Oct. 12, 1943. P. X. FOX 2,331,674

COIL WINDING MACHINE

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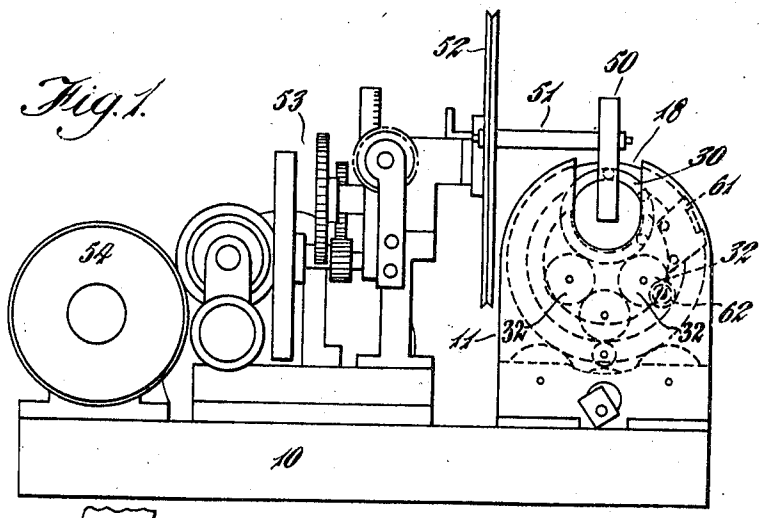
Fig. 1.



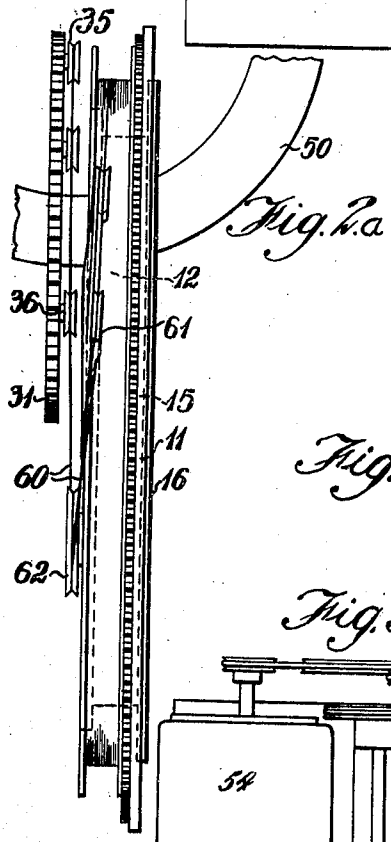


Fig. 2a.

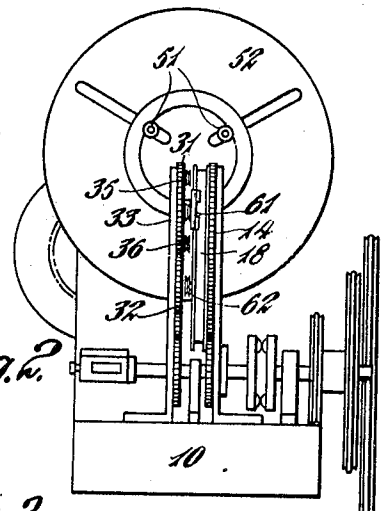


Fig. 2.

Fig. 3.

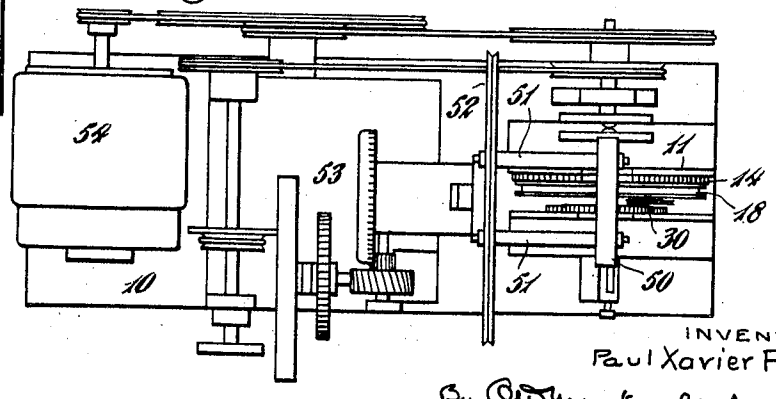


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Fig. 4.

