United States Patent

Moertel

[15] **3,688,805**

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[54] **MACHINE FOR COILING FILAMENTARY MATERIAL**

[72] Inventor: **George B. Moertel,** Conneautville, Pa.

[73] Assignee: **Textron Inc.,**

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[52] **U.S. Cl.** .....**139/11,** 18/19 C, 139/124 A

[51] **Int. Cl.** **D03d 35/00**

[58] **Field of Search** ....18/19 C, DIG. 7; 139/11, 116, 139/122, 123, 124, 127; 57/34 HS

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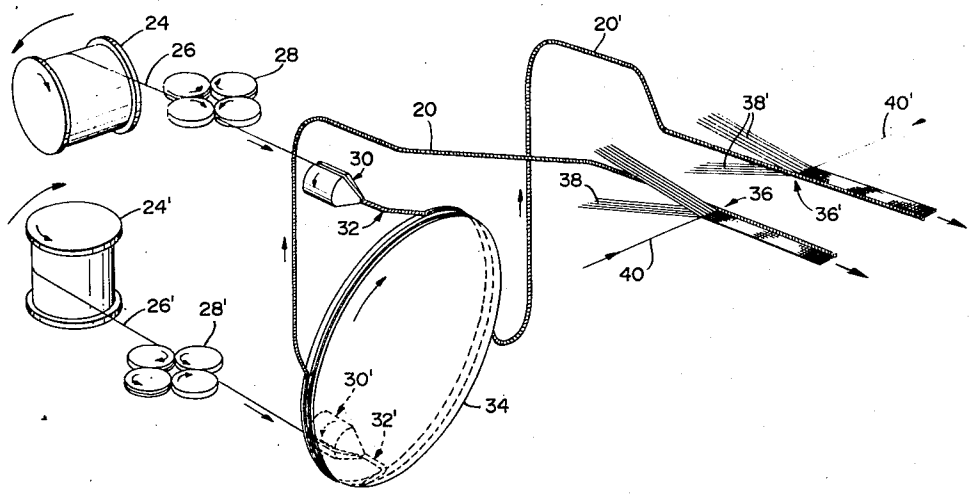
Primary Examiner—Henry S. Jaudon
Attorney—Meech & Field

[57] **ABSTRACT**

A coiling machine for forming a coiled filament for a slide fastener and for use directly with weaving apparatus including a rotatable shaft carrying a spool of continuous filamentary material at one end and having a mandrel rotatably supported in its other end, a device for tensioning the filamentary material prior to its application to the mandrel, and a roller cooperating with a curing wheel to capture the mandrel and hold it in a stationary position such that rotation of the shaft coils the filamentary material around the mandrel and the coiled filamentary material is drawn onto the curing wheel. A pair of the coiling machines are mounted on the same frame as the weaving apparatus and a pair of coiled filaments are formed simultaneously and supplied from the curing wheel to the weaving apparatus where they are directly weaved into a slide fastener tape.

