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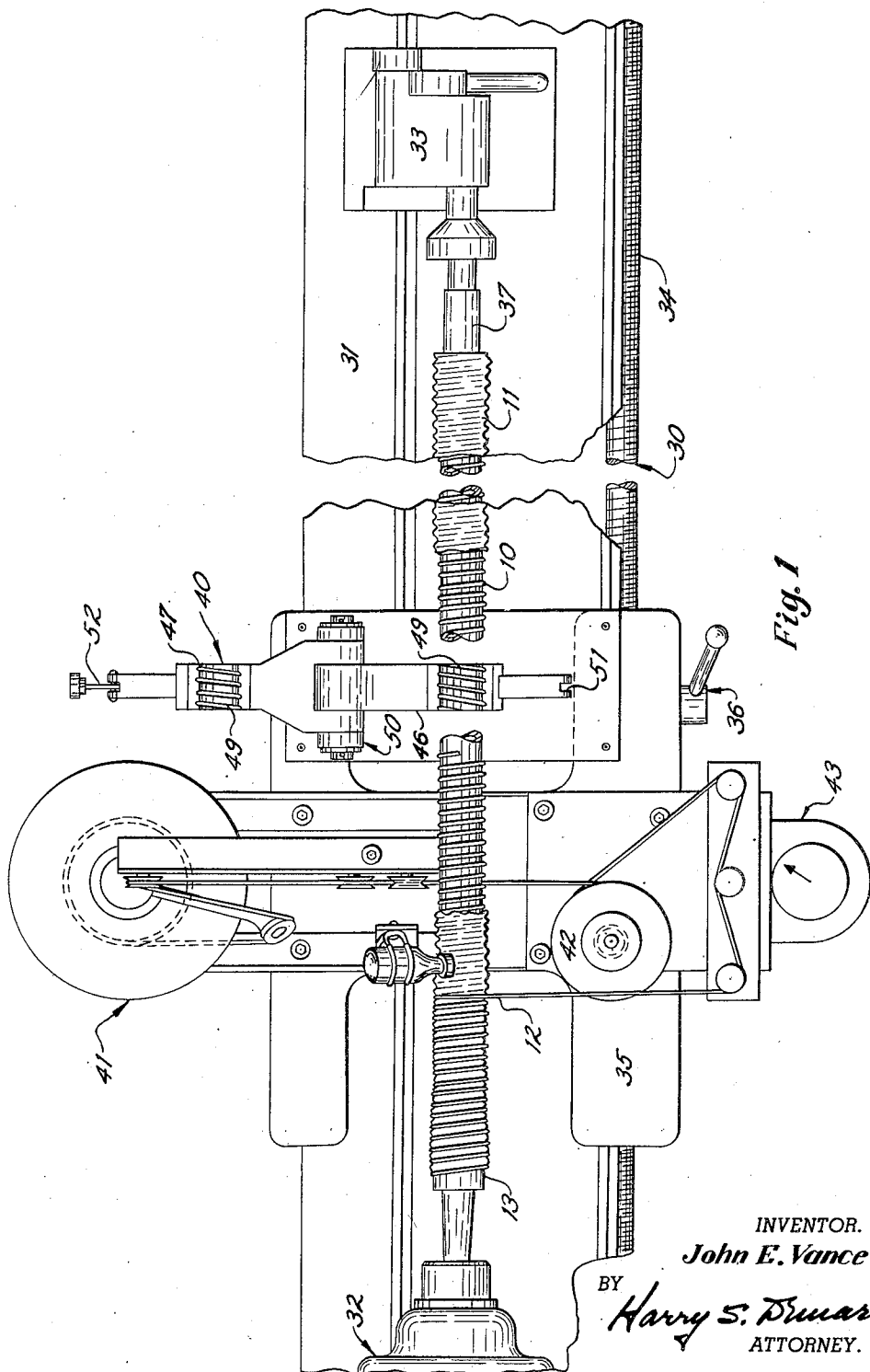
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2,550,099

