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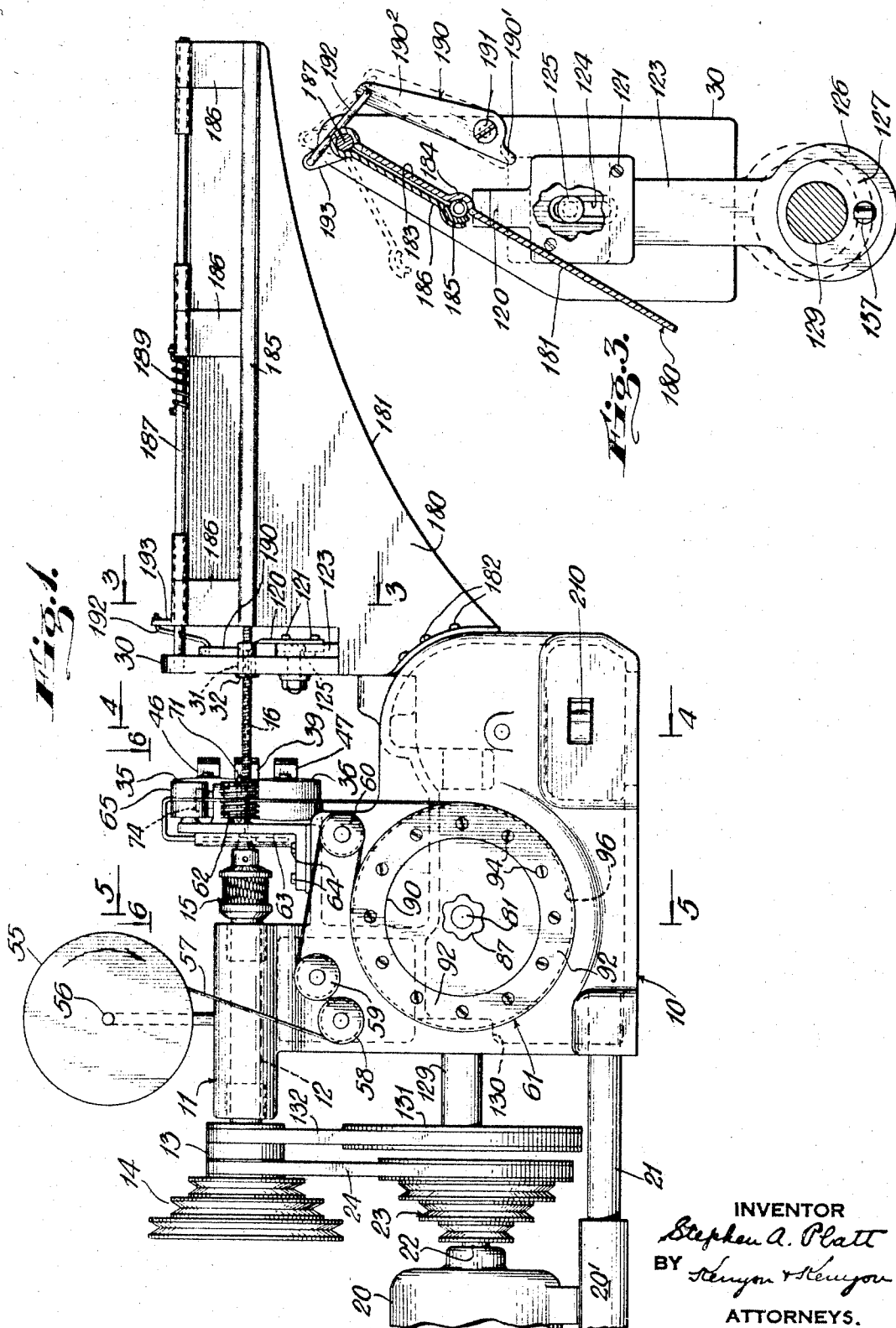
S. A. PLATT

2,227,602

AUTOMATIC COIL WINDING MACHINE

Filed Aug. 16, 1939

4 Sheets-Sheet 1



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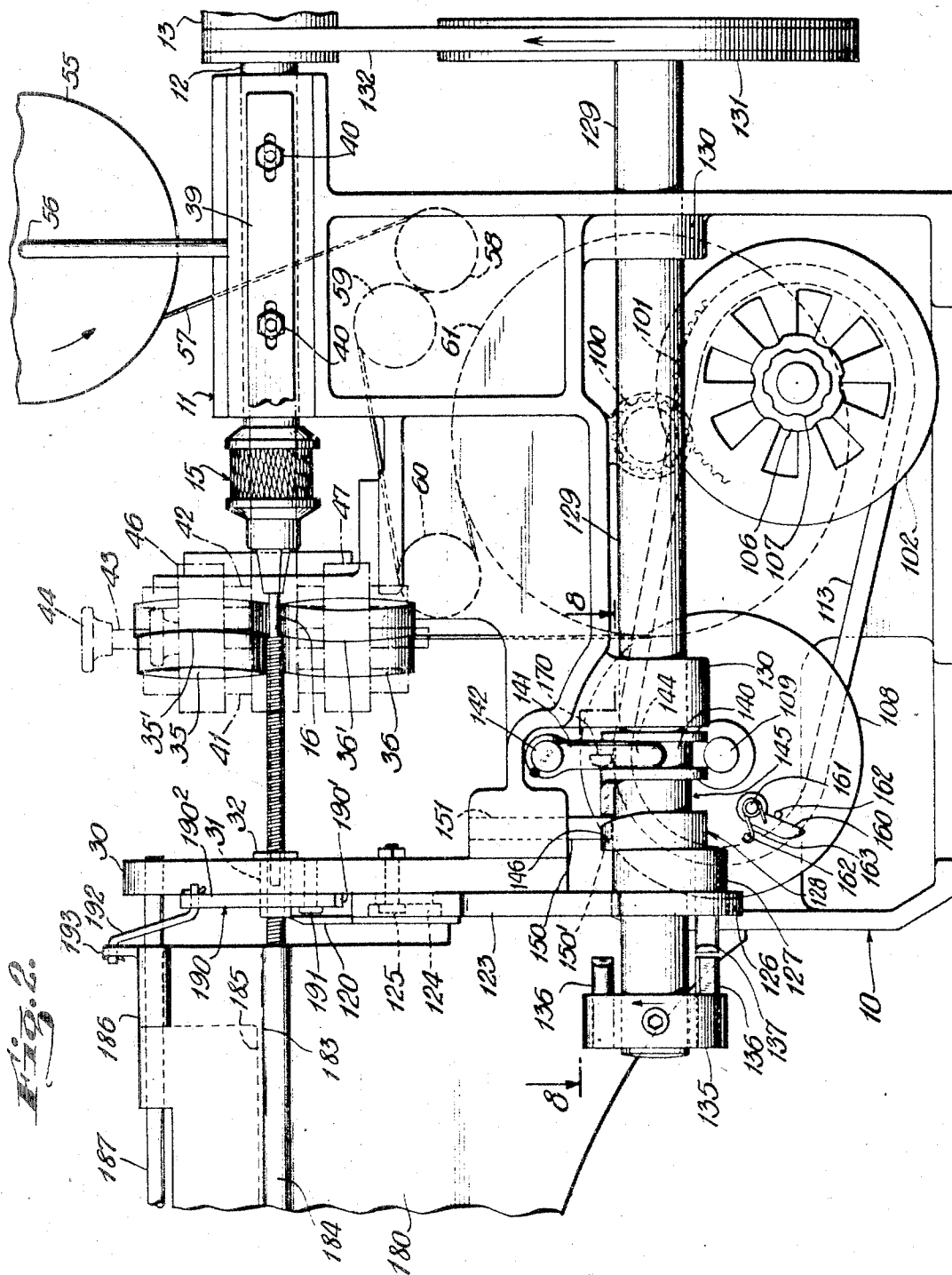
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AUTOMATIC COIL WINDING MACHINE

