Feb. 1, 1966 H. CROUZET 3,232,037

FALSE-TWIST SPINDLE

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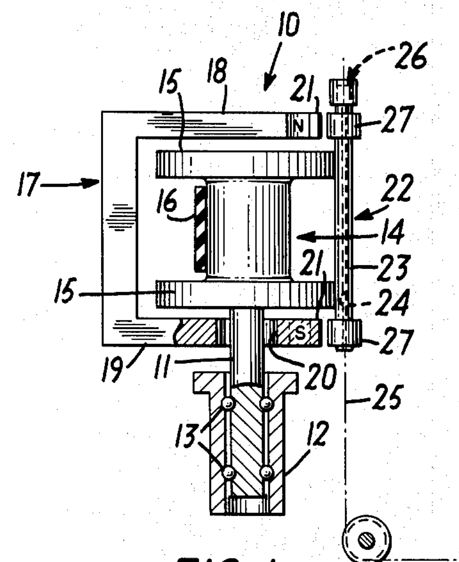

FIG. 1

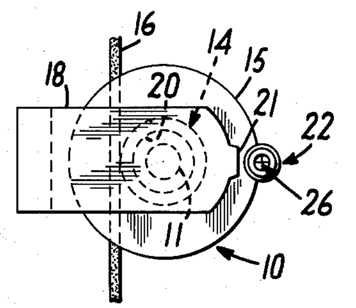

FIG. 2

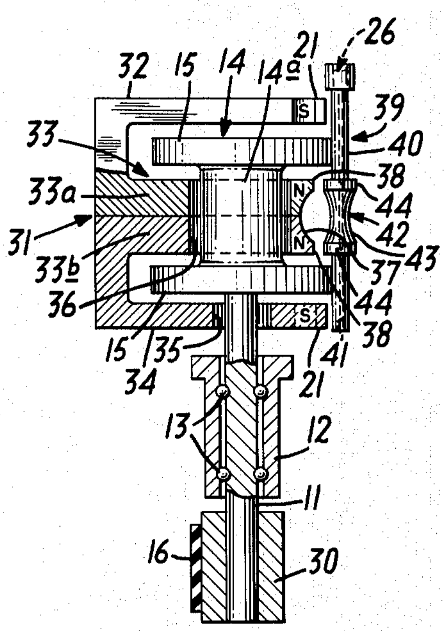

FIG. 3

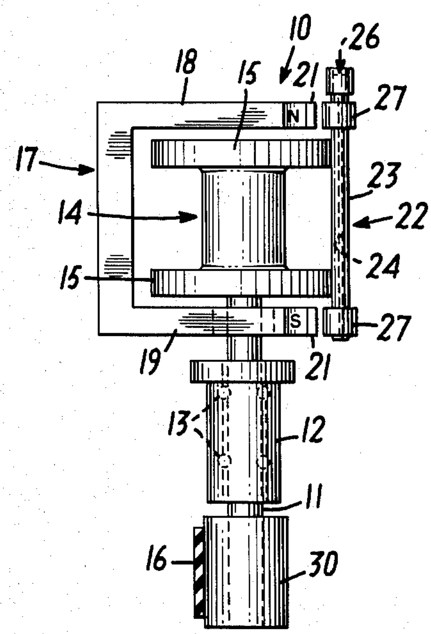

FIG. 4

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FALSE-TWIST SPINDLE

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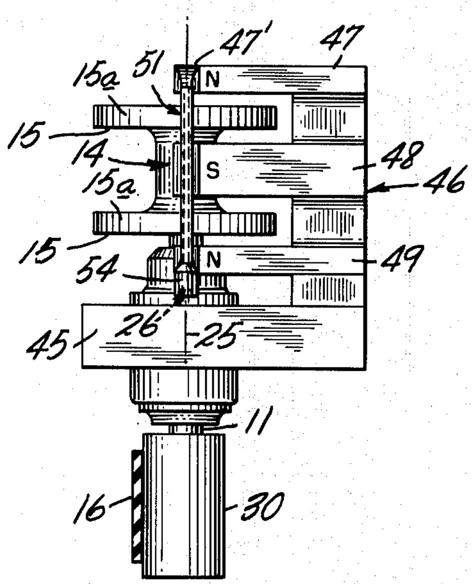