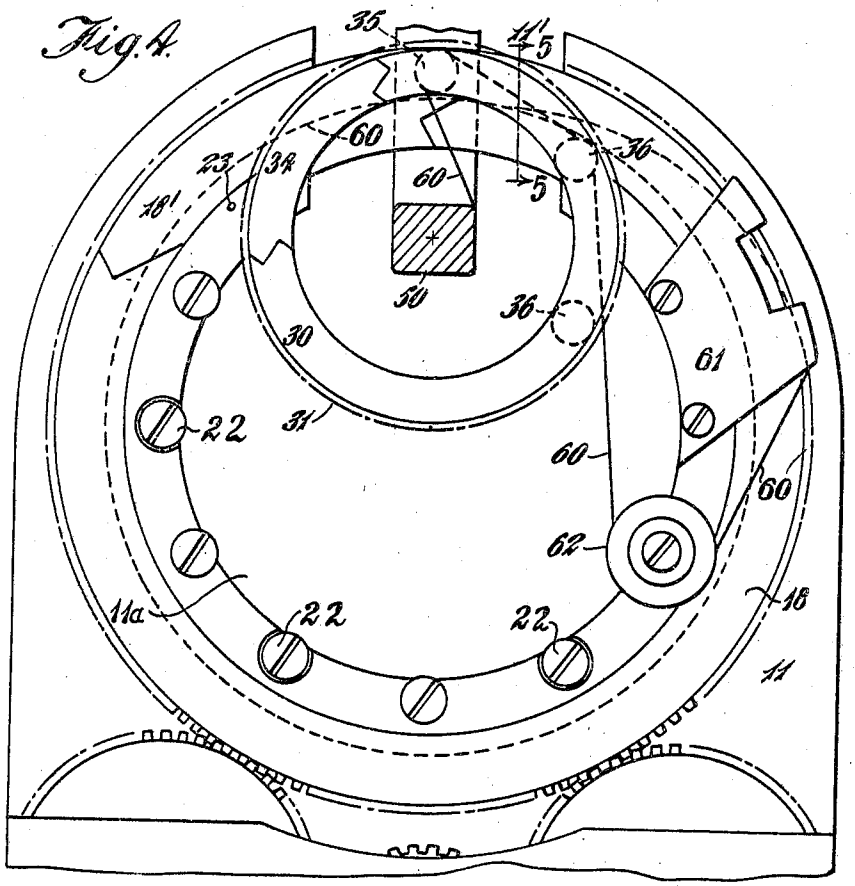


Fig. 5.

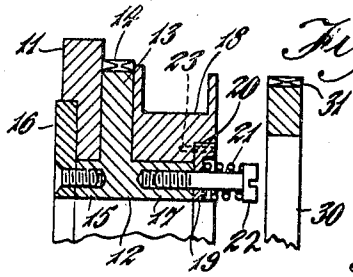


Fig. 6.

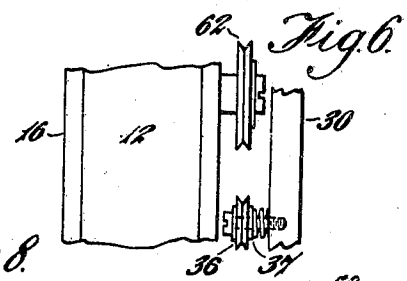


Fig. 7.

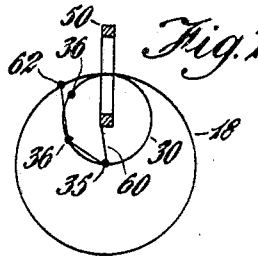


Fig. 8.

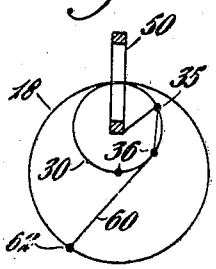
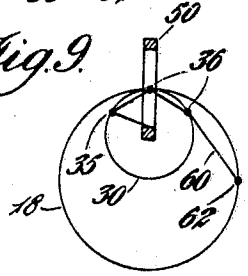


Fig. 9.



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Patented Oct. 12, 1943

2,331,674

UNITED STATES PATENT OFFICE

2,331,674

COIL WINDING MACHINE

Paul Xavier Fox, Horsforth, near Leeds, England

Application June 20, 1941, Serial No. 398,894
In Great Britain May 29, 1940

9 Claims. (Cl. 242—4)

This invention relates to improvements in coil winding machines, more particularly machines for producing electric toroidal coils although, as will be readily appreciated, the same is equally applicable to machines for producing toroidal or like windings of tape or any other members.