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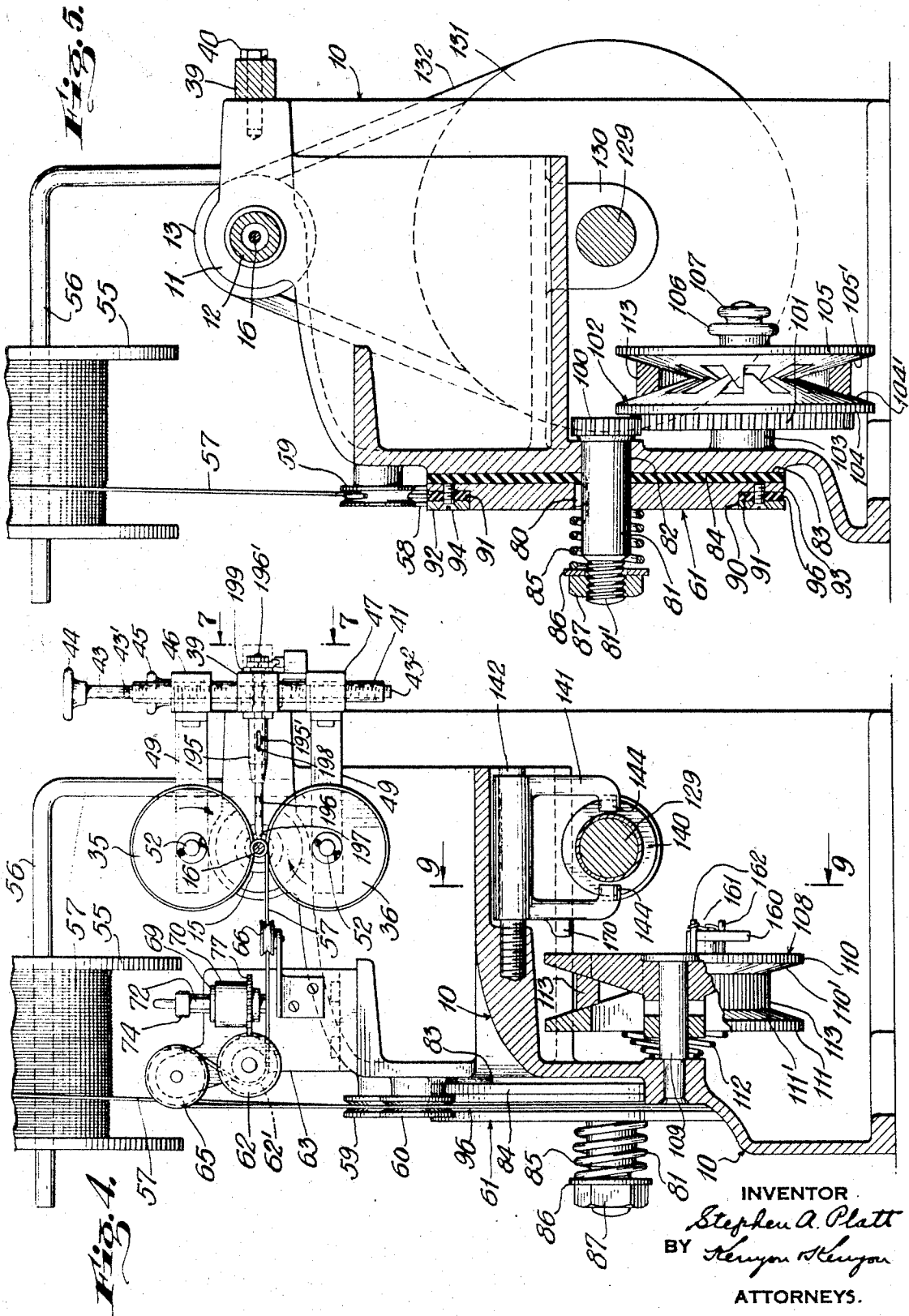
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AUTOMATIC COIL WINDING MACHINE

