Nov. 4, 1947. R. M. CONKLIN 2,430,105

COIL WINDING MACHINE

Filed Aug. 22, 1945 4 Sheets-Sheet 1

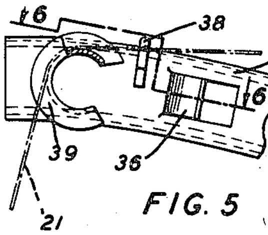
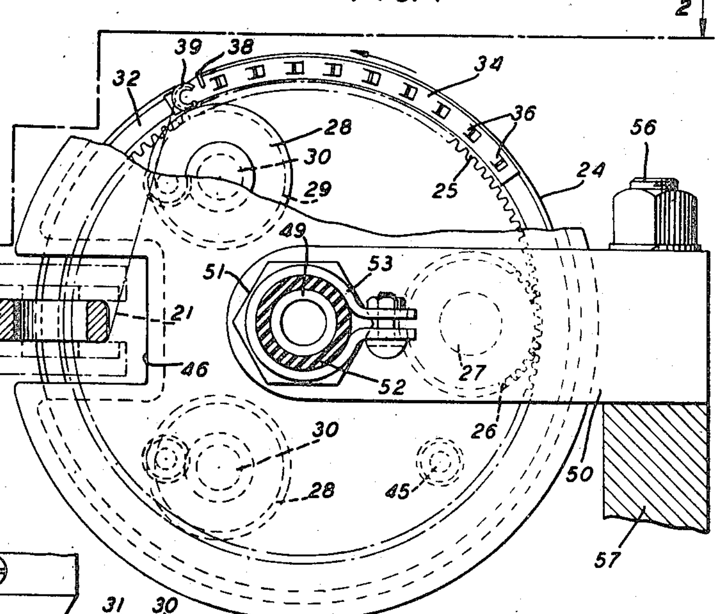


