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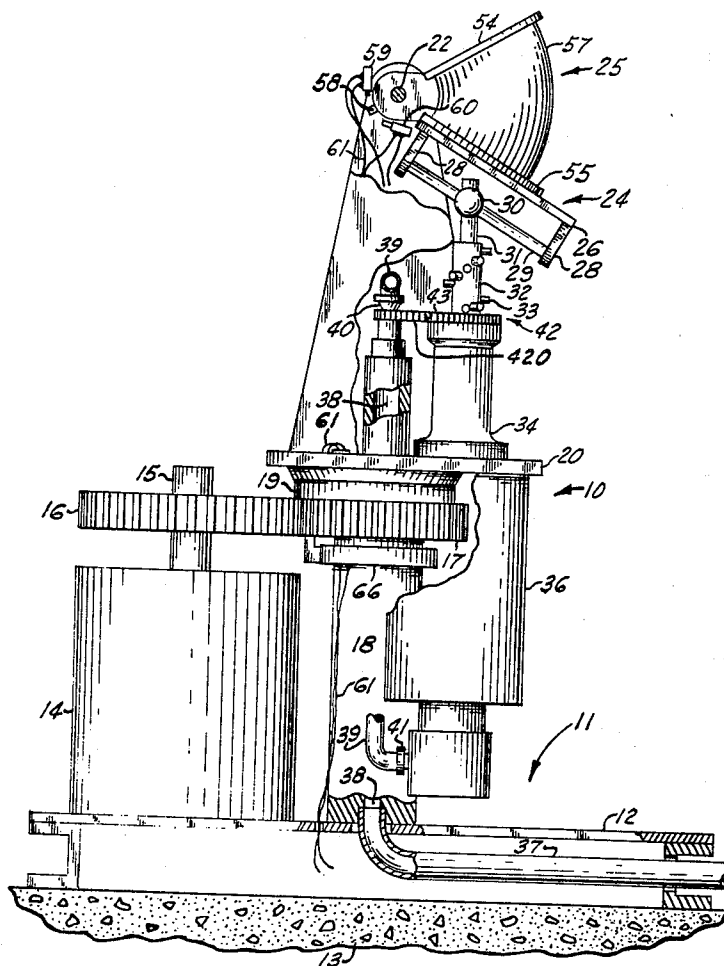
[54] INDEXING MECHANISM FOR A FILAMENT WINDING MACHINE