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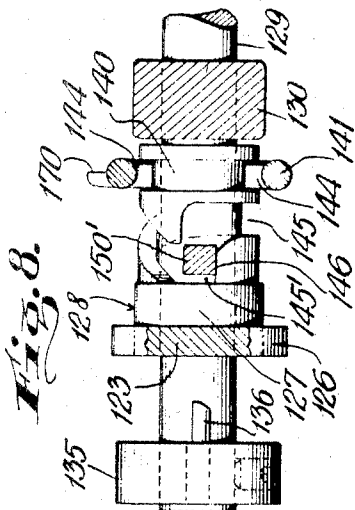
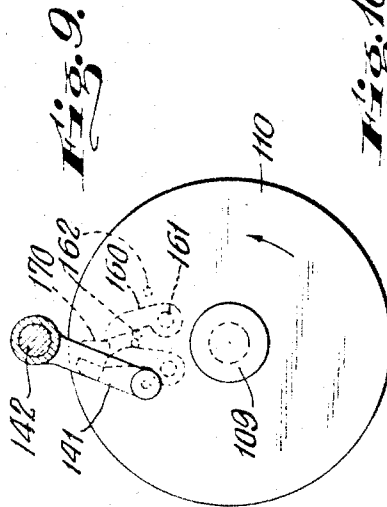
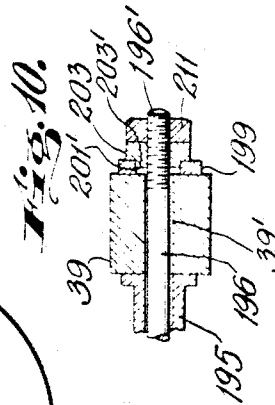
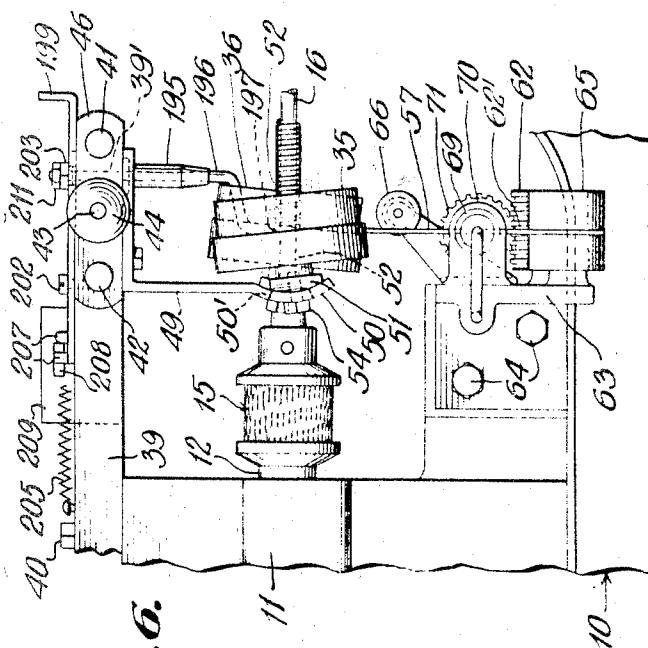
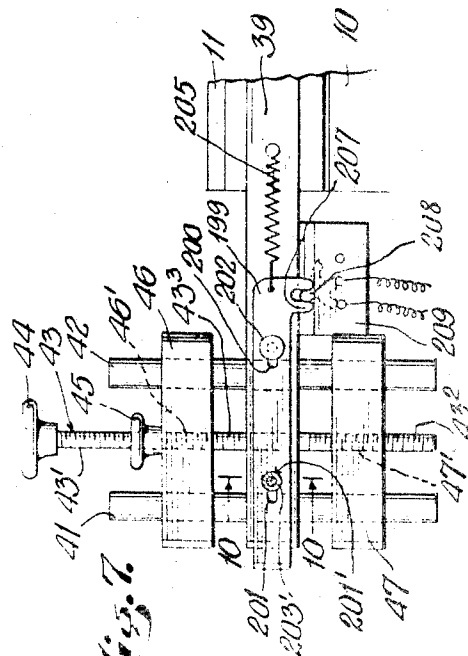
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2,227,602

AUTOMATIC COIL WINDING MACHINE

Filed Aug. 16, 1939

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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AUTOMATIC COIL WINDING MACHINE

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Application August 16, 1939, Serial No. 290,397

23 Claims. (Cl. 153—64)

The present invention relates to automatic coil winding machinery, and more particularly to automatic machinery for manufacturing electrical resistance coils.

5 The automatic production of resistance coils on a quantitative basis requires a machine capable of producing coils of uniform physical and electrical characteristics. The coils produced should be uniformly wound and with small tolerances have the same electrical resistance ratings for a given length and wire size.

10 The importance of uniformity is so great that in some instances, where, for example, the resistance units operate very close to their melting point, the resistance coil units are X-rayed after being embedded in magnesium oxide, or the like, to check the spacings of the windings.

15 Unlike spring wire or steel wire, electrical resistance wire is soft or malleable and is not readily "pushed" or forced into coil form. It must be pulled or drawn into the desired form. Since the resistance per unit length of the wire depends upon its cross-sectional area, the pulling or drawing operation in winding of the coil must not stretch the wire, and thereby reduce its cross-sectional area and resistance. Moreover, the coiling machine must not otherwise deform the wire and thus alter its electrical characteristics.

20 The coil winding operation usually winds the adjacent turns of the coil in contact with each other. Thereafter, the coil is stretched to separate the adjacent turns. It is important to have uniform spacing between adjacent turns of the coil because lack of uniformity results in a concentration of heat in the region of the closest adjacent turns. If the coil is operating close to the melting point of its wire, such heat concentration at a "hot spot" between two turns which are too close results either in a quick fusing of the coil or quick deterioration thereat. Winding of the coil turns uniformly as is accomplished in the machine of the present invention, insures uniform stretching and uniform spacing between individual coil turns when stretched.

25 The operation of the machine depends upon the fact that if coil wire under necessary tension is led to a rotating polished mandrel having a comparatively low coefficient of friction, and wound around the latter under pressure from two freely rotating resilient biased rolls having high coefficients of friction, the wire will form a continuous coil of uniformly wound and spaced turns having a uniform pitch determined by the bias of the rolls. The coil turns will move along the mandrel and, after passing from the zone of

pressure of the rolls, expand slightly so that the coil will slide freely along the major length of said mandrel and may then be transferred to a suitable guide from the mandrel end, and cut off into predetermined lengths intermediate the end of the mandrel and the entrance to the guide.

It is, therefore, a principal object of the invention to provide a machine meeting the foregoing requirements.

It is another object of this invention to produce a successfully operating machine depending upon the principles of operation noted above which is efficient and which may be produced for commercial use at reasonable cost.

Another object of the invention comprises the provision of means for cutting off predetermined coil lengths during the winding of the coil without interfering with the winding operation. This cut-off mechanism must operate intermittently so as to sever, in highly accurate manner, coils having substantially uniform predetermined electrical and physical characteristics.

Still another object of the invention is to provide special wear-resistant metering mechanism which serves to operate the cut-off mechanism and which does not require frequent replacement or resurfacing.

A further object is to provide a machine adaptable for winding coils of differently sized wire, and for such coils to have desired different pitches.

An additional object is to provide a machine having mechanism for detecting defects in coils being wound and automatically stopping operation of the machine when defective coiling occurs.

