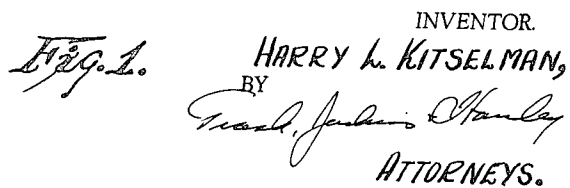


H. L. KITSELMAN
APPARATUS FOR FORMING FILAMENTARY MATERIAL
INTO AN ANNULAR BUNDLE

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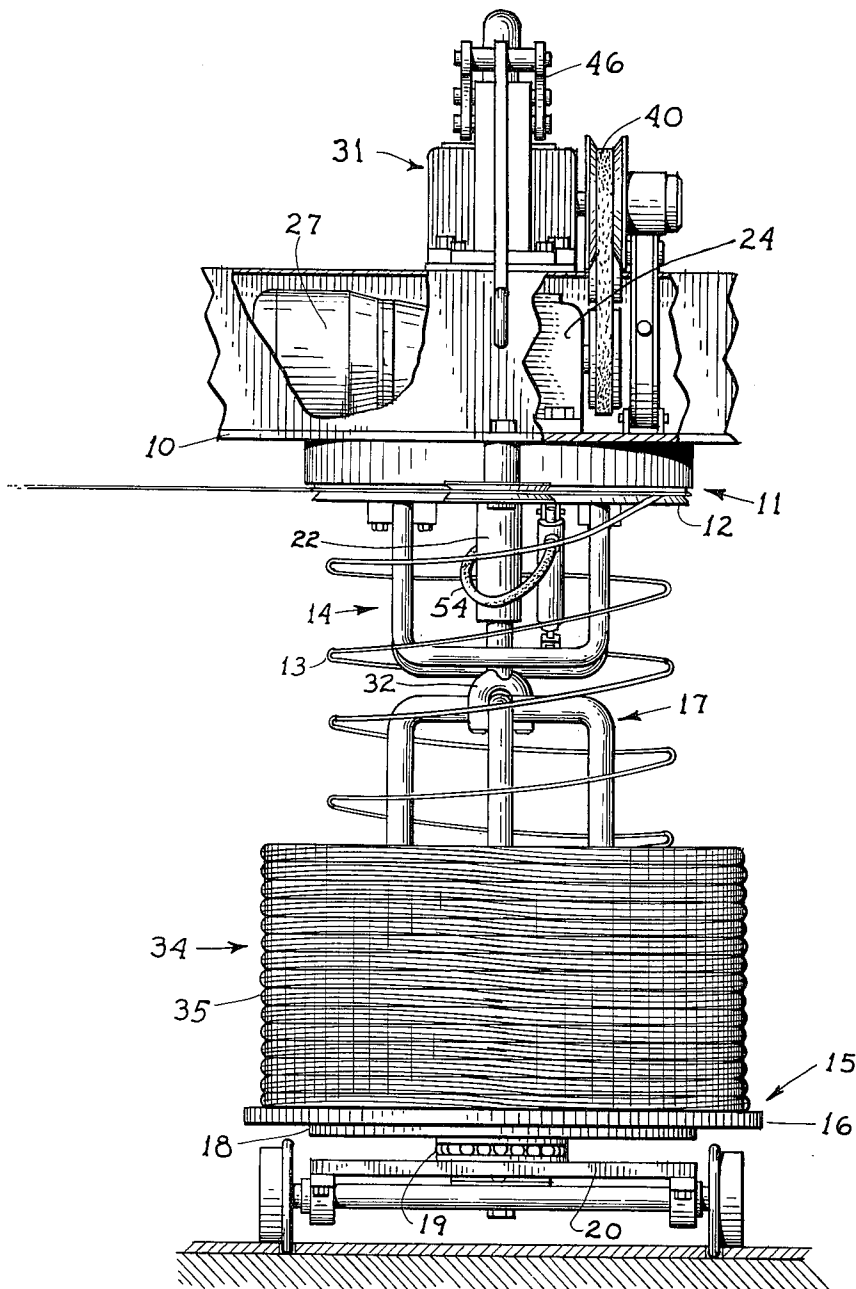


Fig. 2.