FIG. 5

FIG. 1



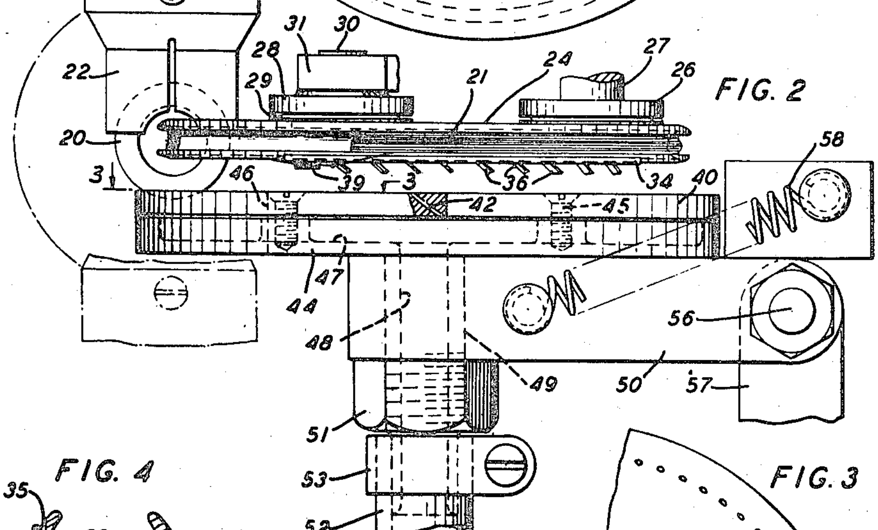


FIG. 2

FIG. 4

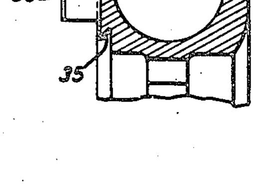


FIG. 3

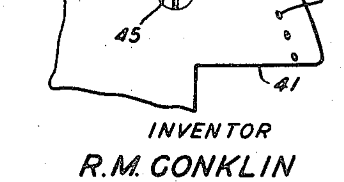


FIG. 6

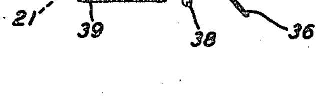


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FIG. 8

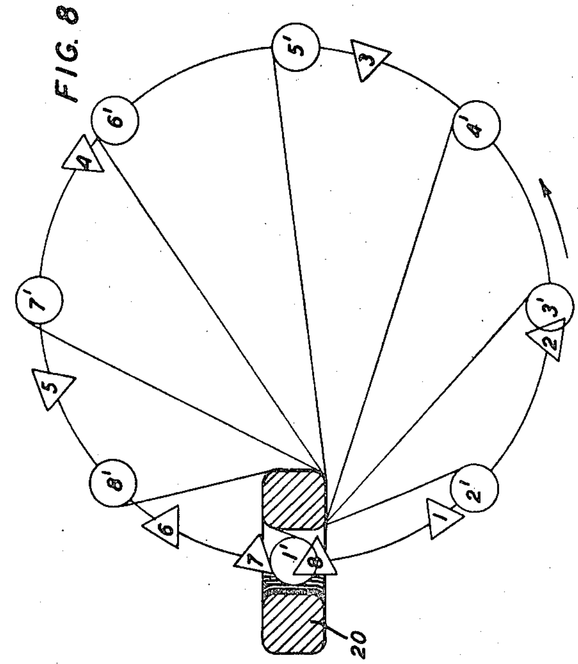


FIG. 7

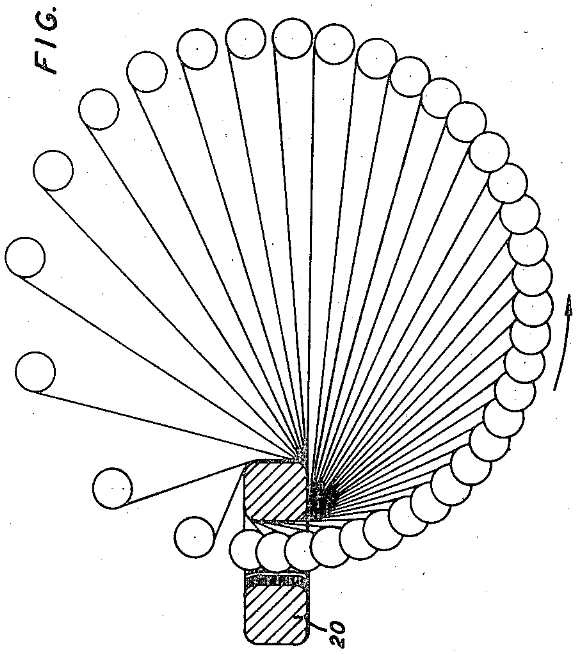
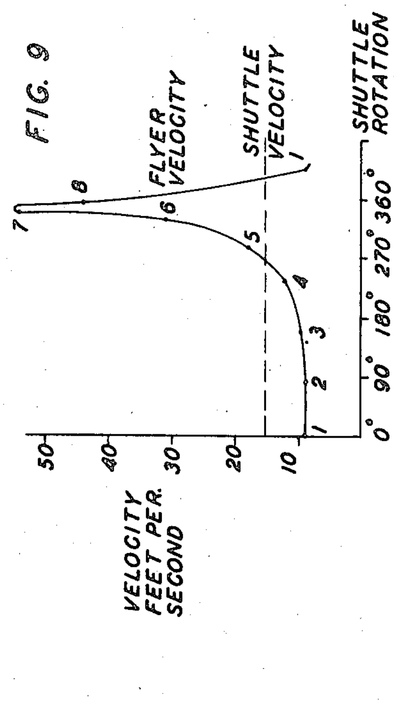


FIG. 9



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COIL WINDING MACHINE

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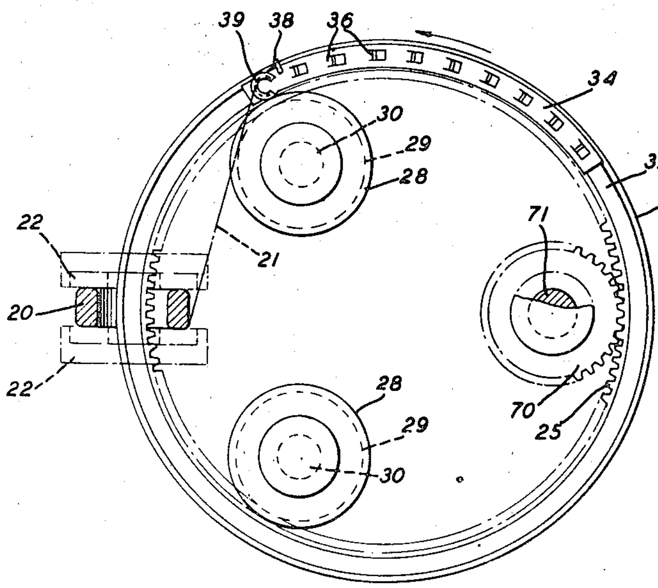