FLEXIBLE HOSE FOR SUCTION CLEANERS

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

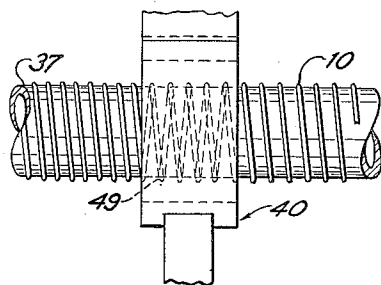


Fig. 2

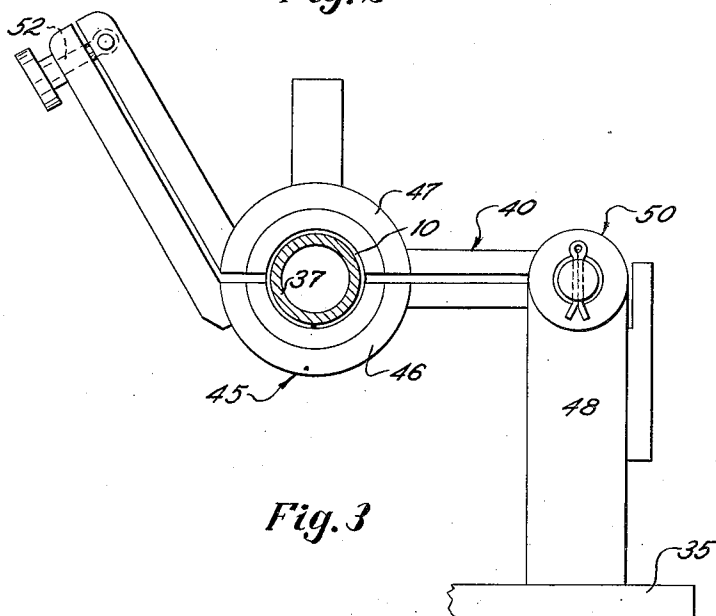


Fig. 3

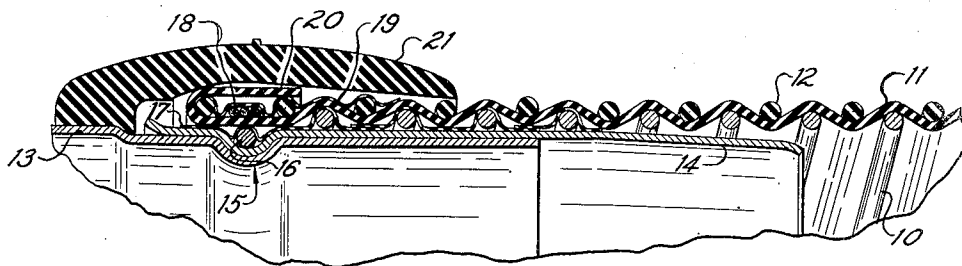


Fig. 4

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2,550,099

FLEXIBLE HOSE FOR SUCTION CLEANERS

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6 Claims. (Cl. 138—56)

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This invention relates to flexible hose for suction cleaners and to the method of making the same.

A suction cleaner hose must be as flexible as possible for ease in manipulating the cleaning tools, it must be rigid against compressive stresses so as to resist collapse when accidentally trod upon or placed beneath articles of furniture, and the impervious wall must be supported against collapse due to the suction applied on its interior.

According to the present invention the impervious tube comprises an elastomeric thermoplastic such as polyvinyl chloride or copolymer of vinyl of about 0.026 inch in thickness and about 1 3/8 inches inside diameter. A spirally wound reinforcing wire of spring steel is positioned interiorly of the tube and a vinyl chloride cord is wrapped spirally over the tube between the convolutions of the wire under sufficient tension to draw the material of the tube inwardly between the wire convolutions so as to render the completed hose more flexible.

According to the method of this invention the steel spring is spirally wound in suitable lengths with a pitch of substantially 1/4 inch. The spring is preferably originally wound on a mandrel of somewhat smaller diameter than the diameter of the desired coil. (In making suction cleaner hose it has been found that a final inside diameter of approximately 1 3/8 inches is suitable.) When the coil is released it will expand to the proper diameter under its own resiliency.

The spiral spring thus formed is placed on a mandrel having a diameter a few thousandths of an inch smaller than the free inside diameter of the coil and one end taped to the mandrel, or to a fitting sleeve anchored to the mandrel, preferably by a pressure sensitive tape. The pitch of the coil in its free state is slightly less than it is in the finished hose as is the number of its convolutions.

A spacing tool is then applied to the taped end of the coil and the mandrel rotated reversely to expand the pitch of the coils axially and to space them equidistant and to tightly grip the mandrel while at the same time the tool applies a contracting effect spirally upon the coils as they are spaced to wind the coils closely about the mandrel with the result that there is a greater number of loops formed than that which was present in the coil in its free state. The combined effect of spacing the coils a greater distance apart and the forming of additional loops cause the coils to tightly grip the mandrel so that each loop is substantially immovable axially

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of the mandrel. After the spacing operation the other end of the coil is suitably attached to the mandrel or to a coupling fitting tube positioned on the mandrel.