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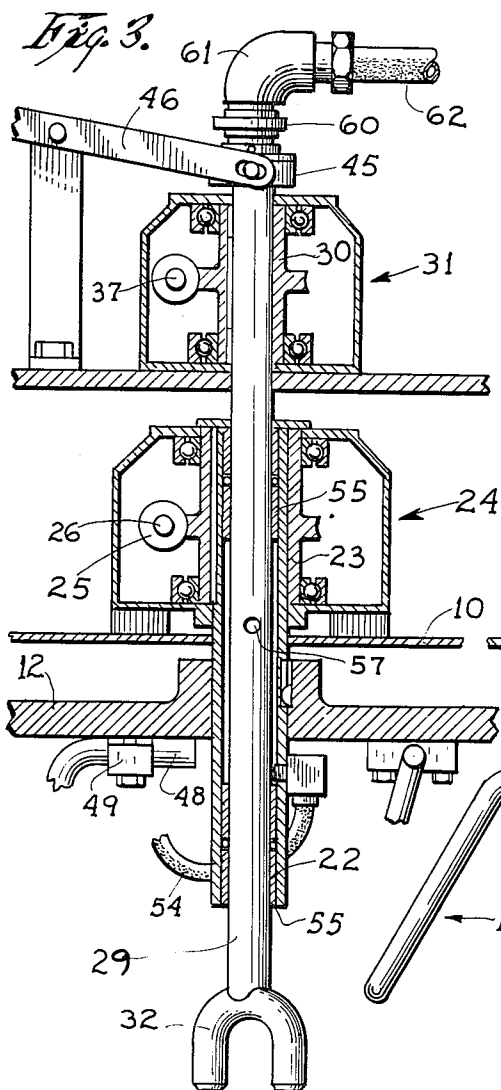
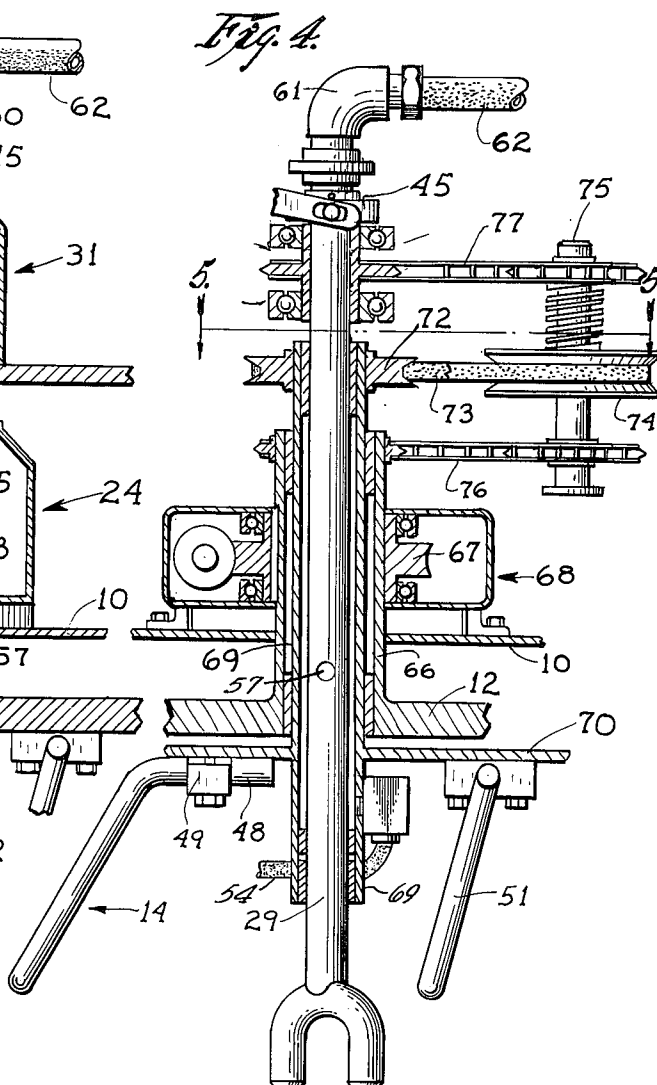
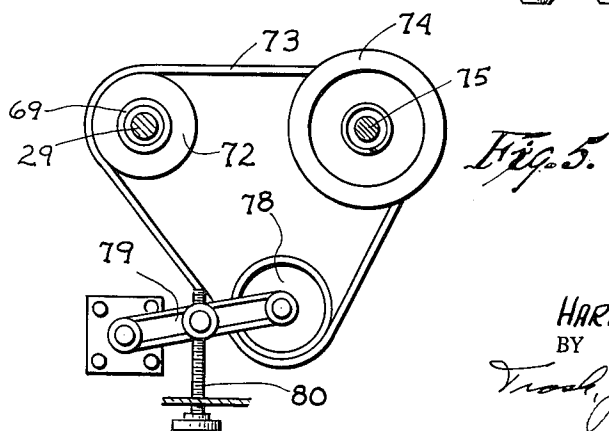
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3,232,553