FIG. 10

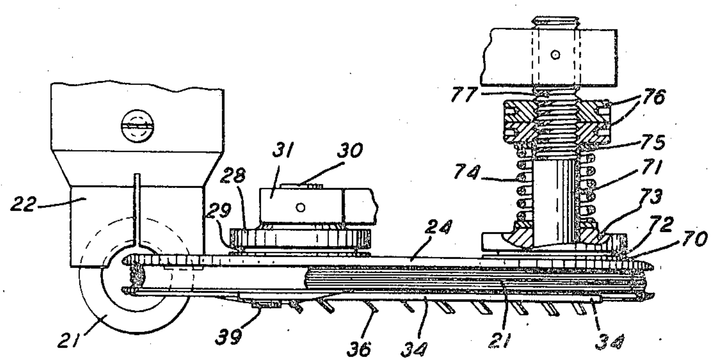

FIG. 11

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FIG. 12

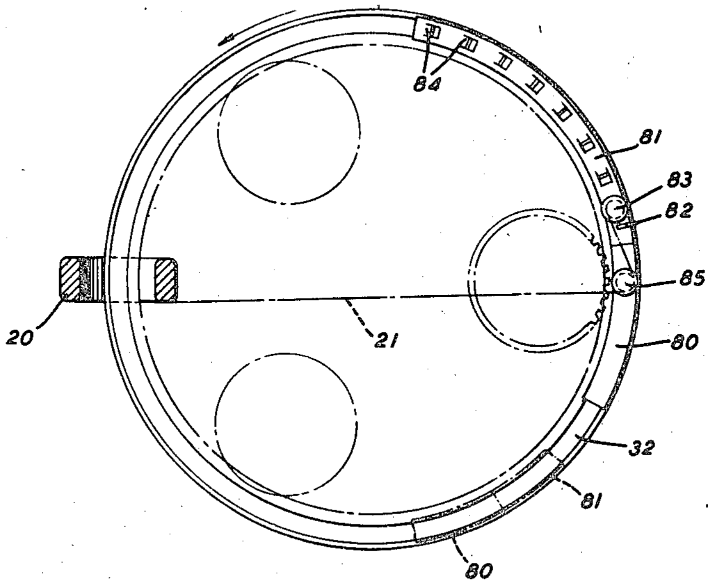
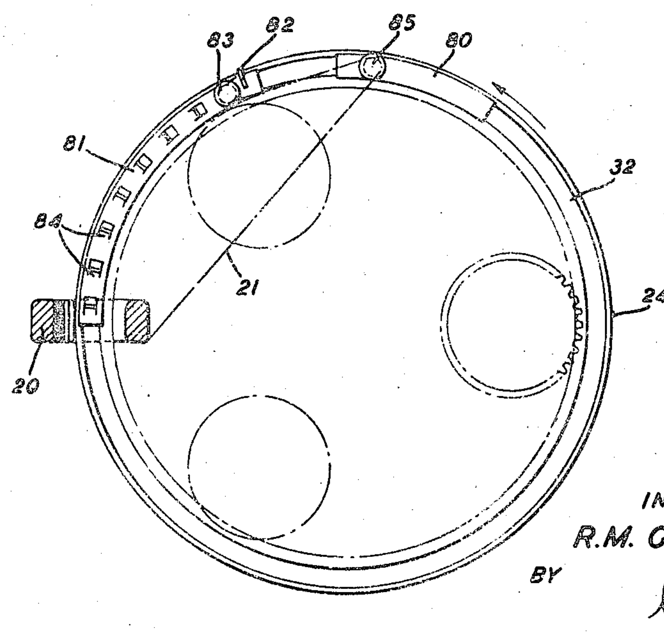


FIG. 13



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Patented Nov. 4, 1947 **2,430,105**

UNITED STATES PATENT OFFICE

2,430,105

COIL WINDING MACHINE

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Application August 22, 1945, Serial No. 611,933

10 Claims. (Cl. 242—4)

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This invention relates to coil winding machines, particularly those of the toroidal winding type and the primary object of the invention is a machine for winding such coils in which the wire is maintained under substantially constant tension throughout the winding operation.