To the accomplishment of the foregoing and such other objects as may hereinafter appear, this invention consists in the construction and arrangement of parts hereinafter described, and then sought to be defined in the appended claims, reference being had to the accompanying drawings forming a part hereof and which show, merely for the purpose of illustrative disclosure, a preferred embodiment of the invention, it being expressly understood, however, that various changes may be made in practice within the scope of the claims without digressing from the inventive idea.

In the drawings, in which similar reference characters denote corresponding parts:

Figure 1 is a front elevational view of my novel coil-winding machine;

Figure 2 is a rear elevation on an enlarged scale of the left hand portion of the said machine shown in Figure 1;

Figure 3 is a vertical section taken along line 3—3 of Figure 1, viewed in the direction of the arrows, and illustrating the cut-off mechanism and part of the guide mechanism for receiving the wound coil;

Figure 4 is a vertical section taken along line 4—4 of Figure 1, viewed in the direction of the arrows;

Figure 5 is a vertical section taken along line 5—5 of Figure 1, viewed in the direction of the arrows, and illustrating the metering wheel construction as well as the drive connection between said wheel and a part of the cut-off mechanism;

Figure 6 is a fragmentary top plan view of the portion of the machine between the boundaries 6—6 of Figure 1, viewed in the direction of the arrows;

Figure 7 is an elevational view taken in direction of the arrows between the boundaries 7—7 in Figure 4 and illustrating the safety switch-operating mechanism;

Figure 8 is an enlarged detail view of the clutch control means for operating the cut-off mechanism;

Figure 9 is a detail view of the yoke and clutch trip mechanism for operating the clutch means viewed in the direction of the arrows 9—9 of Figure 4; and

Figure 10 is an enlarged vertical section taken along line 10—10 of Figure 7, viewed in the direction of the arrows and illustrating a detail of the switch-operating mechanism of Figure 7.

Referring now to the drawings and first to Figure 1, 10 denotes generally a machine frame. This frame is provided with a bearing flange 11 which rotatably supports on suitable bearings the journal portion of an axle or shaft 12 which protrudes from each end of the flange 11. One end of the shaft has keyed to it the pulley wheel 13 and the cone pulley wheel 14. Each pulley wheel being provided with V-shaped grooves to receive V-sectioned driving belts to be presently described. The opposite end of the shaft 12 is constructed to receive any standard form of chuck 15, that illustrated being a well-known key-tightening type. This chuck 15 is adapted to receive and support horizontally by one of its ends a winding mandrel 16 upon which the wire is wound into coil form.

A motor 20 has a swinging base 20' adjustably carried on a support rod 21 extending laterally from the machine frame 10. The rotor shaft 22 of the motor has a cone pulley wheel 23 keyed thereto and whose apex extends oppositely to that of cone pulley wheel 14. This pulley wheel 23 likewise has V-shaped grooves and a driving belt 24 passed around the two pulley wheels 23 and 14 serves to couple the motor and chuck-bearing axle or shaft 12, so that the motor drives the mandrel 16. Variability of speed is obtained by shifting the belt from step to step of the cone pulley wheels 14 and 23.

The frame 10 forwardly has an upwardly extending vertical arm 30 which has a bore 31 in axial alignment with the shaft 12. A tube 32 is fitted into this bore 31 and the free end of the mandrel extends into, but not through, the entire length of said tube whose diameter is so admeasured as to be only slightly in excess of the diameter of the wire coil wound on the mandrel, as will be presently described.

The rolls 35 and 36 of resilient material, such as rubber having a high coefficient of friction and which cooperate with the mandrel 16 in winding the coil, are supported from the frame 10 at di-

ametrically opposite points with respect to said mandrel. To this end, a bracket arm 39 (Figs. 6 and 7) is suitably attached to the rear of the flange 11 of the frame 10 by bolts 40, or the like, and extends parallel to the mandrel. This arm 39 has a pair of parallel vertically extending guide rods 41 and 42 attached thereto and projecting from the top and bottom faces of said arm. Midway between these guide rods 41 and 42, the arm is bored to receive a vertically extending rotatable bolt 43. The bolt 43 has two oppositely threaded portions 43' and 43'' separated by an unthreaded, smooth portion 43³ whose length is in excess of the thickness of the arm 39. The bolt also has a manipulating knob 44 at its upper end and a suitable lock nut 45 threadedly engaging the portion 43' of the bolt. Slidably supported on the guide rods 41 and 42 on opposite sides of the arm 39 are the blocks 46 and 47 having respectively the oppositely threaded openings 46' and 46'' in which the respective threaded portions 43' and 43'' of the bolt 43 engage. Rotation of the bolt 43 in suitable direction causes the blocks to move toward or away from each other. The lock nut 45 serves to lock the blocks in any desired position relative to each other. A bracket arm 49 suitably attached thereto projects laterally from each block substantially perpendicularly to the axis of the mandrel 16. Each bracket arm at its free end has an arcuate bearing portion 50 for the reception of an arcuate bearing block 51 provided on the end of an axle 52. Each arcuate bearing portion is slotted at 50' and a set screw or bolt 54 movable therein and threadedly engaging the arcuate bearing block 51 serves to permit angular adjustment of each axle 52. Each axle 52 carries one of the rolls 35 or 36. The angular adjustability of the axles 52 permits biasing of the rolls 35 and 36 with respect to each other and with respect to the axis of the mandrel 16. The relative biasing determines the pitch of the coil being wound, as will be presently described. The bracket arms 49 are so admeasured in length that when the axles 52 are parallel with the axis of the mandrel 16, their center lines all lie in the same vertical plane. Since the blocks 46 and 47 are movable vertically, the rolls 35 and 36, carried by the bracket arms 49 thereon, are movable toward or away from the mandrel by manipulation of the bolt 43 and capable of being fixed in any adjusted position by the lock nut 45.

Wire for forming the coils is fed to the mandrel from a spool 55. This spool is rotatably and removably carried on a spool spindle 56 suitably supported from the machine frame. The wire 57 from said spool is led around a pulley wheel 58, over a second pulley wheel 59, around a third pulley wheel 60, and around substantially the major portion of the peripheral surface of a metering wheel 61. All of the wheels are rotatably supported on the front of the frame 10. The location of the axis of the metering wheel and the diameter of the latter are so arranged that the wire leaves the surface of the metering wheel on the tangent which is perpendicular to the axis of the mandrel. The pulley wheels 58, 59 and 60, and particularly pulley wheel 60, are so positioned that the wire must pass from the latter around the major portion of the periphery of the metering wheel 61.