FIG. 5

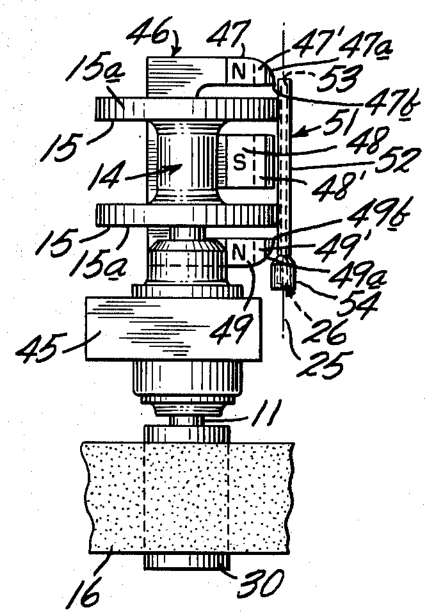

FIG. 6

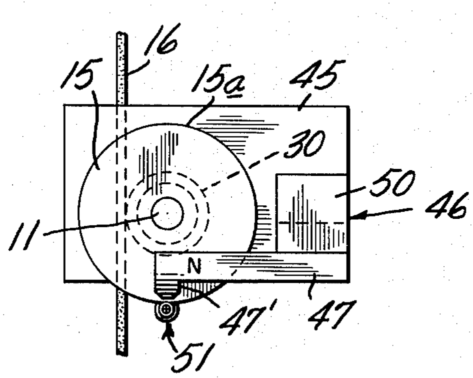

FIG. 7

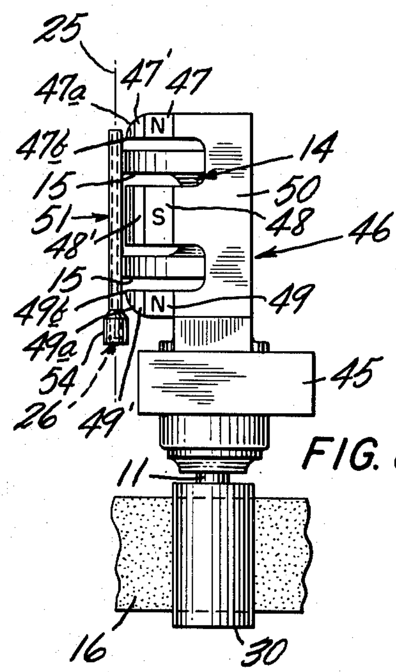

FIG. 8

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FALSE-TWIST SPINDLE

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14 Claims. (Cl. 57—77.45)

This invention relates to an apparatus for driving elements at very high speed and, more particularly, to a new and improved apparatus for driving false-twist tubes or spindles at very high speed.

This is a continuation-in-part of my U.S. application Serial No. 311,118 filed September 24, 1963, now abandoned.

As is well known in the art, stretch fabrics are woven or knitted from yarn having a permanent curl. A false-twist apparatus is utilized to attain the desired curl. The yarn is first twisted, and then by application of heat, for example, this twist may be permanently set in the yarn. The yarn is then "untwisted" and wound on a bobbin ready for weaving or knitting. Because of the permanent set in the "untwisted" yarn, which causes it to tend to return to its twisted condition, the desired stretch property is obtained in the woven fabric. The false twist is applied to the yarn by a rotating spindle or tube through which the yarn passes, suitable elements being provided within the tube for engaging the yarn. It will be apparent that the rate at which the yarn may be fed through the false-twist tube is limited by the rotational speed which can be imparted to this tube.

False-twist apparatus has been used in the past which supported the false-twist tube magnetically, however there are disadvantages in the prior art devices. Patent No. 687,428, issued November 26, 1901, discloses apparatus for rotating a shaft, spindle or the like, wherein the shaft (of magnetizable material) is held against two bearing disks by an electromagnet located between the bearing disks. Thus the holding force is applied to the shaft at its central portion resulting in instability because of the wobbling of the shaft permitted about an axis perpendicular to the shaft's longitudinal axis. Another disadvantage of the apparatus is the complicated mounting of the elements necessary when the electromagnet is disposed between the bearing disks. French Patent No. 1,239,013, issued July 11, 1960, discloses a false-twist apparatus wherein the spindle is held against two pulleys so disposed that the disks of one pulley partially overlap those of the other. Once again a fixed magnet is located between the disks of both pulleys. It is immediately apparent that this apparatus is quite complicated and cumbersome. Furthermore, there is considerable contact friction between the spindle and the pulleys, there being four disks in contact with the spindle. Moreover, a loss of driving power results from an arrangement in which two pulleys must be driven. Patent No. 3,059,408, issued October 23, 1962, discloses a magnetically supported false-twist tube, wherein a driving belt or similar element is disposed between and in contact with fixed magnet pole tips and the "floating" false-twist tube. Here a foreign element (the driving belt) is introduced into the magnetic circuit, i.e., is driven through the flux path between the magnet and the false-twist tube. Furthermore, there is considerable friction and consequent heating developed between the driving belt and the stationary magnet. Also, the belt must be driven at very high speed, since the speed step-up afforded by a pulley is not available.

