March 28, 1967 L. E. CARPENTER ETAL 3,311,523

APPARATUS FOR FORMING A CONTINUOUS REINFORCED FLEXIBLE HOSE

Filed March 25, 1964 4 Sheets-Sheet 1

Fig 1

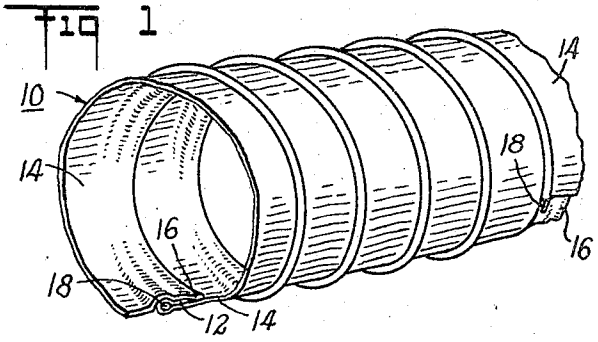


Fig 2

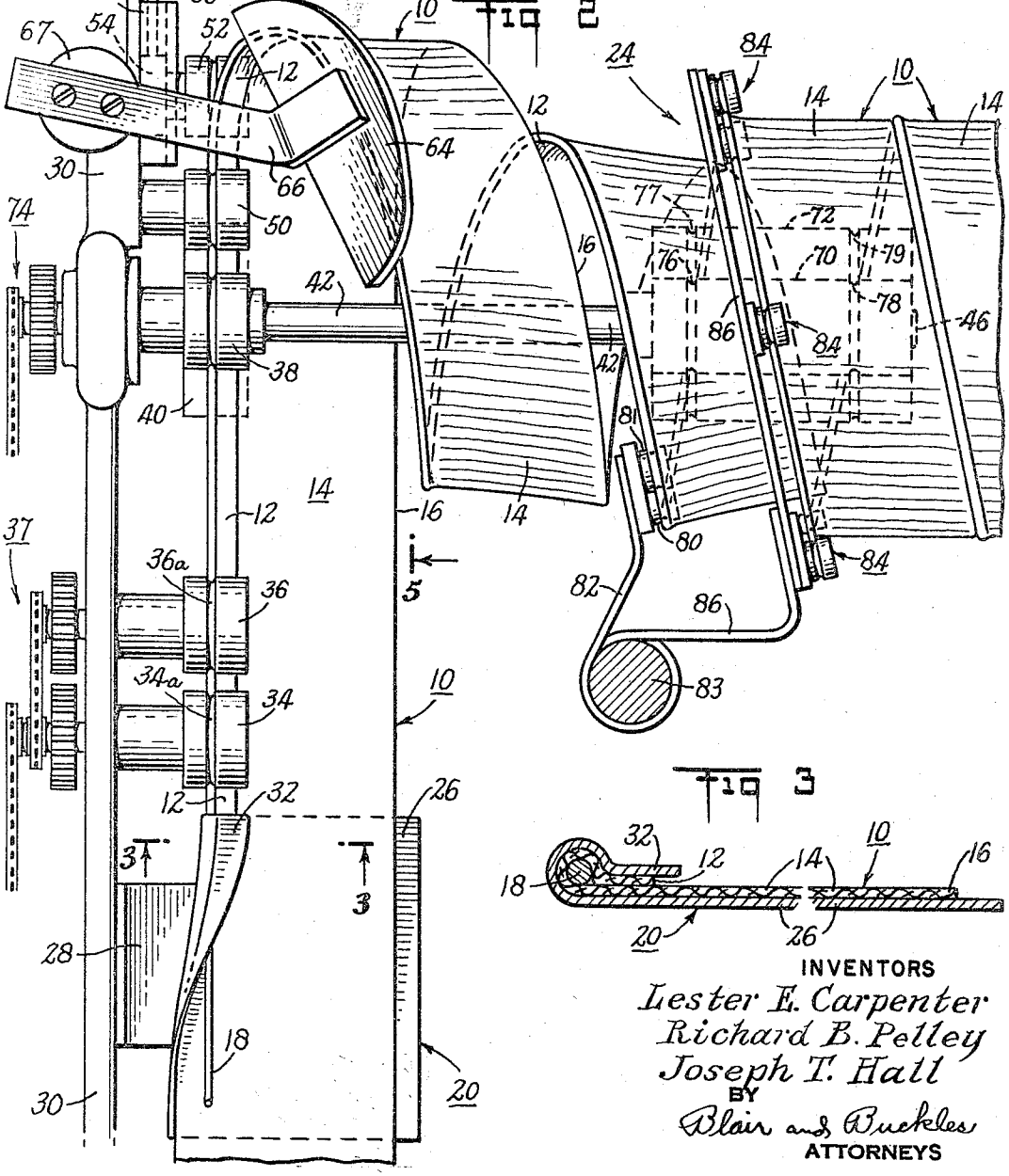


Fig 3

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Filed March 25, 1964 4 Sheets-Sheet 2

