

July 8, 1969

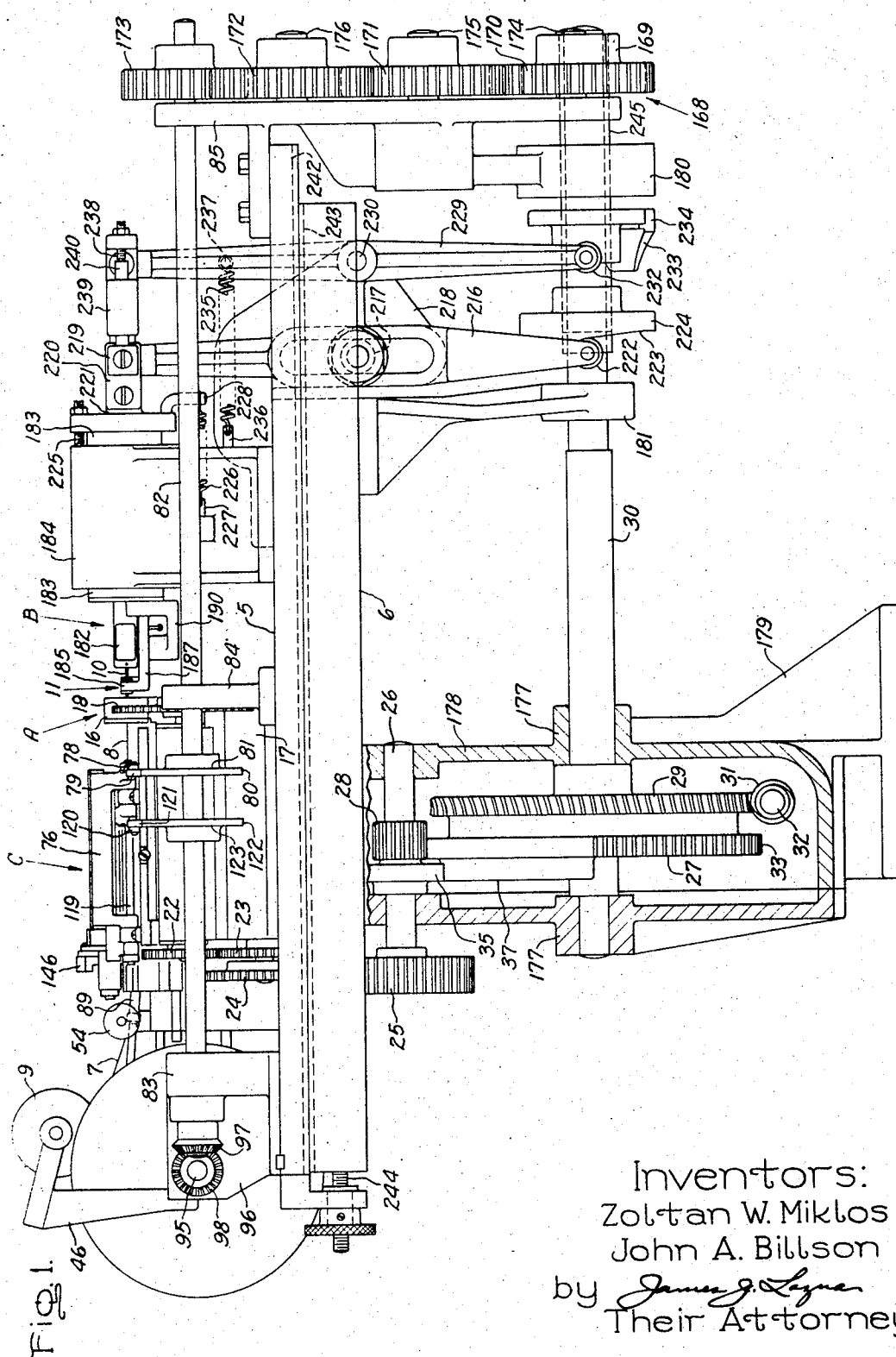
Z. W. MIKLOS ETAL

3,454,053

COILED FILAMENT FORMING APPARATUS

Filed March 6, 1967

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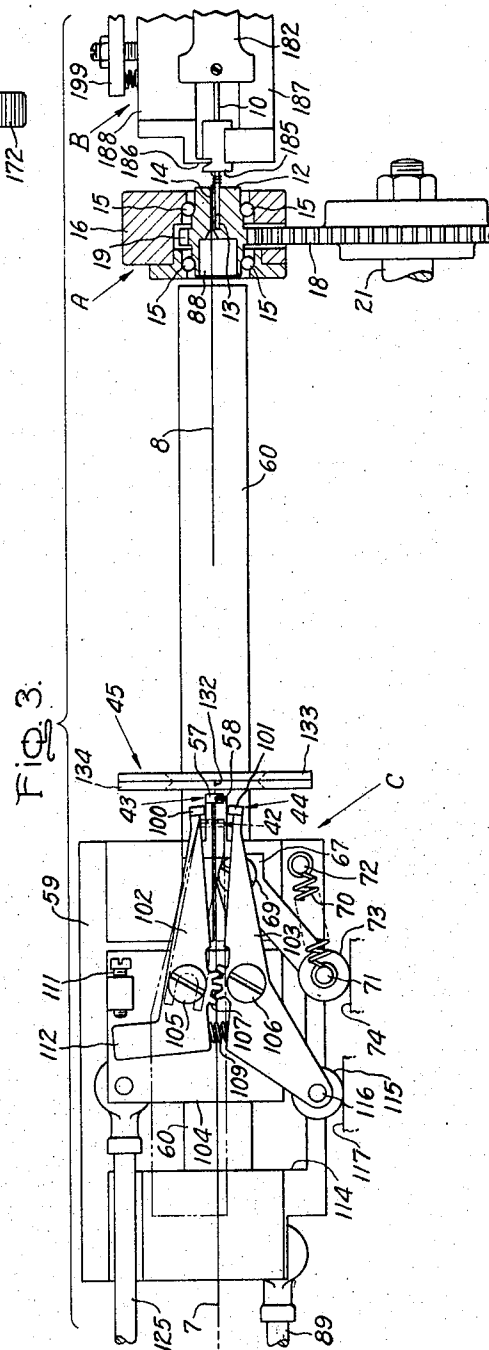
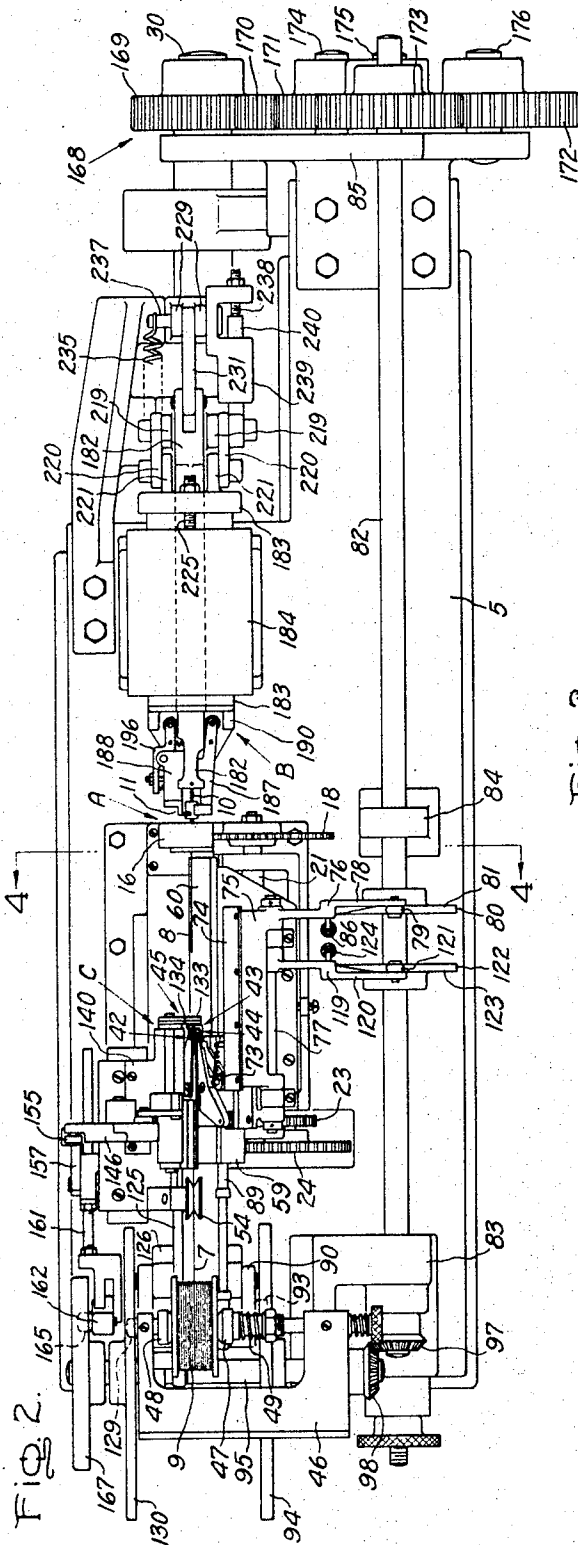
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COILED FILAMENT FORMING APPARATUS

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COILED FILAMENT FORMING APPARATUS

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Fig. 4.

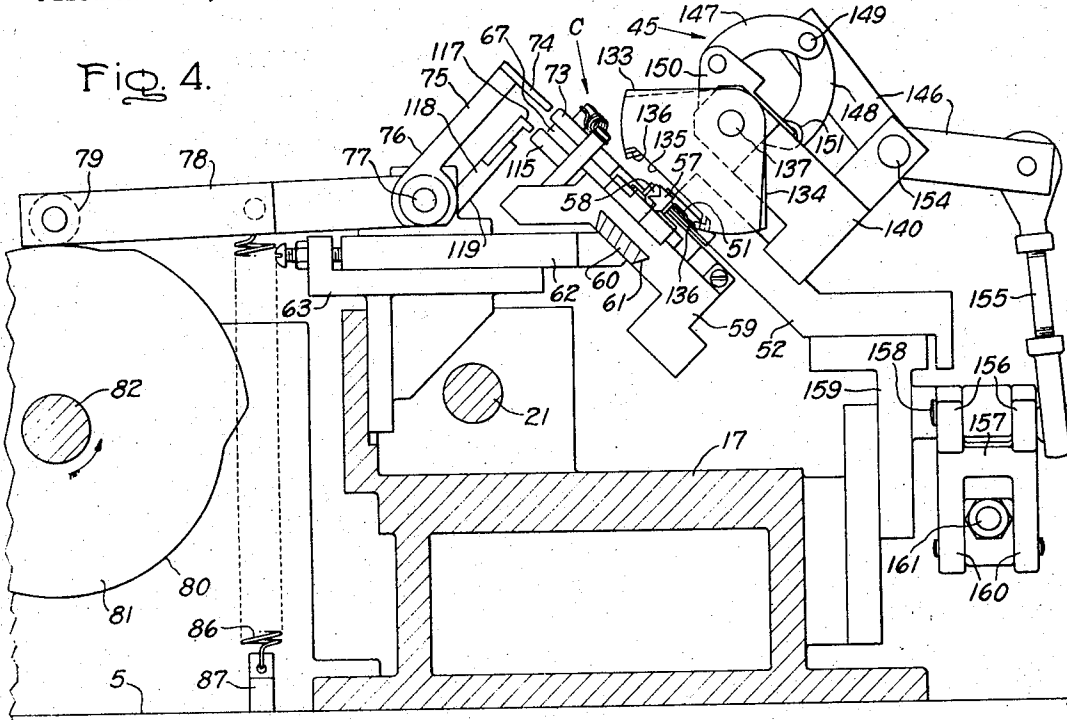


Fig. 6.