23 Claims, 16 Drawing Figures



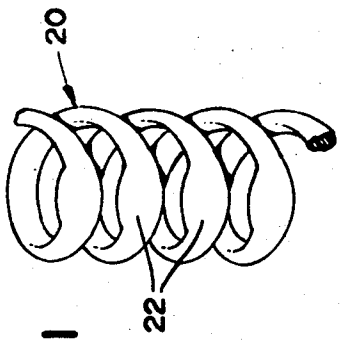


FIG. 1

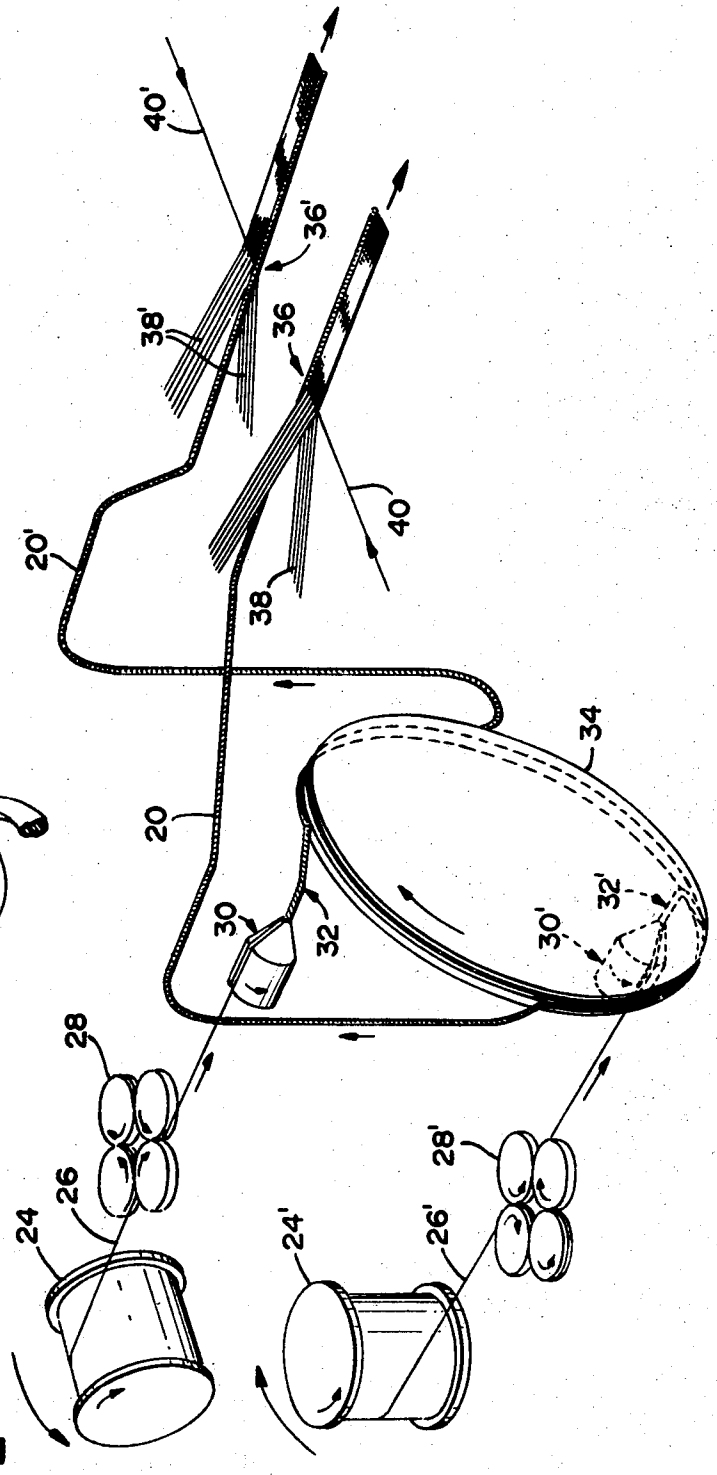


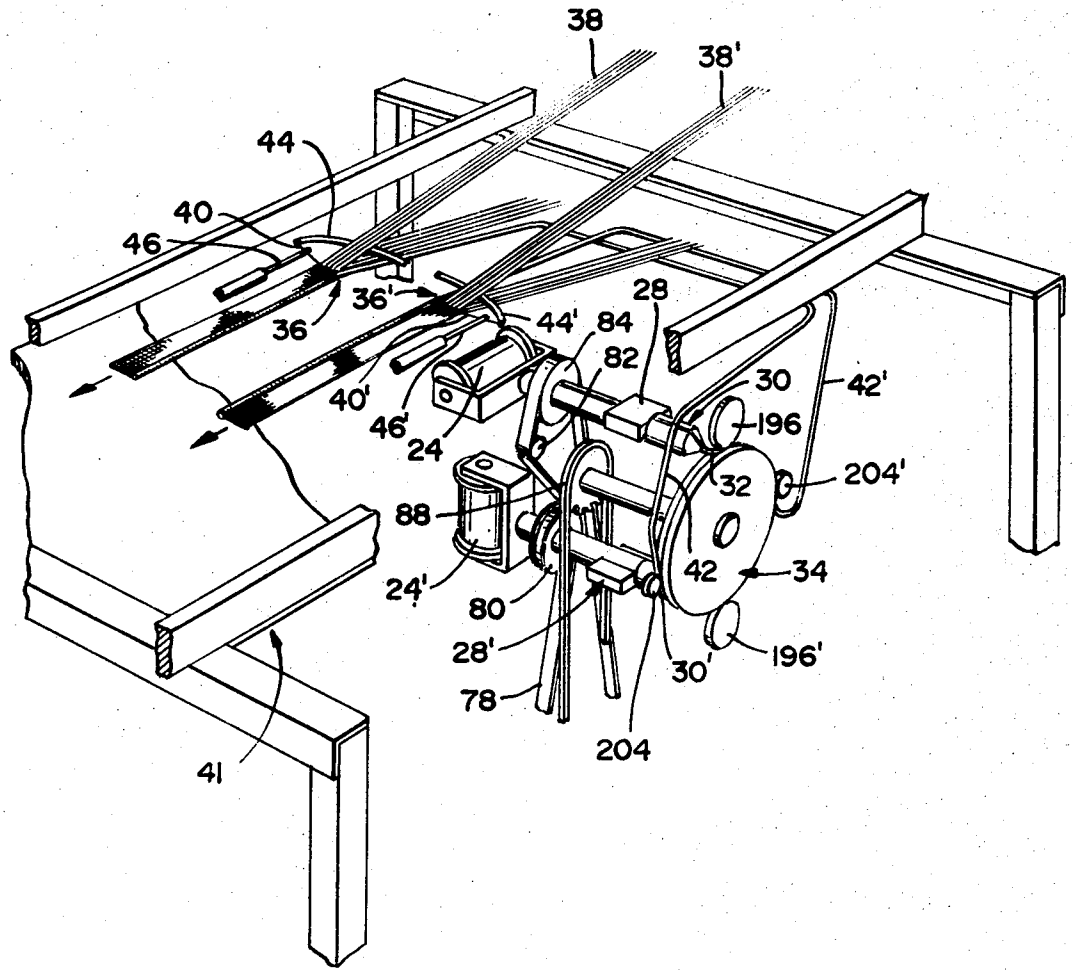
FIG. 2

INVENTOR,
George B. Moertel

BY

Meech & Field
ATTORNEYS

FIG. 3



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George B. Moertel

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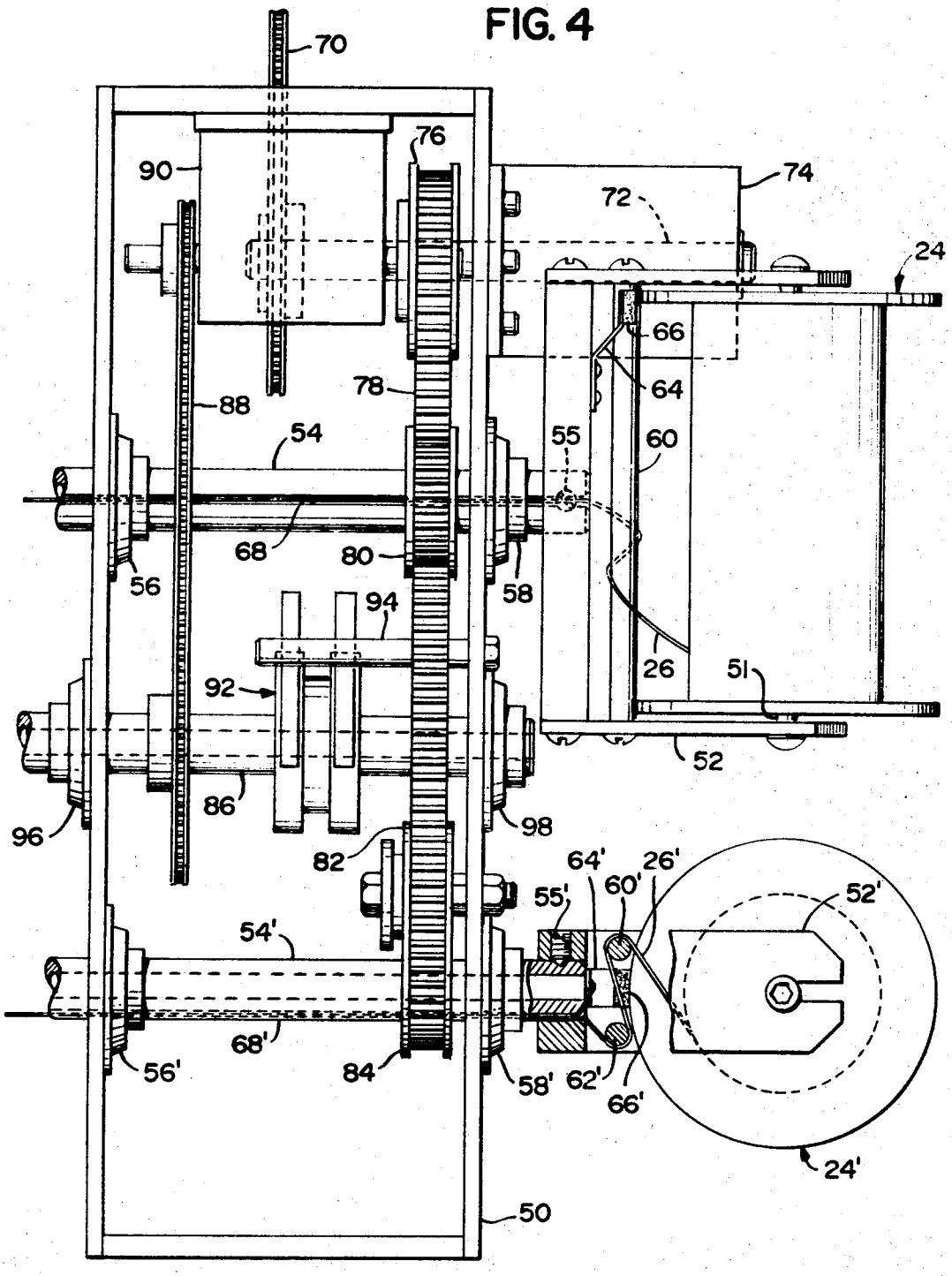
FIG. 4



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George B. Moertel

BY

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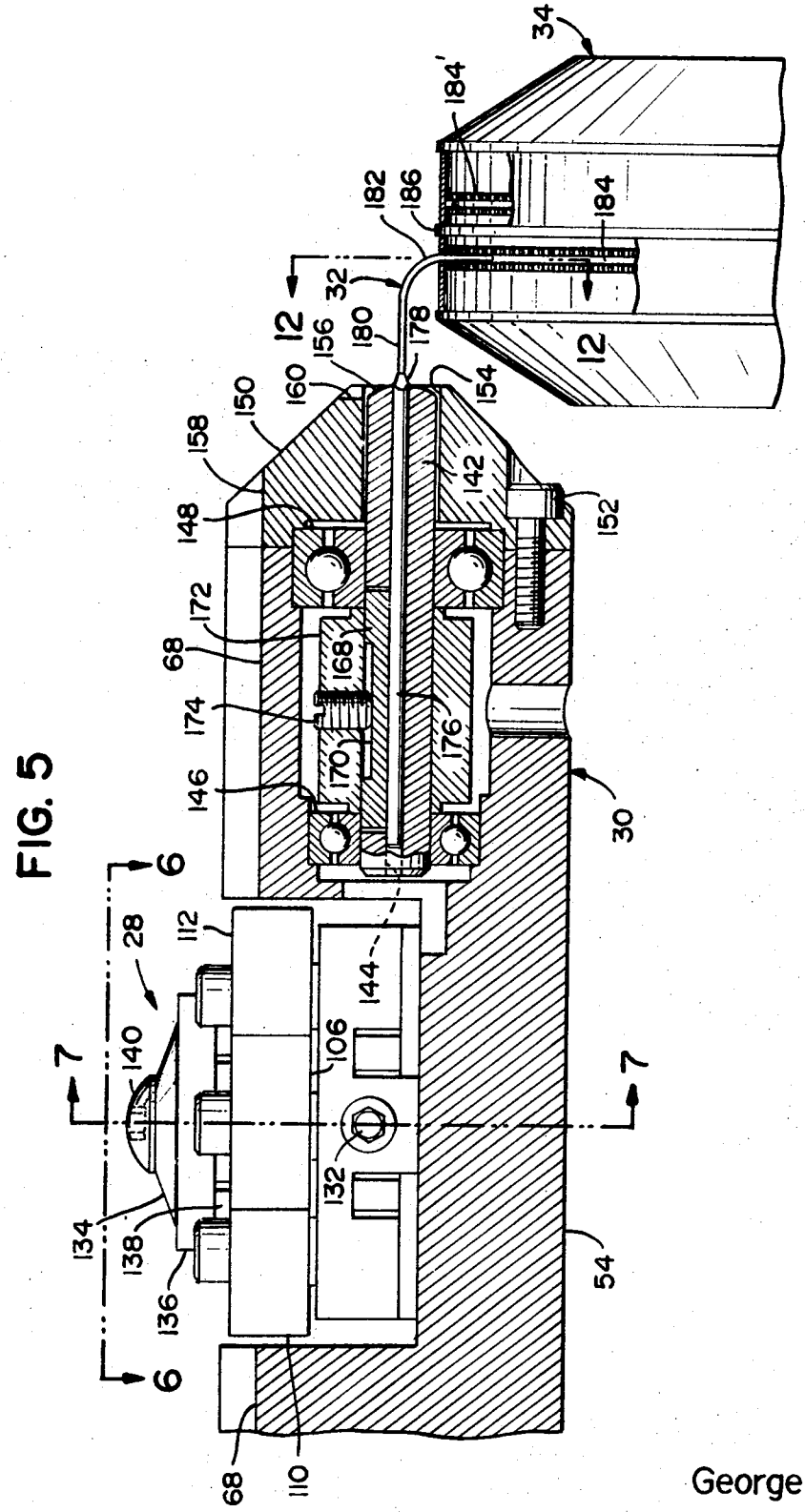
FIG. 5