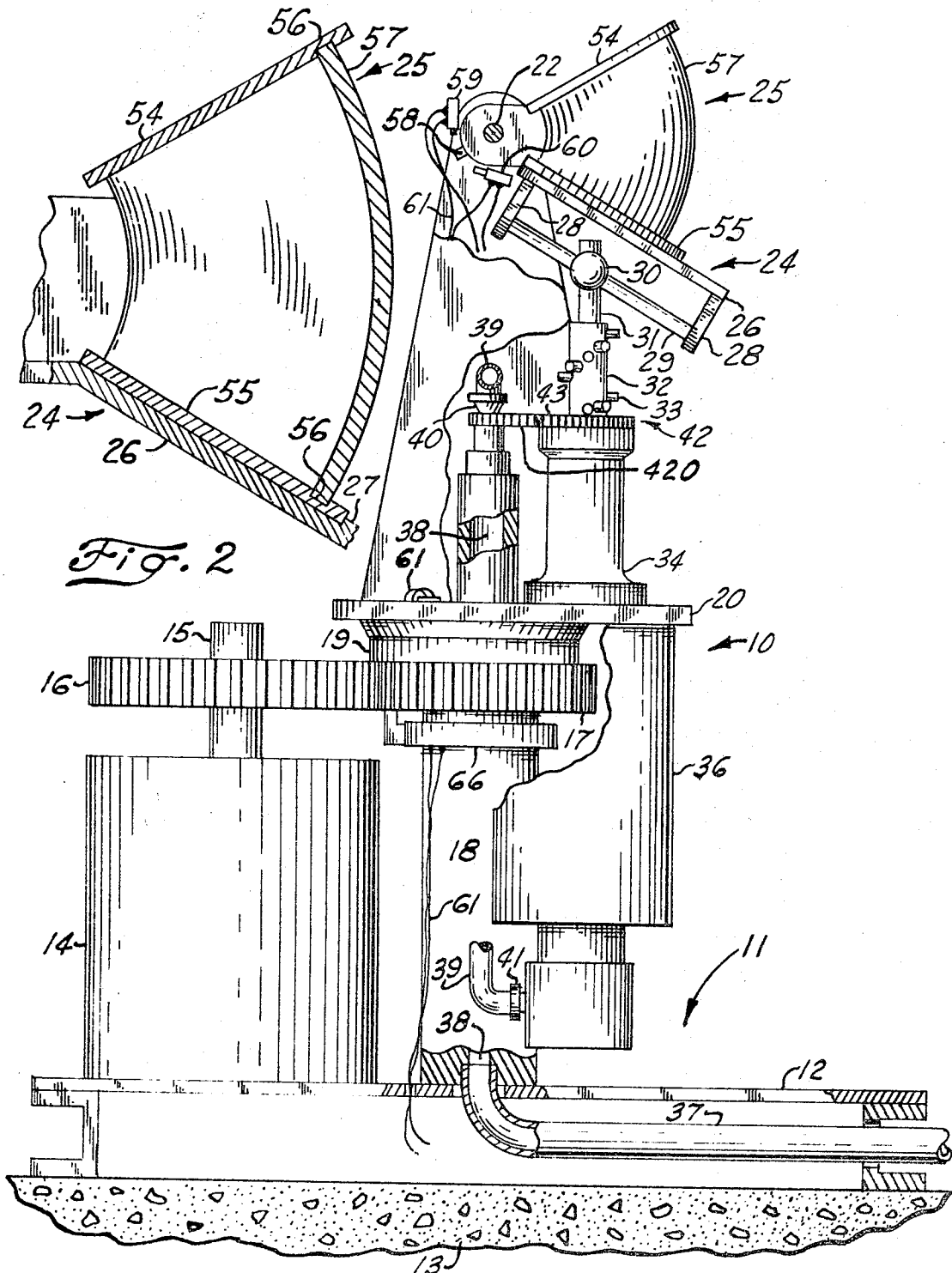
10 Claims, 6 Drawing Figs.