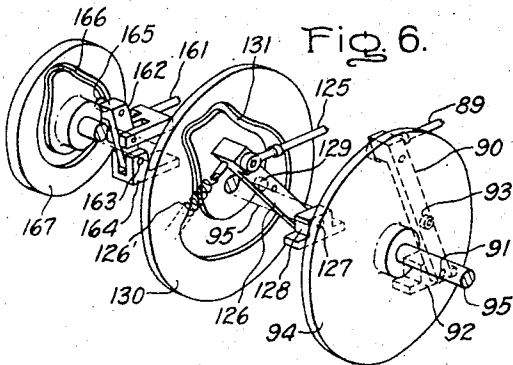


Fig. 5.

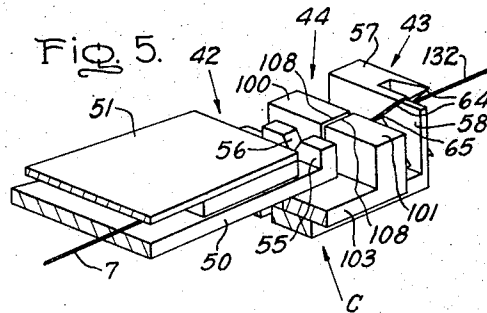
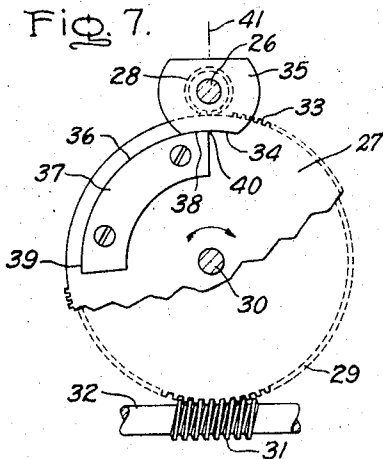


Fig. 7.



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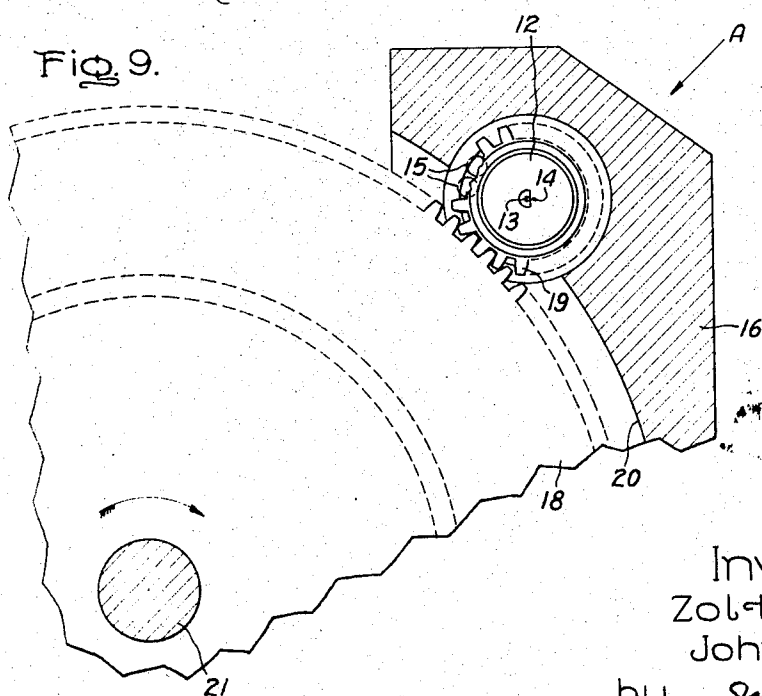
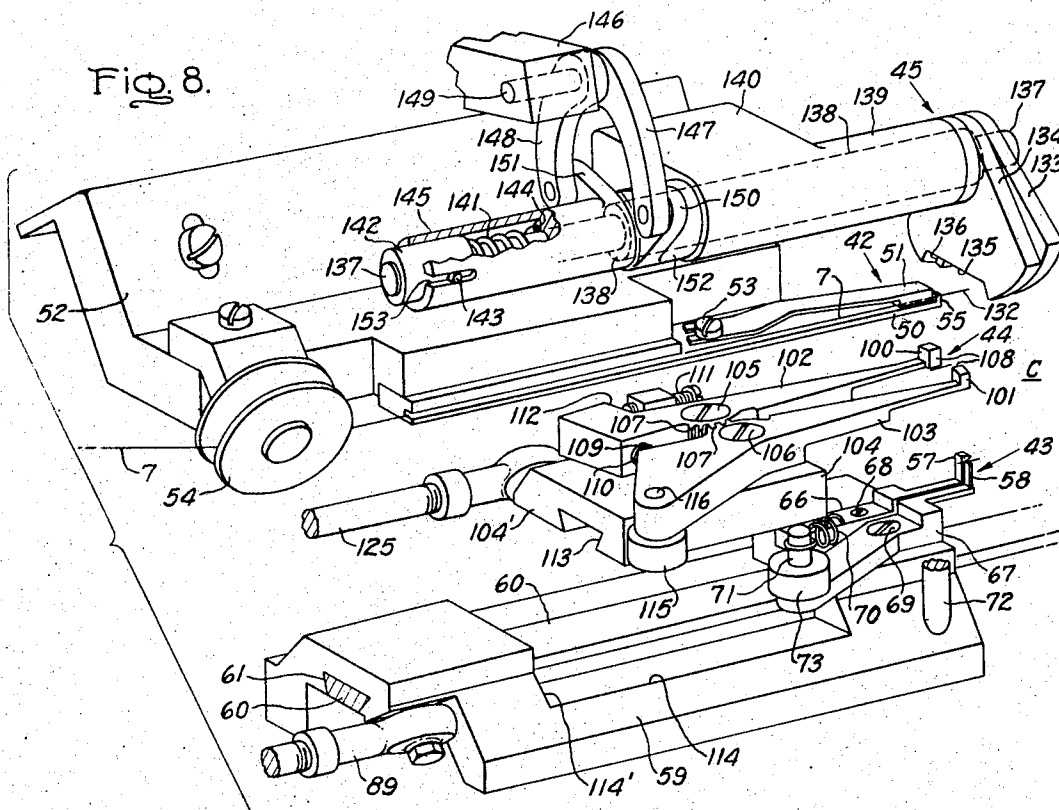
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COILED FILAMENT FORMING APPARATUS

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Sheet 4 of 5



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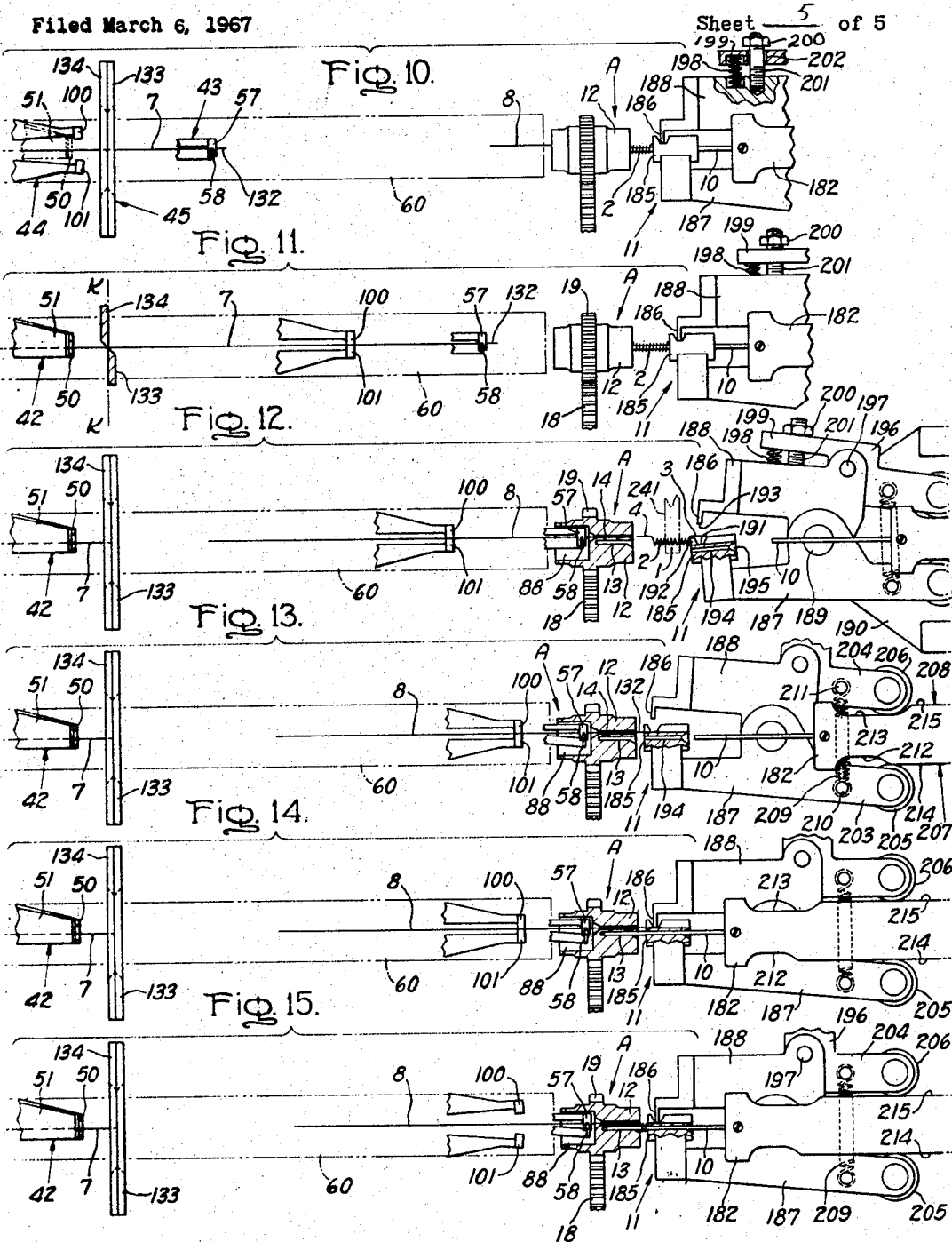
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COILED FILAMENT FORMING APPARATUS

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Sheet 5 of 5



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3,454,053

COILED FILAMENT FORMING APPARATUS
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17 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for coiling wire around a mandrel to form a coiled filament has a wire feeding mechanism which withdraws and cuts off predetermined individual lengths of filament wire from a continuous supply thereof on a spool and feeds the precut wire lengths endwise into a coiling spindle mounted independently of the wire feed mechanism for rotation to coil the precut wire lengths around the mandrel.

BACKGROUND OF THE INVENTION

This invention relates, in general, to apparatus for coiling fine wire into coiled filaments for electric incandescent lamps and other similar electrical devices. More particularly, the invention relates to a wire feeding and winding or coiling mechanism for such apparatus.

The formation of coiled wire filaments such as are employed as light sources in electric incandescent lamps and having straight or uncoiled end legs extending endwise from the coil, is a very exact and difficult operation inasmuch as the filaments, in order to function properly in the finished lamps, must be extremely uniform as to length of wire, length and diameter of the coiled portion, and number and pitch of the individual turns of the coiled portion. The filaments must also be economically produced and therefore must be formed at a high rate of speed. To this end, filament coiling machines have been developed, and have been in general use for many years in the lamp-making industry, for producing such type coiled wire filaments repetitively from a continuous supply of filament wire and at high production rates ranging up to 2000 per hour or thereabouts, depending of course on various factors such as wire size, coil diameter and number of turns in the filament coil.