An electromeric thermoplastic tube is then applied over the mandrel and spring, in any suitable manner, such as by expanding it by air pressure and sliding it axially over the mandrel and the spiral spring positioned thereon.

A few turns of the vinyl cord are then wrapped by hand over the vinyl tube at one end midway of the convolutions of the wire and taped to the tube preferably by a pressure sensitive tape. The mandrel, wire, and tube are then rotated while a tensioning device holding the cord is advanced axially to wind the cord about the tube midway of the wire convolutions. When the cord applying operation is completed the free end of the cord is severed and taped to the tube at the other end by means of a pressure sensitive tape.

Preferably, a suitable solvent is simultaneously applied to the tube a few turns ahead of the cord during the winding operation to cement the cord to the tube midway of the wire convolutions so that the cord cannot be moved from between one wire convolution to an adjacent one or vice versa.

The vinyl cord is stretched slightly by the tensioning device so that when the tube is removed from the mandrel the coils of the vinyl cord will contract to press the walls of the tube inwardly between the wire convolutions to form a corrugated effect and render the tube more flexible. At the same time the convolutions of the wire will tend to return to their original pitch and number so that the coils will expand outwardly by an amount permitted by the elasticity of the vinyl tube and cord.

The tube preferably extends beyond the ends of the wire and vinyl cord and is turned backwardly over the tube and vinyl cord so as to permit an attaching fitting to be applied.

Other objects and advantages of this invention will become apparent as the description proceeds when taken in connection with the accompanying drawings in which:

Figure 1 shows a schematic view of the machine for spacing the wire coils on the mandrel and for winding the vinyl cord about the tube;

Figure 2 is a detailed view showing the operation of the spacing nut;

Figure 3 is a plan view of the spacing device showing how it is mounted on the machine; and

Figure 4 is a longitudinal cross-sectional view

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through the tube of this invention showing one form of an attachment coupling applied thereto.

Referring to Fig. 4 the hose of this invention comprises an inner spirally wound spring wire 10 stressed axially and spirally from its normal unstressed state, an elastomeric thermoplastic vinyl tube 11 positioned thereover and forced between the convolutions of the wire 10 by a spirally wound elastomeric thermoplastic vinyl cord 12.

The end connection for the hose may take any suitable form but as shown in Fig. 4 comprises an inner swivel tube 13, an outer swivel tube 14 having a swivel connection with the inner tube 13 generally indicated by the reference numeral 15 in the form of inwardly pressed annular grooves in the tubes. The end 16 of the wire 10 rests in the groove of the outer swivel tube 14. The few end turns of the wire 10 are secured to the tube 14 by a pressure sensitive tape 17 spirally wound over the wire. Near its end the tube 11 is anchored to the tube 14 over the end 16 of wire 10 by waxed threads 18. The threads 18 and the end coils of the cord 12 are secured to the tube 11 by a pressure sensitive tape 19. The end 20 of the tube 11 is then turned backwardly over the threads 18, tape 19, and the first few coils of cord 12 and a phenolic or other plastic sleeve 21 attached to the inner swivel sleeve 13 so as to surround the end 20 of the tube 11 as shown in Fig. 4. It is within the scope of this invention that other types of end couplings be used, the one of Fig. 4 being shown as an example.

The hose of Fig. 4 is formed by any suitable apparatus such as the machine of Fig. 1 generally indicated by the reference numeral 30, similar to a turning lathe. The machine comprises a bed plate 31, a head stock 32, a tail stock 33, a lead screw 34, and a traveling carriage 35 connectible to the lead screw 34 by a manually actuable clutch 36 in a manner similar to an ordinary turning lathe. The driving mechanism for the head stock 32 and for the lead screw 34 are geared to both in a manner similar to an ordinary turning lathe. A mandrel 37 is rotated by the head stock 32 and is rotatably mounted by the tail stock 33.

The carriage 35 carries a coil spacing device generally indicated by the reference numeral 40, a reel holder 41 for carrying a reel of vinyl cord, a tensioning pulley 42, and a cord tension measuring device 43. Carriage 35 is also provided with suitable guide pulleys to guide the cord from the reel 41 to the tensioning pulley 42, from the tensioning pulley 42 to the tension measuring device 43 and from the tension measuring device to the mandrel 37. The tension measuring device 43 includes a clocklike dial and hand which register the tension on the cord to constantly inform the operator of the tension applied. It has been found in the example given that a tension of 56 to 64 ounces is satisfactory for the conditions specified.

The spring spacing device 40 includes a sort of nut 45 split axially to form two halves 46 and 47, the lower half 46 being secured to the traveling carriage 35 by means of a supporting lug 48.