A worm gear wheel 62 having an annular guide groove 62' in its peripheral surface is rotatably supported from a bracket 63 with its axis horizontal and parallel to the mandrel 16 and so

positioned that wire leaves the groove 62' on a tangent substantially in the horizontal plane of the lower face of said mandrel. The bracket 63 is carried by the frame 10 and attached thereto as by bolts 64. The groove 62' is centrally located with respect to the widths of the rolls 35 and 36. The wire leaving the metering wheel surface is passed around a fourth pulley 65 also supported from the bracket 63, around the groove 62', and then past a vertical guide pulley 66; and finally between the bight formed by the mandrel 16 and the lower roll 36.

It is desirable to lubricate only that surface of the wire which comes in direct contact with the surface of the mandrel 16. In the embodiment shown, the wire surface to be lubricated is the top surface of the wire 57 as it passes from the groove 62' to the vertical pulley 66. To this end, a hollow socket 69 is vertically and rotatably carried in a bearing flange 70 provided on the bracket 63. This socket is provided with an external gear 71 meshing with the worm gear 62. The hollow socket has a polygonal section and receives a polygonally shaped stick of lubricating medium 72, such as paraffin or other suitable substance. The lubricating stick is pressed against the top of the wire 57 by its own weight or by the use of a slidably supported weight 74 which is suitably carried by the bracket 63. This weight is adapted to press downwardly on the upper end of the lubricating stick. The axis of the lubricating stick is arranged to lie substantially perpendicular to the top face of the wire 57 and in the same plane therewith. Passage of the wire in the groove 62' rotates the worm wheel 62 and consequently causes rotation of the lubricating stick socket 69 through gear 71. As a result, the lubricating stick 72 rotates as the wire passes under it and wears down uniformly while lubricating only the one face of the wire 57 which comes into direct contact with the mandrel 16.

It is necessary to tension the wire 57 as it passes from the spool 55 to the mandrel 16 during the winding operation. This tensioning is accomplished herein through the agency of the metering wheel 61. The latter is slidably keyed at 80 to the rotatable shaft 81 borne in a bearing opening 82 in the front face of the frame 10. The said front face is provided with a pad surface 83 concentric about the bearing opening 82 and of substantially the same diameter as the metering wheel 61. A circular friction disc or mat 84 is mounted around the shaft 81 between the inner face of the metering wheel and the pad surface 83 and pressed between the two by the compression spring 85 carried on the shaft 81. The pressure of spring 85 is adjustable through the agency of the washer 86 and clamping nut 87 which latter threadedly engages the outer threaded end 81' of the shaft 81. This variability of pressure permits adjustment of the frictional resistance between the metering wheel and the frame and consequently permits variation in tension on the wire 57.

Since the wire passes over the peripheral surface of the metering wheel at high speed during the coil-winding operation a special wear-resisting peripheral surface is necessary to eliminate the necessity for frequent replacement of the metering wheel and consequent readjustment of the machine, particularly because the metering wheel also serves to drive a special cut-off mechanism whose accuracy must be maintained. To this end, the peripheral surface of the meter-

ing wheel has a portion 90 of reduced diameter. On the said reduced portion a rubber ring 91 is mounted which is somewhat less in external diameter than the maximum external diameter of the wheel 61. A clamping ring 92, also mounted on said reduced portion 90, serves to clamp the said ring to the annular flange 93 of said metering wheel. Suitably spaced bolts 94 extending through said clamping ring, and rubber ring, and into said flange 93, serve to effect clamping. The rubber ring 91 may be replaced by other suitable resilient material having a high coefficient of friction. This ring, if of rubber, is compressed to about one-third of its original axial thickness by the clamping ring. Its peripheral surface is then slightly below that of the peripheral surfaces of the flange 93 and clamping ring 92 so that a groove 96 is provided in the peripheral face of the composite metering wheel in which the wire 57 travels. The friction between the wire 57 and the compressed rubber ring surface in conjunction with the retarding action of the friction pad 84 on the metering wheel surface affords an adjustable means for tensioning the wire. This specific metering wheel structure has been found to be exceedingly wear-resistant. In actual practice hundreds of thousands of miles of wire run over such metering wheels have not required refacing thereof.

The rotation of the metering wheel caused by the passage of the wire over it is used to drive automatic cut-off mechanism which serves to cut off predetermined lengths of wound coil. To this end, the wheel shaft 81 is provided with a pinion 100. The latter meshes with a pinion 101 of larger diameter attached to a pulley wheel 102, which latter is rotatably supported from the frame 10 by the spindle 103. The pulley 102 is of the variable speed type, i. e., it has opposed inclined faces 104' and 105' on separate sections 104 and 105 which are adjustably movable toward or away from each other by means of a manipulating nut 106 and clamping nut 107.

A second variable speed type pulley 108 is rotatably borne on the spindle 103 carried by the frame 10. This pulley, too, has oppositely inclined faces 110' and 111' on separate sections 110 and 111, one of which is movable toward and away from the other by the action of, or against the action of, a compression spring 112 on the spindle 103 between one of the sections and the frame. This pulley 108 is coupled to the pulley 102 by a V-shaped belt 113 operating between the opposed faces of the respective pulley sections. The two pulleys and the belt constitute a variable speed drive of the "Reeves" type in which the rotational speed of the pulley 108 is adjusted by the relative adjustment of the opposing faces of the pulley 102. Thus, it is possible to vary the lengths of the coils cut off by the mechanism now to be described.

The cut-off mechanism comprises a reciprocally movable knife blade 120 movable transversely of the axis of the mandrel 16 and the coil wound thereon. This knife blade 120 is adapted to move across the outer end of the tube 32 and sever the wound coil whenever so moved. The knife blade is removably attached at 121 to the connecting rod 123. This connecting rod is provided with a longitudinal slot 124 and a headed guide pin 125, engageable in the vertical arm 30, serves to guide the vertical movement of the connecting rod. The latter at its lower end has a bearing 126. An eccentric 127 integrally formed with a clutch member 128 operates in the bearing

and serves upon rotation to reciprocate the connecting rod and the blade carried thereby.