In the most common form of filament coil forming machine in use heretofore to produce such individual filament coils having straight end legs extending endwise from the coil, one end of the filament wire, which eventually becomes one of the filament end legs, is firmly clamped in a pair of gripper jaws which, in combination with an opposed rotatable coiling spindle having a die opening through which the filament wire is drawn during the coiling operation from a continuous supply of the wire on a supply reel or bobbin, initially holds the filament wire in a position extending alongside a reciprocable mandrel. The coiling spindle is then rotated about the mandrel axis to wind the filament wire around the mandrel. During the winding or coiling operation, the filament wire gripper jaws and the mandrel are retracted in unison away from the coiling spindle to thereby impart the desired pitch to the individual turns of the filament coil. When the required number of turns of the filament wire have been wound around the mandrel, the rotation of the coiling spindle is stopped whereupon the filament wire gripper jaws and the mandrel are retracted a short further distance away from the coiling spindle to withdraw an additional length of wire through the coiling spindle sufficient to form the other straight end leg of the filament. The completed filament coil is then severed from the remainder of the supply of filament wire, follow-

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ing which the mandrel is withdrawn from the filament coil and the gripper jaws are opened to thereby release the completed filament.

To prevent twisting and possible breakage of the filament wire between the supply bobbin and the coiling spindle during the coiling operation—a factor of particular importance where the filament wire employed is of very fine size, e.g., as small as .001 inch wire diameter or less—the filament wire supply bobbins of such prior filament coil forming machines customarily have been mounted to rotate as a unit with the coiling die during the coiling operation. To this end, the coiling die and the filament wire supply bobbin, in the usual form of such prior machines, have been mounted on opposite ends of a hollow coiling spindle which is rotatably mounted in bearings in order to permit the rotational movement of the coiling spindle for the filament coiling operation. The filament wire from the supply bobbin is fed to the coiling spindle through the hollow interior of the spindle which, for that purpose, is customarily provided with apertured wire guides mounted internally thereof.

With such prior type filament coiling machines, the considerable mass of the coiling spindle assembly, comprised of the coiling die and its associated spindle and filament wire supply reel, places a limit on the maximum speed at which the coiling head can be effectively started and stopped to perform the successive coiling operations. For such reason, it has been the customary practice, in order to minimize the total mass of the coiling head unit and thereby permit greater coiling speeds, to respool the filament wire supply, as it is conventionally received on comparatively large size reels from the wire drawing factory, onto relatively small size reels or bobbins. However, besides introducing an added cost-increasing operation to the filament coil forming process, such respooling of the filament wire onto small size bobbins also results in a limitation being placed on the length of time the machine can be operated without interruption before the bobbin must be replaced with a full one. This period of uninterrupted operation will, of course, vary with the particular type of coiled filament being produced, but for the more common types of coiled filaments, it averages around one-half hour or so. Moreover, each time the bobbin is replaced, the filament wire must be threaded through the guides in the coiling head spindle and through the guide opening in the coiled die itself. This threading procedure is a difficult and time-consuming operation, requiring as long as one-quarter of an hour for a skilled operator to perform. It is thus evident that the necessity for periodically replacing the filament wire supply bobbin results in an appreciable amount of so-called “down” or idle time for the filament coil forming machine such as materially limits the production rate capacity thereof.

Also, with the prior type filament coil forming machines as described above, the weight of the filament wire supply bobbin and the tension on the bobbin which is necessary to keep the wire from tangling, causes a tension or drag in the filament wire as it is withdrawn from the bobbin during the coiling operation. Especially in the case where very fine filament wire is employed, this drag or tension in the filament wire, besides causing occasional breakage of the filament wire such as necessitates the time-consuming rethreading of the wire through the wire guides in the coiling head spindle and through the coiling die itself, also causes a stretching of the coils of the wound filament, particularly the last two or three turns thereof, during the pulling of the trailing leg of the filament off the supply reel and out of the coiling spindle by the retractive movement of the filament wire gripper jaws away from the coiling head. As a result, the formed

filament coils are not of exact uniform character throughout their entire coil length. The drag or tension in the filament wire as it is withdrawn from the bobbin during the coiling operation also acts to introduce additional internal strain into the filament wire owing to the fact that the taut wire is drawn across the rim edge of the coiling head die opening as the wire is wound around the mandrel. This added internal strain in the wire then increases the tendency of the coiled filaments to distort when subsequently heated to incandescence during the operation of the lamp in which they are incorporated.

SUMMARY OF THE INVENTION

It is an object of the invention, therefore, to provide a fully automatic filament coil forming apparatus capable of producing coiled lamp filaments of the type having straight ends legs extending endwise therefrom at materially higher speeds than heretofore possible.

Another object of the invention is to provide a filament coil forming apparatus which is adapted to produce coiled lamp filaments of the above-mentioned type and which has a materially higher production capacity than prior type apparatus.

Still another object of the invention is to provide a filament coil forming apparatus for producing coiled lamp filaments of the above-mentioned type at high production speeds and with improved coil uniformity and decreased susceptibility to distortion when operated in the finished lamps.

A further object of the invention is to provide a filament coil forming apparatus for producing coiled lamp filaments of the above-mentioned type at appreciably higher speeds than heretofore possible and which is capable of operating uninterruptedly for materially longer periods of time and with appreciably less idle time than previous apparatus.

A still further object of the invention is to provide a filament coil forming apparatus capable of producing coiled lamp filaments of the above-mentioned type at high production speeds and with appreciably decreased susceptibility to and frequency of breakage of the filament wire supply as compared to that of prior type apparatus.

Another object of the invention is to provide a filament coil forming apparatus in which the procedure for threading the supply of filament wire into the coiling head of the apparatus is greatly simplified, and the time required to perform such threading operation is materially reduced, as compared to that of prior type apparatus.

Briefly stated, in accordance with one aspect of the invention, the filament coiling apparatus is constructed to cut off predetermined lengths of filament wire from a continuous supply of filament wire on a supply reel and successively feed the precut wire lengths endwise into the rotatable coiling die of the apparatus for coiling into filaments. Only the coiling die of the apparatus is mounted for rotation about the axis of the associated mandrel to coil the wire lengths therearound, the severing from the wire supply of each individual filament wire length prior to the coiling thereof around the mandrel serving to obviate the need for rotating the filament wire supply and feeding mechanism as a unit with the coiling die during the coiling operation. A material reduction in the mass of those parts of the apparatus (i.e., the coiling spindle unit) which must be rotated to perform the coiling operation is thereby made possible, in consequence of which the starting and stopping of the rotational movement of the coiling spindle during each wire coiling cycle is greatly facilitated and appreciably higher coiling speeds are thereby rendered attainable. The severing of each individual wire length from the remainder of the supply of filament wire prior to the coiling operation also serves to eliminate all drag on the filament wire during the coiling operation and subsequent drawing of the trailing straight end leg of the filament coil out of the coiling spindle. As a result, stretching of the turns of the coiled filament is eliminated

so that coiled filaments of greater uniformity and freedom from distortion under lamp operating conditions are produced by the apparatus according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will appear from the following description of a species thereof and from the accompanying drawings.

In the drawings:

FIG. 1 is a front elevation, partly in section, of filament coiling and forming apparatus comprising the invention;

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

FIG. 3 is a plan view of the filament wire feeding means and coiling head of the apparatus together with the associated filament wire gripper and retractable mandrel, with the coiling head shown in section;

FIG. 4 is a sectional view on the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary perspective view, on an enlarged scale, of the filament wire retention fingers and feeding jaws of the apparatus;

FIG. 6 is an exploded perspective view of the cam-actuated operating means for the filament wire feeding and cut-off mechanism of the apparatus;

FIG. 7 is a fragmentary elevation of the intermittent drive mechanism for the coiling head of the apparatus;

FIG. 8 is an exploded perspective view of the filament wire feeding and cut-off mechanism of the apparatus;

FIG. 9 is an end elevation, partly in section, of the coiling head and associated gear drive means; and

FIGS. 10-15 are plan views of the filament wire feeding and coiling mechanism of the apparatus illustrating the successive operations performed thereby during each filament coil forming cycle of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the invention is there illustrated as embodied in filament coil forming apparatus adapted to form coiled wire filaments 1 (FIG. 12) of tungsten or other refractory metal and comprised of a linear coil portion 2 having straight wire end legs 3, 4 extending endwise therefrom. The filament coil forming apparatus comprises, in its general organization, a coiling head A and a wire-gripping slide head B mounted in opposed relation on the upper side of a bedplate or base member 5 adjustably mounted on a table 6.

In accordance with the invention, the filament wire 7 to be formed into the coiled filaments 1 is supplied to the coiling head A by wire feeding means C adapted to successively withdraw and cut off predetermined lengths 8 of the filament wire 7 from a supply reel or spool 9 thereof and then feed the individual precut wire lengths 8 successively into the coiling head A for coiling around a steel mandrel 10 normally projecting toward the coiling head from the nose of a filament wire gripper means 11 carried by the slide head B. The precut wire lengths 8 are fed endwise into the coiling head A by the wire feeding means C a distance such that a portion of their leading free end, of sufficient length to form the front leg 3 of the completed filament 1, protrudes from the coiling head A toward the opposing slide head B.

At the start of the wire coiling operation, this protruding front leg portion 3 of the filament wire length 8 is clamped by the filament wire gripper means 11 of the slide head B to thereby hold the wire length 8 lengthwise of and immediately contiguous the mandrel 10 carried by the slide head B (FIG. 14). The coiling head A is then rotated about the axis of the mandrel 10 while the wire gripper means 11 and mandrel 10 are simultaneously retracted at a uniform speed from the coiling head, in a direction longitudinally of the mandrel 10, to thereby cause the wire length 8 to be drawn through the coiling head and coiled around the mandrel. When the desired number of coil turns have been thus formed,

the rotation of the coiling head is discontinued, whereupon the filament wire gripper means 11 and mandrel 10 are retracted a further distance away from the coiling head so as to completely withdraw therefrom the remaining uncoiled trailing end portion of the wire length 8, which end portion constitutes the other or trailing end leg 4 of the completed filament 1. Thereupon, the mandrel 10 is withdrawn into and beyond the wire gripper means 11 of the slide head B to strip the coiled filament 1 from the mandrel, and the wire gripper means 11 then opened to release the completed filament 1 and permit its removal from the apparatus.

Coiling head mechanism

As shown more particularly in FIGS. 3 and 9, the coiling head A comprises a rotatable coiling spindle consisting solely of a die 12 mounted for rotation about a horizontal axis coincident with the axis of the horizontally disposed opposed mandrel 10 carried by the slide head B. The coiling spindle 12 is provided with a horizontal mandrel guide opening 13 parallel to the axis of rotation of the coiling spindle and aligned with the mandrel 10, and also with a horizontal filament wire guide passageway 14 offset a slight distance to one side of and parallel to the mandrel guide opening 13. The extent of offset of the wire guide passageway 14 from the mandrel guide opening 13 corresponds to the extent of offset desired for the filament end legs 3, 4 from the axis of the coil section 2 of the completed filament 1. The mandrel guide opening 13 is adapted to snugly receive and support the projecting free end of the mandrel 10 throughout that period of the filament forming operation during which the filament wire is being wound or coiled around the mandrel. The filament wire guide passageway 14 is adapted to closely receive the precut filament wire lengths 8 and guide their forward or leading ends into the filament wire gripper 11 of the slide head B, as well as to guide the wire lengths 8 onto the mandrel 10 during the subsequent winding or coiling operation.

As mentioned hereinbefore, in the usual prior type apparatus for producing coiled filaments 1 of the particular form here involved, the free end portion of the supply of filament wire 7 on the supply spool is successively formed into coiled filaments 1 which are cut off, as each filament is formed, from the remainder of the filament wire supply on the spool. Such an operating procedure necessarily requires that the filament wire supply spool and associated wire feeding mechanism be rotated as a unit along with the coiling head die 12 during the winding or coiling of the filament wire 7 around the mandrel 10, in order to thereby avoid twisting and resultant breakage of that portion of the filament wire supply extending between the coiling head and the filament wire supply spool. In contrast to such prior operating procedure, the filament wire supply 7 is, in accordance with the present invention, first precut into predetermined wire lengths 8, each of the exact length required to form one of the completed filaments 1, and the precut wire lengths 8 then successively fed endwise into and wound by the coiling spindle or die 12 around the mandrel 10. Such a manner of operation thus obviates the need for rotating the filament wire supply spool 9 and associated wire feeding mechanism C as a unit with the coiling spindle or die 12 during the coiling operation, to prevent twisting and resultant breakage of the filament wire 7. In consequence thereof, the coiling head spindle or die 12 need not be made unitary with the filament wire supply spool 9 and the associated wire feeding mechanism C. Accordingly, in the filament coil forming apparatus according to the invention, only the coiling die or spindle 12 is mounted for rotation about the axis of the mandrel 10 to coil the wire lengths 8 therearound, the filament wire supply spool 9 and associated wire feeding mechanism C being mounted independently of the coiling spindle 12, i.e., non-unitary therewith, so as not to rotate along

with the coiling spindle during the wire coiling operation. An appreciable reduction in the mass of the rotating parts of the coiling head A, as compared to that in prior conventional type filament coil forming apparatus, is thereby achieved, the coiling die or spindle 12 being a relatively small size unit of comparatively little mass.