Heretofore it has been the general practice commercially to wind toroidal coils by hand, but in my co-pending patent applications No. 397,380, filed June 10, 1941, and No. 398,895, filed June 20, 1941, both abandoned, I have described certain machines which may be effectively used for winding toroidal coils of a high degree of accuracy and at a high speed. It is just possible that when the machines described in my said co-pending patent applications are used for winding toroidal coils of small diameter, or where the core is to be wound with so many layers of wire that the resulting aperture in the finished coil is small, a certain difficulty may be encountered. Such difficulty is liable to arise from the fact that it is impossible to provide a sufficient store of wire on a magazine of small enough cross-section in the construction described in application No. 397,380, or correspondingly on a bobbin of sufficiently small size in the construction described in application No. 398,895. It is, therefore, the chief object of the present invention to overcome this possible disadvantage.

The toroidal coil winding machine according to the present invention is characterized in that the wire or the like to be wound, instead of being fed directly to the core from a magazine or bobbin, is fed thereto through the intermediary of a ring-form flyer which is rotatably arranged and driven about the core in order to lay the wire or the like about the same, the store of wire or the like being carried by a circular magazine which is of larger diameter than and eccentrically disposed about the flyer and passes through the centre of the core in close proximity to the flyer at this point.

Preferably the toroid core is so disposed with respect to the flyer that the axis of rotation of the flyer lies within the perimeter of that cross-section of the core lying within the plane of the flyer. Thus, since the point from which the wire or the like is fed to the core from the flyer is at all times substantially the same distance from that part of the core being wound there will be no slack or loop formed between the flyer and the core, the tension will be maintained and an even winding may be easily secured. In order to secure the best results, it is desirable that the axis of rotation of the flyer should pass through the centre of the cross-section being wound.

In the preferred embodiment of the present invention, means are further provided, on both the magazine and the flyer, for applying tension to the wire or the like being wound, the two tensioning means being independent of one another.

In order that this invention may be the more clearly understood and readily carried into effect, I will proceed to describe the same with reference to the accompanying drawings, which illustrate by way of example and somewhat diagrammatically one convenient embodiment of the present invention, and in which—

Figure 1 is a front elevation of the toroidal coil winding machine according to the present invention, and

Figures 2 and 3 are respectively end elevation and plan view of the same.

Fig. 2*a* shows a part of Fig. 2 on an enlarged scale.

Figure 4 is a face view, on an enlarged scale, of the magazine and flyer and their driving means shown in Figure 1.

Figure 5 is a sectional view showing the relative disposition of the magazine and flyer.

Figure 6 is a partial end elevation of the magazine and flyer, and

Figures 7, 8 and 9 are diagrammatic views illustrating the operation of the machine according to the present invention.

Referring now to the drawings, the coil winding machine therein illustrated comprises a base **10** to which is secured a bearing plate **11** having a circular aperture **11***a* (see Fig. 4) therein. On this bearing plate is mounted a T-section supporting ring **12**, the leg **13** of the ring extending up the face of the plate **11** and being toothed as at **14** to provide a toothed driving edge. One of the flanges **15** of the ring **12** extends into the aperture in the plate **11** to form a bearing, the whole being rotatably held in position by a securing ring **16**. The other flange **17** of the ring extends out in the opposite direction (see more particularly Figure 5) to form a bearing on which is mounted a channel section magazine **18**. As above stated, friction means are provided to apply tension to the wire on the magazine, for example by providing means tending to prevent relative rotation between the supporting ring and the magazine, said friction means taking any convenient form, say a ring **19** carried by the flange **17** and pressed into engagement with a shoulder **20** on the magazine **18** by means of

springs 21. The friction ring 19 also prevents axial movement of the magazine 18 with respect to the supporting ring 12, as will be readily understood. As the springs 21 are carried by screws 22 their effective pressure and hence the force tending to prevent relative rotation between the ring 19 and the magazine, i. e., the tension on the wire, may be easily adjusted. Means are also provided for locking the magazine 18 to the supporting ring 12 for a purpose hereinafter described, said means conveniently comprising a pin which passes through a hole 23 in the friction ring 19 into a hole in the magazine 18.

The supporting member 12 and the bearing plate 11 are cut away over a small arc 11' and a portion 18' of the magazine 18 is made removable so that when the gaps are brought into register with one another the toroid core 50 may be inserted in position about the magazine 18 and mounted in a plane at right angles, or substantially at right angles, to the plane of the magazine.