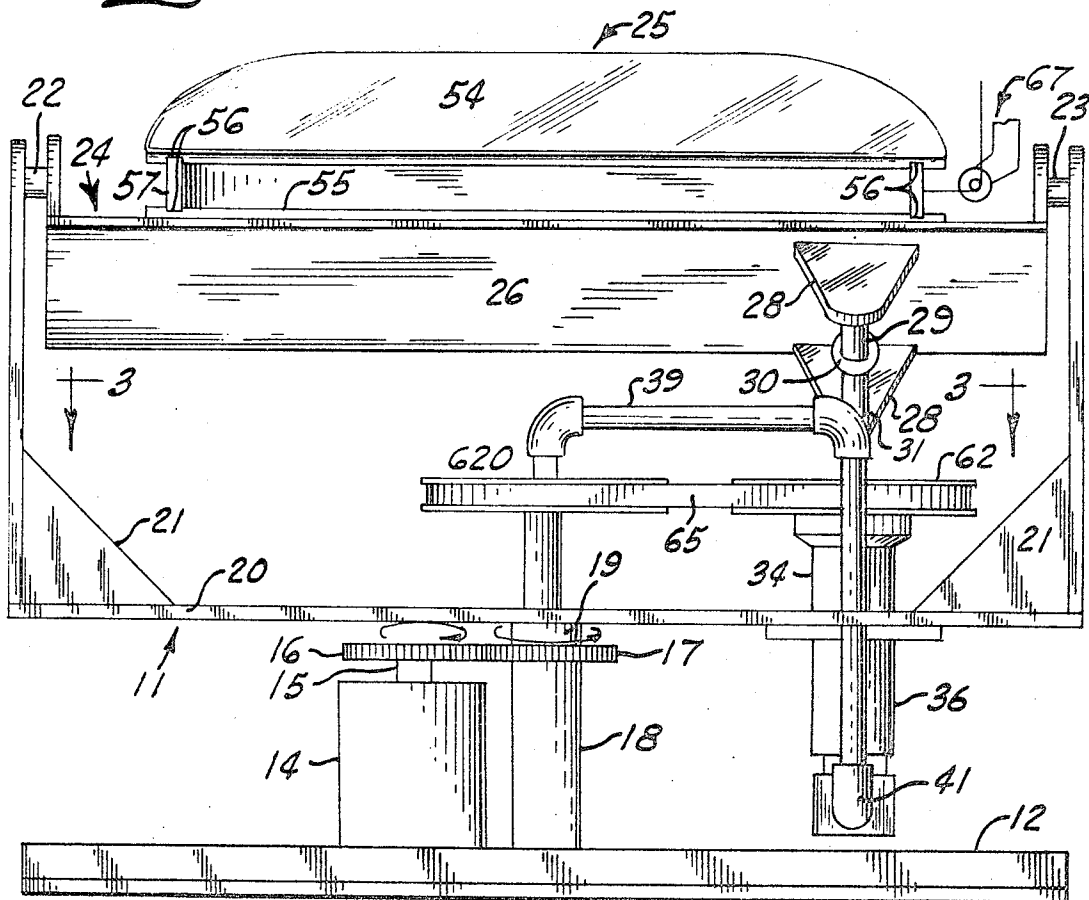
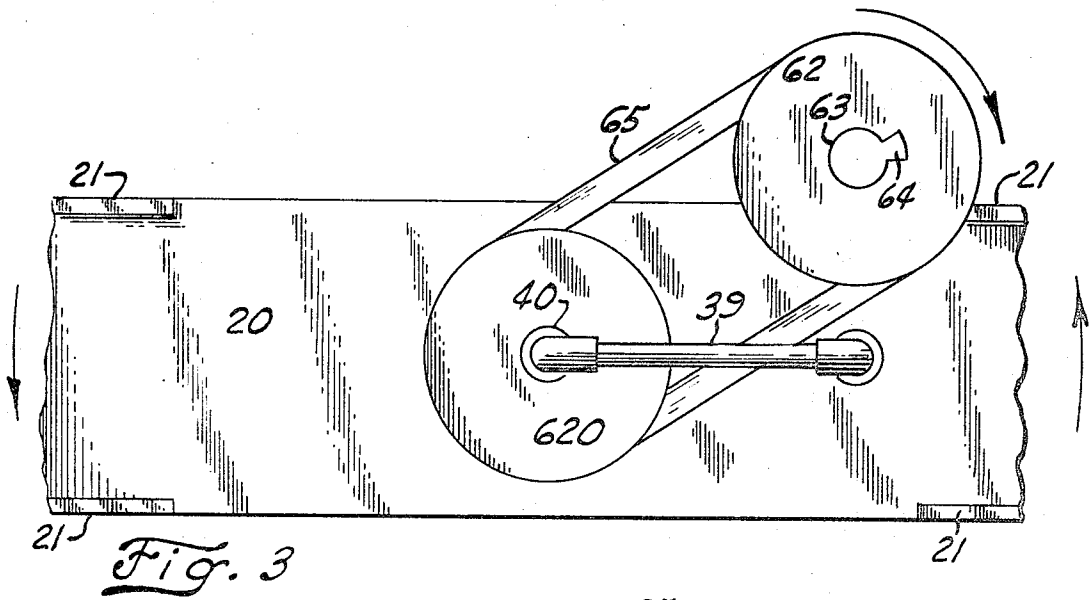
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ABSTRACT: This winding machine includes a frame rotatably driven to wind filament onto a mandrel carried on the frame. To distribute the windings, the frame has an oscillated cradle pivoted thereon to support the mandrel. The cradle is oscillated by an indexing means which includes a shaft with a helically arranged row of pins projecting at right angles from the shaft. The shaft projects through a rotated indexing plate having one or more apertures which are aligned with succeeding pins to allow stepwise longitudinal movement of the shaft which is connected by linkage to the cradle to oscillate same and the mandrel carried thereby. The shaft is urged to move in either direction by an air motor controlled by limit switches actuated by the mandrel to reverse the direction of movement of the shaft.