The coiling die or spindle 12 is rotatably mounted, as by means of roller bearings 15 (FIG. 3), in an upstanding bearing bracket or housing 16 fastened to a support block 17 secured to the bedplate 5 of the apparatus. During the wire coiling time period of each filament forming cycle, the coiling spindle 12 is rotated to effect the coiling of the wire length 8 around the mandrel 10. This intermittent rotation of the coiling spindle 12 is imparted thereto by a spur or drive gear 18 intermeshed with a unitary spur gear 19 on the coiling spindle 12. For this purpose, the bearing block 16 is hollowed out, as shown at 20 in FIG. 9, to accommodate the drive gear 18 therein so as to permit its intermeshing engagement with the unitary spur gear 19 on the coiling spindle 12. The drive gear 18 is fastened onto one end of a horizontally extending coiling head drive shaft 21 rotatably mounted on the support block 17. Fastened to the other end of the shaft 21 is a spur gear 22 (FIG. 1) which is driven, through an intermeshing spur gear 23 and an associated train of spur gears 24, 25, by an auxiliary or intermittent drive shaft 26 located beneath the table 6. The auxiliary drive shaft 26 is intermittently rotated by an intermittent drive gear 27, i.e., one having gear teeth around only a part of its peripheral extent, which gear 27 meshes with a pinion gear 28 fastened on the auxiliary drive shaft. The intermittent drive gear 27 is unitarily fastened to, and rotates as a unit with, a worm gear 29 which is fastened on the horizontally extending main drive shaft 30 of the apparatus. The worm gear 29 is driven by a worm 31 on worm shaft 32 which is driven by an electric motor and speed reducer combination (not shown).

In the operation of the apparatus, the intermittent gear 27 is continuously rotated by the intermeshed worm 31 and worm gear 29. The auxiliary or intermittent drive shaft 26, however, is driven by the intermittent gear 27, and thus drives the main coiling head drive shaft 21, only when the pinion gear 28 on shaft 26 is meshed with the toothed segment portion 33 of the intermittent gear 27. One full revolution of the worm gear 29 and the associated intermittent gear 27 and main drive shaft 30 effects one full filament forming cycle of the apparatus, and the gear ratios of gears 23, 24 and 25 are properly selected, relative to the gear ratio of the pinion gear 28 and intermittent gear 27 and the number of teeth in the toothed segment portion 33 thereof, so that one revolution of the intermittent gear 27 will rotate the coiling spindle 12 through the required number of revolutions to wind the required number of turns of each filament wire length 8 around the mandrel 10 to form the coil portion 2 of the completed filament 1.

As shown in FIG. 7, the auxiliary or intermittent drive shaft 26, and thus the coiling head drive shaft 21 and coiling spindle 12, are all positively locked against rotation, during the time the pinion gear 28 on shaft 26 is out of meshed engagement with the intermittent gear 27, by the riding engagement of a concavely indented peripheral section 34 of a stop disc or shoe 35, fastened on the intermittent drive shaft 26, with the arcuate cam track portion 36 of a locking cam segment 37 fastened on the intermittent gear 27, the cam track 36 being concentric with the intermittent gear 27. The indented section 34 of the stop disc 35 conforms to the curvature of, and engages with the leading end 38 of the cam track 36 immediately following the disengagement of the teeth 33 on the intermittent gear 27 from the pinion gear 28 on shaft 26, during the rotational movement of the intermittent gear 27. The cam segment 37 loses control of the stop disc 35 and associated shaft 26, thereby permitting them to turn freely once again, as soon as the trailing end 39 of the cam track 36 passes beyond the center

point 40 of the concavely indented section 34 of the stop disc 35, which occurs just before the toothed segment portion 33 of the intermittent gear 27 meshes once again with the pinion gear 28. As shown in FIG. 7, the center point 40 of the indented section 34 of stop disc 35 lies on the center line 41 passing through the respective axes of the two shafts 26 and 30 when the indented section 34 is in engagement with the cam track 36.

Because of the comparatively small size, and therefore greatly reduced mass of the coiling spindle 12, the forces required to overcome both the static and the dynamic inertia of the coiling spindle, in order to start and stop the rotational movement thereof during each wire coiling cycle, are therefore greatly decreased from that required in the case of prior conventional type filament coil forming apparatus such as described hereinbefore. As a consequence, the starting and stopping of the rotational movement of the coiling spindle 12 is facilitated to such a degree as to permit greatly increased coiling speeds for the apparatus. To this end, the speed ratio of the coiling spindle gear 19 and its drive gear 18 may be made as high as 8 to 1 or thereabouts, so that the coiling spindle 12 will turn through eight revolutions for each revolution of the drive gear 18. Such a high speed ratio is many times higher than that which could be tolerated heretofore in prior type filament coil forming apparatus. As a result, the filament coil forming apparatus according to the invention is capable of producing coiled filaments 1 at greatly increased production rates as much as 50% and more higher than heretofore possible.

Wire feed mechanism

The wire lengths 8 are successively fed into the coiling head A by the wire feeding and cut-off mechanism C, shown more particularly in FIGS. 3, 4 and 8. In its manner of operation, the wire feeding mechanism C functions to successively withdraw and cut off the wire lengths 8 from the supply of filament wire 7 on the supply spool 9 and feed them one by one endwise into the coiling head A for their formation into completed coiled filaments 1.

The wire feeding mechanism C is mounted on the upper side of the bedplate 5 in a position on the opposite side of the coiling head A from the slide head B and, in its general organization, is comprised of a filament wire supply 7 on the supply spool 9, a filament wire retention means 42 through which the filament wire supply 7 passes and by which it is frictionally retained in place after each wire length 8 is drawn off and severed from the spooled wire supply 7, a filament wire transport or feed jaw means comprised of primary and secondary sets of feed jaws 43 and 44, respectively, for withdrawing the predetermined lengths 8 of the filament wire 7 off the supply spool 9 and, after the cut-off of each wire length 8 from the remainder of the supply of filament wire 7, transporting the precut wire length 8 endwise into the coiling head A, and a cut-off mechanism 45 for severing the wire lengths 8 from the filament wire supply 7.

As shown in FIGS. 1 and 2, the supply spool 9 of filament wire 7 is rotatably mounted on a support bracket 46 fastened on and upstanding from the bedplate 5 of the apparatus. The spool 9 is spring-clamped between a pair of opposed cone-shaped bearings 47 and 48 which fit into the axial center bore of the spool 9 and are mounted on roller bearings (not shown) carried by the arms of the yoke-shaped upper end of the support bracket 46 for rotation about an axis transverse to the axis of rotation of the coiling head spindle 12. One of the bearing cones, e.g., bearing cone 47, is axially spring-loaded, as by means of a compression coil spring 49 pressing thereagainst, so that the spool 9 is spring-clamped with a comparatively light spring pressure between the two bearing cones 47 and 48.

The filament wire retention means 42, as shown more particularly in FIGS. 5 and 8, comprises a stationary flat lower finger or jaw 50 and a flat spring finger upper

jaw 51 between which the supply of filament wire 7 leading from the spool 9 is passed and is clamped at all times during the operation of the apparatus, the spring finger jaw 51 exerting only a very slight spring pressure on the filament wire 7 just sufficient to frictionally hold it in place in the jaws against any undesired longitudinal movements such as might result, for instance, from the possible recoiling action of the supply spool 9, yet permit the free sliding movement of the filament wire supply 7, without breakage, between the jaws 50, 51 as it is drawn off the supply spool 9 by the wire feed jaws 43 and 44. The stationary lower jaw or finger 50 is fastened to a support bracket 52 which is secured to the support block 17 and which also carries the wire cut-off mechanism 45 of the apparatus. The spring finger upper jaw 51 is suitably secured, as by a fastening screw 53, to the fixed lower jaw 50. The supply of filament wire 7 from the spool 9 first rides around the underside of a V-type idler pulley 54 and is guided within the V-groove thereof to the jaws 50, 51 of the filament wire retention means 42. The idler pulley 54 is rotatably mounted on the support bracket 52.

At its forward end, the stationary lower jaw 50 of the filament wire retention means 42 is formed with an upstanding lip 55 provided with a V-shaped guide notch 56 (FIG. 5) within which the filament wire 7 is received and guided. The bottom of the V-notch 56 is aligned with the filament wire 7 when, in the initial set-up adjustment of the apparatus, the filament wire 7 is stretched taut between the guide pulley 54 and the filament wire guide opening 14 in the coiling spindle 12 with the latter in its idle rotative position. Thus, the V-notch 56 positions that portion of the filament wire 7 resting within the V-notch 56 in axial alignment with the filament wire guide opening 14 in the coiling spindle 12 when in its idle rotative position. In this connection, the coiling spindle 12 always occupies the same idle rotative position at the start and stop of each filament coiling operation, the coiling spindle 12 rotating through the same number of full turns during each filament coiling operation. The idle rotative position of the coiling spindle 12 is that rotative position thereof, shown in FIG. 9, which it occupies during the dwell period between the successive wire coiling rotational movements of the coiling spindle. In such idle position of the coiling spindle 12, its mandrel guide opening 13 and filament wire guide opening 14 are located in horizontally side-by-side relation to one another, with the filament wire guide opening 14 being located to the rear side of the apparatus relative to the mandrel guide opening 13, i.e., to the right side of the mandrel guide opening 14 in the coiling spindle 12 as viewed from the slide head B of the apparatus.

The primary feed jaw means 43 comprises a V-shaped stationary jaw 57 and a cooperating spring-loaded pivoted jaw 58 both mounted on a main slide member 59 which is slidably mounted on the support block 17 for horizontal reciprocating movement toward and away from the coiling head A and parallel to the wire guide opening 14 therein. As shown more particularly in FIG. 4, the main slide member 59 is slidably supported, at an angular position of approximately 45 degrees to the horizontal, on a dovetail-type slide bearing bar 60 having a sliding fit within a corresponding dovetail-type slideway 61 in the under side of the slide member 59. The slide bearing bar 60 extends horizontally, and parallel to the wire guide opening 14 in the coiling spindle 12, and it is fastened on a horizontally disposed support plate 62 adjustably mounted on an intermediate support bracket 63 for horizontal adjustment transversely to the wire guide opening 14 in the coiling spindle 12. The bracket 63 is, in turn, adjustably mounted for vertical adjustment on the support block 17.

As shown in FIG. 5, the stationary jaw 57 is formed with two spaced V-shaped jaw faces 64 against the bottom of the V's of which the filament wire 7 is clamped by the flat face 65 of the movable jaw 58, when moved

to its closed position between the two V-shaped jaw faces 64, and in which position the filament wire 7 is held during the advance movement of the jaws 57, 58 toward the coiling head A. The bottom of the V's of the jaw faces 64 are located in alignment with the filament wire guide opening 14 of the coiling spindle 12, when in its idle rotative or dwell position, so as to locate the portion of the filament wire 7 clamped in place in and projecting forwardly from the jaws 57, 58 in exact alignment with the said filament wire guide opening 14 in position for ready insertion into the flared out back or entrance end thereof. The jaws 57, 58 are provided on the ends of respective jaws support arms 66 and 67. Jaw support arm 66 carrying the stationary jaw 57 is fixedly fastened to the upper side of the slide 59 as by fastening screws 68, while jaw support arm 67 carrying the movable jaw 58 is pivoted on a pivot pin 69 upstanding from the upper side of the slide 59 for pivotal movement to swing the jaw 58 toward and away from the stationary jaw 57 so as to open and close the two jaws 57, 58. The pivoted jaw 58 is normally held in its closed position against the stationary jaw 57 by the pull of a tension coil spring 70 which is connected at one end to a pin 71 fastened on the jaws arm 67 and at its other end to a spring post 72 on the slide 59.

