	1-7
A	US, A, 4412880, PUBLISHED 01 NOVEMBER 1983, WINTERMANTEL (SEE FIG 1).	
A	US, A, 4425174, PUBLISHED 10 JANUARY 1984, MCLOUGHLIN (SEE FIG 3, 5-6).	
Y	US, A, 4425390, PUBLISHED 10 JANUARY 1984, CHANGANI ET AL (SEE FIG 8).	1, 4, 7
Y	GB, A, 2082110A, PUBLISHED 03 MARCH 1982, CHANGANI ET AL (SEE FIG 7).	1, 4, 7
<p><sup>6</sup> Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>19</sup>	Date of Mailing of this International Search Report <sup>20</sup>	
04 JUN 1984	05 JUN 1984	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>20</sup>	
ISA/JUS	