Present standard machines of this general type have winding rings equipped with wire guides and supplies of wire and traveling in circular paths which extend through the annular cores upon which the wires are being wound. During the travel of the wire guide in each instance to the point farthest from the core, a length of wire is withdrawn from the ring to form one turn on the core. This length of wire in standard practice forms a loop during the travel of the wire guide from its position farthest from the core to its position after it has passed through the core. This loop is carried around and then suddenly pulled tight on the core thereby subjecting the wire to a sudden and abnormally high tension. Before the loops are tightened, the wire is free to whip from side to side and frequent overlapping of the turns occurs often to the extent of increasing the cross-sectional area of the coil by twenty or thirty per cent.

It is, of course, desirable to make these coils as small and compact as possible and this is particularly true when they are to be used in military communication systems where minimum volume and weight are of primary importance. The size of a coil of given electrical constants is largely determined by the diameter of the wire used and the size of central aperture of the finished coil. The aperture cannot be reduced beyond the diameter required for the passage of the wire guiding structure and with existing machines the wire must be at least number 38 (A. W. G.) in order to withstand the tension imposed on it when the loops are tightened.

Attempts have been made to control the loops by pulling them between spring backed plates before the wire passes to the core, but insofar as applicant is aware, none of these expedients have been successful in eliminating either the overlapping of the turns or the high tension produced when the loops are tightened on the core.

Broadly, this invention comprises a toroidal coil winding machine having an annular shuttle, for a supply of wire, movable in a circular path extending substantially through the center of a core and a fluid driven flyer mounted for movement, in a like circular path, relative to the shuttle and having a portion to guide the wire from the shuttle and around portions of the core, to create a

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constant tension in the wire and eliminate the formation of a loop therein.

More specifically, in one embodiment of the invention, a flyer is formed with a plurality of fins and is slidably mounted to travel on one side of the shuttle due to the force applied to it by jets of air directed toward the fins. This force causes the flyer to travel at variable speeds during the constant speed travel of the shuttle and creates a constant tension in the wire during the winding of each turn.

In another embodiment of the invention, the fluid driven flyer is caused to drive the shuttle through a pull on the wire necessary to create the desired tension, supported for free rotation with the exception of a brake applying means. The brake applying means causes a variable brake drag on the shuttle to vary the tension created in the strand by the flyer pulling the strand from the shuttle.

Another species of the invention includes a flyer formed of relatively movable members mounted for movement on the shuttle, portions being provided at adjacent ends of the flyer for the traveling of the wire from the shuttle to the core. The leading flyer member is provided with fins so that it may be driven by a fluid under pressure while the trailing member must be pulled by the wire. The frictional contact between the trailing member and the shuttle during the driving of the leading member by air under pressure results in the irregular movement of the flyer members in their circuitous path to maintain a constant tension on the wire.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, wherein

Fig. 1 is a fragmentary side elevational view of one species of the toroidal coil winding machine;

Fig. 2 is a fragmentary top plan view taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary detailed view taken along the line 3—3 of Fig. 2;

Fig. 4 is an enlarged sectional view of the shuttle and flyer;

Fig. 5 is an enlarged fragmentary side elevational view of the flyer;

Fig. 6 is a fragmentary sectional view taken along the line 6—6 of Fig. 5;

Fig. 7 is a schematic illustration of thirty-six positions of the flyer during constant shuttle velocity;

Fig. 8 is a schematic illustration of a plurality of positions of the flyer during given positions of the shuttle;

Fig. 9 is a graphical illustration of the travel of the flyer during one revolution of the shuttle;

Fig. 10 is a schematic illustration of another species of the invention wherein the fluid driven flyer drives the shuttle;

Fig. 11 is a top plan view of the structure shown in Fig. 10;

Fig. 12 is a schematic illustration of another species of the invention with the slider employed in conjunction with the fluid driven flyer; and

Fig. 13 is a similar view of the structure shown in Fig. 12, but with the flyer and slider at different positions.