The machine so far described is the same as that covered by my co-pending patent application No. 397,380 but in the machine described in my said patent application the wire or the like to be wound was fed directly from the magazine to the core. As distinct therefrom, in the machine according to the present invention the wire or the like to be wound is fed to the core from the magazine through the intermediary of a flyer. This flyer comprises a ring 30 which may be toothed at its periphery as at 31 and driven by means of spaced pinions 32 carried by a supporting plate 33, the flyer being otherwise mounted similarly to the toothed ring 12 above described in order to ensure a free rotation thereof with the absence of axial movement. The flyer is also gapped as at 34 to allow the toroid core to be inserted into the centre of the same and, if desired, a removable part may be provided to fill in this gap. Either arrangement may be used without departing from the scope of the present invention, the latter permitting the flyer to be driven by means of a single pinion instead of the two pinions above mentioned. The magazine and flyer are mounted eccentrically with respect to one another as will be seen from the drawings, the mounting, furthermore, being such that the flyer and the magazine lie close together inside the core 50. As shown in the drawings, the flyer ring 30 lies slightly to one side of the magazine but it is also possible so to mount the parts that the flyer lies inside the magazine at the center of the core without departing from the scope of the present invention. The flyer 30 is provided with a feeding member, for example a pulley 35, from which the wire or the like is led to the core and is also provided with a guide to form in effect a groove to accommodate the loop of wire existing between the magazine and the flyer, as will be described more fully hereinafter. This grooved guide may take any form whatsoever, for example, it may be constituted by the pulleys 36 spaced around the periphery of the flyer. As above stated, in the preferred embodiment of the present invention means are also provided for applying tension to the wire or the like being wound on the flyer independent of the tension applied thereto on the magazine. To this end the wire or the like may be passed twice round one of the pulleys which is provided with a spring-controlled friction pad 37 to impart an adjustable drag on the pulley.

For the accurate winding of electric toroidal coils it is, of course, desirable that a constant tension shall at all times be maintained on the wire as it is being wound. To a certain extent this is obtained with the machine according to the present invention by the provision of the tension means on the flyer 30, but it will be appreciated that this advantage will be lost if the distance between the point of winding and the feeding pulley 35 varies to any appreciable extent during the revolution of the flyer 30 about the core 50. In order, therefore, to avoid any possibility of the tension varying, it is desirable that the axis of rotation of the flyer should lie within the perimeter of that cross-section of the core lying in the plane of the flyer and, furthermore, it is desirable in order to secure the best results that this axis should pass through the geometric centre of the cross-section of that part of the core being wound. The length of wire between the core 50 and the feed pulley will then remain constant and an even tension will be applied to the wire throughout the whole winding operation. Such an advantage was secured with the machine described in my co-pending patent application No. 397,380 where the axis of rotation of the magazine passed through the centre of the cross-section of the core being wound, but such a machine was limited in the size of magazine that could be used without loss of this advantage and was hence limited in the amount of wire which could be carried on the magazine and wound on to the core at one filling of the magazine. This limitation is no longer present with the machine according to the present invention for although the cross-sectional size of the magazine is limited by the fact that it, as well as the flyer, must pass through the centre of the core being wound, and hence with small cores or with coils having a large number of turns with a resulting small hole at the centre, must be small, the diameter of the magazine may be whatever is necessary to enable the same to accommodate the desired amount of wire. The larger the diameter of the magazine the greater will be its eccentricity relative to the flyer and the centre of the cross-section of the core being wound, but this is without any effect whatsoever on the winding operation.

The core 50 may be held in the desired position by means of arms 51 carried by a face plate 52 located adjacent the supporting member 12 and, of course, in a plane at right angles thereto. This face plate 52 is driven through reduction gearing 53 from a motor 54 at a speed depending upon the particular winding to be effected, variable speed gearing of any desired form being included, if desired, in order that the machine may be adapted to various gauges of wires or the like.

In order to allow a ring-shaped former to be rotated through 360°, or over an arc approximating the same, an additional arm or arms may be clamped on to the former and the face plate and one or more of the original arms removed atfer the core has been partially wound.

