US 20020163102A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2002/0163102 A1**

Thompson (43) **Pub. Date: Nov. 7, 2002**

(54) **MACHINE AND METHOD FOR PROVIDING FOLDED PIPE LINERS**

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(21) Appl. No.: **10/183,831**

(22) Filed: **Jun. 28, 2002**

Related U.S. Application Data

(62) Division of application No. 09/629,174, filed on Jul. 31, 2000, now Pat. No. 6,423,258.

Publication Classification

(51) **Int. Cl.**[7] **B29C 53/08**; B29C 63/26

(52) **U.S. Cl.** **264/285**; 264/36.16; 264/322; 425/11; 425/182; 425/343; 425/385

(57) **ABSTRACT**

A machine and method for providing a folded liner for insertion into a pipe, comprises an upper section and a lower section. A flattened heated thermoplastic liner is fed downwardly through the upper section to the lower section, where it is redirected and fed substantially horizontally from the lower section. The flattened liner introduced to the upper section is broadly indented at one side of the liner and is then more acutely indented to provide loops disposed side-by-side in a substantially horizontal direction. The lower section reorients the loops so that they are stacked side-by-side in a substantially vertical direction. The liner is cooled as its leaves the lower section to maintain its cross-sectional configuration. The upper section is separable from the lower section, and portions of the upper and lower sections are displaceable and removable to facilitate insertion of the liner into the machine and removal of the machine from the liner.

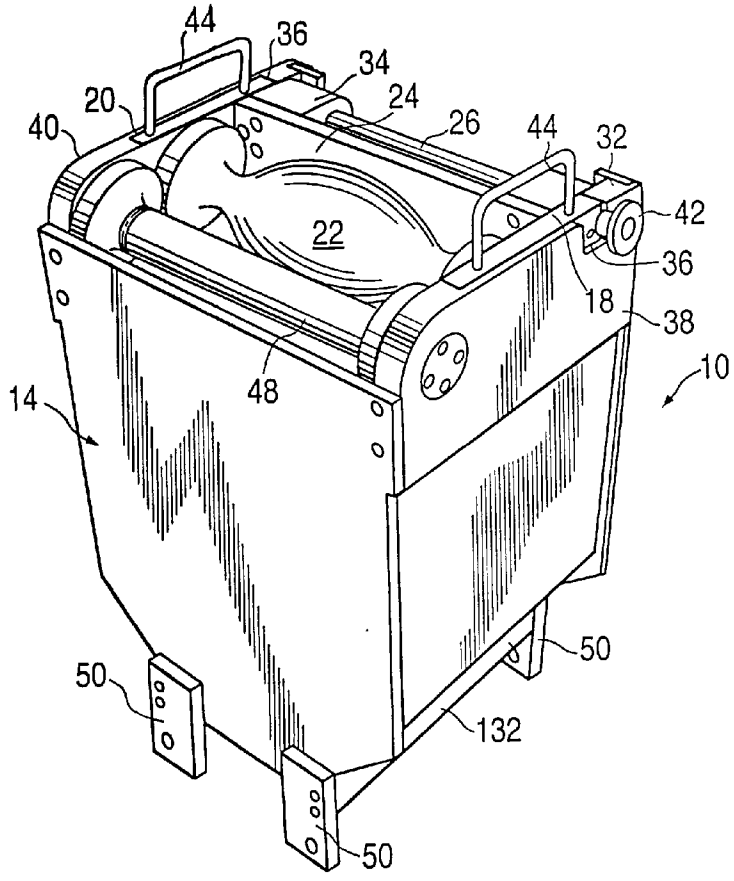

FIG. 2

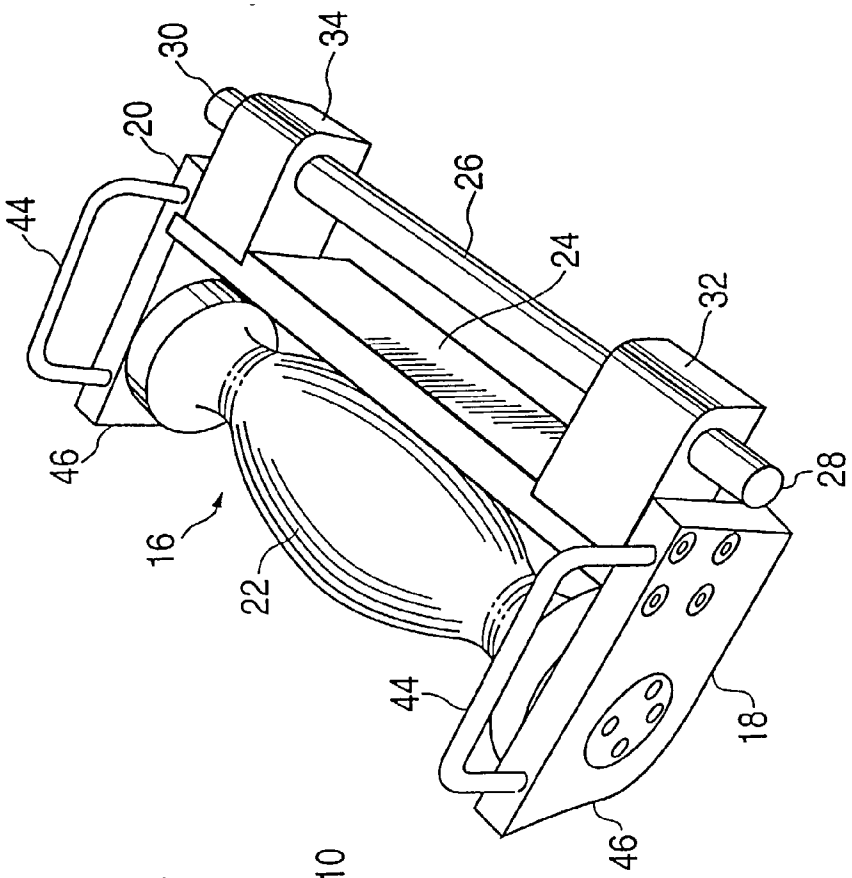
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FIG. 1