Referring now to the drawings, attention is first directed to Figs. 1 to 6 inclusive, which illustrate one species of the invention.

In view of the fact that toroidal coil winding machines are well known, only those portions of the machine necessary to illustrate the invention are shown.

The annular core **20** upon which wire **21** is to be wound is held in a chuck or clamp **22**, the latter being supported for movement in a given path to repeatedly rotate the core **20** about its axis, a given number of one-half revolutions to cause distribution of the wire thereon.

The wire **21** in the present instance is a number 40 wire. A supply of this wire is stored upon a shuttle **24** in the conventional manner. In other words, the shuttle **24** may be provided with a section which is removable for the mounting of the annular core **20** in the chuck **22** with the shuttle extending substantially through the center of the core. After this has been accomplished, the shuttle may be driven in a reverse direction, from that in which it will be driven during the operation of the machine to wind the wire on the core, to fill the shuttle with a quantity of wire necessary for the coil to be wound therefrom. The shuttle is provided with gear teeth **25** at its inner periphery for interengagement with teeth of a gear **26**. The gear **26** is mounted upon a shaft **27** which may be driven in reverse directions by any suitable means (not shown). Idler rollers **28** have their peripheries grooved at **29** to receive the teeth **25** of the shuttle **24** and to cooperate with the gear **26** in supporting the shuttle for rotation about its axis. The rollers **28** are mounted upon shafts **30**, the latter being journalled in suitable bearings **31** of a supporting structure (not shown). An annular projection or track **32**, having a dovetail cross-sectional contour, as illustrated in Fig. 4 is formed at one side of the shuttle, including the removable section thereof, to provide a circular and continuous track for a flyer **34**.

The flyer **34** is light in weight, yet sufficiently durable in structure to control the winding of the wire to the core. The flyer **34** has a general arcuate contour with inwardly projecting edges **35** to conform to the track **32**. There is sufficient clearance, however, between the flyer and the track for free movement of the flyer relative to the shuttle. Fins **36**, stamped out of the material of the flyer, project outwardly at like angles as shown in Fig. 2. The leading end of the flyer is provided with a hook member **38** and a sheave or wire guide **39** to control the wire passing from the shuttle to the core as illustrated in Fig. 2.

Means is provided to direct a fluid under pressure to the fins **36** of the flyer to cause the flyer to travel on its track about the shuttle and through the core **20**. This means includes the plate **40**, cylindrical in general contour, but having a cutaway portion at **41** to allow for the movement of the chuck **22** from its solid line position (Fig. 2) to its dotted line position. The plate **40** has a multiplicity of passageways **42** disposed in circular arrangement about the center of the plate which is in alignment with the center of the shuttle. The passageways **42** extend diagonally through the plate as illustrated in Fig. 2 for a purpose hereinafter described. The plate **40** is secured to a housing **44** by screws **45** to completely close the open side of the housing. The housing **44** conforms, in general, to the plate **40**, it also having a cutaway portion **46** to allow for movement of the chuck **22**. A hollow portion **47** of the housing **44** communicates with a passageway **48** in a hollow shank **49**. The shank **49** is threaded for a portion of its length and extends through an aperture in an arm **50** where it is secured in place by the aid of a nut **51**. A flexible hose **52** has one end secured by the aid of a clamp **53** to the outer end of the hollow shank **49**, the other end of the hose being connected to a suitable fluid supply through a variable drive pump or other means **54**. The arm **50** is pivotally supported at **56** upon a stationary member **57** and is normally held in the position shown by the aid of a spring **58**. To facilitate in the loading of the machine, it is possible to move the structure supported by the arm away from the shuttle and chuck.