Accordingly it is an object of this invention to pro-

vide a new and improved false-twist apparatus which effectively overcomes the above-mentioned disadvantages of the prior art.

Another object of the invention is to provide an apparatus for rotating a shaft or the like at very high speeds, for example 300,000 to 600,000 revolutions per minute or even faster.

A further object of the invention is to provide a false-twist apparatus of simple and compact design which is capable of rotating a yarn at considerably higher speeds than the conventional devices now in use.

These and other objects of the invention are attained by providing a spindle or false-twist tube of magnetizable material which floats free of any bearings. The spindle is held against a drive element, formed of two parallel disks coaxially mounted on a rotatable shaft, by means of a magnet, the poles of which are disposed externally of the disks of the drive element. The spindle is thus disposed against the peripheral surfaces of the disks in parallel relationship with the rotatable shaft. Alternatively, a magnet arrangement may be employed having one pole piece disposed between the disks and two other pole pieces (of opposite polarity from the first) disposed externally of the disks.

Further objects and advantages of this invention will be apparent from a reading of the following detailed description in conjunction with the accompanying drawings showing preferred embodiments, in which:

FIG. 1 is an elevational view, partly in section, of a typical false-twist apparatus in accordance with the invention;

FIG. 2 is a top plan view of the apparatus of FIG. 1;

FIG. 3 is an elevational view, partly in section, of another embodiment of a false-twist apparatus according to the invention;

FIG. 4 is an elevational view of still another embodiment of a false-twist apparatus according to the invention;

FIG. 5 is an elevational view of still another embodiment of a false-twist apparatus according to the invention;

FIG. 6 is an elevational view looking from the left in FIG. 5;

FIG. 7 is a top plan view of the apparatus of FIG. 5; and

FIG. 8 is an elevational view looking from the right in FIG. 5.

In the typical embodiment of the invention shown in FIGS. 1 and 2, a false-twist apparatus **10** comprises a shaft **11**, preferably of non-magnetizable and electrically non-conductive material, supported for rotational movement in a base structure **12** by means of the bearings **13**. The shaft **11** carries a pulley **14**, preferably of non-magnetizable and electrically non-conductive material, having two disks **15** which are parallel to each other and coaxial with the shaft **11**. The two disks **15** may each be provided with a sleeve (not shown) of material with a high co-efficient of friction, such as natural or synthetic rubber. A belt **16** is in driving engagement with the pulley **14** and, in order to support a spindle presently to be described, a stationary magnet **17**, having pole pieces **18** and **19**, is disposed so that the pole pieces **18** and **19** are positioned externally of the disks **15**. The pole piece **19** is provided with a bore **20** of sufficient diameter to permit the shaft **11** to rotate freely without making contact with the pole piece **19**. The pole pieces **18** and **19** taper near their extremities to form relatively narrow protruding portions or tips **21**, as best illustrated in FIG. 2.

A false-twist tube or spindle **22** comprises a tubular body **23**, preferably of magnetizable material, having a bore **24** extending through the length of the body **23**. The bore 24 is of suitable diameter to permit passage therethrough of the yarn 25 (shown in phantom) to be twisted. Within the false-twist tube 22 is an element 26 (for example, as disclosed in British Patent No. 881,788 published November 8, 1961), preferably of non-magnetizable and electrically non-conductive material, for engaging the yarn 25. Two collars 27 of magnetizable material are formed upon the tube 22, being spaced to agree with the spacing of the magnetic pole pieces 18 and 19.

In operation, stationary magnet 17 exerts holding forces upon the collars 27 of the false-twist tube 22. These forces hold the tube 22 firmly against the disks 15 of the pulley 14 and since the holding forces are applied near the extremities of the tube, the stability of the tube is assured since undesirable wobbling is avoided. Directing the application of force by concentrating the magnetic flux through the small protruding portions or tips 21 contributes to the stability. When the pulley is rotated by the belt 16, the rotation of the pulley is transmitted to the false-twist tube due to is contact with the peripheral surfaces of the disks. It thus becomes possible to rotate the false-twist tube at speeds of 300,000 to 600,000 revolutions per minute and higher. Since the tube is "floating" free of any bearings and there is only rolling friction along one line of contact with the disks, the heat generated in the tube is minimized. Furthermore, if the pulley is of non-magnetizable and electrically non-conductive material, heating of the pulley due to eddy currents is avoided.