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George B. Moertel

BY

Meech & Field
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FIG. 6

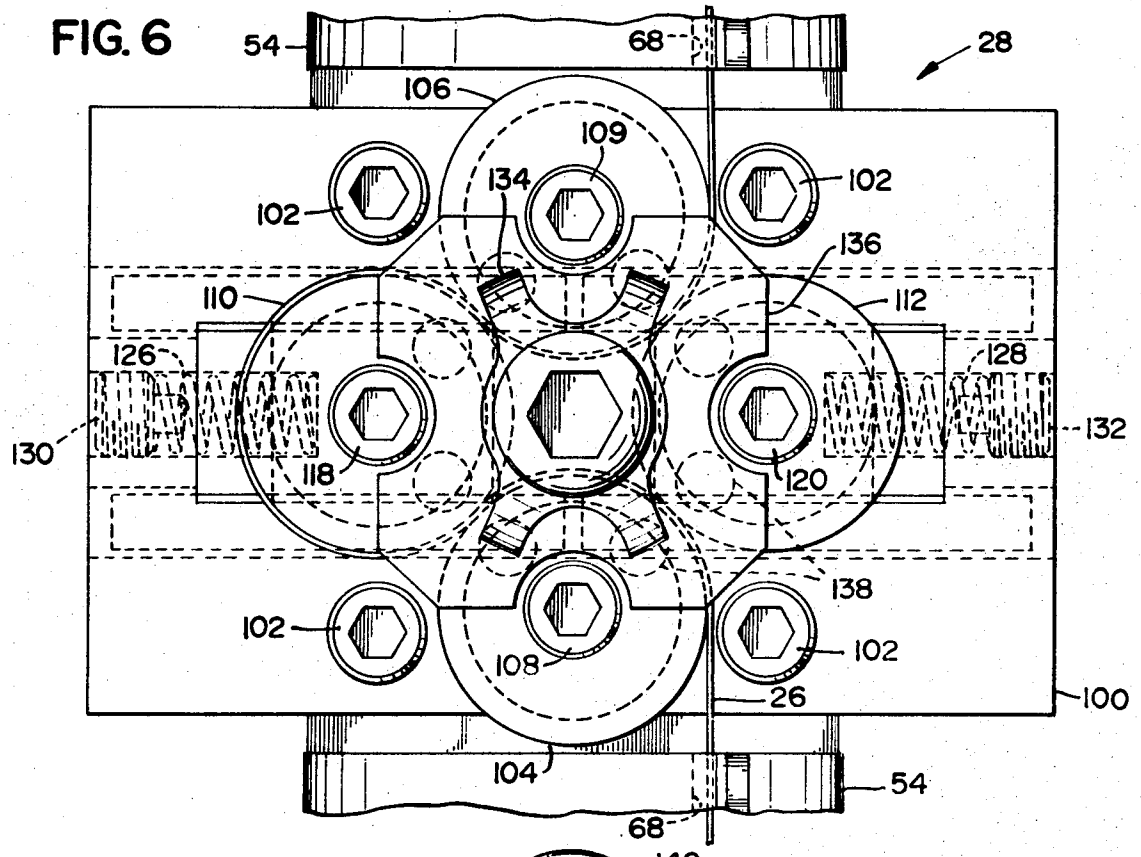
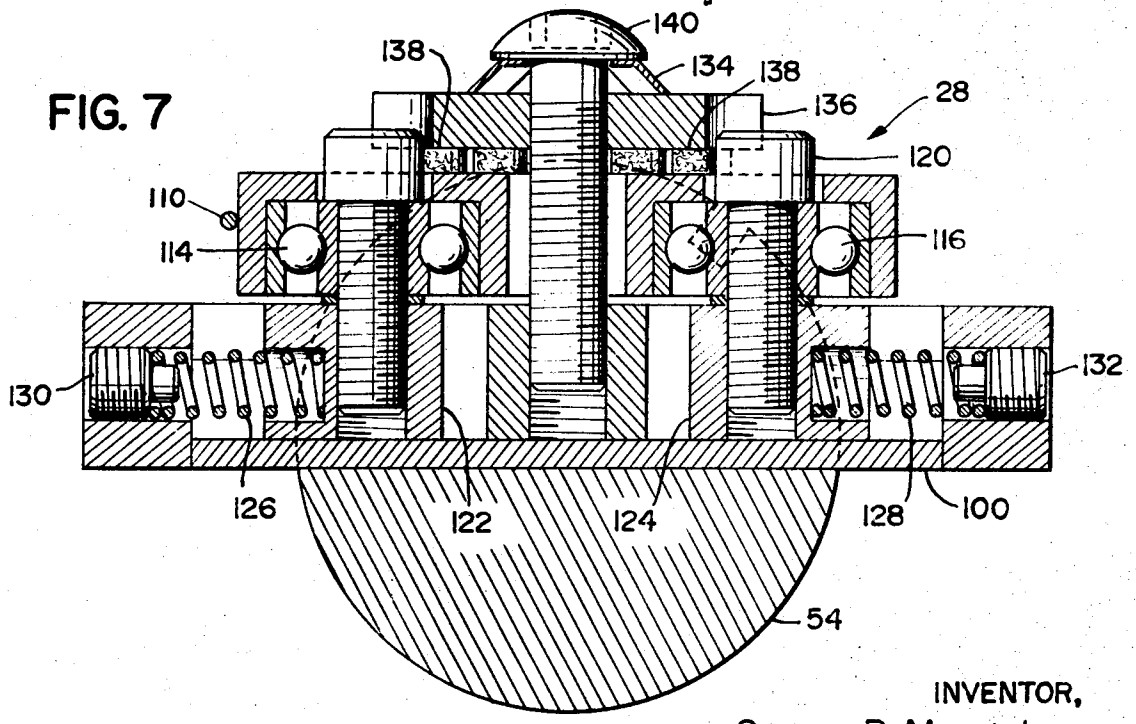


FIG. 7



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George B. Moertel

BY

Meech & Field
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FIG. 8

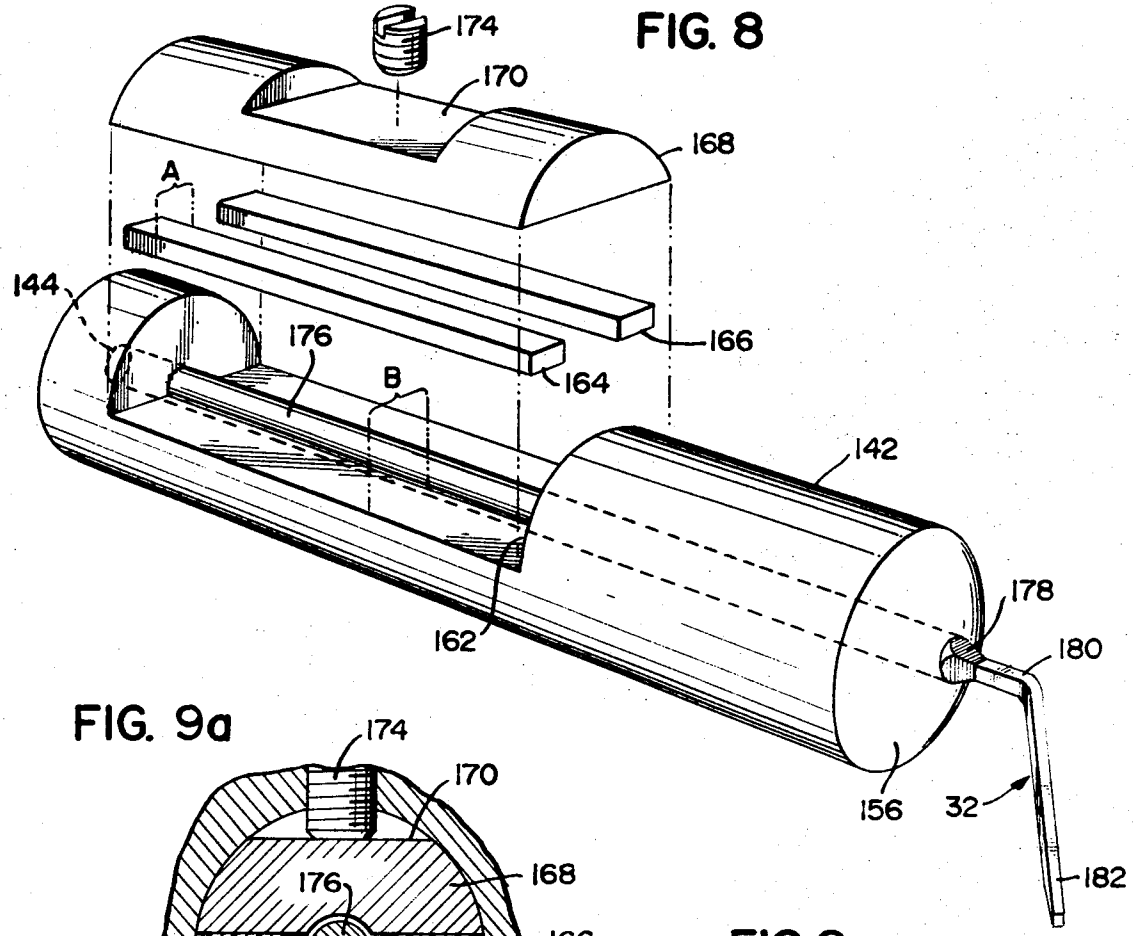


FIG. 9a

FIG. 9b

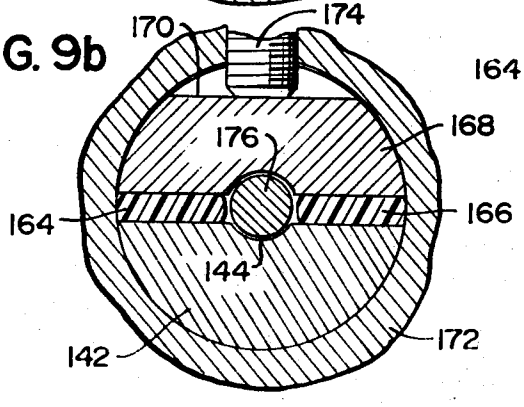
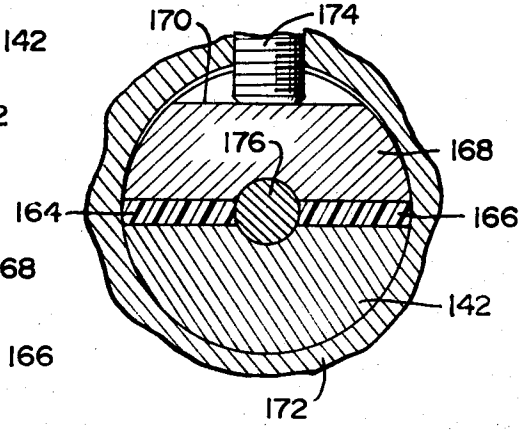