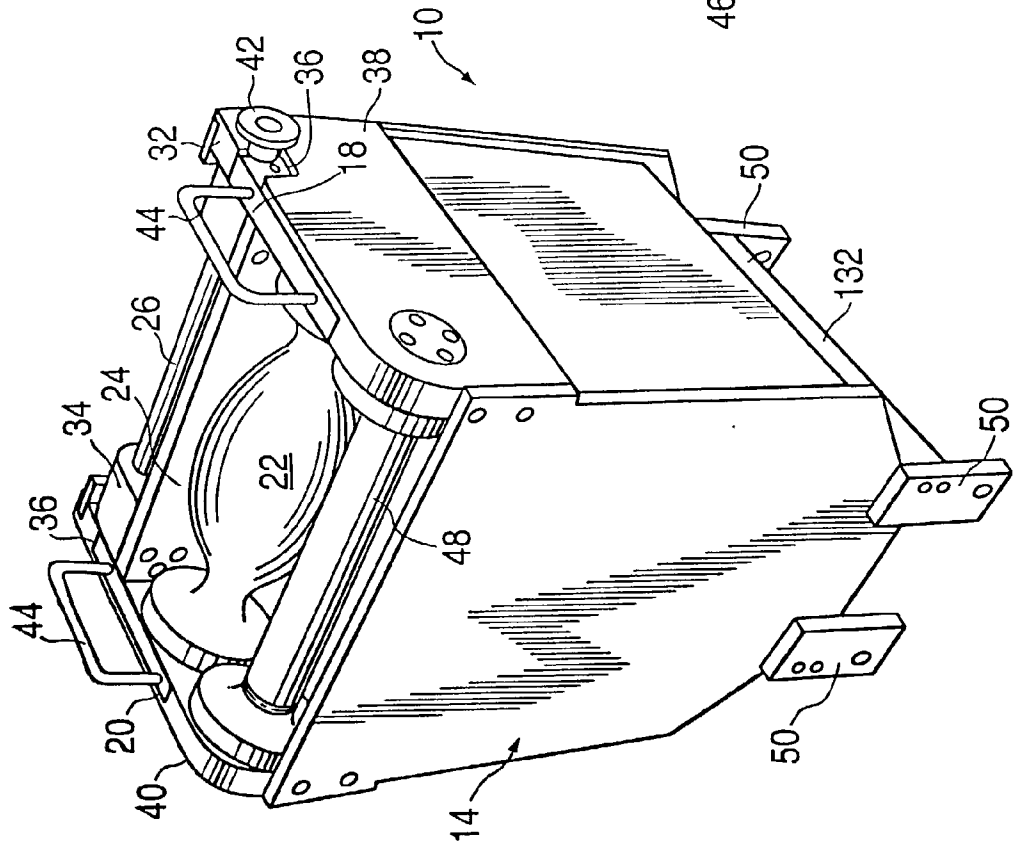
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FIG. 3

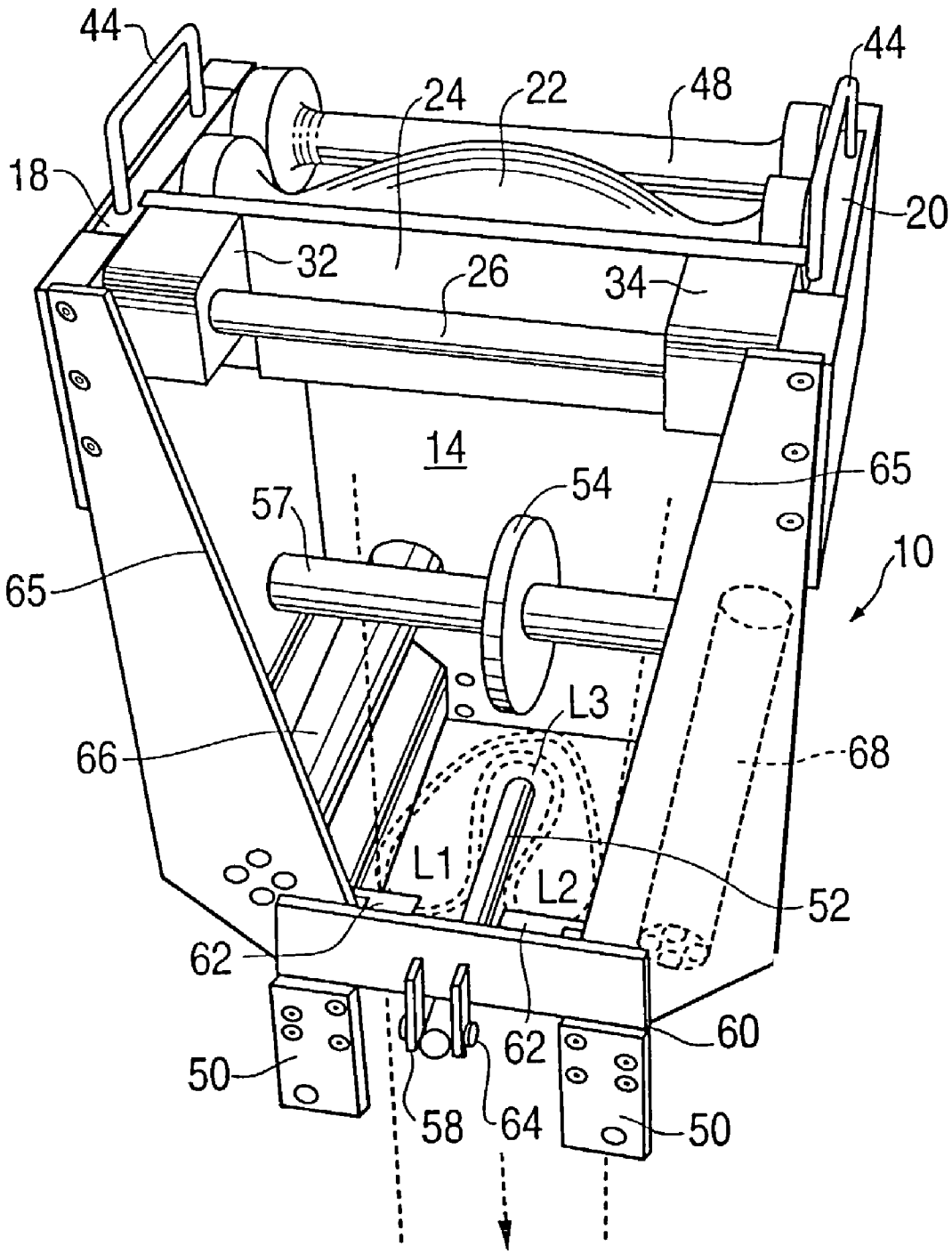
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FIG. 4