The movable jaw 58 is opened by the engagement of a roller 73 on the pin 71 with the cam track edge of a movable plate cam 74 which traverses the full extent of movement of the roller 73 during the advance and retraction movement of the jaws 57, 58 by the slide 59 during the operation of the apparatus. The plate cam 74 is arranged for movement toward and away from the roller 73 so as to either engage it to open the jaws 57, 58 or else disengage from the roller so as to permit from the roller so as to permit the spring 70 to close the jaws 57, 58. To this end, the plate cam 74 is fastened on the end of one arm 75 of a bell crank lever 76 which is pivoted intermediate its ends on a horizontally extending pivot rod 77 fastened on the upper side of the support plate 62 for the slide 59. Rotatably mounted on the end of the other arm 78 of the bell crank lever 76 is a cam follower roller 79 which rides on the cam track periphery 80 of an edge or disc cam 81 fastened on a horizontally extending top cam shaft 82 located above the bedplate 5 and journaled in bearings 83, 84 and 85 mounted thereon. The plate cam 74 is normally held in a position disengaged from the follower roller 73 on the jaw arm 67 for the pivoted jaw 58 of the primary feed jaw means 43 by the pull of a tension coil spring 86 which is connected at one end to a spring post 87 fastened on the bedplate 5 and at its other end to the arm 78 of the bell crank lever 76, the spring 86 thereby acting to hold the cam follower roller 79 on the bell crank lever in constant engagement with the cam track periphery or edge 80 of the disc cam 81.

The slide 59 is reciprocated on its slide bearing 60, 61 to carry it from a retracted position as shown in FIGS. 2 and 3, wherein the primary wire feed jaws 57, 58 carried by the slide are located closely adjacent the fingers 50, 51 of the wire retention means 42, to an advanced position as shown in FIGS. 12-15 wherein the feed jaws 57, 58 are entered within a recess 88 in the back end of the coiling head spindle 12. The linear reciprocating movement of the slide 59 on its slide bearing 60, 61 is imparted thereto by an actuating rod 89 pivotally connected at its opposite ends to the slide 59 and to one end of a lever arm 90 (FIG. 6) pivoted at its other end on a pivot pin 91 extending from a bracket 92 mounted on the upper side of the bedplate 5. The lever arm 90 carries a cam follower roller 93 which is engaged with the cam track of suitable cam such as, for example, a face or box cam 94 having a cam track groove (not shown) within which the roller 93 rides. The cam 94 is fastened on a horizontally extending auxiliary or cross cam shaft 95 which is located above the bedplate 5 and extends transversely to the direction

of sliding movement of the slide 59. The cam shaft 95 is journaled in bearings 96 fastened on and upstanding from the upper side of the bedplate 5, and it is driven by the top cam shaft 82 through intermeshed bevel gears 97 and 98 fastened on the ends of the respective shafts 82 and 95.

As shown more particularly in FIGS. 3, 5 and 8, the secondary wire feed jaw means 44 of the apparatus comprises a pair of cooperating flat faced jaws 100 and 101 provided on the ends of respective jaw arms 102 and 103 which are pivotally mounted on a subslide 104, as by means of respective pivot pins 105 and 106, so as to swing the jaws 100, 101 toward and away from one another to open and close them. The jaw arms 102 and 103 are formed with opposed sector gear portions 107 which are concentric with the pivot axes of the respective jaw arms and are intermeshed with one another so that the two gear-interlocked jaw arms will pivot about their respective pivot pins 105 and 106 in unison but in opposite directions, pivotal movement of one jaw arm in one direction causing a corresponding pivotal movement of the other jaw arm in the other direction. The jaws 100 and 101 are normally held in their closed position, with their flat jaw faces 108 in engagement with one another, by the force of a compression coil spring 109 (FIG. 3) which is compressed between, and received within well openings 110 in the heel end portions of the jaw arms 102, 103. The secondary feed jaws 100, 101 are adapted to grip the filament wire 7 while it is being drawn off the supply spool 9 by the advancing primary feed jaws 57 and 58, and for this purpose they are properly positioned, as by means of an adjustment screw 111 on the subslide engaging with a stop shoulder 112 on jaw arm 102, so as to be centered relative to the filament wire 7 when the jaws 100, 101 are closed thereagainst.

The subslide 104, like the main slide 59, is also mounted for horizontal reciprocating movement toward and away from the coiling head A and parallel to the wire guide opening 14 therein. To this end, the subslide 104 is slidably supported on the same dovetail-type slide bearing bar 60 that supports the main slide 59, the subslide 104 for such purpose being provided with a slide-way 113 within which the slide bearing bar 60 has a sliding fit. For compactness purposes, the main slide 59 is formed with a cut-away center or recessed section 114 in its upper side to expose the slide bearing bar 60 and receive the subslide 104 therewithin. The subslide 104 slides relative to the main slide 59 within the recess 114 therein and on that portion of the slide bearing bar 60 which is exposed within the recess 114.

The jaws 100, 101 are opened by the engagement of a roller 115, rotatably mounted on a pin 116 on the heel end of jaw arm 103, with the cam track edge of a movable plate cam 117 which traverse the full extent of movement of the roller 115 during the advance and retraction movement of the jaws 100, 101 by the subslide 104 during the operation of the apparatus. The plate cam 117, like the plate cam 74 which controls the opening and closing of the primary feed jaws 57, 58, is arranged for movement toward and away from the roller 115 so as to either engage it to open the jaws 100, 101 or else disengage from the rollers so as to permit the spring 109 to swing the jaw arms 102, 103 so as to close the jaws 100, 101 through the action of the intermeshed gear sectors 107 on the jaw arms. To this end, the plate cam 117 is fastened on the end of one arm 118 of a bell crank lever 119 which is pivoted intermediate its ends on the pivot rod 77. The other arm 120 (FIG. 2) of the bell crank lever 119 is provided with a cam follower roller 121 which engages with the cam track periphery 122 of an edge or disc cam 123 fastened on the top cam shaft 82. The plate cams 117 is normally held in a position disengaged from the roller 115 on jaw arm 103 by the pull of a tension coil spring 124

which is connected at one end to the arm 120 of the bell crank lever 119 and at its other end to a spring post (not shown) fastened on the bedplate 5, the spring 124 thereby acting to hold the cam follower roller 121 on the bell crank lever in constant engagement with the cam track periphery or edge 122 of the disc arm 123.

The subslide 104 is reciprocated on the slide bearing bar 60 to carry it from a retracted position as shown in FIGS 2 and 3, wherein the secondary wire feed jaws 100, 101 carried by the subslide are located closely adjacent and between the respective sets of jaws 50, 51 and 57, 58, to an advanced position as shown in FIGS. 13-15 wherein the secondary feed jaws 100, 101 are located adjacent the back end of the coiling head spindle 12. The linear reciprocating movement of the subslide 104 on its slide bearing 60, 113 is imparted thereto in part by an actuating rod 125 pivotally connected at its opposite ends to the subslide 104 and to one end of a spring-loaded lever arm 126 (FIG. 6) pivoted at its other end on a pivot pin 127 extending from a bracket 128 mounted on the upper side of the bedplate 5. The lever arm 126 carries a cam follower roller 129 which engages with the cam track of a suitable cam such as, for example, a face cam 130 having a cam track groove portion 131 extending part way therearound within which the roller 129 rides. The cam 130 is fastened on the auxiliary cam shaft 95. The actuating rod 125 and associated subslide 104 are spring-biased in a backward direction away from the coiling head A by a tension coil spring 126' connected to the lever arm 126. During the course of the advance movement of the main slide 59 and the associated primary feed jaws 57, 58 to withdraw the filament wire 7 off the supply reel 9, and just before the secondary feed jaws 100, 101 close to grip the advancing wire 7, the forwardly facing end wall 114' of the recess 114 in the main slide 59 abuts against the back end 104' of the spring-biased subslide 104 to advance the subslide in unison with the main slide 59 throughout the remainder of the advance movement of the main slide and associated primary feed jaws 57, 58, the roller 129 on the actuating lever arm 126 for the subslide 104 being disengaged from the cam 130 during this interval.

At the start of each filament forming cycle of the apparatus, the primary feed jaws 57, 58 and secondary feed jaws 100, 101 are located in their retracted position immediately contiguous to one another and to the wire retaining jaws or fingers 50, 51 of the wire retention means 42, as shown in FIG. 3. In their said retracted position, both the primary feed jaws 57, 58 and the secondary feed jaws 100, 101 initially are held in their open position by the engagement of the plate cams 74 and 117 with the rollers 73 and 115 on the jaw arms 67 and 103 of the jaws 58 and 101. However, as soon as the primary feed jaws 57, 58 become thus located in their retracted position on the return strokes of the slide 59 and subslide 104, the primary feed jaws 57, 58 are closed, by the movement of plate cam 74 out of engagement with the roller 73 on jaw arm 67 through the action of disc cam 81 on the lever 76, to thereby cause the jaws 57, 58 to grip the free end portion 132 (FIG. 8) of the filament wire supply 7 which is left projecting forwardly from the wire retention fingers 50, 51 following the severance of the filament wire supply 7 by the wire cutting mechanism 45 during the previous filament forming cycle of the apparatus. While the length of this free end wire portion 132 left projecting from the wire retention jaws 50, 51 may vary somewhat depending on the size of the filament wire 7 and its relative stiffness and ability to support itself in a straight line extending out from the retention jaws 50, 51, in most cases a projecting length of around one-quarter inch or so has been found to be generally satisfactory for the purposes of the invention.

Wire cut-off mechanism

The wire cut-off mechanism 45 of the apparatus operates to sever from the remainder of the filament wire

supply 7 the predetermined wire lengths 8 as they are successively drawn or pulled through the retention fingers 50, 51 of the wire retention means 42 by the wire feed jaw means 43 and 44 of the apparatus. As shown more particularly in FIGS. 4 and 8, the wire cut-off mechanism 45 comprises a cooperating pair of sector-shaped rotary cutter knives 133 and 134 which are rotatably mounted for swinging movement transversely to the wire supply 7 to shear off the wire length 8 from the remainder of the supply of filament wire 7. The cutter knives 133, 134 are located slightly in advance of the primary feed jaws 57, 58 in the retracted position of the latter (FIG. 3), and generally above and contiguous to the portion of the filament wire supply 7 drawn through the retention fingers 50, 51 by the wire feed jaw means 43 and 44. To provide clearance for the passage of the feed jaws 57, 58 and 100, 101 past the cutter knives 133, 134 during their advance and retraction movement, the cutter knives are each formed with a notched mid-section 135 in its arcuate periphery to serve as a passageway for the feed jaws. One of the side walls of the notched section of cutter knife 133, and an opposing one of the side walls of the notched section of the other cutter knife 134, are sloped to form cutting edges 136 at the interfaces of the two cutter knives.