FIG. 9c



INVENTOR,

George B. Moertel

BY

Meech & Field

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FIG. 10

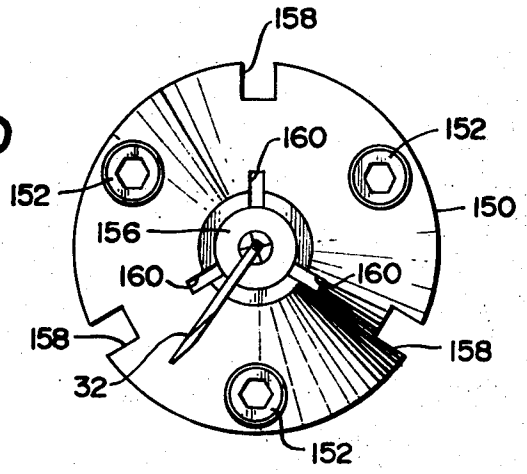
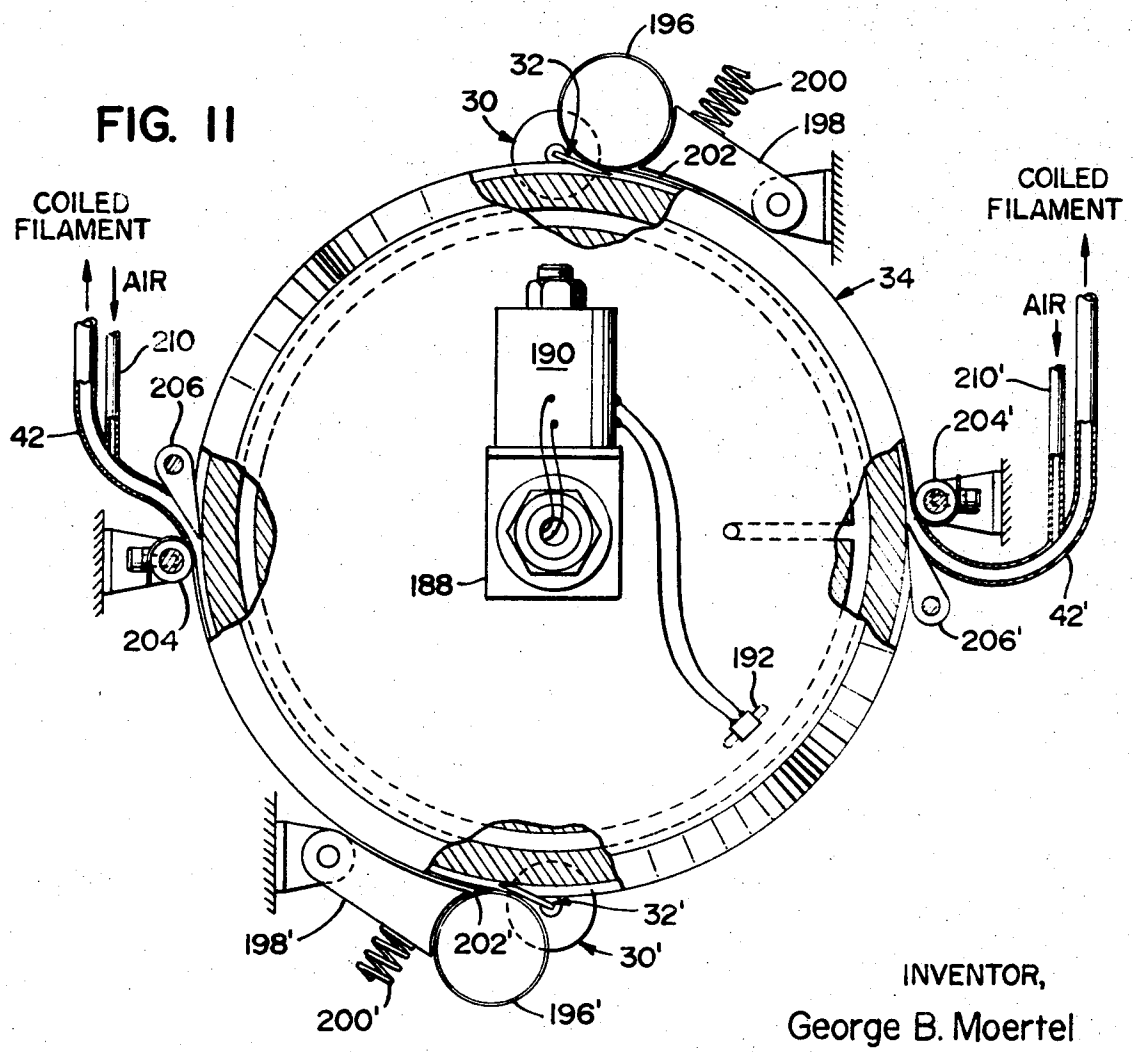


FIG. 11



INVENTOR,
George B. Moertel

BY Meech & Field
ATTORNEYS

FIG. 12

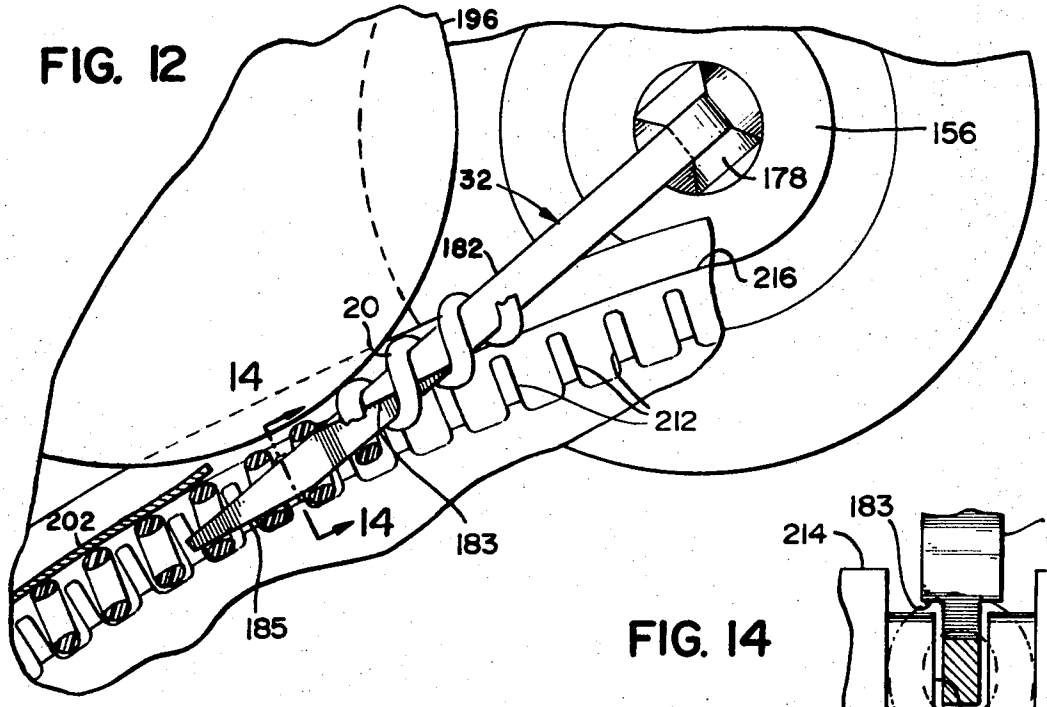


FIG. 14

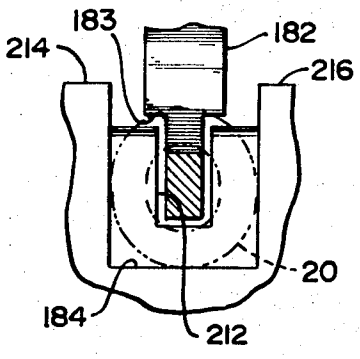
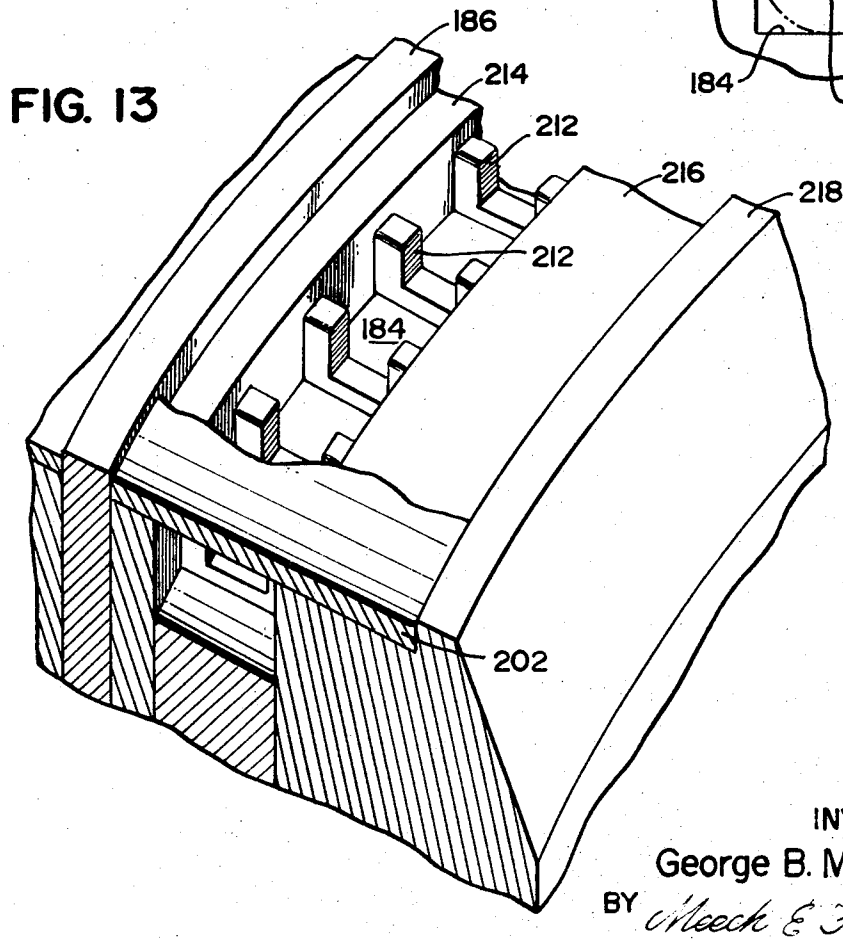


FIG. 13



INVENTOR,
George B. Moertel
BY Meeck & Field
ATTORNEYS

MACHINE FOR COILING FILAMENTARY MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to coiling machines for forming continuous coiled filaments for slide fastener stringers and, more particularly, to such machines which may directly feed the coiled filaments to a loom for weaving into the edge of a tape.