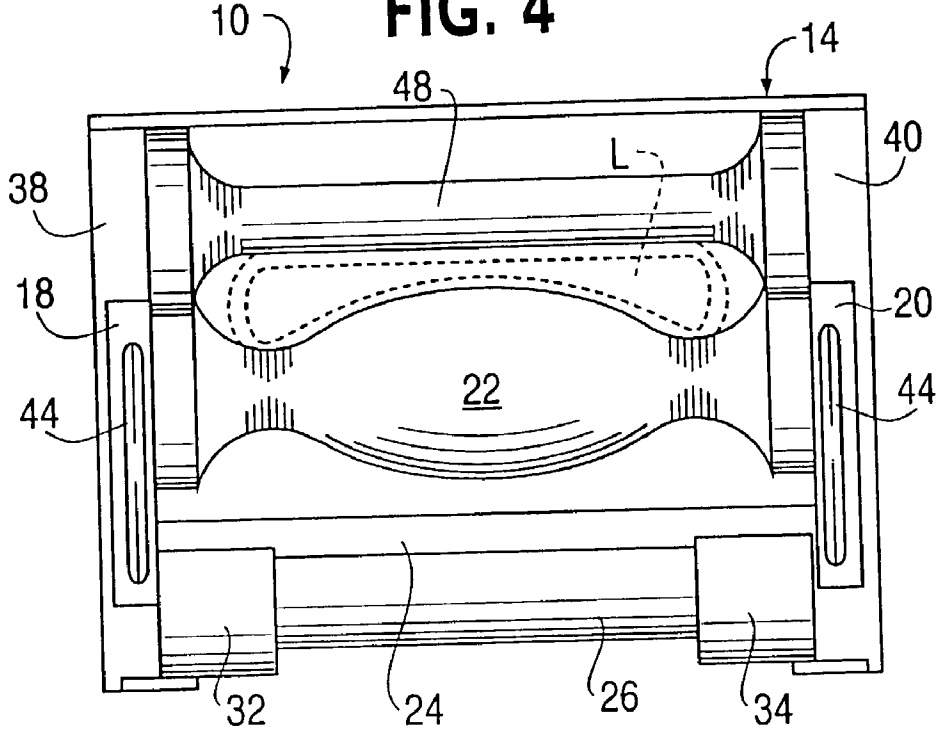

FIG. 10

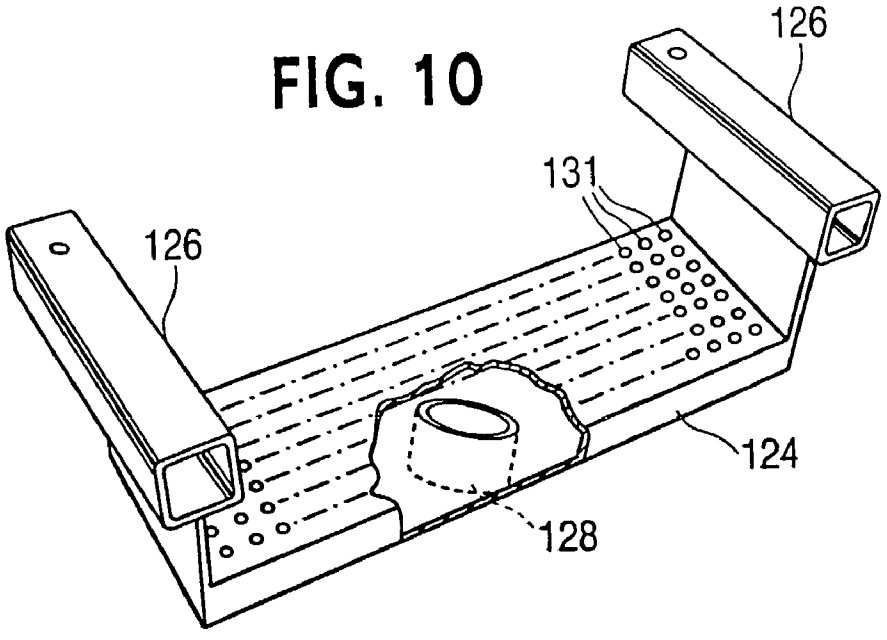

FIG. 6

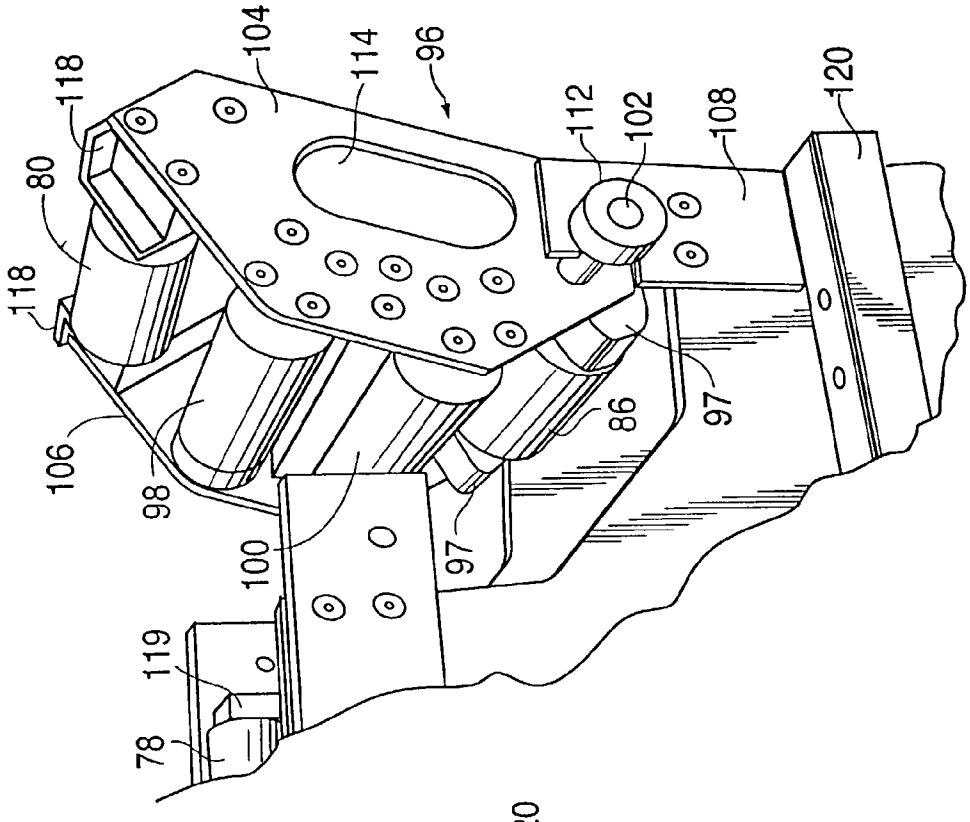
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FIG. 5