During the operation of this embodiment of the invention, let it be assumed that the shuttle is loaded with a supply of the wire **21** and that a core **20** is mounted in the chuck **22** with the chuck at the starting position. The leading end of the wire is threaded beneath the hook or guide **38** and around the sheave or guide **39** after which it is secured in a conventional manner to the core. By operating a valve **60** in the fluid supply line, and starting the driving means for the shuttle, the machine will begin its operation. The fluid in the present instance is air under pressure which is forced in jets through the passageways **42** to impinge upon the fins **36** and thus provide a driving force for the flyer **34**, which is variable with variation in the pressure of the fluid. It will be noted that the openings in the flyer formed by the pressing out of the fins provide pockets which are closed by the flat surface of the shuttle or track **32**. The openings, therefore, do not provide outlets for the jets of air, but serve to provide pockets for the jets of air. Through the constant application of the driving force, namely, the fluid or air under pressure to the flyer, the latter is driven at a speed controlled by the wire **21**.

During the travel of the leading end of the flyer from a position adjacent the core to a position farthest from the core, a length of wire is being withdrawn from the shuttle to form the next turn of the wire on the core. During this interval, the flyer is traveling slower than the shuttle, the latter being driven at a constant rate of speed. As the flyer passes this position farthest from the core, a loop could be formed in the wire if the flyer traveled at the same speed as the shuttle. However, the constant application of the driving force to the flyer will cause it to travel at a faster rate of speed applying a constant tension on the wire to eliminate the formation of the loop. This point is illustrated in Fig. 9 where the dotted line illustrates the constant shuttle velocity, while the curved line illustrates the varying velocity of the flyer from its number one position shown in Fig. 8, represented by the triangular members through one complete cycle and back to the number one position. During the first four positions, the flyer is traveling slower than the shuttle, while during the last four positions, the speed of the flyer is increased so that it will constantly control the wire and eliminate the formation of the loop. A further illustration is given in Fig. 7 showing thirty-six positions of the flyer with like time intervals therebetween during constant shuttle velocity. In Fig. 8 a fewer number of positions of the flyer are illustrated by the triangular members during the constant velocity of the shuttle, the wire takeoff portions of the shuttle illustrated by the circular members with the numbers 1' to 8' shown therein.

The species shown in Figs. 10 and 11 embodies the same principles shown in Figs. 1 to 6, inclusive, and like reference numerals are directed to identical parts. The only difference between this species and that shown in Figs. 1 to 6, inclusive, is the driving means for the shuttle. In this structure, the shuttle is driven by the strand and the pull applied thereto through the movement of the flyer. The flyer is driven in the same manner by the jets of air under pressure. It is desirable, therefore, to provide free rotating supports for the shuttle in the form of the rollers 28 and a gear 70. The gear 70 is mounted for free rotation upon a shaft 71 and interengages the teeth 25 of the shuttle 24. A suitable brake member 72 carried by a disk 73 supported against rotation on the shaft 71 will apply a variable braking force on the gear 70 depending upon the force of a spring 74. The spring 74 is disposed concentric with the shaft 71 and interposed between the member 73 and a washer 75. Lock nuts 76 disposed upon a threaded portion 77 of the shaft may be adjusted to vary the force of the spring. Through this structure, a constant tension may be created in the wire which may require little braking force at the gear 70, added to the force necessary to rotate the shuttle through the pull on the wire. Otherwise, the operation of this species of the invention is identical to that of the structure shown in Figs. 1 to 6, inclusive.

The structure of the species shown in Figs. 12 and 13 is substantially identical with that shown in Figs. 1 to 6, inclusive, the only difference lying in the structure of the flyer. The shuttle being identical in structure to the shuttle 24 is given the same reference numeral. The flyer in this structure differs from the flyer 34 in that it is formed of two separate portions 80 and 81. Furthermore, a guide 82 and a sheave 83 are mounted adjacent the rearmost end of the portion 81 instead of at the leading end thereof. This portion is provided with fins 84 identical with the fins 36 and both portions of the flyer are formed to ride on the track 32 of the shuttle. The portion 80 is similar in structure to the portion 81 with the exception of the provision of fins therein. A sheave 85 is mounted upon the portion 80 adjacent the leading end thereof to receive the wire from the sheave 83. During the operation of this structure, it should be assumed that the shuttle is traveling at a constant speed and that the jets of air are causing movement of the flyer portion 81 at a speed controlled by the wire and the flyer portion 80. Although the portion 80 is formed to move freely on the track 32 of the shuttle, the existing resistance therebetween will cause it to move slower than the driven portion 81 when there is a tendency for the formation of any slack in the wire. In reality, there will be no slack in the wire, but during the travel of the flyer from its position farthest from the core 20 and until it has passed through the core, its speed of travel must be increased rapidly to maintain the constant tension on the wire. With this structure, the flyer portion 80 assists the flyer portion 81 in maintaining the constant tension on the strand by lagging behind as illustrated in Fig. 13. Although a loop is formed in the wire extending about the guides 83 and 85, there does not exist a loose loop or a portion of the wire which is out of control of the flyer. Furthermore, there will be no jerking or snapping of the wire, which would exist in the forming of a loose loop. The frictionally supported, air driven flyer, although described as consisting of two parts, may be further defined as flyer 81 and a slider 80. Considering the flyer portions in this manner, they act as a cushioning means for the wire, making it possible for the wire to drag the slider portion 80 toward the main flyer portion 81, should the tension in the wire be caused to increase at any point during the circular travel of the flyer. In operation, the portions 80 and 81 abut each other adjacent the dotted line positions shown in Fig. 12, but as they begin their travel toward the core, where the loop in general practice begins to form, the portion or slider 80 will lag behind as the flyer portion 81 is urged onward at a more rapid rate of speed to maintain the constant tension in the wire and uniformly lay the wire on the core.