The two halves of the nut 45 are provided with spiral grooves 49 in the nature of screw threads but circular in cross-section to fit snugly over the wire 10. The pitch of the grooves 49 is somewhat greater than that of the convolutions of the wire 10 in its free state for a purpose which will presently appear.

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The two halves 46 and 47 of nut 45 are pivoted together and to the support 48 at 50, the lower half 46 being slotted at 51 on the side opposite the pivot 50 to receive a clamping bolt 52 pivoted to the upper half 47 as shown in Fig. 3.

The carriage 35 may also carry a solvent applying dispenser in the form of a container as shown in Fig. 1 having a valved tube leading to a point immediately above the mandrel at a point a few turns ahead of where the cord is wrapped about the mandrel. The solvent used may be a 50-50 by volume mixture of toluene and methyl ethyl ketone.

Method of forming hose

A steel spring wire of suitable diameter is spirally wound into a coil of substantially the same internal diameter as the diameter of mandrel 37 and with a pitch slightly less than that of the wire 10 in the finished hose. The wire is preferably wound on a mandrel slightly smaller than the mandrel 37 so that when it is released the coils will expand to the proper diameter and pitch.

It has been found in practice that a wire having a diameter of 0.058 inch and a tensile strength of 275,000 pounds per square inch is suitable. The free diameter of the coil should be close to $1\frac{3}{8}$ inches and have a pitch of approximately $\frac{1}{4}$ inch.

Coupling sleeves similar to the sleeves 13 and 14 are positioned on the mandrel at the head stock end thereof. The wire coil is placed on the mandrel 37, which in practice is approximately $1\frac{3}{8}$ inches in diameter, the sleeves 13 and 14 slid onto the tail stock end of the mandrel beneath the wire coils with the end coil 16 positioned in the peripheral groove 15, it being noted, Fig. 4, that the inside diameter of the inner end of tube 14 is substantially the same as the inside diameter of tube 13 whereby they can be positioned on the mandrel. The wire 10 is taped to the sleeve 14 by the pressure sensitive tape 17 at the tail stock end thereof and the sleeves 13 and 14 anchored against rotation relative to the mandrel.

The turns of the wire on the sleeve and the first few turns on the mandrel are suitably spaced by hand or otherwise and the spacing nut 45 arranged over the turns with the wire lying in the spiral grooves 49. It has been found in practice that the pitch of the spiral grooves in the nut 45 should be about 0.286 inch when the normal free pitch of the wire coils is $\frac{1}{4}$ inch.

The diameter of the spacing nut and the depth of the grooves 49 is such that the nut will grip the wire coils quite firmly when the bolt 52 is clamped.

After the nut 45 is applied to the first few coils of wire positioned on the mandrel at the tail stock end, the clutch 36 is manually operated to engage the carriage 35 with the lead screw 34 and the head stock 32 rotated forward or counterclockwise as viewed from the tail stock end.

Such rotation of the arbor will cause the coils to be spaced uniformly thereon and the gripping action of the nut will also deform or stress the coils circumferentially so that under the conditions given above there will be approximately one percent more coils formed on the mandrel than there are in the coiled wire in its unstressed state. The foregoing action will cause the coils to grip the mandrel tightly so that they will not move during the subsequent application of the elastomeric thermoplastic vinyl tube. When the

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spacing nut reaches the left hand end of the mandrel, to the sleeve positioned thereon, the few end turns of the coiled wire are tightly taped to a sleeve 14 by pressure sensitive tape and the sleeve clamped to the mandrel in any suitable manner.

Tail stock 33 may then be removed and a vinyl tube applied by air pressure in a manner disclosed in a copending application by John E. Vance and Dale C. Gerber, Serial No. 787,544, filed November 22, 1947. According to that application a tapered sleeve having an inside diameter of a size suitable to slide over the coiled wire on the mandrel is inserted into the end of a vinyl tube having an inside diameter substantially the same as the diameter of the mandrel and air pressure applied to its opposite end. The air pressure expands the tube sufficiently that it can be slid axially over the coiled wire positioned on the mandrel. It is to be noted from Fig. 4 that the length of the tube 11 should be greater than that of the coiled wire on the mandrel by an amount sufficient to form the backwardly extending portions 20 at each end.

An alternate method is to make the mandrel 37 hollow and apply air pressure to the interior thereof through the head stock 32 and plug the free end of the tube so that air pressure will expand the tube sufficiently that it can be slid over the coiled wire.