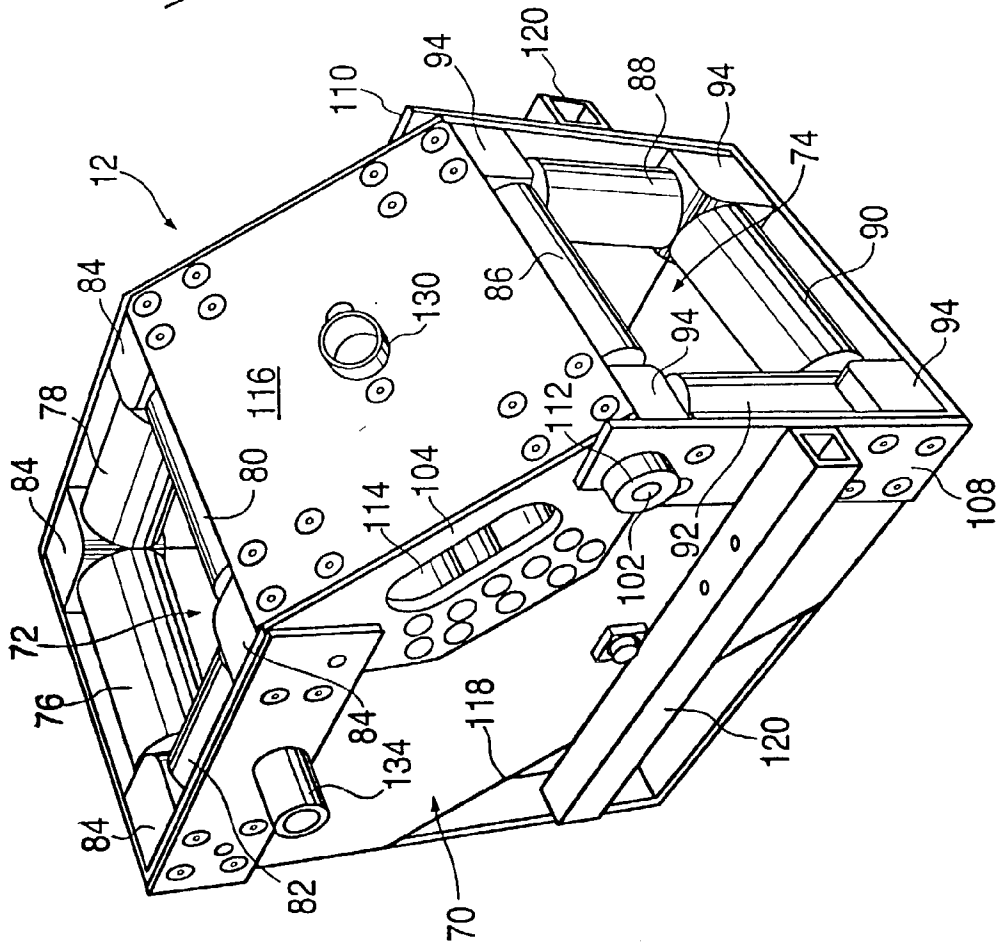
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FIG. 7

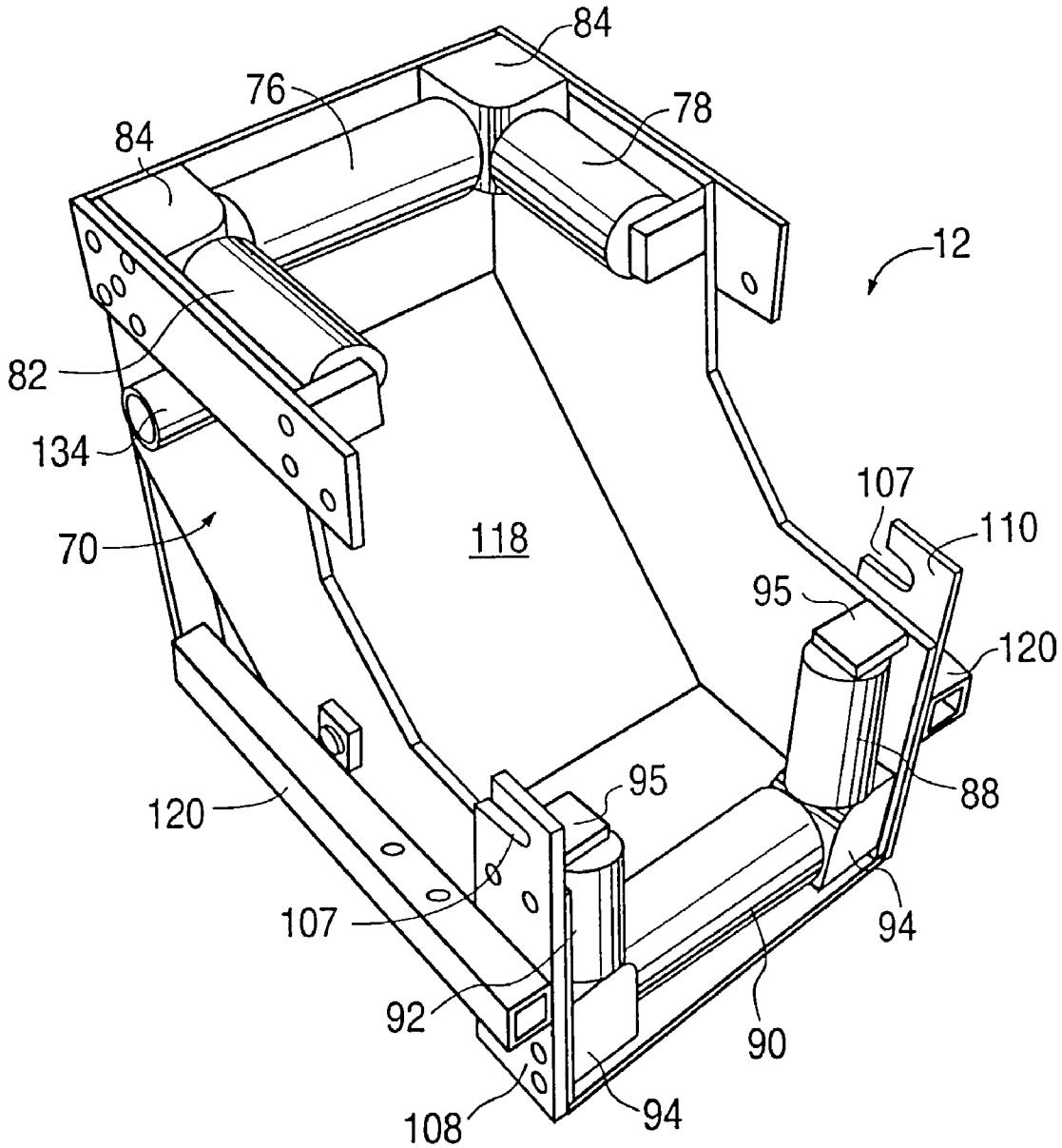
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FIG. 8