APPARATUS FOR FORMING FILAMENTARY MATERIAL INTO AN ANNULAR BUNDLE

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14 Claims. (Cl. 242—83)

This invention relates to machines for forming a continuous wire or other filament into a succession of circular loops and depositing those loops in such fashion that they will form an annular bundle. Various expedients have been employed in such machines to control the diameter and/or the positioning of successively deposited loops with the object of eliminating voids in the bundle and increasing the length of wire that can be incorporated in a bundle of given dimensions. Certain of such expedients have aimed at producing an annular bundle in which loops having a substantially uniform diameter, approximately equal to the mean diameter of the bundle, lie in uniformly eccentric positions angularly spaced progressively about the bundle axis. This invention is particularly concerned with machines for producing such a bundle.

The most common form of machine employed to form wire into loops and deposit the loops in an annular bundle embodies a coiler of the so-called dead-block type in which the wire to be coiled is fed axially through a stationary capstan and wound on and off such capstan with the aid of one or more wire-guiding sheaves orbiting about the capstan-axis. Such machines are capable of operating at high speeds, but they have a disadvantage in that they impart a twist to the wire, such twist amounting to approximately 360° for each loop of wire discharged from the coiling mechanism. In soft wire the existence of the twist is largely immaterial; but in hard wire, the twisted condition tends to cause each deposited loop to warp or assume an objectionable non-planar condition, which can be removed only by subjecting the coiled wire to cold working so severe as to produce undesirable effects on the physical properties of the wire. Because of this disadvantage of dead-block coilers, I employ a live-block, or rotating-capstan, coiler in practicing the invention described below.

A preferred form of machine embodying the present invention comprises a capstan rotating on a vertical axis and arranged to discharge successively formed wire-loops downwardly onto a bundle-support disposed beneath the capstan. The bundle-support is arranged for rotation about an axis substantially coincident with that of the capstan and includes an upwardly projecting core about which wire loops falling from the capstan are received. In one form of the invention, the capstan carries a loop-deflector serving to deflect each falling loop into a position eccentric with respect to the common axis of the capstan and bundle-support; and means are provided for rotating the capstan and bundle-support at slightly different speeds with the result that successively falling loops, deflected into eccentric positions, are deposited in angularly spaced relation about the capstan axis, the angular interval between successively deposited loops depending upon the difference between respective rotational speeds of the capstan and the bundle-support. In another form of the invention, the capstan and bundle-support rotate at the same speed and the loop-deflector rotates at a slightly different speed to produce the desired angular displacement of successively deposited loops.

Conveniently, the bundle-support is carried on a table rotatably supported from a truck which can be rolled into and out of a position beneath the capstan. In a preferred arrangement for rotating the bundle-support, the

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capstan is mounted on a hollow shaft through which a second shaft extends. The second shaft is vertically slidable within the hollow shaft to permit engagement and disengagement of a drive coupling through which the second shaft is operatively connected to the bundle-support to drive such support at the speed of the second shaft. When a wire bundle is completed, the inner shaft is raised to sever the driving connection between it and the bundle-support, thus making it possible to roll the truck out of position below the capstan, remove the bundle and its carrier, place a new bundle-support on the truck, and restore the truck to its position below the capstan, whereupon the inner shaft is lowered to re-establish the driving connection between it and the new bundle-support.

If desired, means may be provided for catching and retaining loops falling from the capstan while the wire is severed and the filled bundle-support replaced with an empty one.

Other features of the invention will become apparent from the following more detailed description and from the accompanying drawings, in which:

FIG. 1 is a side elevation of one form of apparatus embodying the invention;

FIG. 2 is a front elevation of the apparatus shown in FIG. 1;

FIG. 3 is a vertical sectional view showing the arrangement of the two shafts;

FIG. 4 is a view similar to FIG. 3 but illustrating a modified arrangement; and

FIG. 5 is a horizontal section on the line 5—5 of FIG. 4.