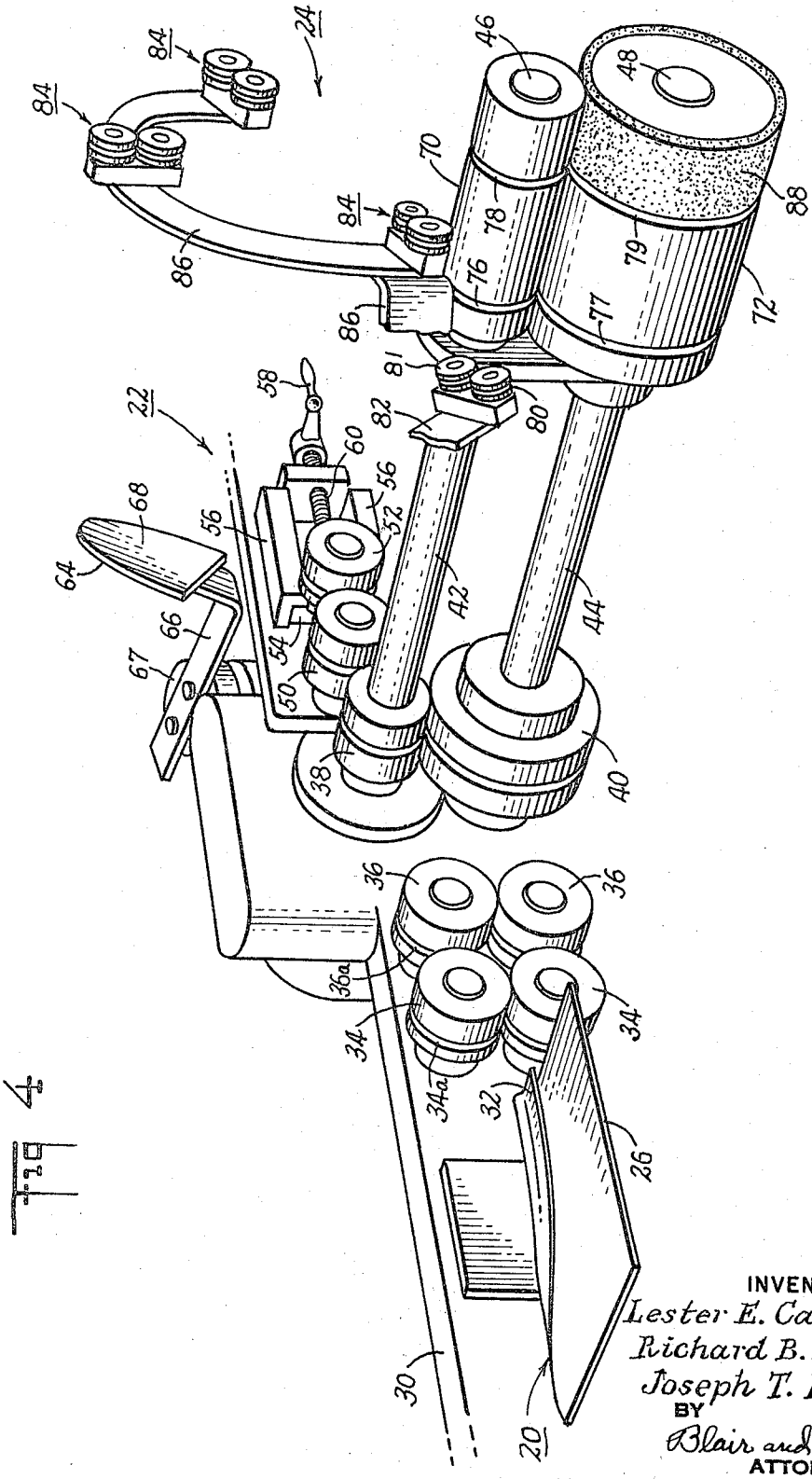


FIG. 4

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APPARATUS FOR FORMING A CONTINUOUS REINFORCED FLEXIBLE HOSE

Filed March 25, 1964 4 Sheets-Sheet 3

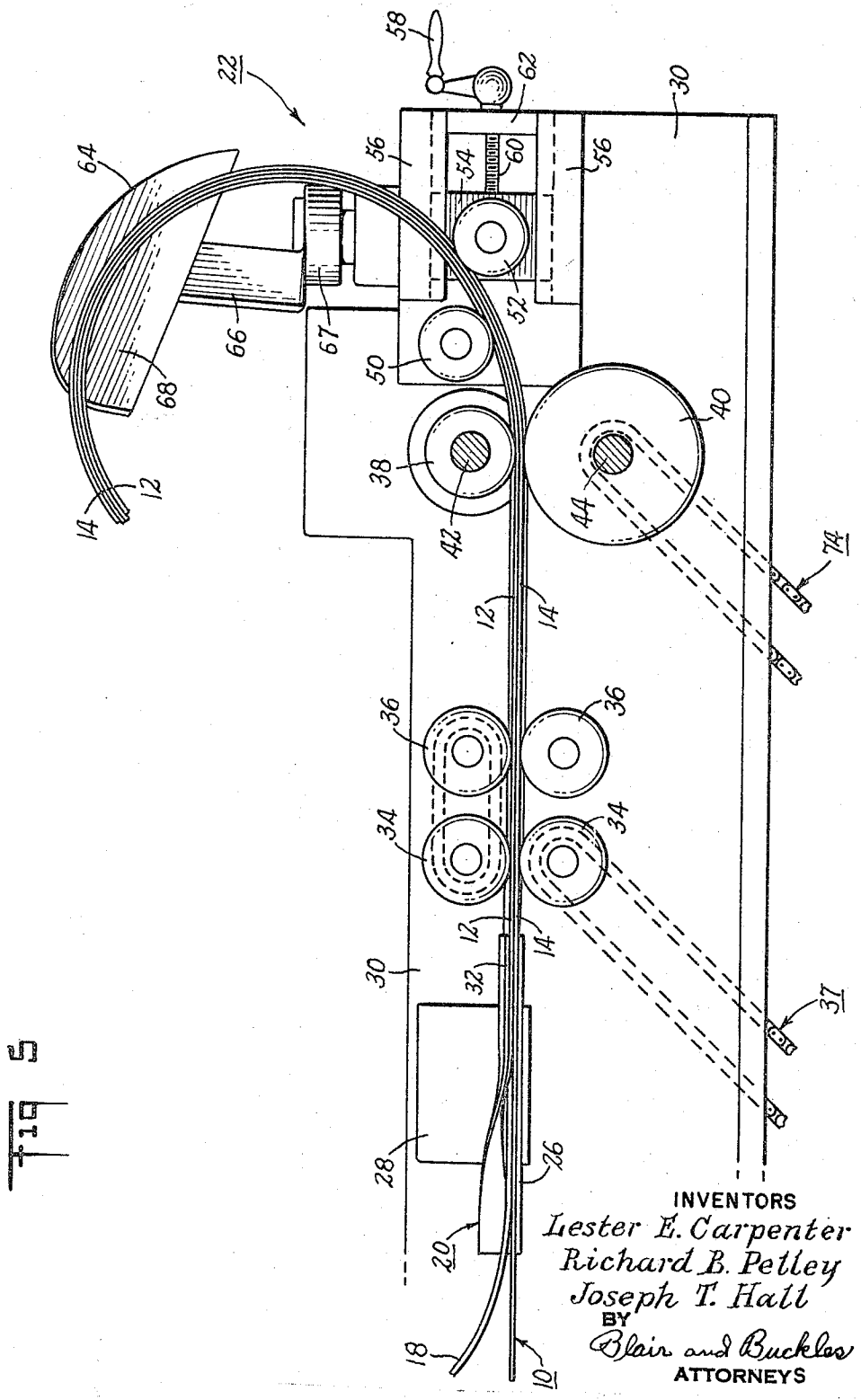


FIG 5

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APPARATUS FOR FORMING A CONTINUOUS REINFORCED FLEXIBLE HOSE

Filed March 25, 1964 4 Sheets-Sheet 4

Fig 6

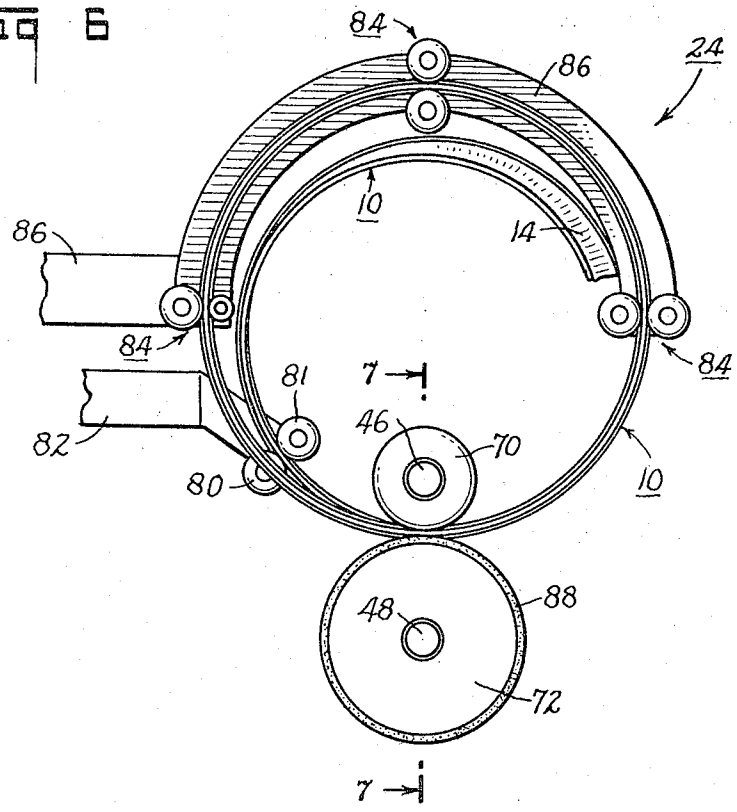
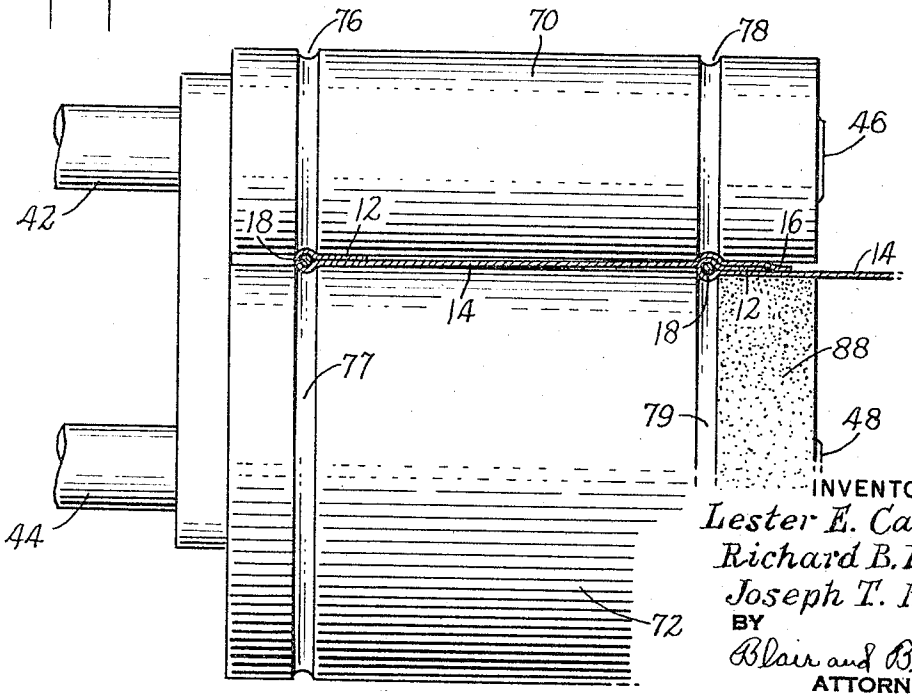


Fig 7



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3,311,523

APPARATUS FOR FORMING A CONTINUOUS REINFORCED FLEXIBLE HOSE

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Filed Mar. 25, 1964, Ser. No. 354,525
13 Claims. (Cl. 156—429)

This invention relates to a method and apparatus for making flexible hose and to flexible hose. More particularly, it relates to a flexible hose of the type formed as a series of overlapping helical loops of wire reinforced tape. The tape used in hose of this type typically has an adhesive coating along one longitudinal edge and a reinforcing spring wire is secured to the tape along its other longitudinal edge.