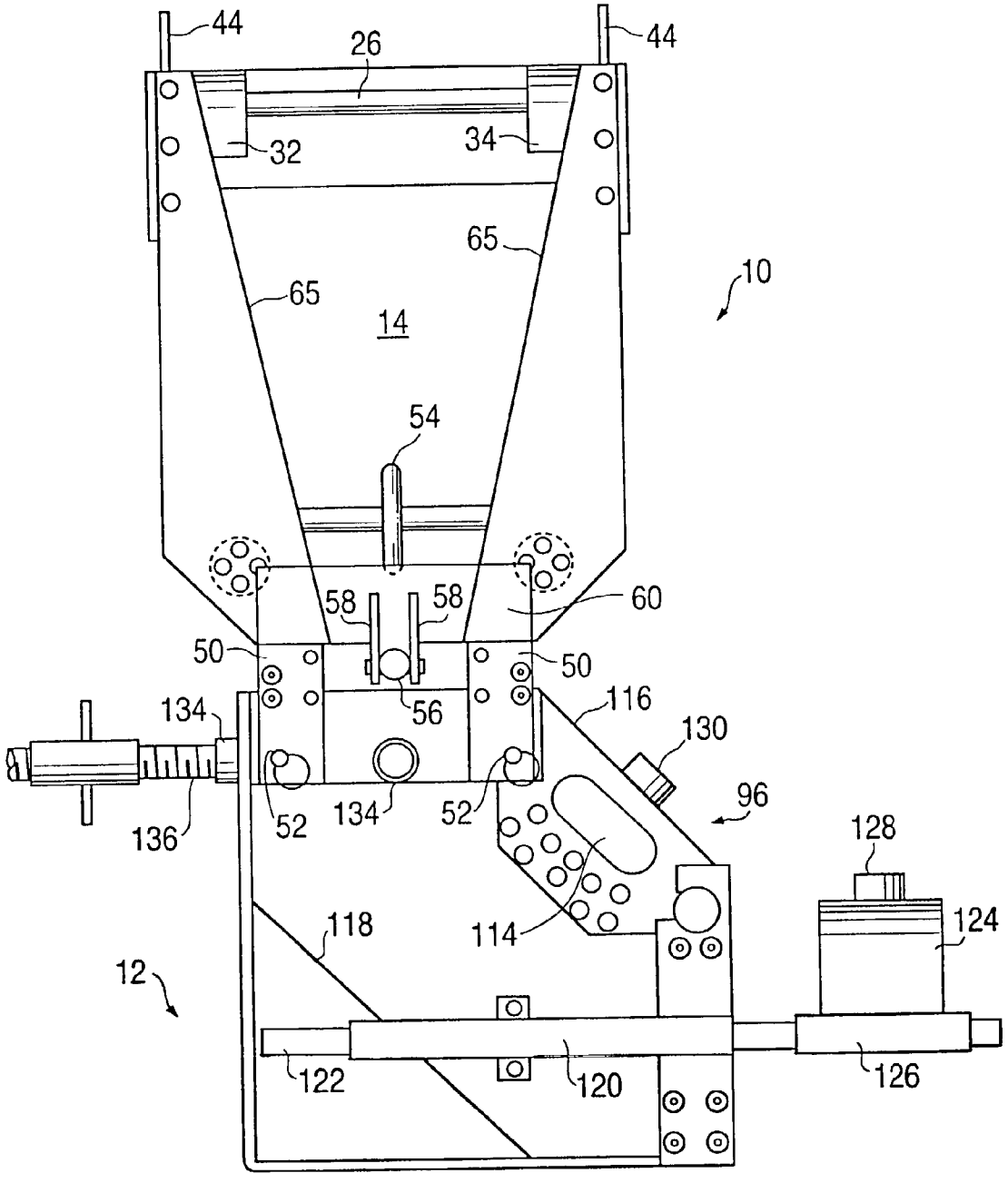
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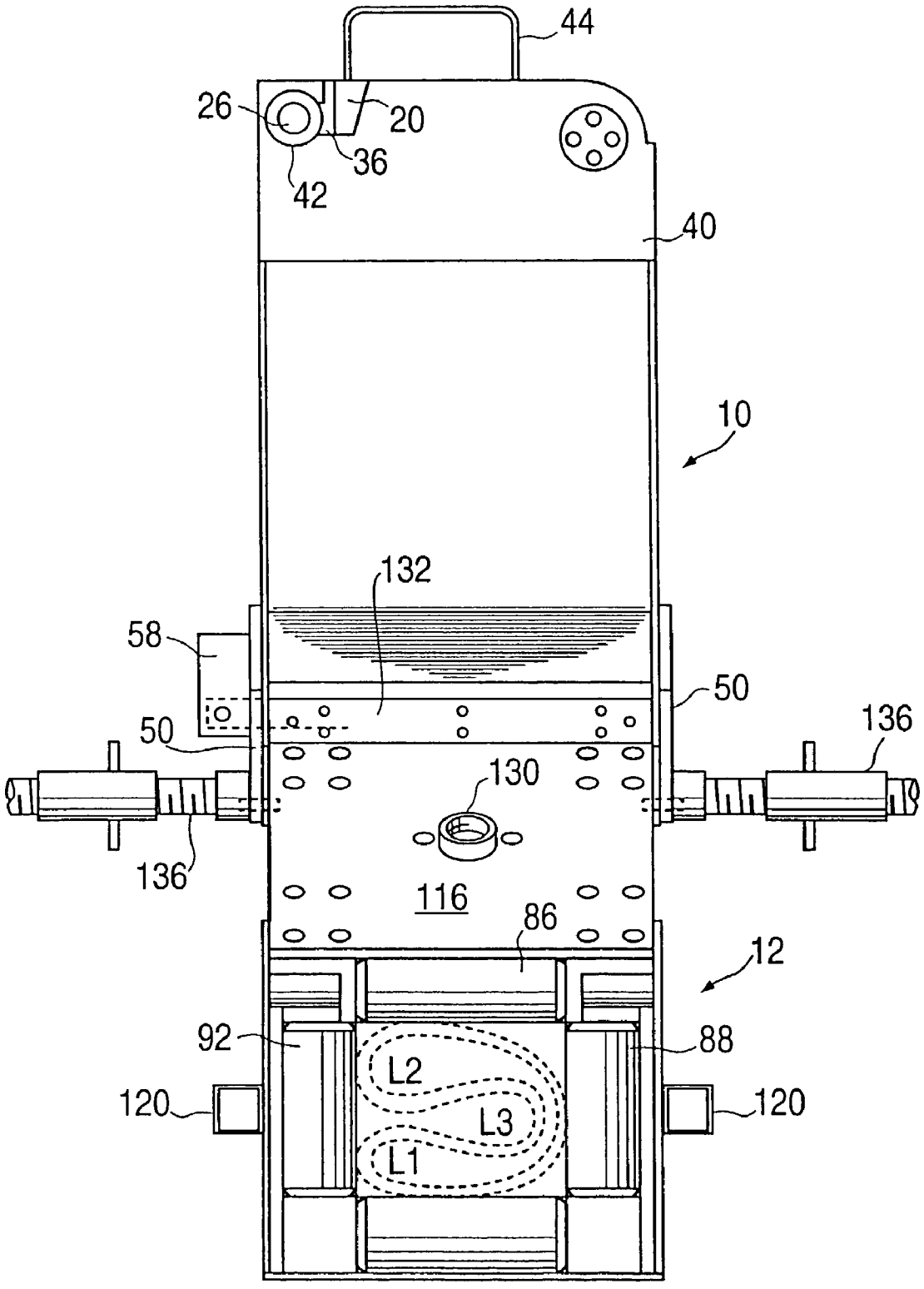
FIG. 9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MACHINE AND METHOD FOR PROVIDING FOLDED PIPE LINERS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a division of application Ser. No. 09/629,174 filed Jul. 31, 2000.