The clutch member 128 is rotatably borne and slidable longitudinally on a rotary shaft 129 suitably journaled in bearings 130 in the frame 10. This shaft extends parallelly to shaft 12 and at one end has a driving pulley 131. Belting 132 connects this driving pulley with the pulley 13 on shaft 12 so that when the latter is driven by the motor 20, the shaft 129 is likewise driven. In the embodiment shown, the pulley ratio of the diameters of pulleys 13 and 131 is such that shaft 129 is driven at a lower speed than shaft 12. The opposite end of shaft 129 has a collar 135 fixed thereto. This collar has two diametrically arranged, axially extending, engaging pins 136, one or the other of which is adapted to engage an oppositely extending pin 137 on the eccentric 127 when the latter and the clutch member 128 are moved into one position on the shaft 129, thereby serving to drive the eccentric and reciprocate the connecting rod. In another position of the eccentric 127 and clutch member 128 on the shaft, the pins 136 clear the pin 137 without engaging it and do not drive the eccentric.

The intermittent engagement of the pins 136 and 137 is such that a single revolution of the clutch and eccentric, and, consequently, a single reciprocation of the connecting rod, takes place for each single revolution of the pulley 108.

To effect the intermittent engagement, the clutch member 128 has an annular yoke groove 140. A U-shaped yoke 141 is pivotally supported on a spindle 142 attached to the frame 10 and extending transversely of the shaft 129 so that the yoke 141 swings longitudinally of said shaft. The yoke has oppositely extending lugs 144 which permanently engage in the yoke groove 140. When the yoke is swung about its spindle 142, the lugs in the groove 140 serve to shift the clutch member 128 longitudinally on the shaft 129.

The clutch member 128 (Fig. 8) has a single-turn, helical cam groove 145 in its peripheral face whose beginning and end are connected by a longitudinally extending passageway 145' which serves to define a shoulder 146 at the exit end of the cam groove and adjacent its entry end.

A cam groove follower 150 of substantially square cross section is suitably supported in vertical direction at 151 from the frame 10. The lower end 150' of the follower is adapted to engage in the cam groove 145 and normally to abut the shoulder 146 at the exit end of said groove. While so positioned, the clutch member is locked against rotation and the pin 137 is clear of the pins 136. In the embodiment shown, a shift of the clutch member 128 to the left will cause the follower 150 to clear the shoulder and enter the starting end of the cam groove, thus freeing the clutch member and permitting it to rotate. This tripping action is effected by a trip lever 160 (Figs. 2, 4 and 9) carried on a face of the section 110 of the pulley wheel 108. Trip lever 160 is pivoted at one end to the face of said section by a pivot pin 161. Stop pins 162 also projecting from the face of said section serve to limit rotation of the trip lever about its pivot pin and a resilient member 163 serves to urge said lever against the forward stop pin in the direction of rotation of the section 110.

The yoke 141 has a lug 170 projecting laterally into the path of travel of the trip lever 160. As the lever moves upon rotation with the section

110, its free end engages the lug 170 causing the said lever to move back against the rear stop pin 162 whereupon said lever rotates the yoke 141 and slides the clutch to the left until the cam follower 150 clears the shoulder 146 and enters the start of cam groove 145. At this instant of clearance one of the pins 136 engages the pin 137 of the eccentric and starts to rotate the latter and the clutch member of which it is part while the follower moves in the groove 145. In so doing it, of course, follows the helical angle of the said groove and shifts the clutch still further to the left moving with it the yoke 141 into a release position (Fig. 9), where the trip lever 160 disengages the lug and is snapped by resilient member 163 to the front stop pin 162 and clear of the lug 170. The follower moving in the cam groove as the clutch rotates then causes the clutch to shift toward the right (Fig. 8) so that after a single revolution when said follower again abuts the shoulder 146, the clutch member has been so shifted that its pin 137 has disengaged the pins 136. Thus, a single rotation only of the clutch member 128 occurs each time the trip lever engages the lug 170. The latter engagement occurs once for each revolution of section 110 of pulley wheel 108. Therefore, the speed of rotation of said wheel determines the frequency of single rotations of the clutch member. In consequence, the frequency of the single reciprocations of the knife blade 120, which is reciprocated once for each revolution of the eccentric 127, is controlled and the lengths of coil cut off can be controlled by changing the speed of the pulley wheel 108.

The clutch-operated cut-off mechanism driven by rotation of the metering wheel is positive in its action and eliminates any irregularity in coil lengths. There is no danger of double tripping. Simple adjustment of the variable speed pulley 105 permits a change in the length of coil cut-off by changing the relative frequency of cut-off action as compared to the speed of coiling of the wire.

The coil formed on the mandrel and moved off the latter at its forward end passes through the tube 32 and is received by a guide 180. This guide 180 comprises an arm 181 attached to the frame 10 at 182. The upper portion 183 of this arm is provided with a semi-circular groove 184 extending in the same direction as said mandrel 16 and concentric with respect to the axis of said mandrel. A semi-circular tube 185 having lateral arms 186 is rotatably supported by these arms from a pivot spindle or rod 187 carried by the vertical arm 30 and extending parallel to the groove 184. The concavity of tube 185 faces that of the groove 184 and the two function when in register as a tubular guide for the coiled wire passing thereto from the mandrel. Resilient means as a torsion spring 189 acting on the rod 187 and an arm 186 tend to maintain the tube 185 in registry with the groove 184.

When a length of coil is cut off from that being wound on the mandrel it is desirable to effect quick removal thereof from the guide 180. To this end a crank lever 190 is pivotally mounted on a pivot pin 191 carried by the vertical arm 30. One arm 190' of the lever extends into the path of travel of the connecting rod 123. The other arm 190² is connected by a linkage member 192 to a projecting lug 193 on one of the arms 186 supporting the tube 185. Thus, as the connecting rod reaches the top of its stroke, shown in dotted lines in Figure 3, its upper edge engages the

arm 190' of lever 190 and rotates the latter to the dotted line position causing the linkage member 192 to rotate the arm 186 and tube 185 to the dotted position shown and permits the severed coil to fall from the groove 184. The impact of the cut-off stroke of the blade is sufficient to dislodge the severed coil section from said groove. Spring 189 returns the tube 185 to full line position of the figure when the connecting rod returns to non-cutting-off position.

Occasionally, during coiling, an overlapping of turns will occur at the coiling point. A detector device and safety switch operated by the detector device are provided to stop the machine when this occurs.