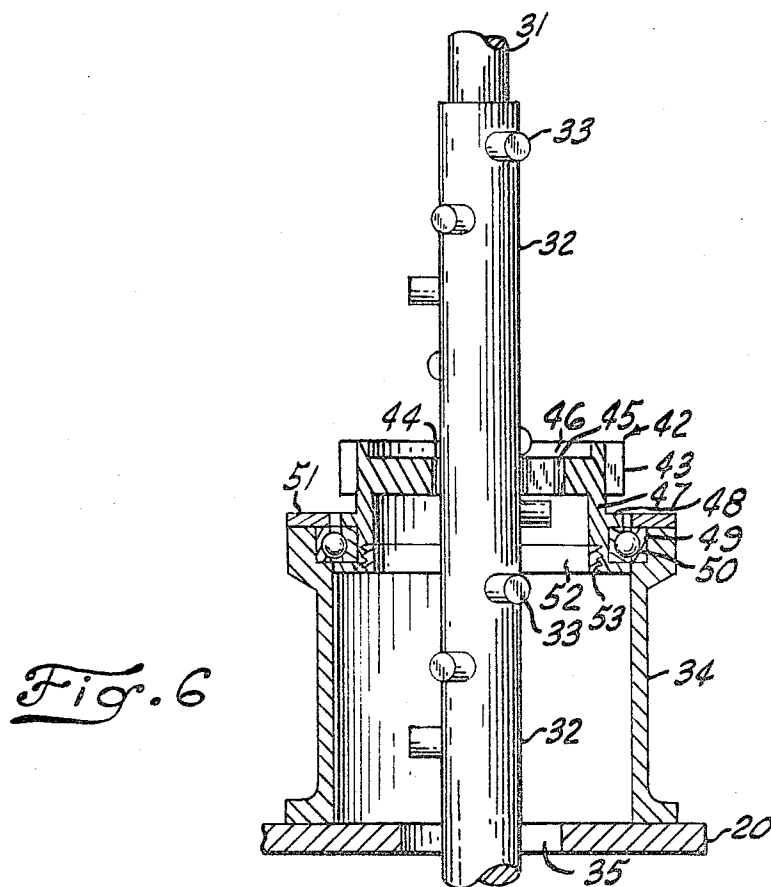
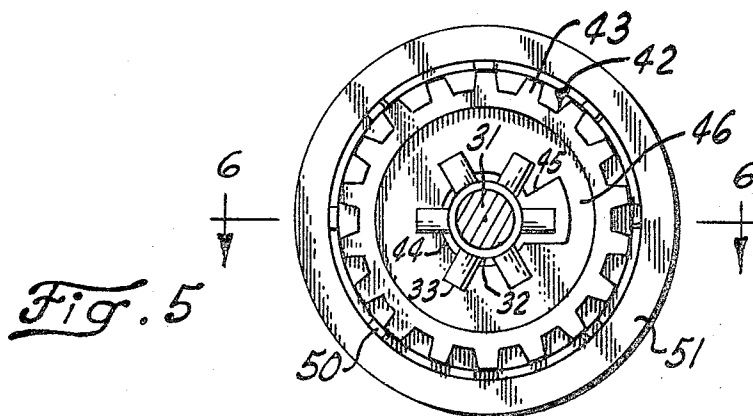




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INDEXING MECHANISM FOR A FILAMENT WINDING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

Many types of winding machines for producing filament wound pressure vessels have been developed wherein filaments have been wound onto a mandrel in spaced transverse contactual relation to each other, as well as in longitudinal spaced contactual relation to each other. Winding machines have also been developed wherein segments such as in the "Barrel Stave" concept of pressure vessels have been wound and then later assembled to provide the pressure vessel.

The instant invention relates to an indexing mechanism for the type of winding machine that provides synchronized rotation and oscillation of a mandrel for the winding machine so that each strand or filament is wound in a predetermined relation to the next successive strands or filaments that are wound onto the mandrel so that all strands or filaments are wound onto the mandrel at a desired predetermined angle and having the same tension applied thereto.

2. Description of the Prior Art

There have been many guide systems developed for winding machines for guiding the filament as it is wound on the mandrel to meet certain requirements as to spacing, tension and etc., but it is believed that the indexing mechanism embodying the instant invention is unique as to the guide systems that are in use at the present time.

SUMMARY OF THE INVENTION

This invention relates to improvements in winding machines and more particularly to an indexing mechanism for a filament winding machine whereby the rotating and oscillating movement of the mandrel for the winding machine is synchronized so that the filaments are wound thereon in longitudinal contactual relation to each other.

Motor cases for solid propellant rocket motors are conventionally fabricated from metal, but attempts have been and are being made to fabricate such motor cases from filaments that are wound on a mandrel that is contoured to conform to the final desired shape of the motor case, and this same procedure also applies to pressure vessels. The filaments have been wound on the mandrels longitudinally thereof, as well as transversely thereof and one concept of motor case or pressure vessel has been termed the "Barrel Stave" concept.