In the prior art method and apparatus for manufacturing hose of this type, the tape, with reinforcing wire adjacent one edge, is fed from a continuous supply to a pair of nip rolls. The nip rolls are both journalled at one end in a suitable frame member and extend in parallel relation from that frame member, their opposite ends being free. The wire reinforced tape, after passing between the nip rolls, is looped back on itself and its free end again fed between the nip rolls in overlapping relation to the adhesive edge of the tape just entering between the nip rolls. The nip rolls are continuously rotated to wind the tape, as well as the wire secured thereto, into a series of helical loops. The loops are adhesively sealed together at their overlapping edges by the pressure of the nip rolls as the tape passes therebetween. The hose thus continuously formed gradually feeds axially off the free ends of the nip rolls.

In the hose produced according to this prior art method and apparatus, the reinforcing wire in the hose has a tendency to contract axially, thereby contracting the hose; this may cause the hose to creep away from its desired location. Thus, for example, where the hose is employed to deliver fresh air to a user working in an oxygen scarce area, or where the hose is used to exhaust air therefrom, it may contract, pulling its free end away from the worker with resultant loss of fresh air. Such contraction of the hose also results in a wrinkling and twisting of the fabric, producing an unsightly appearance and tending to impede the free passage of gases through the hose.

Several attempts have been made to solve this problem of hose contraction. For example, a heavier fabric tape has been used to resist the tendency of the wire helix to contract. To some extent, this resisted contraction, but the resulting hose was stiff and could not be collapsed lengthwise easily; it therefore required excessive storage and shipping space. Such hose was also difficult to dispose and maintain in any curved configuration.