Description of the Prior Art

The use of plastic filamentary material material as slide fastener stringers is extremely popular, inexpensive and advantageous; however, one problem yet to be obviated is that of forming the stringers efficiently. Specifically, coiled filaments utilized as stringers in the past have been formed on machines which are unduly intricate, bulky and expensive; and, aside from the disadvantages of high initial cost and high repair costs, such machines have a further disadvantage in that they cannot be operated directly with looms for weaving tapes for the slide fasteners onto the coiled filaments. Accordingly, the memory of the filamentary material has an opportunity to recover slightly before attachment of the coiled filaments with a tape, and the final slide fastener product suffers from the slight recovery by the two mating coiled filaments being unevenly matched to cause difficult closure and a tendency for the slide fastener to pull apart at uneven portions.

Conventional coiling machines utilize a needle-like mandrel which remains stationary while a shaft carrying the filamentary material to be coiled rotates therearound to coil the filamentary material around the mandrel. Complex gearing systems or staking apparatus is normally utilized to maintain the mandrel stationary while the shaft rotates, and such apparatus increases the initial cost of the machines, the number of components which may malfunction, the maintenance cost for the machines and the size and weight of the machines. Tensioning apparatus is provided throughout the path of travel of the filamentary material through the machine in order to maintain the filamentary material at a constant high axial tension prior to coiling. Such tensioning apparatus increases initial and maintenance costs of the machines and also increases power requirements for driving the machine due to friction.

Once a coiled filament is formed by the machines, it is removed therefrom, cured by heat and stored in baskets for delivery to a loom and weaving with a tape. As previously mentioned, the interim between curing and weaving has the disadvantage of permitting memory recovery and adversely affecting the finished slide fastener. Attempts to combine conventional coiling machines with slide fastener tape weaving looms have not met with success due to the large size and weight of the machines and the different power requirements for the looms and the machines. That is, the bulk an support means of conventional coiling machines, which are necessary to hold the mandrel stationary, require the coiling machines to be located at different physical locations from the loom, and a coiled filament cannot be directly forwarded over a great distance to a loom because tension or compression will deform the coiled filament and render it inoperative for

use with a slide fastener. Furthermore, for proper cooperation between the looms and the coiling machines their operations must be synchronized, and this is best and most easily accomplished by utilizing the same motive power source. The frequency of repair of conventional coiling machines prevents efficient loom operation since the breakdown of one coiling machine renders inoperative the loom and any other coiling machines operating therewith until the broken machine is fixed.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to construct an inexpensive, small and dependable coiling machine having a reduced number of components and being adaptable for cooperation with weaving apparatus to supply coiled filaments directly to the loom for weaving into a slide fastener tape.

The present invention is summarized in a coiling machine including a rotatable shaft having a supply end and a hollow coiling end, a supply of continuous filamentary material provided at the supply end of the shaft, a mandrel having a shank portion disposed within the hollow end of the shaft and a needle portion extending from the shank portion, a guide in the shaft for supplying the filamentary material from the supply end to the mandrel at the coiling end, and holding means capturing the needle portion of the mandrel to maintain the mandrel stationary while the shaft rotates such that the filamentary material is coiled around the needle portion.

Another object of the present invention is to render a mandrel in a coiling machine stationary by capturing the needle portion thereof.

A further object of the present invention is to supply tension to the filamentary material to be coiled on a mandrel immediately prior to the supply of the filamentary material to the mandrel.

The present invention has another object in that a coiling machine is mounted on the same frame as weaving apparatus and supplies coiled filaments directly thereto.

Another object of the present invention is to construct a coiling machine with a minimal number of rotating components.

A further object of the present invention is to construct a coiling machine which is easily mounted for cooperation with a curing wheel and is easily interchanged with another similar coiling machine for repairs.

The present invention has another object in that a coiling machine is constructed with a movable mandrel that is rendered stationary only after the mounting of the coiling machine such that a needle portion of the mandrel is captured.

Another object of the present invention is to produce a slide fastener by supplying continuous filamentary material, warp threads and filler threads to combination coiling and weaving apparatus.

A further object of the present invention is to utilize a plurality of coiling machines with a curing wheel and weaving apparatus to simultaneously provide both halves of a slide fastener.

Some of the advantages of the coiling machine of the present invention over the prior art are that initial costs

and repair costs are reduced due to the minimal number of rotating components, the coiling machines are interchangeably operative due to their small size and weight, the coiling machines may be utilized directly with weaving apparatus for forming a slide fastener tape, and coiled filaments formed by the coiling machine are improved due to their incorporation into a slide fastener tape immediately after removal from curing apparatus.

Further objects and advantages of the present invention will become apparent from the following description of the preferred embodiment taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an enlarged isometric view of a coiled filament to be formed with the coiling machine of the present invention.

FIG. **2** is a schematic diagram of the formation of a slide fastener in accordance with the present invention.

FIG. **3** is a perspective view of coiling and weaving apparatus according to the present invention.

FIG. **4** is a side elevation of a portion of the coiling machine of the present invention.

FIG. **5** is a sectional view of a tension device and a mandrel support assembly for the coiling machine of the present invention.

FIG. **6** is a view of the tension device taken along line **6—6** of FIG. **5**.

FIG. **7** is a section of the tension device taken along line **7—7** of FIG. **5**.

FIG. **8** is an exploded view of the mandrel support assembly of FIG. **5**.

FIGS. **9***a*, **9***b* and **9***c* are sectional views of the mandrel support assembly during adjustment.

FIG. **10** is a side elevation of the mandrel support assembly of FIG. **5**.

FIG. **11** is a side elevation of the curing wheel in association with the mandrel support assemblies.

FIG. **12** is an enlarged, broken view illustrating the delivery of the coiled filament to the curing wheel.

FIG. **13** is an enlarged, broken view of the curing wheel of FIG. **11**.

FIG. **14** is a section taken along line **14–14** of FIG. **12**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A continuous coiled filament **20** to be formed by the coiling machine of the present invention is illustrated in FIG. **1**. The coiled filament **20** is generally helical, and each convolution has a deformity **22** on the outwardly facing portion thereof. The deformities are longitudinally aligned, and when two coiled filaments are utilized to form a slide fastener, the coiled filaments may be intermeshed with the use of a slider such that they are held together by the increased width of the deformities.

A schematic diagram of apparatus for forming the coiled filament of FIG. **1** and weaving the coiled filament into a slide fastener tape is illustrated in FIG. **2**. A filamentary material, preferably a thermoplastic material such as nylon, is supplied on spools **24** and **24'** which rotate counterclockwise and clockwise, respectively, while filamentary materials **26** and **26'** are paid off as the spools spin about their central axes. The filamentary materials **26** and **26'** are supplied through tension devices **28** and **28'** to mandrel support assemblies **30** and **30'**, respectively. Tension devices **28** and **28'** and mandrel support assemblies **30** and **30'** rotate counterclockwise and clockwise about stationary mandrels **32** and **32'**, respectively, to form two coiled filaments **20** and **20'** by coiling the filamentary materials around the mandrels. The coiled filaments **20** and **20'** are drawn off mandrels **32** and **32'** onto laterally spaced grooves in a curing wheel **34** where the coiled filaments are heated or cured to maintain their newly coiled form. Curing wheel **34** rotates clockwise, and coiled filaments **20** and **20'** are carried approximately three-quarters of the way therearound before being stripped from curing wheel **34** and supplied to a loom.

The loom includes weaving assemblies **36** and **36'** which operate upon a plurality of warp threads **38** and **38'** to weave a slide fastener tape with filler thread **40** and **40'**, respectively. Coiled filaments **20** and **20'** are weaved into the slide fastener tape as warp threads such that they face each other on the inner edges of the slide fastener tape. As the woven slide fastener tape leaves the loom, coiled filaments **20** and **20'** are intermeshed by the use of a slider.

The relative size of the coiling machine of the present invention in comparison with a loom for weaving slide fastener tapes is illustrated in FIG. **3** wherein it may be seen that two coiling machines are mounted beneath a frame **41** on the top of which is supported weaving assemblies **36** and **36'**. Coiled filaments **20** and **20'** are delivered from curing wheel **34** to weaving assemblies **36** and **36'** through guiding conduits **42** and **42'**, respectively. Weaving assemblies **36** and **36'** include laterally actuated filler needles **44** and **44'** which operate in conjunction with selvage needles **46** and **46'** to weave coiled filaments **20** and **20'** into a slide fastener tape having outer selvage edges. The loom apparatus to be utilized with the present invention is conventional, and reference is made to U.S. Pat. No. 3,123,103 to Hendley for more detailed information wit respect to an example of a slide fastener tape weaving loom which may be modified for use with the present invention.