The apparatus shown in FIGS. 1-3 comprises a frame including a plate 10 below which is mounted a coiling mechanism 11 embodying a rotating capstan 12 and adapted to form wire into a succession of circular loops 13 coaxial with the capstan and to discharge such loops downwardly. The coiling mechanism 11 may be of any desired rotating-capstan type, that shown in the drawing including an idler 12' and otherwise generally following the teaching of my prior Patent No. 3,106,354, granted October 8, 1963. The successively descending loops are deflected into eccentric positions by a deflector 14 mounted on the capstan 12 and are received by a rotating bundle-support 15 comprising a disk-like base 16 and an upwardly extending, central core 17 about which each descending loop falls. As shown, the bundle support rests on a table 18 rotatably supported, desirably through anti-friction bearings 19, on the frame of a wheel-supported truck 20.

For the purpose of rotating the capstan 12, it is secured to a shaft 22 which extends upwardly through the plate 10 for operative connection to the output element 23 of a speed-reducer 24. See FIG. 3. As shown, the speed-reducer 24 is of the worm and worm-wheel type, the worm-wheel being rigid with the output element 23 and the worm 25 being fixed on a shaft 26 driven in any convenient manner by a motor 27 (FIG. 2).

For the purpose of rotating the bundle support 15, which is coaxial with the capstan 12, it is connected to a shaft 29 which extends upwardly through the capstan-shaft 22 and into driving association with the output element 30 of a second speed-reducer 31 mounted above the reducer 24. In order to permit replacement of a filled bundle-support by an empty one, the shaft 29 is vertically movable and is provided at its lower end with a coupling member engageable with the bundle support. As shown, the core 17 of the bundle support comprises four metal posts the upper ends of which are bent inwardly and joined at the axis of the bundle support, and the lower end of the shaft 29 is provided with a fork 32

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the arms of which are adapted to enter spaces between the in-bent post-ends to establish a driving connection from the shaft 29 to the bundle support.

If the bundle support and capstan rotated at the same speed, the loops 13 would all fall in substantially the same eccentric position on the bundle support rather than being distributed about the axis of that support, as is desired. However, if the capstan and support rotate at slightly different speeds, successively deposited loops will be angularly displaced about the capstan axis and the bundle 34 formed will have the appearance of comprising a plurality of superposed layers 35. The angular displacement of successive loops, which determines the number of loops in each layer, will depend upon the respective speeds of the capstan and bundle support. For example, if the capstan rotates through 600 revolutions while the bundle support rotates through 601, approximately 600 loops will be received by the bundle support during the interval required for the bundle support to make one complete revolution relative to the deflector 14, and those 600 loops will constitute a layer 35 in the bundle.

In practice, it may be desirable to vary the angular interval between successively deposited loops, and the apparatus shown in FIGS. 1-3 therefore embodies means for varying the relative speeds of the two shafts 22 and 29. As shown, the speed reducer 31 is of the worm and worm-wheel type, the worm thereof being rigidly mounted on a shaft 37. The two shafts 26 and 37 project from the respective reducer-housings and carry pulleys 38 and 39, one of which, shown as the pulley 39, is of the spring-loaded, variable-diameter type. A belt 40 runs over the pulleys 38 and 39 and also over an idler pulley 41 mounted at the end of a swinging arm 42 controlled in position by an adjusting screw 43. By operation of the screw 43, the arm 42 can be adjusted to increase or decrease tension in the belt 40, thereby reducing or increasing the effective diameter of the pulley 39 and changing the relative speeds of the shafts 26 and 37.

For the purpose of raising and lowering shaft 29 to control the connection of the fork 32 with the support-core 17, a collar 45 is rotatably mounted in fixed position on the shaft 29. Such collar is operatively connected to one end of a lever 46, by which the collar 45 and shaft 29 can be elevated when desired to raise the fork 32 out of engagement with the support-core 17 and permit the truck 20, with the bundle 34 thereon, to be rolled from its position beneath the coiling mechanism, whereby to facilitate removal of a filled bundle-support 15 and its replacement with an empty one. When the truck, carrying the empty bundle support, is repositioned beneath the coiler 11, the lever 46 may be released, permitting the shaft 29 to descend under its own weight and establish a driving connection with the new bundle support.