Hose has also been made by forming a length of spring wire into a helix of greater pitch than that desired in the final hose. Then the wire helix was elastically compressed to the desired pitch. Thereafter successive loops of tape fabric were stitched to the compressed wire helix so that the resulting hose was pre-stressed and was continuously biased toward its full length. This hose, however, was not adaptable to high speed manufacture and the resulting stitch holes in the tape weakened the hose and allowed gas leakage. Also, stitching produced a selvage edge which projected into the interior of the completed hose where it restricted gas flow through the hose.

Accordingly, it is an object of the present invention to provide an improved method and apparatus for the continuous manufacture of flexible hose of the wire reinforced type.

It is a more specific object of the present invention to provide a method and apparatus of the above character for the continuous manufacture of flexible wire reinforced hose of the pre-stressed type.

It is a further object to provide a wire reinforced hose of the above character having relatively smooth internal and external wall surfaces.

It is a still further object to provide a wire reinforced pre-stressed hose of the above character which is less subject to fatigue failure than known hoses of this type.

It is yet another object to provide a wire reinforced pre-stressed hose of the above character which is initially more fluid tight than known hoses of this type and which will retain its fluid tightness even over periods of sustained usage.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, the apparatus embodying features of construction, combinations and arrangements of parts which are adapted to effect such steps, and the article which possesses the characteristics, properties and relation of elements, all as exemplified in the detailed disclosure hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a fragmentary perspective view of a flexible wire reinforced hose produced according to the method of, and by the apparatus of, the present invention;

FIGURE 2 is a view of an apparatus for the continuous manufacture of the hose of FIGURE 1,

FIGURE 3 is an enlarged fragmentary sectional view taken on line 3—3 of FIGURE 2,

FIGURE 4 is a perspective view of the apparatus shown in FIGURE 2,

FIGURE 5 is a side elevational view looking from the right of FIGURE 2 and taken on line 5—5 of that figure,

FIGURE 6 is a side elevational view looking from the right of FIGURE 2, and

FIGURE 7 is a fragmentary sectional view looking from the left of FIGURE 6 and taken on line 7—7 of that figure.

The hose of the invention, as seen most clearly in FIGURE 1, comprises a strip 10 of flexible tape fabric having a side edge portion 12 folded over onto and secured to the main body portion 14 of the fabric. The fabric strip is wound helically to form a continuous tube with the folded edge portion 12 lying at the inner surface of the tube and overlapping, for each convolution, the unfolded side edge portion 16 of the adjacent convolution. The unfolded side edge portion 16 of each convolution, in addition to being secured to and overlapped by the folded edge portion of the adjacent convolution, passes beyond the folded edge portion for securement to the main body portion 14 of the fabric. The hose further comprises a helically wound spring wire 18 lodged in the fold of the fabric to reinforce the finished hose.

In the production of the above described hose by the method and apparatus of the present invention, the tape fabric 10 and spring wire 18 are fed continuously and simultaneously to a folder generally indicated at 20 where the side edge portion 12 of the advancing tape is folded over the wire 18 to form a tape having a wire reinforcement along one side edge. The wire reinforced tape is thereafter fed continuously by suitable means to a forming zone generally indicated at 22 where the tape and wire are bent upwardly and then twisted, thereafter advancing

through a helical path to a bonding zone indicated generally at 24. Here the tape and wire helix is elastically compressed axially and the overlapped edges of the compressed tape sealed together to form a pre-stressed hose.

As will be seen in FIGURES 2 and 4, the folder 20 comprises a folder plate 26 secured as by a bracket 28 to the main frame member 30 of the apparatus. The tape 10 is fed continuously to the plate 26 from a roll supply (not shown) and is provided with adhesive coatings on the upper face of its side edge portion 12 and on the lower face of its side edge portion 16. The wire 18 is fed continuously to the folder plate 26 from a spool supply (not shown) along a path lying immediately above the path of the advancing tape and parallel to, but spaced from, the side edge of the advancing tape. As the tape and wire are advanced together over and along the folder plate 26, the side edge portion 12 of the tape is engaged and gradually folded over the wire by an upturned end 32 of the folder plate. The tape with the wire lodged in the fold of the side edge portion 12 is thereafter advanced between two sets of grooved coacting nip rollers 34 and 36 which are journalled in frame member 30 and driven in tandem by a suitable chain and gear system indicated generally at 37. Roller sets 34 and 36 firmly bond the adhesive side edge portion 12 to the main body portion 14 of the tape fabric and act to pull the tape and wire through the folder from their respective supply sources. The grooves 34*a* and 36*a* in the roller sets 34 and 36 are aligned with the path of travel of the wire 18 so that as the tape fabric passes between the rollers of each set the folded edge of the tape fabric holding the wire is received in the grooves.