The detector device comprises a tubular support 195 carried by the arm 39 (Figures 4 and 6). This support extends toward the mandrel from the said arm 39 and carries a longitudinally slidable pointer rod 196 whose forward end is bent to permit the tip 197 to engage the coil surface adjacent the rear of entry point of the wire into the bight between the mandrel and roller 36. Tubular support 195 is longitudinally slotted at 195' and a guide pin 198, fastened to the pointer rod 196, is movable in said slot to limit the extent of movement of said rod. The said rod 196 extends from the rear end of the tubular member, through a suitable bore 38' in the arm 39 and projects beyond the rear face (Fig. 10) of the latter. Said rod is threaded at its rear end 196'.

A switch-operating member 199 extending longitudinally of the rear face of the arm 39 is provided with two longitudinally extending slots 200 and 201. A suitable guide bolt 202 screwed into the arm 39 through the slot 200 serves as one of the guides for said member 199.

The slot 201 in width is slightly in excess of the diameter of the end 196' of the pointer rod 196, and said end projects through said slot. This slot 201 has also an enlargement 201' at one end defining shoulders with respect to the balance of the slot 201. An engaging nut 203 having a reduced portion 203' of substantially the same diameter as the enlargement 201' of the slot is screwed onto the end 196' of the pointer rod 196. When said reduced portion rests in said enlargement 201', the member 199 is prevented from sliding longitudinally of the arm 39 notwithstanding tension applied to induce such sliding by the tension spring 205 fixed at opposite ends to said arm 39 and to said member 199. A longitudinal shift of the rod 196, caused by overlapping turns of coil pushing its pointer end rearwardly, moves the reduced portion 203' of the nut out of the slot portion 201' and permits the spring to snap the switch-operating member longitudinally until the opposite ends of the slots 200 and 201 are reached by the bolt and rod 196. Laterally projecting lugs 207 on the member 199 engage a toggle switch lever 208 of an electrical switch 209. If the latter is connected in electrical series with the main motor switch 210 the electrical circuit to the motor is broken by a movement of the toggle switch lever 208 induced as described above. Thus, the motor stops if overlapping is detected by the pointer rod 196, and the attendant can reset the machine for proper coiling. A clamping nut 211 on the end of the rod 196 permits adjustable setting thereof to compensate for different sizes of wire used in winding coils.

Operation of the machine in brief is as follows:

Wire 57 from the spool 55 is led over the various pulleys 58, 59, 60, metering wheel 61, pulley 65 and around groove 62' of gear 62 and past pulley

66 to the bight between the lower rubber roll 36 and the mandrel 16. Then the shaft 12 and, consequently the mandrel 16, are given a few manual rotations to start the wind on the mandrel. The rolls 35 and 36 are given the desired opposing bias with respect to each other and moved toward each other until they both press firmly on the wire-windings on the mandrel. They are clamped in this position by the clamping nut 45. The motor is then started, causing the mandrel 16 to rotate at high speed. The coefficient of friction between the mandrel and the wire, aided by the pressure of the lower roll 36, is sufficient to draw the wire from the spool and coil it about the mandrel. The bias of the rolls 35 and 36 determines the pitch of the wind and forces the windings to move along the mandrel and clear of the rolls 35 and 36. Once clear of the rolls, the turns on the mandrel expand slightly and slide freely along the mandrel surface in axial direction toward the guide 180, passing off the mandrel in the tube 32 on the way to said guide. The lubricant applied by stick 72 to the face of the wire adjacent the face of the mandrel facilitates the sliding of the coil along the mandrel. At intermittent periods controlled by the trip lever 160, as hereinbefore described, the cut-off knife sweeps across the exit end of tube 32 cutting off predetermined lengths of coil which fall from the opened guide 180 at the time of severance. The adjustable ratio of speed between the coiling speed of the mandrel and the rotational speed of the trip lever 160 determines the length of coil cut-off. This ratio can be adjusted with a high degree of accuracy to insure highly accurate cut-off of uniform predetermined lengths of coil.

In the embodiment shown, the rolls 35 and 36 have respectively the annular shoulders 35' and 36' at the mid-points of their surface peripheries. These shoulders produced by slightly reducing the diameter of the respective rolls on one side of the respective shoulders facilitate the guiding of the wire at the desired pitch angle during the coiling operation. The shoulder height depends upon the wire size and in cases of very small-sized wire can be eliminated. For the larger wire sizes, however, the shoulder is important.

The adjustability of the speed of drive of various parts, the adjustability of tension by the metering wheel, as well as the adjustability of the pressure and degree of bias of the rolls 35 and 36 makes the machine adaptable for making accurate coils of any desired predetermined length and of desired different wire sizes.

The material of the mandrel is optional as long as it is wear-resistant and has a low coefficient of friction. "Nitrided" steel mandrels have been found satisfactory.

The special metering wheel construction, including its specially constructed wear-resisting peripheral surface, eliminates a source of error normally induced by wear and also eliminates the necessity for frequent readjustment of the machine during the preparation of a particular length of coil of a particular wire size.

The variable biasing of the rubber rolls 35 and 36 permits the winding of differently pitched coils.

The safety switch and detector mechanism prevents the production of defective coils or windings.

Various other advantages are inherent in the structure described. It is to be understood, however, that variations in structural features with-

in the scope of the appended claims may be made without departing from the inventive idea. There is no intention of limitation to the exact details of construction shown and described.

5 I claim:

1. A coil winding machine comprising a drivable mandrel, a pair of rolls oppositely biased with respect to each other and in surface contact with said mandrel, means for driving said
10 mandrel, and means for leading coil wire to said mandrel to be wound thereon.

2. A coil winding machine comprising a drivable mandrel, a pair of rotatable rolls oppositely biased with respect to each other and in frictional surface contact with said mandrel, means for driving said mandrel, means for leading coil
15 wire to said mandrel between it and said rolls, and means for cutting off predetermined lengths of coils wound on said mandrel.

3. A coil winding machine comprising a drivable mandrel, a pair of rolls oppositely biased with respect to each other and in surface contact with said mandrel, means for driving said
20 mandrel, means for leading coil wire to said mandrel between it and one of said rolls, rotating means for lubricating only that surface of the coil wire coming into direct contact with the surface of said mandrel, and means for driving
25 said mandrel to wind said wire in coil form thereon.

4. A coil winding machine comprising a drivable mandrel, a pair of stepped rolls oppositely biased with respect to each other and in surface
30 contact with said mandrel, means for driving said mandrel, and means for leading wire to said mandrel between it and one of said rolls adjacent the shoulder formed by the step on said one of said rolls to wind said wire about said
35 mandrel with a predetermined pitch.