As shown in FIG. 8, the cutter knives 133-134 are respectively supported, in face-to-face rotative sliding relation to each other, on corresponding ends of a shaft 137 and a sleeve 138, respectively, through which sleeve the shaft 137 extends and within which it is rotatable. The sleeve 138 is journaled in an elongated bearing portion 139 of a cutter support bracket 140, which is fastened on the bracket 52, for rotation about a horizontal axis essentially parallel to the portion of the filament wire supply 7 drawn through the retention fingers 50, 51 of the apparatus by the wire feed means 43 and 44. The cutter knives 133 and 134 are held in spring-pressed face-to-face engagement with one another, for proper cutting action, by the force of a compression coil spring 141 (FIG. 8) which is fitted over the other end of the shaft 137 from the knife-carrying end thereof and the compressive force of which is applied in opposite directions to the shaft 137 and sleeve 138 and transmitted thereby to the cutter knives. For this purpose, the spring 141 is compressed between a stop collar 142 secured on the said other end of the shaft 137 by a locking pin 143 fastened crosswise therein, and an internal shoulder 144 on a thrust sleeve 145 slidably mounted on the shaft 137 and abutting endwise against the end of the knife-carrying sleeve 138.

Operation of the cutter knives 133, 134 to sever the filament wire 7 is effected by rotating the shaft 137 and the sleeve 138 in opposite directions, and thus swinging the associated cutter knives in opposite directions so as to move their knife edges 136 toward and past one another to catch the filament wire 7 therebetween and sever it at the cutting plane K-K of the knives (FIG. 11). The rotational movement of the shaft 137 and sleeve 138 in opposite directions is imparted thereto by a lever arm 146 acting through a toggle type linkage comprised of a pair of toggle links 147 and 148 which are pivoted at one end on a common pivot pin 149 fastened on one end of the lever arm 146. The other ends of the toggle links 147, 148 are pivotally connected to respective swivel arms 150 and 151 which are rotatively interlocked with the sleeve 138 and shaft 137, respectively. Swivel arm 150 extends from a collar 152 fastened on the other end of sleeve 138 from the knife-carrying end thereof, the said other end of the sleeve projecting from the bearing portion 139 of the support bracket 140. The other swivel arm 151 extends from the thrust sleeve 145 on the end of shaft 137 which is opposite to the knife-carrying end thereof and which projects beyond the collar 152. The thrust sleeve 145 and shaft 137 are locked against relative rotation by means of the locking pin 143 which is fastened in the shaft 137

and which projects into and has a colse sliding fit within a longitudinal slot 153 in the thrust sleeve 145.

The lever 146 which actuates the toggle linkage 147, 148 and 150, 151, is pivoted intermediate its ends on a pivot pin 154 (FIG. 4) carried by the support bracket 140, and the other end of the lever 146 from the end connected to the toggle links 147, 148 is pivotally connected by a connecting link 155 to one yoke arm 156 of a bell crank lever 157 pivoted on a pivot pin 158 carried by an intermediate support bracket 159 fastened on the support block 17. The other yoke arm 160 of the lever 146 is pivotally connected to one end of a horizontally extending actuating rod 161 which, as shown in FIG. 6, is pivotally connected at its other end to a cam follower arm 162 pivoted at one end of a pivot pin 163 carried by a bracket 164 fastened on the bedplate 5 of the apparatus. The other end of the follower arm 162 carries a roller 165 which rides in the cam track groove 166 of a face cam 167 fastened on the auxiliary cam shaft 95. Swinging movement of the cam follower arm 162 by the action of the cam 167 is transmitted through actuating rod 161, bell crank lever 157, connecting link 155 and lever 146 to the toggle links 147, 148 which then rotate the arms 150, 151 and their associated sleeve 138 and shaft 137 in opposite directions to thereby swing the cutter knives 133, 134 likewise in opposite directions either toward one another to sever the filament wire 7, or away from one another to return them to their retracted inoperative position (FIG. 4) wherein the peripheral notches 135 in the cutter knives are substantially aligned with one another and centered over the filament wire 7 so as to provide an unobstructed passageway for the wire feed jaws 57, 58 and 100, 101 during the advance and retraction movement thereof toward and away from the coiling head A during each cycle of operation of the apparatus. The operation of the cutter knives 133, 134 to sever the filament wire supply 7 occurs after the primary feed jaws 57, 58 and secondary feed jaws 100, 101 have advanced a sufficient distance toward the coiling head A, during each operating cycle of the apparatus, to withdraw the required predetermined lengths 8 of the filament wire 7 through the wire retention jaws 50, 51 and past the cutting plane K—K of the cutter knives 133, 134 to form one complete filament 1, as shown in FIG. 11, at which time the advance movement of the slide 59 and subslide 104 and the feed jaws 57, 58 and 100, 101 carried thereby is then momentarily interrupted so as to hold the filament wire 7 still while it is severed by the cutter knives 133, 134.

Since the operating mechanisms for opening and closing the primary feed jaws 57, 58 and secondary feed jaws 100, 101 and the actuating mechanisms for operating the cutter knives 133, 134 and effecting the advance and retraction movement of the slide 59 and subslide 104 and their associated feed jaws 57, 58 and 100, 101, are all controlled by cams mounted on one or the other of the gear-interconnected cam shafts 82 and 95, these operations therefore will occur in the desired time relation to each other as determined by the shapes of the cam tracks on the respective cams. The top cam shaft 82 is driven from the main drive shaft 30 of the apparatus through a gear train 168 (FIG. 1) consisting of a series of intermeshed spur gears 169, 170, 171, 172 and 173, gears 169 and 173 being fastened on the ends of the shafts 30 and 82, respectively, and the other gears 170, 171 and 172 being rotatably mounted on respective pivot pins 174, 175 and 176 extending from the cam shaft support bracket 85. The main cam shaft 30 is journaled at one end in bearings 177 in a gear housing portion 178 of the pedestal 179 on which the table 6 of the apparatus is supported, and at its other end in bearings 180 and 181 respectively carried by support bracket 85 and by the table 6.

Wire gripping and retractable mandrel mechanism

Following the severance of the filament wire supply 7

by the cutter knives 133, 134 during each cycle of operation of the apparatus to form the predetermined wire lengths 8, the wire feed jaws 57, 48 and 100, 101 then continue their advance movement toward the coiling head A to insert the free end portion 132 of the wire lengths projecting forwardly from the primary feed jaws 57, 58 into the guide opening 14 in the coiling spindle 12, and to then carry the said wire end portion 132 completely through the guide opening 14 and position it between the opened jaws of the filament wire gripper means 11 of the apparatus, as shown in FIG. 13. The filament wire gripper means 11, and the associated mandrel 10 around which the precut wire lengths 8 are coiled, are carried by the slide head B which, together with the actuating mechanism therefore, may be of the general type heretofore in use.

In each operative cycle of the apparatus to form a completed filament 1, the filament wire gripper means 11 of the slide head B clamps and holds, in position alongside the mandrel 10, the free end portion 132 of the wire length 8 which projects forwardly from the coiling spindle 12 and which subsequently forms the uncoiled front end leg 3 of the completed filament 1. During the ensuing coiling of the wire length 8 around the mandrel 10 by the coiling spindle 12 to form the coiled portion 2 of the filament 1, the wire gripper means 11 and the mandrel 10 retract from the coiling spindle in unison and at a uniform rate of speed to thereby control the pitch of the wire turns as they are being wound around the mandrel. As soon as the coiling spindle 12 stops rotating, upon winding of the required number of turns of the wire lengths 8 on the mandrel 10 to form the coil portion 2 of the filament 1, the mandrel 10 and wire gripper means 11 are then retracted in unison a further distance, preferably at an increased rate of speed, to withdraw the uncoiled trailing end leg portion 4 of the completed filament 1 from the coiling spindle 12 so as to lie clear thereof to permit the subsequent removal of the completed filament from the apparatus. Thereupon, the mandrel 10 is further retracted, while the filament wire gripper means 11 is held stationary, to thereby withdraw the mandrel from within the coil portion 2 of the filament 1 as well as from within the mandrel guide opening in the filament wire gripper means 11, and then open the filament wire gripper means so as to release the grip thereof on the filament 1 and permit the removal of the latter from the apparatus.

In its general organization, the slide head B is comprised of a mandrel-carrying center spindle or slide rod 182 axially aligned with the axis of rotation of the coiling spindle 12 and slidable within a surrounding sleeve 183 (FIGS. 1 and 2) which carries the filament wire gripper means 11. The sleeve 183 is slidably mounted for horizontal reciprocating movement, in a direction parallel to the axis of rotation of the coiling spindle 12, within suitable slide bearings (not shown) in a housing 184 mounted on the bedplate 5. Both the spindle 182 and the sleeve 183, however, are non-rotatable in the bearing housing 184, and they project from the opposite ends thereof. The mandrel 10 is fastened within and projects forwardly from the front end of the spindle 182 toward the coiling head A in exact alignment with the axis of rotation of the coiling spindle 12 and with the mandrel guide opening 13 therein so as to enter the said opening, and thus become supported by the coiling spindle, when the mandrel-carrying center spindle 182 is advanced to its forwardmost position within the bearing housing 184 in readiness for the start of the filament wire coiling operation.

As shown more particularly in FIG. 12, the filament wire gripper means 11, which is carried by the center spindle 182 of the slide head B and also serves as a guide means for the mandrel 10, is comprised of a pair of cooperating opposed jaws 185 and 186 upstanding from the forward ends of respective jaw arms 187 and 188 which are pivotally mounted beneath the center spindle 182, for

swinging movement in a horizontal plane about a common vertical axis, on a common pivot pin 189 carried by a bracket arm 190 extending forwardly toward the coiling head B from the front end of the sleeve 183 beneath the center spindle 182 projecting therefrom. Jaw 185 is provided with a flat jaw face 191 against which the free end portion 132 of the wire length 8 projecting from the coiling spindle 12 is clamped, in position at the bottom of the V of a V-shaped lip 192 on the front end of the jaw 185, by the flat end face 193 of the other or clamping block jaw 186, when the two jaws 185, 186 are swung to their closed position in readiness for the start of the wire coiling operation. In the said closed position of jaw 185, the bottom of the V-notch in the lip 192 thereon is axially aligned with the wire guide opening 14 in the coiling spindle 12 in the idle rotative position thereof which it occupies at the start of the wire coiling operation. The V-notched lip 192 on the jaw 185 serves as a gathering or pick-up means to catch and gather thereinto, and thus properly position in the jaw 185, the projecting free end portion 132 of the wire length 8 in the coiling spindle 12 when the jaw 185 is swung to its closed position while located in its advanced or forwardmost position immediately contiguous the coiling spindle 12 just before the start of the wire coiling operation. The jaw 185 is provided with a guide opening 194 (FIG. 12) for the mandrel 10, the guide opening 194 extending through the jaw 185 in a direction such as to be in axial alignment with the corresponding mandrel guide opening 13 in the coiling spindle 12 when the jaw 185 is in its closed or operative position and the coiling spindle is in its idle rotative position. The guide opening 194 is formed with an outwardly funneled or flared rearward end 195 for the purpose of guiding the front end of the mandrel 10 into the guide opening 194 during the advance movement of the mandrel 10 toward the coiling head A to insert it into the guide opening 13 in the coiling spindle 12.

Jaw arm 188 is spring-loaded so that the jaw 186 thereof will be spring-pressed against the free end portion 132 of the wire length 8 to clamp it in place between the two jaws 185, 186 when they are in their closed position. For this purpose, the jaw arm 188 is hinged to an operating lever 196 by a vertical pivot pin 197, and a compression coil spring 198 (FIG. 10) is compressed between the forwardly extending arm 199 of the operating lever and the jaw arm 188 so as to exert spring pressure on the latter tending to swing or pivot it in the direction to close the jaw 186 carried thereby. Outward swinging movement of the jaw arm 188 to open the jaw 186 is imparted thereto by the lever 196 through the engagement of the arm 199 thereof with a stop nut 200 and a stop screw 201 which is screw-threaded into the jaw arm 188 and extends loosely through an opening 202 in the arm 199 of lever 196 so as to move freely therethrough. Jaw arm 187 and lever 196 are provided with rearwardly extending cam follower arm portions 203 and 204, respectively, carrying rollers 205 and 206 which are engaged with respective cam tracks 207 and 208 formed on the opposite sides of the mandrel-carrying center spindle 182. The rollers 205, 206 are held in continuous engagement with their respective cam tracks 207, 208 by the force of a tension coil spring 209 connected across the cam follower arm portions 203 and 204 of the jaw arm 187 and lever 196, the spring 209 being connected at its opposite ends to spring posts 210 and 211 extending from the respective arm portions 203 and 204. The opening and closing of the filament wire gripping jaws 185, 186 is thus controlled by the forward and rearward sliding movement of the center spindle 182 and the associated cam tracks 207, 208 thereon relative to the cam follower rollers 205, 206 on the jaw arm 187 and operating lever 196. The jaws 185, 186 are opened when the center spindle 182 is retracted relative to the jaw arm 187 and lever 196 to locate the low portions 212 and 213 of the respective cam tracks 207, 208 opposite

the follower rollers 205 and 206, and they are closed when the center spindle 182 is advanced relative to the jaw arm 187 and lever 196 to locate the high portions 214 and 215 of the respective cam tracks 207 and 208 opposite the co-operating follower rollers 205 and 206.