It has been found that a plastic tube, having a wall thickness of 0.026 inch, formed of elastomeric thermoplastic vinyl having a minimum tensile strength of 2,000 pounds per square inch at 80° F. is suitable.

The tail stock 33 is then reengaged with the mandrel 37, the first few coils of the cord 12 wound over the tube 11 and sleeves at the head stock end of the mandrel midway between the convolutions of the wire 10. The end of the tube 11 is also rigidly secured to the sleeves and the wire 10 by means of waxed threads 18. The first few turns of the cord 12 and threads 18 are taped to the tube 11 by pressure sensitive tape 19.

It has been found that a plastic cord of elastomeric thermoplastic vinyl having a minimum tensile strength of 2,000 pounds per square inch at 80° F. and a diameter 0.075 inch is suitable.

The tension on the cord is properly adjusted by adjusting the tensioning pulley 42, which tension will be registered on the tension measuring device 43. The clutch 36 is then manually operated to engage the carriage 35 with the lead screw 34 and the head stock 32 rotated backwardly or clockwise as viewed from the tail stock end so as to spirally wind the cord over the tube 11 midway between the convolutions of the reinforcing wire 10 from the head stock end to the tail stock end of the mandrel 37. The end coils of the cord are then taped to the tube 11 by a pressure sensitive tape 19. During the winding of the cord 12 about the tube 11 the valve in the solvent dispensing tube is properly adjusted to apply the proper quantity of solvent two or three coils ahead of the cord as the cord is wound about the tube. The solvent is applied sufficiently ahead of the point where the cord is being wound to permit the surface of the tube to soften sufficiently that the cord will firmly adhere to the tube as it is wound about it.

The tail stock 33 is again removed and the finished tubing removed from the mandrels 37 by applying a twisting action in a direction to expand the coils 10 whereby the finished tube can

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be slid backwardly off the tail stock end of the mandrel 37.

The tension applied to the cord 12 will force the walls of the tube 11 inwardly between the convolutions of the wire 10. Additionally, the wire spiral 10 will tend to return to its original pitch and diameter so as to force the tube 11 outwardly between the convolutions of the cord 12 a distance permitted by the elasticity of the tube wall and of the cord so as to form a very flexible hose.

The end couplings 21 may then be applied to each end of the hose in any suitable manner, note being taken that the end 20 of the tube 11 is turned backwardly over the end coils of the cord 12.

Elastomeric thermoplastic materials as such are old and well known and are made by mixing a thermoplastic resin with a plasticizer. At ordinary temperatures they are slightly elastic in that the material can be stretched somewhat and will return when released. If the material remains in stretched condition it will remain under a definite tension.

While I have shown and described but a single embodiment of the hose and method of my invention it is to be understood that this embodiment is to be taken as illustrative only and not in a limiting sense. I do not wish to be limited to the particular structure shown and described but to include all equivalent variations thereof except as limited by the scope of the claims.

I claim:

1. A flexible hose comprising, a coiled spirally wound reinforcing spring wire, a single thickness tube of elastomeric thermoplastic material having a normal internal diameter substantially the same as the unstressed internal diameter of said spiral positioned over said spiral and an elastomeric cord wound spirally over said tube between the convolutions of said spiral, the coils of said spiral being under both axial, diametric and circumferential stress tending to shorten the pitch and increase the diameter of the coils of said spiral to force the walls of said tube outwardly between the convolutions of said cord, said elastomeric cord being under circumferential tension tending to decrease the internal diameter of its coils and force the walls of said tube inwardly between the convolutions of said spiral and said elastomeric tube being under axial stress tending to resist the action of said spring and cord whereby said tube assumes a corrugated formation.

2. A flexible hose comprising, a coiled spirally wound reinforcing spring the coils of which are under both axial and circumferential stress, a single thickness axially and diametrically expanded elastomeric vinyl tube surrounding said spiral and having an unstressed internal diameter substantially the same as the unstressed internal diameter of said spiral and an elastomeric vinyl cord wrapped under circumferential tension about said tube between the convolutions of said spiral.

3. A flexible hose according to claim 2 in which said cord is bonded to the exterior of said tube by a solvent applied to said tube beneath said cord.

4. A flexible hose consisting of an inner expanded coiled spirally wound reinforcing wire, a single thickness tube of slightly elastic elastomeric thermoplastic material closely surrounding said spiral and a cord of the same material as said tube wound spirally under tension over

said tube between the convolutions of said spiral.
 5. A flexible hose according to claim 4 in which said tube and cord are made of elastomeric polyvinyl chloride.

6. A flexible hose according to claim 4 in which said cord is bonded to said tube over its entire length.

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