BACKGROUND OF THE INVENTION

[0002] This invention is concerned with lining of sewer pipes and the like and is more particularly concerned with providing a folded liner that can be pulled through a pipe for later expansion by conventional techniques.

[0003] Because of the expense of repairing and/or replacing defective sewer pipes and the like, an industry practice has developed in which the pipes are lined with a plastic liner, thereby to provide a new flow path within the defective pipe. In order to facilitate the pulling of the liner through the pipe, techniques have been developed for folding a flattened thermoplastic liner before it is introduced to the pipe so that the cross-dimensions of the liner, when folded, are substantially less than the cross-dimensions of the pipe. However, providing a folded liner efficiently, reliably, and economically has been a problem. The present invention is a solution to that problem.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In a broad sense, the invention concerns a machine and method of providing tubing that is folded about a longitudinal axis whereby the cross-section of the tubing assumes a configuration comprising overlapping loops. More particularly, the loops are formed as the tubing is fed in a first direction, and then the tubing is redirected and the orientation of the loops is changed.

[0005] In a preferred embodiment, a machine of the invention comprises an upper section and a lower section, which are preferably separable. As a heated flexible liner of flattened cross-section is fed into and through the upper section to the lower section, it is broadly indented at one side thereof and is then more acutely indented to fold the liner so that the cross-section assumes a configuration in which a pair of outer loops are disposed at opposite sides of a central loop along a substantially horizontal direction.

[0006] As the folded liner is fed through the lower section, it is redirected so that it is fed substantially horizontally, with the cross-sectional loops stacked substantially vertically. The liner fed from the lower section is cooled to reduce its flexibility, so that the cross-sectional configuration is maintained as the liner is drawn into and through a pipe, in a conventional manner.

[0007] In a preferred embodiment of the invention, portions of the upper and lower sections can be displaced, and can also be removed, to facilitate initial entry of the liner into the upper section, and also to facilitate withdrawal of the machine from the liner after the liner has been drawn to a desired position in the pipe. After the liner has been installed in the pipe, and the machine withdrawn, a trailing portion of the liner can be cut and the liner can be heated and expanded by conventional techniques, thereby unfolding the liner and providing a round cross-section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The invention will be further described in conjunction with the accompanying drawings, which illustrate a preferred and exemplary (best mode) embodiment of the invention and wherein:

[0009] **FIG. 1** is a perspective view of the upper section;

[0010] **FIG. 2** is a perspective view of a removable portion of the upper section;

[0011] **FIG. 3** is a further perspective view of the upper section showing components that are not visible in **FIG. 1** and showing the cross-sectional configuration of the liner after folding;

[0012] **FIG. 4** is a top plan view of the upper section showing the cross-sectional configuration of the liner as it is broadly indented;

[0013] **FIG. 5** is a perspective view of the lower section;

[0014] **FIG. 6** is a fragmentary perspective view showing displacement of a removable portion of the lower section;

[0015] **FIG. 7** is a perspective view showing the lower section with the removable portion of **FIG. 6** removed;

[0016] **FIG. 8** is a side elevation view showing the upper section assembled on the lower section;

[0017] **FIG. 9** is an end view of the machine shown in **FIG. 8**, illustrating the cross-sectional configuration of the folded liner as it leaves the lower section; and

[0018] **FIG. 10** is an inverted perspective view of a cooling manifold that can be used in the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] As shown in **FIGS. 8 and 9**, a machine in accordance with the invention comprises an upper section **10** mounted on a lower section **12**. The upper section, shown more particularly, in FIGS. **1-4**, comprises a casing **14** that is open at the top and at one side thereof. A portion **16** of the upper section, shown in **FIG. 2**, is displaceable and can be removed from the remainder of the upper section. Removable portion **16** comprises a pair of side plates **18**, **20** supporting a convex, bulbous forming roller **22** that is mounted rotatably on the side plates.

[0020] An end plate **24** connects the side plates and supports a rod **26** with ends **28**, **30** that project from a pair of mounting brackets **32**, **34** attached to the end plate. The projecting ends of the rod are received within L-shaped slots **36** in sidewalls **38**, **40** of the upper section, the sidewalls being notched to receive the side plates of the removable portion **16**. Washers **42 (FIGS. 1 and 9)** may be attached to the projecting ends of the rod **26**.

[0021] Handles **44** are mounted on the side plates of the removable portion so that the removable portion can be easily turned and lifted from the position shown in **FIG. 1**. The ends **46** of the side plates, opposite to the projecting ends of the rod **26**, are curved, and the juxtaposed surfaces of the sidewalls **38** and **40** have a complementary curvature, so that the removable portion can be turned about the axis of the rod and then shifted along slots **36** and lifted out of the slots. As shown in **FIGS. 1 and 4**, a cylindrical backup roller

48 is rotatably supported on the sidewalls of the upper section in close proximity with the forming roller 22.

[0022] Four rectangular plates 50 are attached to and extend downwardly from a bottom portion of the upper section to embrace a top portion of the lower section 12 as shown in FIGS. 8 and 9. Removable pins 52 are inserted into aligned bores in the plates and the juxtaposed walls of the lower section.

[0023] As shown in FIGS. 3 and 8, the upper section includes an indenting assembly, which, in the preferred form comprises a rotatable disk 54 and a cylindrical finger 56 that projects substantially horizontally into the interior of the upper section below the disk. The disk is supported on a shaft 57 extending between sidewalls of the upper section and removable therefrom. The finger is supported on a pair of brackets 58 attached to a plate 60 having channel pieces 62 that slide along converging edges 65 of an opening at one side of the upper section. When installed in the upper section, the plate 60 rests atop two mounting plates 50 as shown in FIG. 3. The cylindrical finger 56 is supported on the brackets 58 by a pin 64 that extends through aligned bores in the brackets and an end portion of the finger, and the mounting of the finger is such that, when sufficient manual force is exerted, the finger can be turned downwardly from the position shown in FIG. 3.

[0024] The forming roller 22 and the backup roller 48 rotate about substantially horizontal axes. Preferably, there are two additional rollers, 66, 68 (see FIG. 3), below and at opposite sides of the indenting assembly, that rotate about substantially horizontal axes transverse to the rotational axes of the forming roller and the backup roller.