In addition to providing for varying the relative speeds of the capstan and bundle support, it may be desirable to make the deflector 14 radially adjustable on the capstan so as to vary the eccentricity of the loops 13 falling onto the bundle support. As shown, the deflector 14 is in the form of a length of metal rod or tubing bent into a general U-shape and having the ends 48 of its parallel legs bent to extend in parallel relation to each other but at an oblique angle to the bight of the U. Brackets 49 mounted on the lower face of the capstan 12 slidably receive the deflector-ends 48, such brackets being capable of being tightened to secure the deflector in any desired eccentric position relative to the capstan. In most cases, the eccentricity of the deflector 14 will desirably be such that those portions of the descending loops 13 which are nearest the axis of the bundle-carrier 15 will engage the core 17, as shown in FIG. 1.

By providing the capstan with means for temporarily interrupting the descent of loops while the capstan con-

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tinues to rotate, it is possible to effect replacement of a bundle support 15 while the coiler 11 remains in operation. For this purpose, a loop-retainer 51 may be pivotally mounted on the lower face of the capstan 12 opposite the deflector 14. Normally, the retainer 51 occupies the downwardly and inwardly inclined retracted position shown in full lines in FIG. 1, where it does not interfere with the falling loops. However, if the retainer is advanced into the outwardly and downwardly inclined, position shown in dotted lines in FIG. 1 it cooperates with the outwardly and downwardly inclined deflector 14 to prevent loops from falling onto the bundle support 15, the intercepted loops being retained by the retainer and deflector until the retainer is returned to its retracted position, whereupon the retained loops will fall as a group onto the bundle support.

The position of the retainer 51 is conveniently controlled through the medium of a small, spring-collapsed air-jack 53, the opposite ends of which are connected respectively to the capstan 12 and the lower end of the retainer 51, as shown in FIG. 1. In its collapsed condition, the jack 53 disposes the retainer 51 in its retracted position, where it does not interfere with the falling loops; but when air is supplied to the jack, it will extend and swing the retainer 51 outwardly into its loop-intercepting advanced position.

In order to supply air to the jack 53, it is connected, as through a flexible hose 54, with the annular space between the shafts 22 and 29, such annular space being closed at top and bottom by sleeve bearings 55, which rotatably and slidably support the shaft 29 from the shaft 22. Conveniently, the sleeve bearings 55 are disposed in pairs with an O-ring seal 56 interposed between the two bearings of each pair. Between the upper and lower pairs of sleeve bearings, the shaft 29 is provided with an opening 57 communicating with a passage extending upwardly through the shaft 29 to the upper end thereof. At the upper end of the shaft 29 a rotating union 60 provides communication between the shaft-passage and an elbow 61 connected through a hose 62 and a three-way valve 63 to a source 64 of air under pressure. When it is desired to intercept loops 13 falling from the capstan 12, air under pressure is admitted to the hose 62 and flows therefrom through the elbow 61, union 60, and the axial passage in the shaft 29 to the annular space surrounding that shaft, and thence through the hose 54 to the jack 53, causing extension of the jack and outward swinging of the retainer 51 into its loop-intercepting position.

The general operation of the apparatus illustrated in FIGS. 1-3 will be apparent from the above description, but may be summarized here. With the deflector 14 set to provide the desired eccentricity of the descending loops, with the retainer 51 in its retracted position, and with the screw 43 adjusted to provide the desired angular displacement of loops successively falling onto the bundle support, the coiler 11 forms the wire into loops and discharges those loops onto the bundle support to form the bundle 34. When the bundle support is filled or when, for any other reason, it is desired to terminate the deposition of loops thereon, air under pressure is admitted to the hose 62 to cause outward swinging of the retainer 51, thus intercepting the falling loops while the wire below the retainer is severed, whereupon the lever 46 is operated to elevate the shaft 29 and make possible the replacement of the filled bundle support with an empty one. When such replacement has been effected, the lever 46 is released and the shaft 29 permitted to descend into driving engagement with the bundle support, whereupon the valve 63 is operated to release air from the jack 53 and the retainer 51 is retracted. The loops retained by the retainer when in advanced position fall onto the bundle support, and normal operation of the machine resumes.

While I have referred above to the angular displacement of deposited loops as being controlled by the rela-

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tion between the rotational speeds of the capstan and bundle support, that is only because the deflector 14, in the apparatus of FIG. 1-3, is carried by the capstan. As a matter of fact, the angular displacement between successive loops is controlled by the relation between the respective speeds of the bundle support and the deflector. If the capstan and bundle support rotated at the same speed, the desired angular displacement of successive loops deposited on the bundle support could still be effected by rotating the deflector at a slightly different speed. An arrangement for accomplishing that result is illustrated in FIG. 4.