This concept involved the winding of the filament onto segments similar to barrel staves and then assembling such segments to provide a unitary walled construction. Difficulties were encountered in winding the filaments onto the segments and the instant invention contemplates the use of an indexing mechanism that controls the movement of the mandrel on which the filaments are wound longitudinally in spaced contactual relation to each other to provide a uniform layer of filaments on the segments that can be later assembled to provide an excellent motor case or pressure vessel.

An object of this invention, therefore, is to provide an indexing mechanism that will synchronize the rotation and oscillation of the mandrel to permit filament to be wound thereon in longitudinal spaced contactual relation to each other.

Some winding machines layup filaments on the mandrel at an angle in overlapping relation to each other and such procedure lowers the composite strength of the filaments. The instant invention contemplates laying the filaments on the mandrel in longitudinal side by side contactual relation to each other whereby the full advantage of the maximum effective strength of the filament is accurately obtained in an economical manner. Thus, if the full strength of the filament can be utilized, a motor case or pressure vessel of a higher strength to weight ratio can be obtained, a great advantage over the winding machines that produce helically or polar wound motor cases or pressure vessels wherein the full maximum strength of the filaments are not utilized.

Another object of this invention, therefore, is to provide an indexing mechanism that will correlate the winding of filaments onto a mandrel so that the maximum strength of the filament is utilized.

With the above and other objects and advantages in view, as may appear to one skilled in the art, the invention consists of the novel details of construction, arrangement and combination of parts more fully hereinafter described, claimed and illustrated in the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view partly in section and partly broken away illustrating the indexing mechanism embodying the instant invention;

FIG. 2 is an enlarged detailed sectional view broken away showing the construction of the mandrel;

FIG. 3 is a sectional view, partly broken away and taken on the line 3-3 of FIG. 4;

FIG. 4 is a schematic view of the manner in which the mandrel is mounted in relation to the winding machine with which the index mechanism embodying the invention is associated;

FIG. 5 is a transverse sectional view of the indexing spindle of the indexing mechanism; and

FIG. 6 is a sectional view, partly in elevation and partly broken away of the indexing spindle and an indexing gear plate mounted thereon and is on the line 6-6 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more in detail to the drawings wherein like parts are designated by like reference numerals, the reference numeral 10 is used to generally designate the indexing mechanism embodying the invention.

The indexing mechanism is used with a winding machine 11, more fully shown in a schematic view thereof in FIG. 4, and as shown is mounted on a base 12 which is positioned on a floor or other suitable support 13 of conventional structure.

An electric motor 14 for the operation of the winding machine 11 is mounted on the base 12 and has a drive shaft 15 to which is secured a suitable gear 16. The gear 16 engages and meshes with a second gear 17 which is mounted for rotation on a standard 18 that is also mounted on the base 12 adjacent to the electric motor 14.

The gear 17 is secured by a suitable boss 19 to the undersurface of a U-shaped frame 20 that is equipped with reinforcing corner plates 21. The frame 20 is pivoted at diametrically opposed pivot points 22 and 23 to a cradle structure 24 on which is mounted a mandrel 25.

The cradle structure 24 comprises a bed plate 26 on the upper surface of which is secured within a seat 27 the mandrel 25 and adjacent to one end of the bed plate 26 there is secured to the undersurface thereof in spaced parallel right-angular relation thereto a pair of mounting plates 28 and extending between the plates 28 is a mounting bar 29 that is slidably mounted in a uniball joint 30.

As shown in FIG. 1 the uniball joint 30 is on the upper end of an indexing spindle 31 for the indexing mechanism 10. The spindle 31 comprises an enlarged portion 32 to which is secured, in predetermined staggered helical relation to each other, a plurality of indexing pins 33.

The spindle 31 is mounted for reciprocal movement within a tubular standard 34 that is mounted on the uppersurface of the frame 20 and extends therethrough by means of an opening 35 in the frame 20 to be connected to an air motor 36 that is secured to the undersurface of the frame 20 in axial alignment with the standard 34.

An under pressure for the operation of the air motor 36 is supplied from a suitable source, not shown, by means of a conduit 37 that extends through the base 12 to be connected to the lower end of the standard 18 in communication with a passageway 38 within the standard 18. A second conduit 39 is connected at one end by a swivel connection 40 to the upper end of the standard 18 in communication with the passageway

38 and at the other end by a coupling 41 to the air motor 36, as shown in FIGS. 1 and 4.