As illustrated in FIGS. **2** and **3**, it is desirable to utilize two coiling machines to form coiled filaments for both sides of a slide fastener simultaneously. The two coiling machines are identical in structure; and, accordingly, identical parts are identified by the same reference numerals with primes and are described with respect to only one of the coiling machines.

Support apparatus for spools **24** and **24'** and the driving mechanism for the present invention are illustrated in FIG. **4**. Spool **24** is superposed above spool **24'** on a frame **50** with the spools being disposed 90° out of phase with each other in order to conserve space. Spool **24** is rotatably supported on a spindle **51** extending between the arms of a yoke **52** which is secured to the supply end of a shaft **54** with the aid of a set screw **55**. Shaft **54** is journaled through flange bearings **56** and **58** carried by frame **50**. A pair of parallel alignment rods **60** and **62** are mounted between the arms of yoke **52**, and an offset spring member **64** is mounted on the base of yoke **52** and carries a leather braking pad **66** which is disposed to contact one of the end flanges of spool **24**

to provide a slight braking effect therefor. Filamentary material **26** is paid off spool **24** around alignment rods **60** and **62** and enters a longitudinal guide slot **68** in the outer periphery of shaft **54**.

Motive power for the present invention is supplied from a main drive motor, not shown, which drives the weaving apparatus as well as a chain **70**. Chain **70** drives a shaft **72** which is supported at its outer end by a pillow box **74** and carries a pulley **76** thereon. A belt **78** is driven by pulley **76** and extends under a pulley **80** secured to shaft **54**, over an idler **82**, over a pulley **84** secured to shaft **54'** and back to pulley **76** such that shafts **54** and **54'** are rotated in opposite directions.

A curing wheel shaft **86** is driven by a chain **88** in response to the output from a reducer **90** which is driven by chain **70** such that curing wheel **34** rotates more slowly than shafts **54** and **54'**. A conventional slip ring assembly **92** is supported on frame **50** by a member **94** and is operable to supply electricity to heating apparatus on curing wheel **34**. Shaft **86** is journaled in flange bearings **96** and **98** carried by frame **50**.

As illustrated in FIGS. **5**, **6**, and **7**, shaft **54** carries tension device **28** in alignment with slot **68** to receive filamentary material **26**. Shaft **54** is cut out to receive a rectangular frame **100** which is secured to shaft **54** by a plurality of bolts **102** such that tension device **28** rotates with the shaft. Tension device **28** includes a pair of longitudinally aligned wheels **104** and **106** rotatably mounted on frame **100** by means of bolts **108** and **109** in suitable bearings. A pair of laterally aligned wheels **110** and **112** are rotatably mounted in bearings **114** and **116** by means of bolts **118** and **120**, respectively, which are secured to blocks **122** and **124** slidably disposed on frame **100**. Helical bias springs **126** and **128** are mounted in compression between recesses in blocks **122** and **124** and adjusting screws **130** and **132**, respectively, which adjusting screws are threadedly engaged in the sides of frame **100**.

Wheels **104**, **106**, **110** and **112** are each cup-shaped to receive bearing supports, and the top surfaces of the wheels are aligned in a common plane. A spring **134** having an H-configuration is cup-shaped such that its open end engages a generally rectangular plate **136** which carries a plurality of leather braking pads **138** on the underside thereof. A pair of the braking pads **138** abut the top surface of each of the wheels **104**, **106**, **110** and **112**, and the pressure of the braking pads **138** on the wheels is controlled by a centrally disposed bolt **140** which threadedly engages frame **100** and extends through apertures in the center of spring **134** and plate **136**.

Slot **68** in shaft **54** is aligned with the peripheral edges of wheels **104** and **106** such that filamentary material **26** enters tension device **28** at wheel **104** and is carried around wheel **104** to wheel **112**. From wheel **112**, filamentary material **26** is delivered to wheel **106** for exit from the tension device and into slot **68** in shaft **54**. Thus, looking at FIG. **6**, it may be seen that wheel **104** rotates counterclockwise, wheel **110** rotates clockwise, wheel **106** rotates counterclockwise and wheel **112** rotates clockwise.

In order to initially insert filamentary material **26** in tension device **28**, wheels **110** and **112** are moved away from wheels **104** and **106**. The filamentary material is then properly disposed between the wheels, and wheels **110** and **112** are moved back towards the center of the tension device to grasp the filamentary material between the outer peripheries thereof and the outer peripheries of wheels **104** and **106**.

The coiling end of shaft **54** is hollow and houses mandrel support assembly **30** which includes a cylindrical mandrel holder **142** having a central bore **144** therethrough, as illustrated in FIG. **5**. Mandrel holder **142** is mounted in bearings **146** and **148** so as to be movable relative to shaft **54**. A conical head **150** is secured to the coiling end of shaft **54** by means of three bolts **152**, as illustrated in FIG. **10**; and head **150** has a central bore **154** therein for receiving mandrel holder **142** which has a semispherical end **156** that is positioned near the outer end of head **150**. Three slots **158** are arranged 120° apart in head **150** such that one of the slots **158** always coincides with slot **68** in shaft **54** when the head is secured to the shaft. Three smaller slots **160** are arranged 120° apart in alignment with slots **158** to permit filamentary material **26** to pass through one of slots **158** and smaller slots **160** to mandrel **32**.

Mandrel holder **142** is cut away at **162**, as illustrated in FIG. **8**. Two rectangular, elongated polyurethane pads **164** and **166** are disposed on the flat coplanar surfaces of cut away portion **162**, and a clamping member **168**, which has an arcuate top surface with a notch **170** cut therefrom, has a flat bottom portion abutting the tops of pads **164** and **166**. A cylindrical sleeve **172** abuts bearings **146** and **148** and encircles mandrel holder **142** and has a threaded aperture therein for receiving a set screw **174** which has an end adapted to abut notch **170** of clamping member **168**.

Pads **164** and **166** are identical and have a width A which is less than the width B defined by the distance between the outer periphery of mandrel holder **142** and the central bore **144** therethrough. Pads **164** and **166** are disposed off center so as to be closer to sleeve **172** than mandrel **34** such that the pads may be deformed to engage sleeve **172** and mandrel **32** in a manner to be described hereinafter.

Mandrel **32** has an elongated cylindrical shank **176** which is inserted in central bore **144** of mandrel holder **142**. Shank **176** terminates in a diamond **178** which has four planar sides tapering from the outer surface of shank **176** to a coaxial needle portion **180** having a rectangular cross section. Portion **180** bends smoothly at a right angle into a needle portion **182** which has a gradually reducing rectangular cross section that is cut at **183** to decrease its width as shown in FIGS. **13** and **14**.

Curing wheel **34** has a pair of laterally spaced circumferential grooves **184** and **184'** which cooperate with needle portions **182** and **182'**, respectively; and the curing wheel **34** is identical about a centrally disposed annular wall **186**. Curing wheel **34** is mounted on shaft **86** and carries an L-shaped bracket **188** supporting a thermostatic control device **190** which receives electrical power via slip ring assembly **92**, as illustrated in FIG. **11**. A temperature sensor **192** is mounted adjacent heating elements **194** which are positioned near the circumferential grooves **184** and **184'**.

Mandrel support assembly **30** is disposed at the top of curing wheel **34** such that coiled filament **20** is

drawn off of the needle portion **182** of mandrel **32** and onto the curing wheel. In a similar fashion mandrel support assembly **30'** is disposed at the bottom of curing wheel **34** diametrically opposite mandrel support assembly **30'** such that coiled filament **20'** is drawn off the needle portion **182'** of mandrel **32'** onto the curing wheel.

A roller **196** is positioned with its peripheral edge adjacent needle portion **182** of mandrel **32** and is pivotally mounted on a support by means of a member **198** which is under the force of a spring **200** mounted in compression. A stationary metal insulating band **202** extends from the peripheral edge of roller **196** three-quarters of the way around curing wheel **34** to an anchor **204**. Adjacent anchor **204** is a pointed stripper **206** which removes coiled filament **20** from the curing wheel and delivers it to conduit **42** for supply to the loom after being subjected to air blown through a conduit **210** to complete the curing process prior to delivery to the loom.

In a similar manner a roller **196'** is mounted in compression by means of a pivotal member **198'** and a spring **200'** adjacent the needle portion **182'** of mandrel **32'**; and a stationary metal insulating band **202'** is spaced adjacent roller **196'** and extends three-quarters of the way therearound to an anchor **204'**. Adjacent anchor **204'** is a stripper **206'** which removes coiled filament **20'** from the curing wheel and delivers it through conduit **42'** to the loom after being subjected to air through a conduit **210'**.

The peripheral edge of curing wheel **34** is illustrated in detail in FIG. **13**. Groove **184** has a plurality of equally spaced U-shaped teeth **212** therein. Teeth **212** are arranged in inverted fashion such that radially extending legs abut the side walls of groove **184**, and the side walls of groove **184** terminate in a narrow shoulder **214** and a wide shoulder **216**, respectively, with narrow shoulder **214** abutting wall **186** and wide shoulder **216** abutting an outer annular wall **218**. The width of insulating band **202** is such that it abuts walls **186** and **218** and slidably rests on shoulders **214** and **216**.