5. A coil winding machine comprising a drivable mandrel, a pair of oppositely biased rotatable rolls in surface contact with said mandrel, means for leading coil wire to said mandrel be-
40 tween it and one of said rolls, means for driving said mandrel to coil the wire thereabout, said rolls guiding said wire onto said mandrel, regulating the pitch of the wind thereon by the relative bias of said rolls and pushing the coil
45 forwardly along the mandrel as the latter is driven, receiving means adjacent the end of said mandrel for leading the wound coil off the end of said mandrel, and means for cutting off pre-
50 determined lengths of coils formed on said mandrel between the end thereof and said receiving means.

6. A coil winding machine comprising a drivable mandrel, a pair of adjustable rotatable rolls oppositely biased with respect to each other and
60 in surface contact with said mandrel, means for leading coil wire to said mandrel between it and one of said rolls, and means for driving said mandrel to coil wire thereabout, said rolls serving to guide said wire onto said mandrel, to regulate the
65 pitch of the wind thereon and to push the wound coil forwardly along the mandrel toward the discharge end thereof as the said mandrel is driven.

7. In a device of the character described, means for winding wire into a coil, means for
70 cutting off lengths of coil from the wound coil without impeding the winding operation, and infinitely adjustable means for automatically metering the length of each coil cut off, said last-named means being controlled by the movement
75 of the wire to said first-named means, and be-

ing capable of adjustment while said device is in operation.

8. In a device of the character described, means for continuously winding wire into a coil, means for cutting off lengths of coil from the
5 wound coil without impeding the winding operation, and means for automatically metering the length of each coil cut off, said last-named means including a clutch member for operating said cut-off means operated by movement of the wire
10 to said first-named means.

9. In a device of the character described, means for winding wire into a coil, means for cutting off lengths of coil from the wound coil without impeding the winding operation and
15 means for automatically metering the length of each coil cut off, said last-named means including a clutch member for operating said cut-off means, a metering wheel around which said wire passes prior to being wound into coil form to
20 rotate said wheel, and a trip mechanism operable during a prescribed period of the rotation of said metering wheel for moving said clutch member into operative engagement with said cut-off means.

10. In a device of the character described, means for winding wire into a uniform coil, means for cutting off lengths of coil from the wound coil without impeding the winding operation and means for automatically metering the
25 length of each coil cut-off, said last-named means including a clutch member for moving said cut-off means into operative relationship with said coil, a metering wheel around which said wire passes prior to being wound into coil form to
30 rotate said wheel, a trip mechanism operable during a prescribed period of the rotation of said metering wheel for moving said clutch member into position to cause operative movement of said cut-off means, and variable speed means inter-
35 posed between said trip mechanism and said metering wheel for varying the frequency of the operation of said trip mechanism and said cut-off means.

11. In a device of the character described, means for winding wire into a coil on a driven
45 mandrel and moving said coil along and off said mandrel, guide means for receiving said wound coil from said mandrel, and means for cutting off lengths of coil from the wound coil between its exit from said mandrel and its entrance into said guide means without impeding the coil winding operation.

12. In a device of the character described, means for winding wire into a coil, a reciprocally
55 movable cut-off member for severing lengths of coil from the wound coil without impeding the winding operation, means for reciprocating said cut-off member, and infinitely adjustable metering means controlled by the passage of wire to the winding means adjustable during operation
60 of said device and for actuating said reciprocating means.

13. A metering device for use in a coil winding machine comprising a wheel having a grooved
65 peripheral surface, the bottom of the groove consisting of compressed resilient material, and means for mounting and compressing said material which constitutes the bottom of said groove.

14. A metering device for use in a coil winding machine comprising a wheel having a grooved
70 peripheral surface, the bottom of the groove consisting of highly compressed resilient material.

15. A metering device for use in a coil winding machine comprising a wheel having a peripheral
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flange, a compressed resilient ring adjacent said flange and having a smaller outside diameter than said flange, a clamping member of the same overall diameter as said flange applied over said ring, and attaching means for compressing said ring between said flange and said clamping member.

16. A metering device for use in a coil winding machine whose elements comprise a solid wheel, a compressed resilient member arranged along the side of said wheel adjacent and somewhat below its peripheral rim and a compression member of the same diameter as said wheel for attaching said resilient member to said wheel and highly compressing said resilient member between said wheel and said compression member so that the composite peripheral surface of said wheel comprises two solid rims adjacent opposite side faces of the wheel separated by a groove whose bottom face constitutes the peripheral face of the highly compressed resilient member.

17. In a device of the character described, means for winding wire into a coil, means arranged adjacent to the mandrel at the coiling point for detecting overlapping turns of coil windings, and means operated by said detecting means for stopping said device when said overlapping occurs.

18. A coil winding machine comprising a drivable mandrel, means for driving said mandrel, means for directing wire to be coiled to said mandrel to wind the latter uniformly around said mandrel with a predetermined pitch, means arranged adjacent to the mandrel at the coiling point for detecting overlapping windings on said mandrel, and means operated by said detecting means for stopping said machine when said overlapping occurs.

19. A coil-winding machine comprising a drivable mandrel, a pair of resilient rolls oppositely

biased with respect to each other and in surface contact with said mandrel, means for driving said mandrel and means for leading coil wire to said mandrel to be wound thereon.

20. A coil winding machine comprising a drivable mandrel, a pair of rolls oppositely biased with respect to each other and in surface contact with opposite sides of said mandrel, means for varying the bias of said rolls relative to each other, means for driving said mandrel, and means for leading coil wire to said mandrel to be wound thereon.

21. In a device of the character described means for winding wire into a coil, means for cutting off lengths of coil from the wound coil without impeding the winding operation, and means for automatically metering the length of each coil cut off, said means comprising a metering wheel over which said wire moves in its passage to the winding means, control means for actuating said cut-off means and variable speed means connecting said control means and said wheel whereby the lengths of coils cut off may be varied.

22. A metering device for use in a coil winding machine comprising a wheel having a grooved peripheral surface, resilient material at the bottom of said groove and means for compressing said material highly in the direction of the width of said groove.

23. A coil winding machine comprising a drivable mandrel, a pair of resilient rolls oppositely biased with respect to each other and in surface contact with opposite sides of said mandrel, means for driving said mandrel, means for leading coil wire to said mandrel between one of said rolls and said mandrel and means for varying the bias between said two rolls to vary the pitch of wire coiled on said mandrel.

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