[0025] As shown in FIG. 5, the lower section 12 comprises a casing 70 with a rectangular inlet 72 at the top and a rectangular outlet 74 at one end. The inlet is defined by four rollers 76, 78, 80, and 82 that rotate on corner blocks 84 about substantially horizontal axes. The outlet 74 is defined by four rollers 86, 88, 90, and 92 that rotate on corner blocks 94. One pair of opposed rollers, 86, 90, rotates about substantially horizontal axes and the other pair of opposed rollers, 88, 92, rotates about substantially vertical axes. The corner blocks 94 shown at the top of rollers 88 and 92 in FIG. 5 are actually formed in two parts. Portions 95 of these corner blocks are shown in FIG. 7, and mating portions 97 are shown in FIG. 6.

[0026] As shown in FIG. 6, the lower section 12 has a displaceable and removable portion 96 that supports one of the rollers, 80, of the inlet 72 and one of the rollers, 86, of the outlet 74, as well as two additional rollers 98, 100 that are rotatable about substantially horizontal axes. Short rods 102, one of which is shown in FIG. 6, project from side plates 104 and 106 of the removable portion 96 and are received in slots 107 (FIG. 7) in sidewall portions 108 and 110 of the lower section. The ends of the projecting rods may have washers 112 fixed thereto.

[0027] Openings 114 in the side plates of the removable portion provide hand grips to permit the removable portion to be turned from the position shown in FIG. 5 to the position shown in FIG. 6, whereupon the projecting rods 102 can be displaced from their slots 107 so that the removable portion can be removed from the lower section. The lower section will then appear as shown in FIG. 7. The removable portion 96 has a cover plate 116 that closes off the lower section above the outlet 74 when the removable portion is in the position shown in FIG. 5. In this position angle pieces 118 shown in FIG. 6 mate with plates 119 to form the corner blocks 84 adjacent to the plate 116.

[0028] As shown in FIGS. 5, 7, and 8, the lower section 12 has an inclined plane defined by a sloping wall 118 (or, alternatively, by a series of rollers), angulated at approximately 45° with respect to horizontal. The rollers 98 and 100 of the removable portion are opposed to the sloping wall 118 and define a tangent plane that is substantially parallel to the sloping wall.

[0029] As shown in FIGS. 5-9, a pair of rectangular cross section tubes 120 are attached to opposite sides of the lower section. Rectangular cross-section rods 122, one of which is shown in FIG. 8, can be inserted through the tubes so as to project from opposite ends thereof and can be fixed in position in the tubes by inserting pins (not shown) through aligned bores in juxtaposed walls of the rods and the tubes. The projecting ends can serve as handles for lifting and lowering the lower section.

[0030] Projecting ends of the rods 122 also serve to support a cooling manifold 124, the base of which has rectangular cross-section tubes 126 that receive respective rod ends and that are pinned in position. A threaded fitting 128 at the top of the manifold is provided so that a hose can be attached to the manifold to supply cooling water. A similar fitting 130 provided on the cover plate 116 of the removable portion as shown in FIGS. 5, 8 and 9, can be connected to a hose for additional cooling if desired. FIG. 10 is an inverted view of the manifold showing a plurality of holes 131 through which water is ejected. A baffle or baffles (not shown) can be provided in the manifold to distribute the supply of water evenly to all of the holes.

[0031] To assemble the upper section 10 with the lower section 12 as shown in FIGS. 8 and 9, the upper section is lowered onto the top of the lower section until bars 132, one of which is shown in FIG. 1, that extend between pairs of plates 50 rest on corner blocks 84 at the top of the lower section. The pins 52 (FIG. 8) are then inserted, as described earlier, to lock the upper section to the lower section. The lower section has projecting tubulations 134 for receiving jack screws 136, the purpose of which will be apparent in the following description.

[0032] A typical application of the invention to provide a folded plastic liner in a sewer pipe will now be described.

[0033] It is well known in the art to pull a folded thermoplastic liner through a sewer pipe or the like by a pulling cable that is attached to a leading end of the liner. The coupling between the cable and the liner may include a ball and a swivel. The flattened liner may be supplied from a reel on which the liner is wound, the reel being placed in a steam cabinet to soften the thermoplastic liner material prior to its being fed into the machine of the invention. The machine of the invention can be installed below ground in a manhole, supported on a ledge directly or with intermediate support members and can be braced in position by means of the jack screws 136. The top of the upper section 10 is positioned below the ground level opening to the manhole, and the outlet 74 of the lower section 12 is aligned with an entry opening of the sewer pipe.

[0034] To facilitate insertion of the cable pulling assembly and the leading end of the liner into the upper section, the removable portion **16** of the upper section can be removed, or simply turned out of the way. After the pulling assembly and the leading end of the liner have been drawn through the machine of the invention, the removable portion of the upper section is returned to its home position shown in **FIG. 1**. Installation of the machine of the invention in the manhole is simplified by the separability of the upper and lower sections, so that the lower section can be installed in the manhole first and then the upper section installed atop the lower section.

[0035] The liner fed downwardly into the upper section has a flattened elongated cross-section L that passes between the bulbous forming roller **22** and the backup roller **48** as shown in **FIG. 4**. The forming roller forms a broad indentation in one side of the liner cross-section. This indentation becomes much more acute as it passes the indenting assembly comprising the rotating disk **54** and the finger **56**, as shown in **FIG. 3**, so that the liner is folded about a longitudinal axis at a central region and defines a pair of outer loops L1 and L2 disposed at opposite sides of a central loop L3, with loop cross-sections arranged side-by-side in a substantially horizontal direction. As shown, the central loop L3 is open at one side of the liner and provides a longitudinal groove facing one side of the machine, into which the disk **54** and the finger **56** are inserted. The indenting assembly may, in certain applications, have a different construction from the rotating disk **54** and the finger **56**, comprising only the disk or the finger, for example. The forming roller **22** has been found to be particularly effective in initiating the folding of the liner and in smoothing out dimples or other imperfections in the heated liner.

[0036] The folded liner fed downwardly from the upper section **10** into the lower section **12** impinges on the sloping wall **118** of the lower section, which redirects the liner so that it is fed substantially horizontally from the outlet **74** of the lower section, with the outer loops L1 and L2 disposed above and below the central loop L3, with the loop cross-sections arranged side-by-side in a substantially vertical direction and with the longitudinal groove provided by the open loop L3 facing the same side of the machine as in the upper section, as shown in **FIG. 9**. As the folded liner leaves the lower section it is cooled by cooling water supplied to the cooling manifold **124** to reduce the flexibility of the liner in order that its folded configuration can be maintained as the liner is pulled through the sewer pipe to the desired extent.

[0037] When a liner is pulled, it may tend to shift or twist undesirably. The combination of the forming roller **22** and the backup roller **48** are effective to establish the desired initial orientation of the liner, and the various rollers employed in the lower section are effective in guiding the liner and preventing undesired shifting and twisting.