Referring more specifically to FIGS. 5 and 6, wherein there is shown that an indexing plate in the form of a gear 42 having a row of peripheral gear teeth 43 thereon, coacts directly with the spindle 31 and the indexing pins 33, by means of a central opening 44 therein, having a radially extending slot 45 communicating therewith through which the indexing pins 33 will pass, as will be later described, and the indexing pins 33 are recessed within a circular cavity 46 that is provided in the upper surface of the indexing gear 42 within the inner surface of the row of gear teeth 43.

Depending below the undersurface of the indexing gear 42 is an annular flange 47 that is within the outer ends of the row of gear teeth 43 and extending outwardly from the outersurface of the flange 47, at right angles thereto, is an annular rib 48 that forms half of a seat 49 for a ball race 50, the other half of the seat 49 being provided in the upper inner peripheral edge of the standard 34. An annular ring 51, positioned on the upper edge of the standard 34 in spaced relation to the rib 48, assists in retaining the ball race 50 in the seat 49 with the aid of an annular retaining ring 52 that is threadably engaged at 53 with the lower annular edge of the flange 47 and the gear teeth 43 mesh with and engage a gear 42 that is fixed to the upper end of the standard 18 below the swivel connection 40.

Viewing FIG. 2, it will be noted that the mandrel 25 comprises outer diverging plates 54 and 55, each having a seat 56 on the inner surfaces thereof adjacent the outer ends thereof to receive a circular curved forming plate 57 that is contoured to achieve the desired barrel stave configuration. The mandrel 25 also has at the rear thereof a switch operating stud 58 which will engage and operate electric switches 59 and 60 that are supplied with an electric current by leads 61 that are connected to the air motor 36 and to any well-known source of electrical current, and the purpose of the stud 58 and switches 59 and 60 will be later described.

Also it will be noted that in FIGS. 3 and 4, an indexing plate in the form of a pulley 62, having a central opening 63 and a radially extending slot 64, has been used in lieu of the indexing gear 42 and a pulley 62 is fixed to the upper end of the standard 18 and has replaced the gear 42, shown in FIGS. 1, 5 and 6, a V-belt 65 encircles the indexing pulley 62 and the fixed pulley 62 for the operation thereof, as will be later described.

Basically the winding machine 11 comprises a U-shaped frame 20 which is rotated about a standard 18 by means of a gear 17 rotatably mounted thereon that is secured to the U-shaped frame 20 by the boss 19. An electric motor 14, by rotating a gear 16 mounted on the drive shaft thereof that is in meshing engagement with the gear 17, rotates the U-shaped frame 20 as stated.

Mounted for oscillating movement within the U-shaped frame 20, by means of pivots 22 and 23, is the cradle structure 24 and the mandrel 25 mounted in the cradle structure 24, will rotate with the U-shaped frame 20 and oscillate within the cradle structure 24 by means of pivots 22 and 23.

As previously stated, the cradle structure 24 is connected to the spindle 31 of the mechanism 10 by means of the uniball joint 30. The spindle 31 is connected to the air motor 36 which controls the step by step oscillation of the mandrel 25 by means of the indexing mechanism 10. The reversal of the air motor 36 is controlled by the indexing mechanism 10. The reversal of the air motor 36 is controlled by the engagement of the stud 58 with the switches 59 and 60 and the leads have a brush and slip ring assembly 66 interpolated therein to maintain the supply of the electric current to the switches 59 and 60 as the U-shaped frame 20 rotates.

A segment for the barrel stave concept is mounted on the mandrel 25 in contact with plate 57 intermediate of plates 54 and 55 and a filament is fed to the mandrel 25, as shown at 67. Thus, as the mandrel 25 is rotated, the filament is wound thereon parallel to the longitudinal center line thereof.

During one-half of the rotation of the mandrel 25 the filament is wound onto the segment on the mandrel 25, during the

other half the filament extends across the rear of the mandrel and it is during this half of the rotation of the mandrel 25 that the indexing mechanism 10 will oscillate the mandrel 25 so that the filament will now be wound on the mandrel 25 in longitudinal contactual relation with the first filament wound on the mandrel 25 until successive filaments are wound to provide a complete layer on the segment and successive layers may be wound on the first layers if required.