Needle portion **182** of mandrel **32** extends into groove **184** as shown in FIGS. **13** and **14** and tapers at end **185** such that convolutions of coiled filament **20** slip off the mandrel as they are pulled by teeth **212** with rotation of curing wheel **34**. The speed of rotation of curing wheel **34** and shafts **54** and **54'** are correlated such that convolutions are pulled off mandrel **32** at the same rate that they are formed thereby. Thus, the RPM of curing wheel **34** will be equal to the RPM of shaft **54** divided by the number of teeth **212** in groove **184**.

The operation of the apparatus of the present invention is such that by supplying warp thread, filler thread and continuous filamentary material to the apparatus, a slide fastener is automatically produced that requires the introduction of a slider and end components for completion.

More specifically, the two spools **24** and **24'** of continuous filamentary material are mounted on yokes **52** and **52'**, and each of the filamentary materials is threaded around the alignment rods and through slots **68** and **68'** in shafts **54** and **54'** to tension devices **28** and **28'**, respectively. As previously mentioned, filamentary material **26** is positioned in tension device **20** after moving lateral wheels **110** and **112** away from longitudinal wheels **104** and **106** such that the filamentary material is gripped between the peripheral edges of the wheels. From wheel **106** tension device **28**, filamentary material **26** is supplied through slot **68** of shaft **54** and slots **158** and **160** in head **150** to mandrel **32**. Filamentary material **26'** is similarly positioned in tension device **28'** and supplied to mandrel **32'**.

When motive power is supplied to chain **70**, shafts **54** and **54'** are rotated in opposite directions, and rotational movement of shafts **54** and **54'** cause the filamentary material to be coiled on mandrels **32** and **32'** which remain stationary with respect to the shafts since the needle portions **182** and **182'** thereof are captured between rollers **196** and **196'** and curing wheel **34**, respectively. Spring member **64** and braking pad **66** retard rotation of spool **24** within yoke **52** and spool **24'** is similarly retarded such that filamentary materials **26** and **26'** are under a tension of approximately 4 ounces as they leave spools **24** and **24'** and the spools will quickly stop rotating when motive power to shafts **54** and **54'** ceases. The mouths of slots **68** and **68'** are smoothly rounded to receive the filamentary material from the alignment rods without snagging or offering added tension, and alignment rods **60** and **62**, and **60'** and **62'** serve to centrally align the filamentary material with the mouths of slots **68** and **68'**, respectively.

Tension devices **28** and **28'** increase the tension on the filamentary material to approximately 64 ounces by braking the rotation of wheels **104**, **106**, **108** and **110** in accordance with the adjustment of bolt **140** which controls the force on plate **136** from spring **134**. The tension devices are located in close proximity to the mandrels such that the 64 ounce tension, which is required to properly coil the filamentary material on the mandrels, need not be maintained for a great distance.

The filamentary material **26** is delivered to mandrel **32** via slots **68**, **158** and **160** and is drawn over the curved surface of end **156** of mandrel holder **142** and around diamond **178** onto portion **180** of mandrel **32**. The positioning of end **156** and diamond **178** is critical to proper coiling operation in that as convolutions of the coiled filament are formed they must move along mandrel **32** to the end **185** thereof without causing a build-up of convolutions.

In order to properly position end **156** and diamond **178**, set screw **174** is loosened such that mandrel holder **142** is slidable within sleeve **172** since pads **164** and **166** will not be in contact with the inner surface of the sleeve, as illustrated in FIG. **9***a*. Mandrel holder **142** is moved within the hollow end of shaft **54** until the curved surface of end **156** is aligned with the top of head **150**; and, once mandrel holder **142** is thus aligned, set screw **174** is tightened to deform pads **164** and **166** until the outer ends thereof contact sleeve **172**, as illustrated in FIG. **9***b*, to prevent relative movement between mandrel holder **142** and sleeve **172**. Shank **176** of mandrel **32** is now moved within bore **144** of mandrel holder **142** until diamond **178** is properly aligned with the curved surface of end **156**, and set screw **174** is tightened to further deform pads **164** and **166** until the inner ends thereof contact the outer surface of shank **176**, as illustrated in FIG. **9***c*, to prevent movement of mandrel **32** relative to mandrel holder **142**.

The relative positions of mandrel **32**, mandrel holder **142** and the top of head **150** are thus adjusted for proper coiling operation, and mandrel support assembly **30'** is adjusted in a similar manner to assure proper coiling operation at mandrel **32'**. It will be appreciated that by initially disposing pads **164** and **166** off center so as to be closer to mandrel **32** than sleeve **172**, the relative positions of the curved surface of end **156** of mandrel holder **142** and diamond **178** of mandrel **32** may be established prior to positioning end **156** at the top of head **150**.

As shafts **54** and **54'** rotate the filamentary material is coiled around mandrels **32** and **32'**, and as coiling continues the convolutions are moved along needle portions **182** and **182'** to be supplied to curing wheel **34**. As best illustrated in FIG. **12**, needle portion **182** extends into groove **184** and under roller **196** which acts to hold mandrel **32** stationary. As curing wheel **34** turns, teeth **212** engage the convolutions of coiled filament **20** to pull the coiled filament into groove **184**. Roller **196** and anchor **204** are stationary as is insulating band **202** such that as curing wheel **34** rotates metal band **202** slides on shoulders **214** and **216** relative to the curing wheel.

Coiled filaments **20** and **20'** are cured to retain their convoluted shape by heat from heating elements **194** as the curing wheel turns. The heat applied to the coiled filaments is sensed by sensor **192** and controlled by thermostatic device **190**. After traveling approximately three-quarters of the way around, coiled filaments **20** and **20'** are stripped from the curing wheel by strippers **206** and **206'**, are subjected to an air blast through conduits **210** and **210'** and are supplied to weaving apparatus **36** and **36'**, respectively.

Coiled filaments **20** and **20'** are woven into a slide fastener tape as warp threads in the loom, and the slide fastener is closed by a slider. By weaving the coiled filaments directly into the slide fastener tape after their formation, the memory of the plastic material is further destroyed to provide a strong slide fastener. Furthermore, the newly formed coiled filaments are easy to work with and facilitate the weaving operation.

It may be seen that mandrels **32** and **32'** are held stationary without the use of sophisticated gearing systems and without staking the mandrel or a member therewith thereby material reducing the number of components in the coiling machine of the present invention. That is, roller **196** and curing wheel **34** are utilized to capture mandrel **32** such that movement of needle portion **182** is prevented in either direction; and, consequently, the size and support structure for the coiling machine is reduced to a minimum. Furthermore, the coiling machines are easily interchangeable due to their reduced size and support structure and the unique manner in which mandrel **32** is supported therein so as to be movable with respect to shaft **54** until roller **196** is pivoted against curing wheel **34** to capture the mandrel.

The number of rotating components in the coiling machine of the present invention is significantly reduced not only due to the elimination of gears in maintaining the mandrel stationary but also due to the tensioning of the filamentary material immediately prior to coiling thereof rather than during the entire operation as in conventional coiling machines, due to the rotation of the tension device with shaft **54** and due to the use of a stationary metal band for insulating the curing wheel rather than the moving belt-like band utilized with conventional curing wheels.

Inasmuch as the present invention is subject to many variations, modifications and changes in detail, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A coiling machine comprising

rotatable shaft means having a supply end and a hollow coiling end;

supply means for supplying a continuous filamentary material to said supply end of said rotatable shaft means;

mandrel means having a shank portion disposed within said hollow coiling end of said shaft means and a needle portion extending from said shank portion;

said shaft means including guide means for supplying the filamentary material from said supply end to said mandrel means at said coiling end; and

holding means capturing said needle portion of said mandrel means to maintain said mandrel means stationary while said shaft means rotates such that the filamentary material is coiled around said needle portion;

said holding means including a rotatable curing wheel having a circumferential groove therearound and a roller having an outer surface positioned adjacent said circumferential groove, said needle portion of said mandrel means being positioned adjacent said outer surface of said roller and inserted in said circumferential groove to prevent rotation of said mandrel.

2. The invention as recited in claim **1** wherein said circumferential groove in said curing wheel has first and second parallel sides terminating in first and second annular shoulders, and a stationary insulating band slidably engages said first and second shoulders.

3. The invention as recited in claim **2** wherein the axis of said shaft means is in parallel relation with the axis of said curing wheel and said needle portion of said mandrel means is bent to be tangentially inserted in said circumferential groove in said curing wheel.

4. A coiling machine comprising

rotatable shaft means having a supply end and a hollow coiling end;

supply means for supplying a continuous filamentary material to said supply end of said rotatable shaft means;

mandrel means having a shank portion disposed within said hollow coiling end of said shaft means and a needle portion extending from said shank portion;

said shaft means including guide means for supplying the filamentary material from said supply end to said mandrel means at said coiling end;

holding means capturing said needle portion of said mandrel means to maintain said mandrel means stationary while said shaft means rotates such that the filamentary material is coiled around said needle portion;

said guide means including tension means disposed adjacent said coiling end of said shaft means to subject the filamentary material to a predetermined tension; and

said tension means including first and second wheels longitudinally disposed on said shaft means and third and fourth wheels laterally disposed on said shaft means having edges adjacent the edges of said first and second wheels, and said guide means further including a longitudinal slot in said shaft means, said longitudinal slot being aligned with the edges of said first and second wheels such that the filamentary material enters said tension means between said first and fourth wheels, loops around said third wheel and exits from said tension device between said second and fourth wheels.

5. The invention as recited in claim **4** wherein said first, second, third and fourth wheels have top surfaces, and said tension device further includes braking means contacting said top surfaces of said first, second and third wheels.

6. The invention as recited in claim **5** wherein said braking means includes a plurality of braking pads carried by a plate, and a cup-shaped spring adjustably applying a force to said plate to control the braking of said first, second, third and fourth wheels.