[0038] When the liner pulling is complete, it is necessary to remove the machine from the liner. The construction of the machine of the invention greatly facilitates such removal. The removable portion **16** of the upper section can be removed, and the indenting assembly removed, so that the upper section can then be lifted and shifted laterally of the liner to pass the liner between the edges **65** in **FIG. 3**, thereby to separate the upper section from the liner and permit the upper section to be extracted from the manhole. Then the removable portion **96** of the lower section can be removed, so that the top and one side of the lower section are open as shown in **FIG. 7**. The lower section can then be shifted and lifted to separate it from the liner and to extract it from the manhole.

[0039] A trailing portion of the liner above ground can then be cut so that the installation of the liner can be completed using conventional techniques to soften and expand the liner to the desired round cross-section.

[0040] While a preferred embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that modifications can be made without departing from the principles and spirit of the invention as defined in the appended claims. For example, the machine of the invention can be used above ground, rather than in a manhole, and can be used to provide folded tubing in applications other than sewer pipe lining. Furthermore, terms such as "substantially vertical" and "substantially horizontal" are relative terms used herein in describing preferred orientation of axes, for example, and the redirection of the liner from the upper section through the lower section, but it is to be understood that the liner feed need not be along strictly vertical or horizontal directions. For example, the liner fed from the lower section can be provided to a sloping pipe, which, within the context of the invention, is to be considered as "substantially horizontal".

The invention claimed is:

1. A machine for supplying folded tubing, comprising:

a first section, through which flexible tubing is fed downwardly and that shapes the tubing into a folded configuration having a groove that extends longitudinally and substantially vertically at one side of the tubing and that faces one side of the machine; and

a second section below the first section that receives the folded tubing from the first section and that redirects the folded tubing so that it is fed through the second section with the groove facing said one side of the machine and so that the folded tubing exits the second section substantially horizontally.

2. A machine according to claim 1, wherein the first section has a device that projects into the groove as the folded tubing is fed through the first section.

3. A machine according to claim 2, wherein the first section has an opening at one side thereof and said device is displaceably mounted on said first section adjacent to the opening.

4. A machine according to claim 1, wherein the first section has a portion that flattens the tubing before it is shaped into the folded configuration.

5. A machine according to claim 4, wherein the portion that flattens the tubing includes a bulbous roller that forms a broad indentation in said one side of the tubing.

6. A machine according to claim 5, wherein said bulbous roller is mounted on the first section displaceably to facilitate entry of the tubing into the first section and removal of the first section from the tubing.

7. A machine according to claim 1, wherein the second section has a portion that is mounted thereon displaceably to facilitate removal of the second section from the tubing.

8. A machine according to claim 1, wherein the second section has a group of rollers defining an inlet into the second section and a group of rollers defining an outlet from the second section.

9. A machine according to claim 8, wherein a portion of each group of rollers is displaceably mounted on the second section to facilitate removal of the second section from the tubing.

10. A machine according to claim 8, wherein the second section has an angulated path therein for the folded tubing, and wherein the path is defined in part by at least a roller located between the inlet and the outlet.

11. A method of providing folded tubing, comprising:

feeding flexible tubing in a first feed direction in a machine and then in a second feed direction in the machine transverse to the first feed direction;

shaping the tubing fed in the first feed direction in the machine into a folded configuration having a groove that extends longitudinally at one side of the tubing and that faces one side of the machine; and

maintaining the folded configuration of the tubing with the groove at said one side of the tubing facing said one side of the machine as the tubing is fed through the second section.

12. A method according to claim 11, wherein a portion of the first section of the machine is inserted into the groove.

13. A method according to claim 11, wherein the tubing is flattened before it is shaped into the folded configuration.

14. A method according to claim 11, wherein the folded tubing passes through an inlet and an outlet of the second section defined by rollers.

15. A method according to claim 11, wherein portions of the machine are displaced to provide openings by which the machine is removed from the tubing.

16. A method according to claim 11, wherein the tubing is heated before it is shaped in the first section and is cooled as it exits the second section.

17. A method according to claim 11, wherein the folded tubing moves in the second section along a path that extends at an angle to the first feed direction and the second feed direction.

18. A method according to claim 17, wherein the first feed direction is substantially vertical and the second feed direction is substantially horizontal.

19. A machine for supplying folded tubing, comprising a casing through which flexible tubing is fed downwardly and in which the tubing is folded so that a cross-sectional configuration of the tubing is changed from a flattened configuration broadly indented at one side to a folded configuration having an opening defining a groove extending longitudinally of the tubing at said one side.

20. A machine according to claim 19, wherein the casing has mounted thereon a bulbous roller that forms a broad indentation at said one side of the tubing before the tubing is folded.

21. A machine according to claim 20, wherein the casing supports a device that is inserted into the groove at said side of the tubing as the tubing is fed through the casing.

22. A machine according to claim 21, wherein the casing has an opening at one side thereof to which said side of the tubing faces, and wherein said device is mounted displaceably on the casing adjacent to the opening in the casing to facilitate removal of the casing from the tubing via the opening in the casing.

23. A machine according to claim 20, wherein the bulbous roller is part of a flattening assembly that includes a backing roller adjacent to the bulbous roller, and wherein the bulbous roller is mounted displaceably on the casing to facilitate insertion of the tubing into the casing and removal of the casing from the tubing.

24. In a machine for supplying a folded tubular liner to a pipe and in which a tubular liner is folded so as to provide a longitudinal groove at one side of the folded liner, a casing constructed for removable insertion in a manhole and having an inlet through which the folded liner is fed substantially vertically and an outlet through which the folded liner is fed substantially horizontally, the casing having a structure therein that guides the folded liner from the inlet to the outlet along a path that extends at an angle to the substantially vertical and substantially horizontal feed directions, and with the groove facing towards a same side of the casing as the liner is fed through the casing.

25. A machine according to claim 24, wherein the inlet and the outlet are defined by groups of rollers, and wherein a portion of the casing and portions of the groups of rollers are displaceable to provide an opening through which the casing can be removed from the liner.

26. A method of providing a folded liner to a pipe leading from a lower portion of a manhole, comprising:

providing a machine having an upper section for folding a flexible tubular liner and a lower section for redirecting the folded tubular liner;

installing the lower section in the manhole with an inlet of the lower section facing upwardly and an outlet of the lower section facing into the pipe;

installing the upper section on the lower section with an outlet of the upper section facing the inlet of the lower section;

feeding flexible tubing downwardly through the upper section and into the lower section while folding the tubing to provide a longitudinal groove at one side of the tubing facing one side of the machine; and

feeding the folded tubing through the lower section into the pipe while redirecting the tubing from a substantially vertical feed direction to a substantially horizontal feed direction and while maintaining the groove facing the same side of the machine.

27. A method according to claim 26, wherein after the folded liner is fed into the pipe, the upper section is removed from the liner via an opening in the upper section, the lower section is removed from the liner via an opening in the lower section, and both the upper section and the lower sections are removed from the manhole.

* * * * *