When the core 50 has been inserted into position, as above described, the removable portion 18' of the magazine is replaced and the removable part of the flyer is also replaced, if the same is employed. One end of the wire or the like 60 is anchored to the magazine which is locked to the supporting ring 12, for example, by means of the pin above mentioned. The magazine 18 and supporting ring 12 are driven to wind on the required amount of wire from a supply source. The re-

quired amount of wire having been wound on the magazine, the supply source is cut off and the loose end of the wire 60 is taken over a grooved winding member 61 carried by the friction ring 19 and around one or more guide pulleys 62. From the pulleys 62 the wire is led to the pulleys 36 on the flyer 30, passing two or more times round one of the same to impart the necessary tension, as above described. Finally, the wire is passed around the feeding member 35 to the core 50 to which it is anchored. The pin is then withdrawn from the hole 23 so that the magazine 18 is now only frictionally coupled to the supporting ring 12 and may rotate relative thereto in order to permit of the wire being drawn off.

The flyer 30 and the supporting ring 12 are driven at the same, or approximately the same, angular velocity but their drive mechanism, which is coupled to the motor 54, may include friction devices which allow a certain amount of slip if necessary so that the flyer 30 and ring 12 do not necessarily rotate at the same effective angular speeds but rotate according to the requirements of the conditions under which the machine is operating.

As the flyer 30 rotates the wire will be wound about the core in the required manner and, as explained above, the tension will be maintained constant. It will be appreciated, more particularly on reference to Figures 7, 8 and 9, which show three stages in the winding of a single turn, that as the magazine rotates the wire will be drawn off the magazine as required. Mainly the wire will be drawn off the magazine only on the first half of the revolution, i. e., the left-hand side as shown in Figures 7 and 8. The magazine 18 slips on the supporting ring 12 to allow the wire to be drawn off. Consequently, on the further rotation there will be an excess length of wire available between the feed point of the magazine and the flyer. The drive may be so arranged that this loop is taken up on the flyer as it is formed but even if it should not be taken up no ill effect will result as, in view of the separate tension means on the magazine and flyer, no loss of tension will arise and the loop will never get so large as to interfere with the winding. It will be seen that the loop formation is not cumulative.

If desired, the apparatus may be driven by a direct variable drive which will partially or completely eliminate the loop formed.

It may be found convenient to wind a few turns on the core in advance of the desired start of the winding. This will not only provide an end for connection purposes when the said turns are unwound but will also overcome any uneven winding which might be caused by backlash when the machine starts up. In order to overcome any backlash in the drive to the core the face plate 52 may be weighted.

Any other suitable means of holding the core 50 in the position above defined and of rotating the same over any desired arc may, of course, be employed without departing from the scope of the present invention.

The machine according to the present invention is obviously applicable to winding partial or complete toroidal coils of single or multiple layers whatever be the cross-section of the core and, if desired, relative movement parallel to the axis of the magazine and flyer may be caused between the core and the flyer in certain cases.

I claim:

1. A toroidal coil winding machine comprising a machine frame, means mounted on said frame to rotatably support a ring-shaped core on which wire is to be wound, a substantially ring-shaped flyer including wire feed means and wire guide means, means supporting said flyer on said frame in a position at right angles to said core for rotation along a circular path extending substantially through the center of the core about a fixed axis passing through a cross-section of the core in the plane of the flyer, a substantially ring-shaped wire magazine of a diameter considerably exceeding that of said flyer, and means supporting said magazine on said frame parallel to and adjacent said flyer for rotation about a fixed axis eccentric of the flyer and along a circular path extending substantially through the center of the core in close proximity to the path of the flyer at this point.

2. A toroidal coil winding machine, as claimed in claim 1, in which the axis of rotation of the flyer passes through the centre of the cross-section of that part of the core being wound.

3. A toroidal coil winding machine, as claimed in claim 1, in which the centres of the magazine and flyer lie substantially in the mid-central longitudinally extending plane of the core.

4. A toroidal coil winding machine, as claimed in claim 1, in which the flyer is formed as a complete ring including a removable part to permit the insertion of the core into said flyer ring.

5. A toroidal coil winding machine, as claimed in claim 1, in which said magazine is formed as a complete ring including a removable part to permit the insertion of the core into said magazine ring.

6. A toroidal coil winding machine, as claimed in claim 1, in which said means supporting said magazine includes a rotatably mounted support ring provided with a toothed portion by means of which it may be rotated.

7. A toroidal coil winding machine, as claimed in claim 1, in which said means supporting said magazine includes a rotatable support ring and friction means tending to prevent relative rotation between the magazine and said support ring in order to maintain tension on the wire being wound.

8. A toroidal coil winding machine, as claimed in claim 1, comprising means on both the magazine and the flyer for applying tension to the wire being wound.

9. A toroidal coil winding machine, as claimed in claim 1, including means for rotating said flyer and said magazine at substantially the same angular velocity.

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