From the roller sets 34 and 36 the wire reinforced tape is pushed to and between a relatively small diameter grooved upper idler roller 38 (FIGURE 4) coacting with a relatively large diameter grooved lower idler roller 40. Rollers 38 and 40 are journalled respectively on a pair of elongated shafts 42 and 44 which in turn are journalled in the frame member 30. Shafts 42 and 44 extend in parallel relation laterally away from frame member 30 and have free ends 46 and 48 as seen in FIGURE 4. Located beyond the idler rollers 38 and 40 in the direction of movement of the tape is a grooved idler roller 50 journalled in frame member 30 forwardly of idler rollers 38 and 40. As best seen in FIGURE 5, the periphery of roller 50 is above the bite of the idler rollers 38 and 40. Another grooved idler roller 52 is journalled in the frame member 30 forwardly of and below idler roller 50 with the upper portion of its periphery slightly above the lower portion of the periphery of roller 50. Thus the tape and wire bend upwardly between the idler rollers 50 and 52, and this bending action imparts a permanent arc-like shape to the wire, as can best be seen in FIGURE 5.

To provide an adjustment of the radius of this bend, and hence the ultimate diameter of the resulting hose, the idler roller 52 is mounted on an adjustable carriage plate 54. Plate 54 is slidably mounted between upper and lower tracks 56 and is connected to a screw 60 threaded in a nut 62 on the frame member 30. Thus, the relative position of rollers 50 and 52 may be determined by turning handle 58 secured to screw 60.

Referring now to FIGURES 2, 4 and 5, the advancing tape now curls upwardly from the rollers 50 and 52, to engage a deflector plate 64 mounted on the frame member 30 by a bracket 66. Deflector plate 64 is arranged to present a flat deflecting surface 68 (FIGURE 4) lying obliquely above and laterally outwardly of the idler rollers 50 and 52. The configuration and positioning of the surface of the plate 64 are such as to continuously twist the tape and wire leaving the rollers 50 and 52. The plate 64 thus forces and bends the tape and wire into a helical path winding successively around the upper elongated shaft 42 (FIGURE 2) which eventually feeds each convolution between upper and lower forming rollers 70 and 72 (FIGURE 4), as will be presently described. The

bending action imparted to the advancing wire and tape by the rollers 50 and 52 and the twisting action imparted thereto by the plate 64 are such as to plastically deform the wire. In this manner rollers 50 and 52 and plate 64 coact to impart a permanent diameter and pitch to the wire.

Bracket 66 is mounted on a suitable adjustable support 67 for universal movement with respect to frame member 30, whereby the angle of the deflecting surface 68 to the arcuate path taken by the tape and wire in curling upwardly may be selectively varied.

The relatively small diameter upper forming roller 70 is fixedly secured to the free end 46 of shaft 42 and the coacting relatively large diameter lower forming roller 72 is fixedly secured to the free end 48 of shaft 44. Shafts 42 and 44 and rollers 70 and 72 are rotated in opposite directions by a suitable chain and gear system generally indicated at 74 in FIGURE 2. Rollers 70 and 72 are provided with coacting grooves 76, 77, 78 and 79 axially spaced therealong by a distance which is less than the pitch imparted to the advancing tape by the deflector plate 64 and associated mechanism; this distance is also less than the width of the advancing tape.

Coacting grooved rolls 80 and 81 are arranged to receive therebetween the wire reinforced edge of the tape advancing helically from the deflector plate 64. The rolls 80 and 81 are mounted on the free end of a bracket 82. The bracket 82 is mounted at its other end on a post 83 about which it is adjustable to vary the position of the rolls in relation to the position of plate 64. The rolls 80 and 81 are positioned to guide the advancing tape between the nip rollers 70 and 72 with the folded wire reinforced edge received in the coacting grooves 76 and 77.

As the tape emerges from the coacting grooves 76 and 77, it is engaged successively by a plurality of grooved roll pairs 84 arranged serially around an arcuate shaped mounting bracket 86 as best seen in FIGURES 1 and 4. Bracket 86 is adjustably mounted on post 83. The serially arranged roll pairs 84 engage the folded wire reinforced edge of the advancing tape and guide the tape back between the forming rolls 70 and 72 with the folded edge now received in the coacting grooves 78, 79. Since the axial distance between grooves 76, 77 and grooves 78, 79 is less than the tape width, as the folded edge of the tape enters grooves 78, 79, it overlaps and is pressed against the adhesive unfolded side edge portion 16 of the convolution just entering the grooves 76, 77 as is shown in FIGURE 7. The successive convolutions of the advancing tape are thus adhesively bonded together at the grooves 78, 79 to form a continuous hose. A rubber sleeve 88 on the free end of the roll 72 increases the bonding pressure exerted by rolls 70 and 72; by resiliently deforming in the bonding zone, this sleeve increases the area over which the bonding action is effected. The hose thus formed feeds continually off the free end 46 of the forming roll 70 for delivery to suitable apparatus (not shown) for further handling.