Although specific improvements of the invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined by the appended claims.

What is claimed is:

1. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, a fin carried by the flyer, and means to direct a fluid under pressure to contact the fin and cause the flyer to move in its circular path to apply a constant tension on the wire being wound on the core.

2. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, and means to apply a constant driving force to the flyer to cause the flyer to wind the wire under a constant tension on the core.

3. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, and means to apply a con-

stant variable force to the flyer to cause movement of the flyer at variable speeds to wind the wire under a variable constant tension on the core.

4. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, a fin carried by the flyer, and a fluid control member having a substantially circular arrangement of passageways to direct jets of a fluid under pressure toward the path of the flyer to contact the fin and cause the flyer to move in its circular path to wind the wire on the core under a constant tension.

5. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, a fin carried by the flyer, a fluid control member having a substantially circular arrangement of passageways to direct jets of a fluid under pressure toward the path of the flyer to contact the fin and cause the flyer to move in its circular path to wind the wire on the core under a constant tension, and means to support the fluid control member for movement away from the flyer.

6. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, a fin carried by the flyer, a fluid control member having a substantially circular arrangement of passageways to direct jets of a fluid under pressure toward the path of the flyer to contact the fin and cause the flyer to move in its circular path to wind the wire on the core under a constant tension, means to support the fluid control member for movement away from the flyer, and means to normally hold the member adjacent the shuttle and parallel with the path of the flyer.

7. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a

flyer having a portion to guide the wire from the shuttle around the core, a circular track on the shuttle for the flyer, and means to apply a constant driving force to the flyer to cause the flyer to wind the wire under a constant tension on the core.

8. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer having a leading portion and a trailing portion both movable in a circular path relative to the shuttle through the core, a guide member on the leading flyer portion to receive the wire from the shuttle, a guide member on the trailing flyer portion to receive the wire from the leading flyer portion and guide it to the core, means to drive the leading flyer portion to cause winding of the wire on the core, the trailing flyer portion being driven by the wire.

9. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer having a leading portion and a trailing portion both movable in a circular path relative to the shuttle through the core, a guide on the leading flyer portion to receive the wire from the shuttle, a guide member on the trailing flyer portion to receive the wire from the leading flyer portion and guide it to the core, a fin carried by the leading flyer portion, and means to direct a fluid under pressure to contact the fin and cause the leading flyer portion to move in its circular path to apply a constant tension on the wire, the trailing flyer portion being driven by the wire.

10. In a toroidal coil winding machine, a rotatable support for an annular core on which a wire is to be wound, an annular shuttle for a supply of the wire, means supporting the shuttle in a position at right angles to the core for rotation in a circular path extending substantially through the center of the core and about a fixed axis, a flyer mounted for movement in a like circular path relative to the shuttle and having a portion to guide the wire from the shuttle around portions of the core, a fin carried by the flyer, means to direct a fluid under pressure to contact the fin and cause the flyer to move in its circular path to apply a constant tension on the wire being wound on the core, and means to vary the pressure of the fluid to vary the tension on the wire.

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