As shown in FIG. 4, the capstan 12 is rigid with a hollow shaft 66 which is drivingly interconnected to the output element 67 of a speed-reducer 68 and extends upwardly beyond such speed-reducer. A second hollow shaft 69, rotatably supported within the shaft 66, projects downwardly and beyond it for rigid attachment of a deflector support 70 on which are mounted the deflector 14, retainer 51 and retainer-positioning mechanism, such as previously described. The shaft 29, also previously described, is rotatably and slidably mounted within the shaft 69.

For the purpose of driving the shaft 69 to rotate the deflector support 70, that shaft extends upwardly beyond the outer shaft 66 and has affixed to its upper end a pulley 72 drivingly connected through a V-belt 73 with a spring-loaded, variable-diameter pulley 74 rigidly mounted on a rotating jack shaft 75. The shafts 66 and 29 are interconnected, through chains 76 and 77 and the jack shaft 75, to rotate at the same speed. As in the case of the belt drive shown in FIG. 1, the V-belt 73 runs over an idler 78 rotatably mounted at the end of a swinging arm 79 controlled in position by an adjusting screw 80. By adjustment of the screw 80, the tension in the belt 73 can be altered to vary the effective diameter of the pulley 74 and thus vary the speed of the shaft 69 and the deflector-support 70 relative to the common speed of the capstan 12 and the shaft 29, which drives the bundle support, as before.

The arrangement shown in FIG. 4 operates to produce the same result as that produced by the apparatus of FIGS. 1-3. The falling loops are deflected into eccentric positions by the deflector 14 which, since it rotates at a different speed from that of a bundle support, causes successively falling loops to be angularly displaced about the axis of the bundle support, the angular interval between such loops depending upon the difference between the respective speeds of the bundle support and the deflector support 70.

I claim as my invention:

1. A machine for forming continuous filamentary material into an annular bundle, comprising a coiling mechanism having a capstan rotatable on a substantially vertical axis for forming the filamentary material into circular loops and discharging such loops downwardly in succession, a rotatable bundle-support substantially coaxial with said capstan and located thereunder for receiving the downwardly discharged loops, a deflector disposed beneath the capstan for deflecting the discharged loops horizontally into positions of equal eccentricity with respect to the common axis of the capstan and bundle-support, said deflector being mounted on the capstan for rotation therewith about such common axis, and driving means for rotating the capstan, deflector and bundle support in the same direction, said driving means being constructed and arranged to rotate the deflector and bundle support at slightly different speeds whereby to cause each loop received on the bundle support to be displaced by a small angle from the immediately preceding deposited loop.

2. A machine as set forth in claim 1 with the addition that said deflector is radially adjustable to vary the eccentricity of the deflected loops.

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3. A machine as set forth in claim 1 characterized in that said driving means is adjustable to vary the speed difference between the deflector and the bundle-support.

4. A machine for forming continuous filamentary material into an annular bundle, comprising a coiling mechanism having a capstan rotatable on a substantially vertical axis for forming the filamentary material into circular loops and discharging such loops downwardly in succession, a rotatable bundle-support substantially coaxial with said capstan and located thereunder for receiving the downwardly discharged loops, a deflector disposed beneath the capstan for deflecting the discharged loops horizontally into positions of equal eccentricity with respect to the common axis of the capstan and bundle-support, said deflector being rotatable about such common axis, and driving means for rotating the capstan, deflector and bundle support in the same direction, said driving means being constructed and arranged to rotate the deflector and bundle support at slightly different speeds whereby to cause each loop received on the bundle support to be displaced by a small angle from the immediately preceding deposited loop, said loop-retaining means being rotatable with said deflector, said loop-retaining means comprising a member movable between a retracted position in which it lies out of the path of falling loops and an advanced position in which it lies in the path of falling loops and cooperates with the deflector to interrupt the fall of and retain successively discharged loops, and means to selectively position the member in its advanced and retracted positions.

5. A machine as set forth in claim 4 characterized in that said deflector and member are mounted on a common rotatable support in positions within the discharged loops, said deflector sloping outwardly and downwardly to engage falling loops internally and deflect them outwardly, said member, when in its advanced position also sloping outwardly and downwardly.