7. The invention as recited in claim **1** wherein said circumferential groove has a plurality of spaced teeth therein adapted to pull the coiled filamentary material from said needle portion of said mandrel means.

8. The invention as recited in claim **7** wherein said teeth have first and second legs extending radially along said first and second sides of said circumferential groove to define spaces between said first and second legs, and said needle portion of said means is inserted in said spaces.

9. A coiling machine comprising

rotatable shaft means having a supply end and a hollow coiling end;

supply means for supplying a continuous filamentary material to said supply end of said rotatable shaft means;

mandrel means having a shank portion disposed within said hollow coiling end of said shaft means and a needle portion extending from said shank portion;

said shaft means including guide means for supplying the filamentary material from said supply end to said mandrel means at said coiling end;

holding means capturing said needle portion of said mandrel means to maintain said mandrel means stationary while shaft means rotates such that the filamentary material is coiled around said needle portion; and

support means disposed in said hollow coiling end of said shaft means to rotatably support said mandrel means whereby said mandrel means is movable within said shaft means when said needle portion is not captured by said holding means;

said support means including a mandrel holder having a central bore therethrough receiving said shank portion of said mandrel means, a portion of said mandrel holder being cut away to expose said shank portion in said central bore, and clamping means disposed in said cut away portion of said mandrel holder for adjustably clamping said shank portion of said mandrel means to said mandrel holder.

10. The invention as recited in claim **9** wherein said mandrel means includes a diamond interconnecting said shank portion and said needle portion, and said mandrel holder has an end with a curved surface thereon which is aligned with said diamond by adjusting said clamping means.

11. The invention as recited in claim **10** wherein said coiling end of said shaft means has a conical head secured thereto, said head having a slot aligned with said guide means and a second central bore therethrough receiving said mandrel holder, said clamping means includes deformable pad means disposed on the exposed surface of said cut away portion of said mandrel holder and a clamping member disposed on said pad means, and said support means includes a cylindrical sleeve surrounding said clamping member and said mandrel holder and means forcing said clamping member against said pad means and away from said sleeve to deform said pad means to engage said sleeve and said shank portion of said mandrel means.

12. The invention as recited in claim **11** wherein said pad means includes a pair of elongated polyurethane pads disposed closer to said sleeve than to said shank portion of said mandrel means whereby said pads will engage said sleeve prior to engaging said shank portion of said mandrel means.

13. The invention as recited in claim **12** wherein said holding means includes a rotatable curing wheel having a circumferential groove therearound and a roller having an outer surface positioned adjacent said circumferential groove, said needle portion of said mandrel means being positioned adjacent said outer surface of said roller and inserted in said circumferential groove to prevent rotation of said mandrel, said guide means includes tension means having first and second wheels longitudinally disposed on said shaft means and third and fourth wheels laterally disposed on said shaft means having edges adjacent the edges of said first and second wheels, and said guide means further includes a longitudinal slot in said shaft means, said longitudinal slot being aligned with the edges of said first and second wheels such that the filamentary material enters said tension means between said first and fourth wheels, loops around said third wheel and exits from said tension means between said second and fourth wheels.

14. The invention as recited in claim **13** wherein said circumferential groove has a plurality of peripherally spaced teeth therein, said teeth having legs extending radially along the sides of said circumferential groove to define lateral spaces therebetween, and said needle portion of said mandrel means is inserted in said spaces.

15. Apparatus for simultaneously forming a pair of coiled filaments for use in a slide fastener comprising

first rotatable shaft means receiving a first continuous filamentary material at a first supply end and having first guide means delivering the first filamentary material to a first hollow coiling end;

a first mandrel having a first shank portion disposed in said first coiling end of said first shaft means and

a first needle portion extending from said first shank portion and receiving the first filamentary material;

second rotatable shaft means receiving a second continuous filamentary material at a second supply end and having second guide means delivering the second filamentary material to a second hollow coiling end;

a second mandrel having a second shank portion disposed in said second coiling end of said second shaft means and a second needle portion extending from said second shank portion and receiving the second filamentary material;

a rotatable curing wheel having first and second laterally spaced circumferential grooves, said first needle portion of said first mandrel being inserted in said first circumferential groove and said second needle portion of said second mandrel being inserted in said second circumferential groove;

first holding means disposed adjacent said first needle portion of said first mandrel and said first circumferential groove to capture said first needle portion and maintain said first mandrel stationary such that the first filamentary material is coiled around said first needle portion as said first shaft means rotates; and

second holding means disposed adjacent said second needle portion of said second mandrel and said second circumferential groove to capture said second needle portion and maintain said second mandrel stationary such that the second filamentary material is coiled around said second needle portion as said second shaft means rotates.

16. The invention as recited in claim **15** wherein said first and second circumferential grooves have a plurality of teeth disposed therein to remove the first and second coiled filamentary materials from said first and second needle portions, said first circumferential groove has first and second side walls terminating in first and second annular shoulders, said second circumferential groove has third and fourth side walls terminating in third and fourth annular shoulders, a first stationary insulating band is slidably disposed on said first and second annular shoulders, and a second stationary insulating band is slidably disposed on said third and fourth annular shoulders.

17. The invention as recited in claim **16** wherein said first stationary insulating band is secured to a first anchor, said second stationary insulating band is secured to a second anchor, said first holding means includes a first roller spaced adjacent said first stationary insulating band, said second holding means includes a second roller spaced adjacent said second stationary insulating band, said first and second rollers are disposed at diametrically opposite positions with respect to said curing wheel, and said first and second anchors are disposed at diametrically opposite positions with respect to said curing wheel

18. The invention as recited in claim **17** wherein each of said first and second guide means includes a tension device having first and second wheels longitudinally disposed on said shaft means and third and fourth wheels laterally disposed on said shaft means having edges adjacent the edges of said first and second wheels, and each of said first and second guide means further includes a longitudinal slot in said first and second shaft means, respectively, said longitudinal slot being aligned with the edges of said first and second wheels such that the first and second filamentary materials enter said tension devices between said first and fourth wheels, loop around said third wheel and exit from said tension devices between said second and fourth wheels.

19. The invention as recited in claim **18** wherein first support means is disposed in said first hollow coiling end of said first shaft means to rotatably support said first mandrel, said first support means including a first mandrel holder having a first central bore therethrough receiving said first shank portion of said first mandrel, a first portion of said first mandrel holder being cut away to expose said first shank portion in said first central bore, first deformable pad means disposed on the exposed surface of said first cut away portion of said first mandrel holder, a first clamping member disposed on said first pad means, a first cylindrical sleeve surrounding said first clamping member and said first mandrel holder, and first means forcing said first clamping member against said first pad means and away from said first sleeve deform said first pad means to engage said first sleeve and said first shank portion of said first mandrel, and second support means is disposed in said second hollow coiling end of said second shaft means to rotatably support said second mandrel, said second support means including a second mandrel holder having a second central bore therethrough receiving said second shank portion of said second mandrel, a second portion of said second mandrel holder being cut away to expose said second shank portion in said second central bore, second deformable pad means disposed on the exposed surface of said second cut away portion of said second mandrel holder, a second clamping member disposed on said second pad means, a second cylindrical sleeve surrounding said second clamping member and said second mandrel holder, and second means forcing said second clamping member against said second pad means and away from said second sleeve to deform said second pad means to engage said second sleeve and said second shank portion of said second mandrel.

20. The invention as recited in claim **19** wherein first yoke means is secured to said first supply end of said first shaft means and rotatable therewith, a first spool carrying the first filamentary material is rotatably supported by said first yoke means, second yoke means is secured to said second supply end of said second shaft means and rotatable therewith, and a second spool carrying the second filamentary material is rotatably supported by said second yoke means.

21. Apparatus for forming a slide fastener comprising, in combination,

first rotatable shaft means receiving first continuous filamentary material;

first stationary mandrel means disposed in said first rotatable shaft means and receiving the first filamentary material, said mandrel means including a needle portion;

first holding means capturing said needle portion of said first mandrel means to maintain said mandrel means stationary while said first shaft means rotates such that said first filamentary material is

coiled around said needle portion to form a first coiled filament;

second rotatable shaft means receiving second continuous filamentary material;

second stationary mandrel means disposed in said second rotatable shaft means and receiving the second filamentary material, said mandrel mean including a needle portion;

second holding means capturing said needle portion of said second mandrel means to maintain said mandrel means stationary while said second shaft means rotates such that said second filamentary material is coiled around said needle portion to form a second coiled filament;

curing means receiving the first and second coiled filaments form said first and second mandrel means and heating the first and second coiled filaments to destroy the memory of the material;

weaving apparatus for weaving first and second halves of a slide fastener tape with a plurality of warp threads and a filler thread; and

supply means delivering said first and second coiled filaments from said curing means to said weaving apparatus and positioning said first and second coiled filaments for weaving into the first and second halves of the slide fastener tape as warp threads whereby a slide fastener is automatically formed from warp threads, filler threads and continuous filamentary material.

22. The invention as recited in claim **21** wherein said curing means includes a curing wheel having first and second laterally spaced circumferential grooves therein, said first and second mandrel means have first and second needle portions inserted in said first and second circumferential grooves, respectively, and said supply means includes stripping means for removing said first and second coiled filaments from said first and second grooves in said curing wheel.

23. The invention as recited in claim **22** wherein said first mandrel means is rotatably supported in said first shaft means, said second mandrel means is rotatably supported in said second shaft means, first holding means cooperates with said first groove in said curing wheel to capture said first needle portion to maintain said first mandrel means stationary, and second holding means cooperates with said second groove in said curing wheel to capture said second needle portion to maintain said second mandrel means stationary.

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