The sliding movement of the sleeve 183 within the slide housing 184 to advance and retract the filament wire gripper jaws 185, 186 is imparted to the sleeve by actuating means comprising a vertically extending operating lever 216 which is pivoted intermediate its ends on a horizontal pivot pin 217 extending from a bearing support bracket 218 fastened on the bedplate 5 and is provided with a forked upper end the arms 219 of which straddle the center spindle 182 and are pivotally connected, by a pair of horizontally extending connecting links 220, to ears 221 extending rearwardly from the rear end of the sleeve 183. The lower end of the operating lever 216 carries a cam follower roller 222 which is engaged with the cam track 223 of a cylindrical cam 224 mounted on the main drive shaft 30 of the apparatus. The roller 222 on lever 216 is continuously held in engagement with the cam track 223 of cam 224, and the sleeve 183 and its associated filament wire gripper jaws 185, 186 continuously urged forwardly toward the coiling head A to their advanced position, as determined by the engagement of a stop screw 225 on the rear end of the sleeve with the rear end face of the slide housing 184, by the force of a tension coil spring 226 which is connected at its opposite ends to spring posts 227 and 228, respectively, extending from the slide housing 184 and from the rear end of the sleeve 183.

The sliding movement of the center spindle 182 to advance and retract the mandrel 10 carried thereby and open and close the filament wire gripper jaws 185, 186 carried by the sleeve 183, is imparted to the spindle 182 by actuating means comprised, in part, of a vertically extending operating lever 229 pivoted intermediate its ends on a pivot pin 230 extending from the bearing support bracket 218 and is pivotally connected at its upper end, by a horizontally extending connecting link 231, to the rearward end of the center spindle 182. The lower end of the operating lever 229 carries a cam follower roller 232 which engages with the cam track 233 of a cylindrical cam 234 mounted on the main drive shaft 30 of the apparatus. The spindle 182 and the mandrel 10 carried thereby are continuously urged forwardly toward the coiling head A by a horizontally extending tension coil spring 235 connected at its opposite ends to spring posts 236 and 237 respectively extending from the slide housing 184 and from the upper arm of the lever 229. The forward sliding movement of the center spindle 182 relative to the sleeve 183, under the influence of the spring 235, is limited by the engagement of a stop screw 238 extending from a swivel slide bearing 239 carried by the connecting link 231, with the rearward end of a horizontally extending push rod 240 which is carried by the upper end of the operating lever 216 and which extends rearwardly therefrom and is slidable in the slide bearing 239. The slide bearing 239 swivels on the pivot pin which pivotally connects the upper end of operating lever 229 to the connecting link 231 while the push rod 240 swivels on the pivot pin which connects one of the yoke arms 219 on the upper end of operating lever 216 to the associated connecting link 220. The timing of cams 223 and 234 and the shape of their respective cam tracks 223 and 233 are such that the cam track 233 on cam 234 is completely disengaged from the roller 232 on the operating lever 229, and the latter held free of any control by the cam 234, from the time during each operating cycle of the apparatus when the wire coiling operation first begins until the sleeve 183 and the jaws 185, 186 carried thereby are moved back to their retracted inoperative position away from the coiling head A. During this period of each op-

erating cycle, the sliding movement of the mandrel-carrying spindle 182 is under the control instead of the sleeve 183, by virtue of the action of the spring 235 in urging the upper end of the operating lever 229 and the slide bearing 239 thereon forwardly to thereby hold the stop screw 238 on the slide bearing 239 in abutting engagement with the rearward ends of the push rod 240 which is connected to and moves along with the sleeve 183. As a result, the sleeve 183 and spindle 182, and thus the filament wire gripping jaws 185, 186 and mandrel 10 respectively carried thereby, retract in unison with one another from the coiling head A, under the action of the cam 224 acting on operating lever 216 during the coiling of each wire length 8 and subsequent withdrawal of the trailing leg 4 of each completed filament 1 from the coiling spindle 12.

Filament coiling machines of the general type such as described herein are generally employed as an operative component of an automatic lamp mount making machine having a transfer mechanism incorporating a swinging or other type movable arm 241, as shown diagrammatically in dash-dot lines in FIG. 12, for grasping the completed filaments 1, centrally of their coiled portion 2, as they are released from the filament gripping jaws 185, 186 of the filament coil forming apparatus, and then transferring the filaments to the lamp stem supported in the work-carrying head of the mount making machine, for attachment to the lead-in wires of the lamp stem. To permit fabrication of filaments 1 of various coil lengths or overall lengths while still remaining centered or otherwise positioned with respect to the transfer arm 241 of the mount making machine, the bedplate 5 of the filament coil forming apparatus according to the invention is horizontally adjustable on the table 6 in a direction lengthwise of the coiling mandrel 10. For this purpose, the bottom surface of the bedplate 5 and top surface of the table 6 are formed with one or more guideways 242 and cooperating slide bearings 243 (FIG. 1), respectively, to permit longitudinal sliding movement of the bedplate 5 relative to the table 6. Adjustment screw means 244 interconnecting the bedplate 5 and table 6 at one end thereof may be provided for adjusting the longitudinal position thereof relative to one another. Since the support bracket 218 on which the operating levers 216, 229 are pivoted is fastened on the bedplate 5, the pivot centers of the operating levers 216, 229 therefore will remain in the same operative relationship to the sleeve 183 and center spindle 182 in any adjusted position of the bedplate on the table 6. However, to maintain the same operative relationship of the cams 224, 234 to their respective operating levers 216, 229, in any adjusted position of the bedplate 5 on the table 6, the cams 224, 234 are fixedly secured on a sleeve 245 which is slidable on but rotatively interlocked with the main drive shaft 30, and which is journaled in but locked against axial movement relative to the bearing portion 189 of the support bracket 85 for the gear train 168. Since the bracket 85 is fastened on the bedplate 5 and moves therewith, and since the sleeve 245 is locked against axial movement in this bracket, any adjustment therefore of the bedplate relative to the table 6 will result in a corresponding adjustment of the sleeve 245 and the associated cams 224 and 234, thereby maintaining the positional relationship of these cams relative to operating levers 216, 229. To assure continuity of the gear train drive for the coiling spindle 12, in any adjusted position of the bedplate 5 on the table 6, the gear 25 on the intermittent drive shaft 26 is made sufficiently wide to remain in meshed engagement with the gear 24 carried on the bedplate 5, in any such adjusted position of the latter.

In the operation of the apparatus according to the invention to form a filament 1, the primary feed jaws 57, 58 and secondary feed jaws 100, 101 of the wire feeding means C are initially in their retracted position

(as shown in FIGS. 2 and 3) immediately contiguous the retention fingers 50, 51 of the wire retention means 42, at the start of each filament forming cycle of the apparatus. While thus positioned, the coiling spindle 12 of the coiling head A and the mandrel 10 and filament wire gripping jaws 185, 186 are still operating to form the previously precut wire length 8 into a filament 1. In their said retracted position, both the primary wire feed jaws 57, 58 and the secondary feed jaws 100, 101 are held in their opened position by their respective operating plate cams 74 and 117. The primary feed jaws 57, 58 are then closed by spring 70, through the movement of plate cam 74 out of engagement with the roller 73 on jaw arm 67, so as to grip the free end portion 132 of the filament wire 7 projecting from the retention fingers 50, 51. The closed primary feed jaws 57, 58 are then advanced toward the coiling head A, by the forward sliding movement of the main slide 59 by its actuating means, so as to withdraw the filament wire 7 from the supply spool 9 and through the retention fingers 50, 51. During the course of the advance movement of the main slide 59 to effect this wire withdrawal, the forwardly facing shoulder 114' on the main slide 59 abuts against the back end 104' of the subslide 104 to cause the subslide, and the secondary wire feed jaws 100, 101 carried thereby, to be advanced along and in unison with the main slide. The advancing secondary feed jaws 100, 101 are then closed, by the movement of plate cam 117 out of engagement with the roller 115 on jaw arm 103, so as to also grip the advancing supply of filament wire 7 at a predetermined distance back from the primary feed jaws 57, 58.

When the required length 8 of filament wire 7 has been withdrawn by the advancing feed jaws 57, 58 and 100, 101 past the cutting plane K—K of the cutter knives 133, 134 of the wire cutting mechanism 45 to form one complete filament 1 (FIG. 12), the advance movement of the feed jaws and the filament wire 7 gripped therein is momentarily interrupted, by the action of the cams 94 and 130 that control the sliding movement of the main slide 59 and subslide 104 which carry the feed jaws, and the cutter knives 133, 134 then actuated, by the action of cam 167 on the cutter knife operating mechanism, to thereby sever the advanced wire length 8 from the remainder of the filament wire supply 7. The feed jaws 57, 58 and 100, 101 then resume their advance movement toward the coiling head A, through the action of the cam 94 on the actuating rod 89 for the slide 59 and the latter pushing against the subslide 104, to advance the free end portion 132 of the precut wire length 8 into the wire guide opening 14 in the coiling spindle 12 of the coiling head A. Just before the free end portion 132 of the precut wire length 8 is thus inserted into the guide opening 14 of the coiling spindle by the advancing feed jaws 57, 58, the trailing end leg portion 4 of the previously formed filament 1 still gripped in the jaws 185, 186 of the filament wire gripper means 11 is withdrawn from the guide opening 14 in the coiling spindle 12, by the retraction movement of the jaws 185, 186 away from the coiling head A, so as to clear the said opening 14 for the insertion therein of the free end 132 of the wire length 8 then being advanced into the coiling head A by the wire feed jaws 57, 58 and 100, 101. During the last portion of their advance movement toward the coiling head A, the closed primary feed jaws 57, 58 enter the rearwardly opening recess 88 in the back of the coiling spindle 12, as shown in FIG. 12, to insert the projecting portion 132 of the wire length 8 held by the jaws into the then aligned guide opening 14 in the coiling spindle 12, the flared out rear or entrance end of the guide opening 14 serving as a funnel to guide the advancing wire end portion 132 into the wire-confining guide portion of the guide opening 14.