Since the spacing between the grooves 76, 77 and the grooves 78, 79 is less than the pitch imparted by the deflector plate 64 to the advancing tape, by forcing each convolution of the advancing tape to enter first between the grooves 76, 77 and then between the grooves 78, 79 the permanently formed wire helix lodged in the fold of the advancing tape is compressed in the direction of its length. Since this compression of the wire helix is in the nature of a gradual constraint exerted incrementally by the successive roll pairs 84, the wire helix is elastically rather than plastically compressed. With the wire helix in this elastically compressed condition, the successive convolutions of the tape are then bonded together so that in the finished hose the wire helix continuously resiliently biases the hose to its full length. Thus the finished hose, while it may be readily compressed for storage and shipping purposes, normally extends itself to its full length and exhibits no tendency to contract or shorten in use.

It should be noted in the apparatus herein provided that whereas the tape and wire are pulled from their respective sources through the folder 20, they are pushed through the forming zone 22 by the nip rollers 34, 36. That is, the tape and wire are being pushed at the time they undergo the above-described bending and twisting operations. This is important because it is essential that a positive control be maintained on the stresses of the tape and wire during such bending and twisting. If the tape and wire were pulled through the forming zone, the opposing forces acting on them would tend to change due, for example, to variations in the amount of wire remaining on the supply spool or variations in the consistency of the adhesive occurring as a result of variations of ambient humidity or temperature. With the present arrangement of pushing the tape and wire through the forming zone, such variations produce no appreciable change in the forces acting on the tape and fabric. It will of course be understood that suitable means (not shown) are provided to synchronize the operation of the nip roller drive means 37 and the forming roller drive means 74 so that the tape and wire will be taken up and discharged by the forming rollers 70, 72 at precisely the rate at which it is being pushed through the forming zone by the nip rollers 34, 36.

It will thus be seen that the objects of the invention, as previously set forth, have been fully met by the method, apparatus and product hereinabove disclosed. That is, we have provided an improved method and apparatus for the continuous manufacture of flexible hose of the wire reinforced type and, more specifically, we have provided a method and apparatus whereby flexible reinforced hose of the pre-stressed type may be continuously manufactured at production line speeds. Further, we have provided a wire reinforced hose of the pre-stressed type which is fluid tight and extremely durable, having a continuous firmly bonded adhesive seam rather than a series of spaced and fabric weakening stitches. It will further be seen that we have provided a hose of the wire reinforced type in which both the internal and external walls are relatively smooth so as to afford relatively little resistance to the passage of gases through the hose or over the external surface of the hose.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above method, in the described product, and in the construction set forth without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

We claim:

1. An apparatus for forming a continuous pre-stressed flexible hose from a continuous flexible strip having a continuous reinforcing spring wire secured thereto substantially adjacent one edge thereof comprising

(A) means for continuously plastically deforming the wire reinforced strip into a first helical path,

(B) first and second forming rollers, at least one of said rollers having first and second annular grooves therein,

(C) said forming rollers being mounted for rotation about parallel axes, the flexible strip being passed from said first helical path between said rollers with its wire reinforced edge received in said first groove and being thereafter looped around one of said rollers with its wire reinforced edge received in said second groove in a selected mount of overlapping with the other edge of said strip,

(D) and means for continuously counter rotating said rollers,

(E) said first and second grooves being spaced apart axially by a distance different from the pitch of said first helical path so that said strip is elastically constrained to achieve said selected amount of overlapping.

2. An apparatus for forming a continuous pre-stressed flexible hose from a continuous flexible strip having an adhesive longitudinal edge, and a continuous reinforcing spring wire secured thereto substantially adjacent its other longitudinal edge, comprising

(A) means for continuously plastically deforming the wire reinforced strip into a first helical path,

(B) first and second forming rollers, at least one of said rollers having first and second annular grooves therein,

(C) said forming rollers being mounted for rotation about parallel axes, the flexible strip being passed from said first helical path between said rollers with its wire reinforced edge received in said first groove and being thereafter looped around one of said rollers for repassage between said rollers with its wire reinforced edge received in said second groove in a selected amount of overlapping with the adhesive edge of said strip,

(D) and means for continuously counter rotating said rollers,

(E) said first and second grooves being spaced apart axially by a distance different from the pitch of said first helical path so that said strip is elastically constrained to achieve said selected amount of overlapping said axial distance,

(F) said axial distance being less than the width of said strip so that the strip loop received at its reinforced edge in said first groove laps the strip loop received at its reinforced edge in said second groove and said rollers coact to press the lapped adhesive edge of one of said loops against the reinforced edge of the other of said loops, whereby to form a continuous pre-stressed hose.

3. An apparatus according to claim 2, said axial distance being less than the pitch of said first helical path so that said wire is elastically compressed in, and longitudinally tensions, the completed hose.

4. An apparatus according to claim 1 wherein both said first and second forming rollers have said first and second annular grooves therein,

(A) said rollers being mounted with the first and second grooves in one roller aligned with the respective grooves in the other roller.