6. A machine for forming continuous filamentary material into an annular bundle, comprising a coiling mechanism having a capstan rotatable on a substantially vertical axis for forming the filamentary material into circular loops and discharging such loops downwardly in succession, a rotatable bundle-support substantially coaxial with said capstan and located thereunder for receiving the downwardly discharged loops, a deflector disposed beneath the capstan for deflecting the discharged loops horizontally into positions of equal eccentricity with respect to the common axis of the capstan and bundle-support, said deflector being rotatable about such common axis, and driving means for rotating the capstan, deflector and bundle support in the same direction, said driving means being constructed and arranged to rotate the deflector and bundle support at slightly different speeds whereby to cause each loop received on the bundle support to be displaced by a small angle from the immediately preceding deposited loop, said driving means including two concentric vertical shafts, said deflector being supported from the outer one of said shafts for rotation therewith, the inner one of said two shafts being releasably connectible to said bundle support for rotating it.

7. A machine as set forth in claim 1 with the addition that said driving means includes upper and lower speed-reducers each having rotatable input and output elements, said output elements being disposed on a common vertical axis, variable-ratio means operatively interconnecting said input elements, and inner and outer shafts coaxial with and drivingly connected respectively to the output elements of the upper and lower speed reducers, said deflector being supported from and rotatable with said outer shaft, said inner shaft being releasably connectible to said bundle support for rotating it.

8. A machine as set forth in claim 6 characterized in that said deflector is rotatable independently of said cap-

stan, said driving means operating to rotate said capstan and bundle carrier at the same speed.

9. A machine as set forth in claim 6 characterized in that said deflector is rotatable independently of said capstan.

10. A machine as set forth in claim 9 with the addition that said driving means includes inner, intermediate, and outer shafts rotatable about a common axis and a rotatable jack shaft parallel to and spaced laterally from said outer shaft, said intermediate shaft projecting upwardly and downwardly beyond said outer shaft, said inner shaft projecting upwardly and downwardly beyond said intermediate shaft and having at its lower end a releasable driving connection to said bundle carrier, means of equal ratio operatively connecting said inner and outer shafts respectively to said jack shaft, and variable ratio means operatively connecting the jack shaft to the intermediate shaft, said capstan being rigidly mounted on the lower end of said outer shaft, and said deflector being supported from the lower end of the intermediate shaft for rotation therewith.

11. In a machine for forming continuous filamentary material into an annular bundle, coiling mechanism, including a hollow vertical shaft, for forming the filamentary material into circular loops and discharging such loops downwardly in succession, a rotatable bundle-support disposed under said coiling mechanism in position to receive the discharged loops, an inner shaft extending axially through said hollow shaft, a driving connection between said inner shaft and said bundle-carrier means for driving said shafts, loop-retaining mechanism carried by and rotatable with said hollow shaft, said mechanism including a member disposed within the falling loops and movable outwardly into the path thereof to interrupt the fall of and retain successively discharged loops, said mechanism also including a fluid-pressure motor for so moving said member, said hollow and inner shafts providing between them an annular fluid passage connected at its lower end to said motor, said inner shaft having an axially extending passage communicating at its lower end with said annular passage, and

means for supplying fluid under pressure to the upper end of the passage in the inner shaft.

12. A machine for forming continuous filamentary material into an annular bundle, comprising a coiling mechanism having a capstan rotatable on a substantially vertical axis for forming the filamentary material into circular loops and discharging such loops downwardly in succession, a rotatable bundle-support substantially coaxial with said capstan and located thereunder for receiving the downwardly discharged loops, a deflector disposed beneath the capstan for deflecting the discharged loops horizontally into positions of equal eccentricity with respect to the common axis of the capstan and bundle-support, said deflector being rotatable about such common axis, and driving means for rotating the capstan, deflector and bundle support in the same direction, said driving means being constructed and arranged to rotate the deflector and bundle support at slightly different speeds whereby to cause each loop received on the bundle support to be displaced by a small angle from the immediately preceding deposited loop, said bundle-support having an upwardly projecting central core about which said loops fall, said driving means including inner and outer coaxial vertical shafts, said capstan being fixed to said outer shaft, said inner shaft projecting downwardly into driving association with said core.

13. A machine as set forth in claim 12 characterized in that said inner shaft is movable axially of itself into and out of driving association with said core.

14. A machine as set forth in claim 1 with the addition that said bundle-support has an upwardly projecting central core about which said loops fall.

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MERVIN STEIN, *Primary Examiner*.