The air motor 36 will move the spindle 31 upwardly or downwardly and it is during either of these movements that the indexing mechanism 10 operates.

During the rotation of the mandrel 25 the rear arrangement shown in FIG. 1 or the pulley arrangement shown in FIGS. 3 and 4 will cause the indexing gear 42 or the indexing pulley 62 to rotate and move the spindle 31 in a downward direction of reciprocation, one of the pins 33 will engage the upper surface of the indexing gear 42 or the indexing pulley 62 until it drops through the slot 45 in the indexing gear 42 or the slot 64 in the indexing pulley 62 and the next pin 33 will engage the upper surface of the indexing gear 42 or indexing pulley 62, at this time the air motor, which continually extends a downward pressure on the spindle 31, will move the spindle 31 downwardly until it is stopped by the next successive indexing pin 33, as previously stated, and thus oscillate the mandrel 25 to receive thereon the filament in predetermined positions so that it is in contactual relation with the filament that has already been wound on the mandrel 25, thus, indexing will continue until the stud 58 engages the switch 59 at which time the action of the air motor 36 will be changed to reverse the movement of the spindle 31 and move it in an upward movement of reciprocation, during its upward movement the pins 33 will engage the undersurface of the indexing gear 42 and indexing pulley 62 and be moved upwardly through the respective slots 45 and 64, and such reciprocal action will be repeated until the exact required number of layers of filament have been wound onto the mandrel 25.

The U-shaped frame 20 rotates clockwise and the indexing gear 42 of indexing pulley 62 will rotate counterclockwise during the winding operation, but since the filament is wound onto the mandrel 25 under complete control of the indexing mechanism 10, there is no chance of the mandrel 25 being moved in either direction at the wrong time. After winding, the mandrel 25 is removed, the layers of filament are cured and trimmed and the segment is removed to be fabricated into a pressure vessel.

The indexing mechanism thus described is simple in construction and accurate in operation and requiring few parts is also economical to build.

I claim:

1. In a filament winding machine including a rotatable frame assembly having a mandrel pivoted therein for oscillating motion, the improvement comprising an indexing mechanism for imparting said oscillating motion to said mandrel, said indexing mechanism having incorporated therein a spindle having indexing pins extending therefrom at right angles thereto connected to said mandrel, a rotatable indexing plate having a circular central opening therein and a radially extending slot communicating with said opening, said spindle extending vertically through the opening in said indexing plate, whereby when said indexing pins are alternately aligned with the radially extending slot, said spindle will reciprocate to oscillate said mandrel and power means connected to the lower end of said spindle for the reciprocation thereof.

2. The improvement as in claim 1 wherein second power means is provided for rotating said frame assembly and said second power means is synchronized with the power means for reciprocating said spindle so that said filament winding machine will wind a filament on said mandrel longitudinally thereof so that the windings thereon are in longitudinal contactual relation to each other.

3. The improvement as in claim 1 wherein a switch actuating stud is mounted on said mandrel to actuate electrical switches upon contact therewith to reverse the oscillating motion of said mandrel.

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4. The improvement as in claim 1 wherein a cradle is pivotally connected to said mandrel and said spindle is pivotally connected to said cradle.

5. The improvement as in claim 1 wherein said indexing plate has a row of peripheral gear teeth thereon and a fixed gear is mounted for coaction with said gear teeth for the rotation of said indexing plate.

6. The improvement as in claim 1 wherein said indexing plate is a pulley, a fixed pulley is mounted adjacent said indexing plate and a belt engages said indexing plate and said fixed pulley for the rotation of said indexing plate.

7. The improvement as in claim 5 wherein a first tubular standard is mounted on said frame assembly, said spindle extends through said standard and said indexing plate is mounted for rotation on the upper end of said standard.

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8. The improvement as in claim 1 wherein the index pins are arranged on said spindle in staggered helical relation to the longitudinal axis of said spindle and to each other.

9. The improvement as in claim 1 wherein said mandrel comprises outer plates having seats therein adjacent the outer edges thereof and an intermediate contoured plate is positioned between said outer plates with the longitudinal edges thereof positioned in the seats in said outer plates.

10. The improvement as in claim 7 wherein a second tubular standard is mounted on said frame assembly adjacent said first tubular standard and said fixed gear is mounted on said second standard and an air supply to said power means for reciprocating said spindle is directed through said second standard to be connected to said power means.

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