FIG. 3 illustrates another embodiment of the invention. Here the pulley 14, having a shaft 14A and disks 15, is carried by the shaft 11, which is supported for rotational movement in the base structure 12 by means of the bearings 13, as in the first embodiment. The pulley 14 is driven by the belt 16 which is in driving engagement with a collar 30 secured to the shaft 11 by any conventional means. A stationary magnet 31 comprises the three pole pieces 32, 33 and 34, the two end pole pieces 32 and 34 being of one polarity, while the center pole piece 33 is of the opposite polarity. If desired, the magnet 31 may comprise two component magnets placed "back-to-back" as illustrated in FIG. 3, one component magnet having pole pieces 32 and 33A and the other component magnet having pole pieces 33B and 34. The pole piece 34 has a bore 35 of sufficient diameter to permit the shaft 11 to rotate freely without making contact with the pole piece 34. Similarly, there is a bore 36 in the pole piece 33 of sufficient diameter to permit the pulley shaft 14A to rotate freely therein. The pole pieces 32 and 34 at their extremities taper to form the same relatively small protruding portions or tips 21 which are best illustrated in FIG. 2. The central pole piece 33 is slightly shorter in length than the end pole pieces 32 and 34. The extremity of the pole piece 33 has a central concave portion 37 and two pole tips 38.

A false-twist tube or spindle 39 comprises a tubular body 40 of magnetizable material having a bore 41 extending therethrough to permit passage of the yarn (not shown). The body 40 carries a collar 42 of magnetizable material, the collar having a central concave portion 43 and protruding end rims 44. Here again there is provided a yarn-engaging element 26.

The stationary magnet 31 exerts holding forces on the false-twist tube at four points: viz. on the tubular body 40 opposite the protruding portions 21 of the pole pieces 32 and 34, and on the end rims 44 of the collar 42. The forces exerted by the pole pieces 32 and 34, being applied near the extremities of the false-twist tube, assure stability against wobbling while the forces applied to the end rims 44 hold the false-twist tube against translational movement along its axis. Furthermore, the central portion of the collar 42 will be substantially free of magnetic flux, the flux from the central pole piece 33 following two paths through the end rims 44 and thereafter through the body 40 to the adjacent one of the two end pole pieces 32 and 34. By so designing the apparatus that the magnetic flux is essentially eliminated from the central portion of the collar 42, heating of the false-twist tube due to eddy currents is reduced.

FIG. 4 illustrates still another embodiment of the invention. Here the magnet 17 pulls the false-twist tube 22 against the pulley 14 as in FIGS. 1 and 2. Rather than driving the pulley 14 directly by the belt 16 as in the first embodiment, the belt 16 is in driving engagement with a collar 30 affixed securely to the shaft 11 externally of the magnet 17, as in the second embodiment. This further simplifies the structure within the magnet 17, there being one less moving element therein. Furthermore, heating of the pulley and the false-twist tube by the belt is essentially eliminated.

FIGS. 5 through 8 illustrate still another embodiment of the invention. This is similar to the embodiment of FIG. 3, in that a magnet arrangement is employed having one pole piece disposed between the disks 15 and two other pole pieces (of opposite polarity from the first) disposed externally of the disks, however the pole pieces are displaced or offset from the axis of the pulley 14 and the shaft 11, so that no pole piece need have a bore within which the pulley or shaft may rotate. Furthermore, the tips of the pole pieces are formed differently from those in the prior embodiments.

The shaft 11 is supported for rotational movement in a base plate 45 by means of suitable bearings (not shown). The shaft 11 is driven by the belt 16 which is in driving engagement with the collar 30, as in the embodiments illustrated in FIGS. 3 and 4. The shaft carries the pulley 14, preferably of non-magnetizable and electrically non-conductive material, having the two disks 15, as before. The two disks 15 may each be provided with a sleeve (not shown) of material with a high coefficient of friction, such as natural or synthetic rubber. Mounted on the base plate 45 is a stationary magnet 46 comprising the three pole pieces 47, 48 and 49, the two end pole pieces 47 and 49 being of one polarity while the center pole piece 48 is of the opposite polarity. If desired, the magnet 46 may comprise an E-shaped base 50 on which the pole pieces 47, 48 and 49 are mounted, as seen in FIGS. 7 and 8. With such a magnet arrangement, wherein the pole pieces are displaced or offset from the axis of the pulley 14 and the shaft 11, as best viewed in FIG. 7, no pole piece of the magnet 46 need have a bore to permit the pulley or shaft to rotate freely therein, (such as the bores 20, 35 and 36 in FIGS. 1 and 3). As may be best seen in FIG. 7, the ends 47′, 48′, and 49′ of the pole pieces 47, 48 and 49, respectively, extend radially from the axis of the pulley 14 for reasons to be explained hereinafter.