5. An apparatus for forming a continuous hose from a continuous strip of flexible wire reinforced material comprising

(A) means for feeding said strip material continuously along a substantially straight line path,

(B) means mounted transversely of the plane of said path and engaging said strip material as the latter moves along said path to bend it out of said plane for movement in an arcuate path,

(C) and a deflector member extending across the plane of said arcuate path at an obtuse angle thereto to engage said strip material as the latter moves along said arcuate path and twist it out of said arcuate path plane for movement in a helical path.

6. An apparatus for forming a continuous hose from a continuous strip of flexible wire reinforced material comprising

(A) means defining a substantially straight line feeding path for said strip material,

(B) coating rollers disposed on either side of said path so that said strip material is passed therebetween in its movement along said path,

(C) a first bending roller disposed ahead of said coacting rollers and having a peripheral surface tracing

an orbit intersecting the plane of said path, thereby to engage the strip material as the latter moves along said path to bend it out of said plane for movement in an arcuate path,

(D) and a deflector member presenting a deflection surface extending across the plane of said arcuate path at an obtuse angle thereto to engage said strip material as the latter moves along said arcuate path and twist it out of said arcuate path plane for movement in a helical path.

7. An apparatus according to claim 6 and further including a second bending roller disposed ahead of said coacting rollers and behind said first bending roller and having a peripheral surface tracing an orbit lying completely to one side of and spaced from said straight line path plane, said strip material after passing between said coacting rollers being threaded between said first and second bending rollers which bend the strip material and move it into said arcuate path.

8. An apparatus for forming a pre-stressed flexible hose from a flexible strip having a continuous reinforcing spring wire secured thereto substantially adjacent one edge thereof, comprising

(A) means defining a substantially straight line feeding path for said strip material,

(B) first and second elongated shafts journalled at their one ends and extending in parallel relation transverse to and on either side of said path,

(C) first and second coacting rollers on said first and second shafts, respectively, said strip material passing between said rollers in its movement along said path,

(D) means engaging said strip material at a location beyond said rollers and operative to continuously plastically deform said strip material into a first helical path winding successively around one of said shafts toward the free end of the latter,

(E) first and second forming rollers secured to said first and second shafts adjacent their respective free ends, at least one of said forming rollers having first and second annular grooves therein, the strip material being passed from said first helical path between said forming rollers with its wire reinforced edge received in said first groove and being thereafter looped around the forming roller on said one shaft for repassage between said forming rollers with its wire reinforced edge received in said second groove in a selected amount of overlapping with the other edge of said strip,

(F) and means for continuously counter rotating said shafts and thereby said forming rollers,

(G) said first and second grooves being spaced apart axially by a distance different from the pitch of said first helical path so that said strip material is elastically constrained to achieve said selected amount of overlapping.

9. An apparatus for forming a pre-stressed flexible hose from a flexible strip having an adhesive longitudinal edge, and a continuous reinforcing spring wire secured thereto substantially adjacent the other longitudinal edge thereof, comprising

(A) means defining a substantially straight line feeding path for said strip material,

(B) first and second elongated shafts journalled at their one ends and extending in parallel relation transverse to and on either side of said path,

(C) first and second coacting rollers on said first and second shafts, respectively, said strip material passing between said rollers in its movement along said path,

(D) means engaging said strip material at a location beyond said rollers and operative to continuously plastically deform said strip material into a first helical path winding successively around one of said shafts toward the free end of the latter,

(E) first and second forming rollers secured to said first and second shafts adjacent their respective free ends, at least one of said forming rollers having first and second annular grooves therein, the strip material being passed from said first helical path between said forming rollers with its wire reinforced edge received in said first groove and being thereafter looped around the forming roller on said one shaft for repassage between said forming rollers with its wire reinforced edge received in said second groove in a selected amount of overlapping with the adhesive edge of said strip,

(F) and means for continuously counter rotating said shafts and thereby said forming rollers,

(G) said first and second grooves being spaced apart axially by a distance different from the pitch of said first helical path so that said strip material is elastically constrained to achieve said selected amount of overlapping.

10. An apparatus according to claim 8, said engaging means comprising

(A) a bending roller disposed ahead of said coacting rollers and having a peripheral surface tracing an orbit intersecting the plane of said straight line path, whereby to engage the strip material as the latter moves along said straight line path to bend it out of said plane for movement in an arcuate path, and

(B) a deflector member presenting a deflection surface extending across the plane of said arcuate path at an obtuse angle thereto to engage said strip material as the latter moves along said arcuate path and twist it out of said arcuate path plane and into said first helical path.

11. An apparatus as defined in claim 1 wherein said first and second grooves are spaced apart axially by a distance less than the pitch of said first helical path.

12. An apparatus as defined in claim 8 wherein said first and second grooves are spaced apart axially by a distance less than the pitch of said first helical path.

13. An apparatus as defined in claim 9 wherein said first and second grooves are spaced apart axially by a distance less than the pitch of said first helical path.

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