A false-twist tube or spindle 51 comprises a tubular body 52 of magnetizable material having a bore 53 extending therethrough to permit passage of the yarn 25. The spindle is provided with a collar 54 within which is disposed the yarn-engaging element 26, both preferably of non-magnetizable and electrically non-conductive material. The stationary magnet 31 exerts holding forces on the spindle at three points, i.e., on the tubular body 52 opposite the pole piece ends 47′, 48′ and 49′. Inasmuch as these ends are disposed radially of the pulley 14, the holding forces act along a radius of the pulley and therefore perpendicularly of the peripheral surfaces 15*a* of the disks 15 at the line of contact between the spindle and the disks. There are air gaps between the spindle body 52 and the three pole piece ends 47′, 48′ and 49′ of approximately 0.3 mm. each.

The stability of the spindle against wobbling is assured by terminating the pole piece ends 47′, 48′ and 49′ in a trapezoidal profile as viewed in FIG. 7 in order to concentrate the magnetic flux therethrough. The flux is also concentrated in the vertical plane, i.e. as best viewed in FIGS. 6 and 8, by chamfering the surfaces 47*a* and 49*a* of the pole piece ends 47′ and 49′, respectively, remote from each other. The length of the magnetizable portion of the spindle **51** is substantially that of the distance between the outer edges **47***b* and **49***b* of the chamfered ends **47′** and **49′**, respectively, whereby the magnetic flux is concentrated so as to limit longitudinal displacement of the spindle with respect to the magnet or pulley.

Although this invention has been described with reference to the foregoing specific embodiments, further modifications and variations will readily occur to those skilled in the art. For example, the pole piece ends **47′** and **49′** could be formed with pointed tips inclined towards each other. Therefore, the invention is not to be construed as limited except as defined by the following claims.

I claim:

1. Apparatus for rotating a spindle, at least a portion of which is of magnetizable material comprising driving means having at least one continuous spindle-engaging surface and magnet means disposed externally of the driving means for holding the spindle in driving engagement with the spindle-engaging surface of the driving means.

2. Apparatus according to claim **1** wherein the driving means comprises a rotatable element having a circular periphery adapted to engage the spindle.

3. Apparatus according to claim **1** wherein the driving means comprises a plurality of spaced disks adapted to engage the spindle.

4. Apparatus according to claim **1** wherein the driving means comprises a plurality of spaced disks adapted to engage the spindle and wherein there is provided a spindle provided with enlarged magnetizable portions juxtaposed with respect to the magnet means.

5. Apparatus according to claim **1** wherein the magnet means are formed with relatively narrow pole tips spaced in close proximity to the magnetizable portions of the spindle.

6. A false-twist spindle and driving mechanism therefor comprising a false-twist spindle formed of magnetizable material, spaced disks the peripheries of which are in driving engagement with the spindle, means to rotate the disks, and magnet means spaced externally of the disks for holding the spindle in driving engagement with the peripheries of the spaced disks.

7. Apparatus in accordance with claim **6** wherein additional magnet means is provided between the disks and the spindle is formed with an enlarged magnetizable portion adjacent the last-named additional magnet means.

8. Apparatus in accordance with claim **7** wherein the additional magnet means is formed with a concave portion and spaced pole tips and the enlarged magnetizable portion of the spindle is formed with a concave portion terminating in rims juxtaposed with respect to the last-named pole tips.

9. Apparatus according to claim **6** wherein the magnet means comprise two sets of adjacent magnets having their like poles spaced intermediately adjacent each other between the disks and the other of their poles spaced outside of the disks, all of said poles being in magnetic-force-applying relationship to the spindle, and the spindle is formed with an enlarged magnetizable portion adjacent the magnet poles between the disks.

10. Apparatus according to claim **9** wherein each of the magnet poles terminates in relatively narrow pole tips adjacent the spindle.

11. Apparatus according to claim **6** wherein additional magnet means is provided between the disks and in magnetic-force-applying relation to the spindle, all the magnet means being in offset spaced relation to the disk rotating means.

12. Apparatus according to claim **6** wherein the magnet means comprise pole pieces chamfered at the end surfaces remote from each other.

13. Apparatus according to claim **6** wherein the magnet means comprise pole pieces formed with pointed tips inclined towards each other.

14. Apparatus according to claim **6** wherein the peripheries of the spaced disks are formed with a material having a high coefficient of friction.

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