The instant or just before the primary feed jaws 57, 58 reach the limit of their advance movement into the recess 88 in the coiling spindle 12, the jaws 57, 58 are

opened, by the engagement of plate cam 74 with the roller 73 on the jaw arm 67, to release their grip on the precut wire length 8. The closed secondary feed jaws 100, 101, however, continue their advance movement uninterrupted toward the coiling spindle 12, through the continued forward sliding movement of the subslide 104 under the action of its control cam 130, until they reach their forwardmost position, as shown in FIG. 13. This continued advance movement of the secondary feed jaws 100, 101 carries the free end portion 132 of the wire length 8 completely through the guide opening 14 in the coiling spindle 12 and a sufficient distance outwardly therebeyond to insert the exact length of the wire end portion 132 required to form the front end leg 3 of the filament 1 to be formed, in clamping position between the opened jaws 185, 186 of the filament wire gripper means 11, the said jaws 185, 186 being at that time in their forwardmost advanced position (FIG. 13) immediately contiguous the front end face of the coiling spindle 12, as determined by the engagement of the stop screw 225 on the jaw-carrying sleeve 183 with the slide housing 184, and both jaws also being in their fully opened position (as shown in FIG. 12). While the wire length 8 is thus held in clamping position by the secondary feed jaws 100, 101, the center spindle 182 of the slide head B is advanced toward the coiling head A, by the operation of cam 234 acting on the actuating lever 229 for the spindle, to first position the high portion 214 of the cam track 207 on the spindle 182 opposite the roller 205 on jaw arm 187 so as to swing the V-jaw 185 of the filament wire gripping means 11 into its closed position and bring the mandrel guide opening 194 therein in alignment with the mandrel 10 projecting forwardly from the center spindle 182. The continued further advance movement of the center spindle 182 toward the coiling head A then positions the high portion 215 of cam track 208 on the spindle 182 opposite the roller 206 on the operating lever 196 for the jaw 186 of the filament wire gripping means 11 to cause the lever 196 to swing the jaw arm 188, through the coil spring 198, so as to close the jaw 186 to clamp the end portion 132 of the wire length 8 between the jaw faces 191 and 193 of the two jaws 185, 186. The center spindle 182 continues its advance movement toward the coiling head A to insert the mandrel 10 into and carry it through the guide opening 194 therefor in the filament wire gripping jaw 185 and then insert the free end of the mandrel 10 into the guide opening 13 therefor in the coiling spindle 12. The advance movement of the center spindle 182 is limited by the engagement of the stop screw 238 on the swivel slide bearing 239 with the end of the push rod 240 connected to the sleeve 183. At this point, the wire length 8 is held in position in readiness for the start of the wire coiling operation.

The coiling spindle 12 is now rotated by its drive gear 18 and the associated intermittent drive mechanism therefor through the required number of full turns to form the coil portion 3 of the filament 1, while the filament wire gripping jaws 185, 186 and the mandrel 10 are at the same time retracted in unison away from the coiling spindle 12 at a uniform rate of speed to impart the desired pitch to the turns of the wire coil 3. The unitary retraction of the filament wire gripper jaws 185, 186 and the mandrel 10 is produced by the cam 224 acting through the operating lever 216 connected to the sleeve 183 and through the engagement of the push rod 240 on the upper end of the operating lever 216 with the stop screw 238 carried by the swivel slide bearing 239 connected to the center spindle 182. Meanwhile, the primary and secondary feed jaws 57, 58 and 100, 101 return to their initial retracted starting position to start their next cycle of operation to feed another wire length 8 to the coiling spindle 12 for formation into the next filament to be formed. The coiling spindle 12 stops rotating as soon as the required number of full turns of the wire length 8 have been wound around the

retracting mandrel 10 to form the coil portion 2 of the filament 1. Thereupon, the filament wire gripping jaws 185, 186 and mandrel 10 retract in unison a further distance sufficient to withdraw the trailing end leg 4 of the now completed filament 1 from the guide opening 14 in the coiling spindle 12 so as to free the filament for removal from the apparatus. At this time, the jaw-carrying sleeve 183 is in its fully retracted position, and the automatically operating transfer arm 241, where such is employed to remove the filament 1 from the apparatus, now grasps the completed filament 1 still being held by the closed jaws 185, 186 of the filament wire gripper means 11. As soon as this occurs, the mandrel-carrying center spindle 182 retracts a further distance relative to the now stationary sleeve 183, through the action of cam 234 and operating lever 229, to withdraw the mandrel 10 from within the coil portion 2 of the completed filament 1 and cause the jaw 186 to swing to its open position through the locating of the low portion 213 of the cam track 208 on the spindle 182 opposite the roller 206 on the arm 196 which controls the opening and closing of the jaw 186. With the jaw 186 thus swung open to release its grip on the filament 1, the transfer arm 241 then operates to withdraw the filament from the jaw 185 and transfer it to the filament mounting position of an associated lamp mount making machine. The center spindle 182 meanwhile continues to retract, through the action of cam 234 and operating lever 229, to its fully retracted position as shown in FIG. 12, to first withdraw the mandrel 10 from the guide opening 194 in the jaw 185 so as to permit the latter to be then swung to its open position by the locating of the low portion 212 of the cam track 207 opposite the roller 205 on the jaw arm 187 which controls the opening and closing of the jaw 185. By this time, the wire feed jaws 57, 58 and 100, 101 of the wire feeding mechanism have advanced the next succeeding precut wire length 8 into the guide opening 14 in the coiling head A for the start of the next filament coiling operation. The center spindle 182 and sleeve 183 of the slide head B then begin their advance stroke toward the coiling head A to locate the filament wire gripping means 11 and the mandrel 10 in their advanced operative positions once again for the start of the next filament coiling operation.

Since the operation of the wire feeding and cutoff mechanism C to cut a wire length 8 from the wire supply 7 and feed it into position within the coiling head A for the start of the wire coiling operation takes place during the time the preceding precut wire length 8 is being coiled around the mandrel and the completed filament 1 withdrawn from the coiling head A, and removed from the jaws 185, 186 of the slide head B by the transfer arm 241, there is therefore no time lapse or wasted time between the operating cycles of the wire feeding and cut-off mechanism C and the slide head mechanism B of the apparatus. Thus, the maximum possible filament production rate by the apparatus is assured, as limited only by the time required for the slowest operating one of the two mechanisms B and C to perform its respective operating cycle.

From the above description, it will be apparent that we have provided a filament forming apparatus that possesses many advantages over the prior type apparatus, the most important one of which is, of course, the greatly increased filament production rate resulting from the severalfold reduction in the mass of the rotating coiling spindle which is realized by the incorporation into the apparatus of the novel filament wire feeding and cut-off mechanism C according to the invention whereby the coiling spindle is mounted independently of, i.e., non-unitary with, the wire feeding mechanism of the apparatus. Because of its greatly reduced mass, the coiling spindle can be rotated at much higher coiling speeds than heretofore possible without imposing excessive inertial loads on the apparatus, thereby affording the aforementioned greatly increased filament production rate.

The mounting of the coiling spindle independently of

the filament wire feeding mechanism, in the filament forming apparatus according to the invention, also obviates the need for respooling the filament wire supply, as it is conventionally received on comparatively large size reels from the wire drawing factory, onto relatively small size spools or bobbins. Such wire respooling has been the customary practice heretofore with prior type filament forming apparatus in order to thereby minimize the total mass of its rotative coiling spindle assembly and its limiting effect on the rotational coiling speed of the coiling spindle. By eliminating the respooling of the filament wire supply and the attendant cost thereof, and permitting the use instead of the comparatively large size filament wire supply reels as they are received directly from the wire drawing factory, the length of time during which the filament forming apparatus according to the invention may be continuously operated without interruption, before it must be stopped to permit the replacement of an empty filament wire supply reel with a full one, is increased by a very appreciable amount. Thus, in practice, a filament forming apparatus according to the invention need be stopped for reloading thereof with a full filament wire supply reel only once or so during a continuous eight hour period of operation, whereas the prior type apparatus ordinarily must be stopped for such purpose every half hour or so. Moreover, the rethreading of the filament wire supply into operative position within the filament forming apparatus, each time an empty filament wire supply spool or reel is replaced with a full one, is a very simple and quickly performed operation in the apparatus according to the invention, requiring only one or two minutes to perform, whereas it is a very complicated and time-consuming operation in the case of the prior type filament forming apparatus, requiring as long as one-quarter of an hour or more to perform. It is thus apparent that the greatly decreased frequency of the required replacement of the emptied filament wire supply reels with full ones, and the simplified and faster replacement procedure therefor in the case of the filament forming apparatus according to the invention, results in an appreciable reduction in the amount of so-called "down" or idle time for the apparatus such as materially increases the production rate capacity thereof as compared to that of the prior type filament forming apparatus.

An additional and highly important advantage of the filament forming apparatus according to the invention is the elimination of all tension or drag in the filament wire as it is being coiled around the mandrel 10 and formed into the completed filament 1, there being no pull or restraining force exerted on the filament wire during the coiling thereof such as occurs in the prior type filament forming apparatus by reason of the weight of the filament wire supply bobbin and the tension necessary thereon to keep the filament wire from tangling as it is drawn off the bobbin during the filament coiling and forming operation. This elimination of all tension in the filament wire during the coiling operation avoids the breakage of the filament wire supply which occasionally occurs in the prior type filament forming apparatus due to the tension in the filament wire supply. The attendant necessity for performing the time-consuming operation of rethreading the broken filament wire supply into operative position once again in the apparatus is thereby avoided. The most important advantage, however, which is realized by the elimination of all tension or drag in the filament wire, during the filament coiling and forming operation, is the resulting elimination of any stretching of the individual turns of the coiled filament 1, particularly the last two or three coil turns thereof, during the pulling of the trailing leg 4 of the completed filament 1 out of the coiling spindle of the apparatus. As a result, the completed filaments 1 are of exact uniform character throughout their entire coil length 2. In addition, the absence of any tension in the filament wire, as it is being coiled around the mandrel 10, prevents the introduction into the filament

wire of those additional internal strains which are normally introduced thereto by the prior type filament forming apparatus by reason of the tensioned, and therefore taut filament wire being drawn across the rim edge of the coiling spindle die opening 14 as the wire is wound around the mandrel 10. Because of their greater freedom from internal strains, therefore, coiled filaments 1 formed by the apparatus according to the invention have considerably less tendency to distort, when subsequently heated to incandescent operating temperature in a lamp, than similar type filaments made by the prior type filament forming apparatus.

Although a preferred embodiment of our invention has been disclosed, it will be understood that the specific invention is not to be limited to the specific construction and arrangement of parts shown, but that they may be widely modified within the spirit and scope of our invention as defined by the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In filament coiling apparatus of the type comprising a mandrel and a coiling spindle having a guide opening for the filament wire to be coiled around said mandrel, the combination therewith of wire feeding means comprising support means for rotatably mounting a supply spool of filament wire, retention means disposed between said supply spool and said coiling spindle and adapted to frictionally hold in place the filament wire withdrawn from the spool through said retention means, feed jaw means located between said retention means and said coiling spindle and adapted to grip the end of the filament wire held by and projecting forwardly from said retention means toward said coiling spindle, said feed jaw means being reciprocable toward and away from said coiling spindle to withdraw a predetermined length of the filament wire from said spool on its advance movement toward the coiling spindle and insert the leading end of the said wire length into the said guide opening in the coiling spindle, said feed jaw means constituting the sole means operative to withdraw the filament wire off said spool and advance it endwise toward the coiling spindle, cutter means mounted between said retention means and said coiling spindle for severing the said predetermined length of filament wire from the remainder of the supply thereof on said spool, and actuating means operatively associated with said wire feeding and cutter means for reciprocating and opening and closing the said feed jaw means, and actuating said cutter means, in proper time relation.

2. Filament coiling apparatus as specified in claim 1 and comprising, in addition, means mounting said coiling spindle independently of said wire feeding means for rotation about the axis of said mandrel to coil the said severed wire length therearound, and rotary drive means coaxing with the said coiling spindle to intermittently rotate it.

3. Filament coiling apparatus as specified in claim 2 wherein the said coiling spindle consists solely of a die provided with the said guide opening for the said wire length.

4. Filament coiling apparatus as specified in claim 2 wherein the said coiling spindle consists solely of a die provided with the said guide opening for the said wire length and having an integral spur gear thereon, and rotary drive means comprising a drive gear meshed with the said spur gear on said coiling spindle to intermittently rotate it.

5. Filament coiling apparatus as specified in claim 1 wherein the said wire feeding and cutter means is actuated by the said actuating means therefor to cut off and feed each successive one of said wire lengths during the time the preceding one of said wire lengths is being coiled around the mandrel by said coiling spindle and withdrawn therefrom.

6. Filament coiling apparatus as specified in claim 1 wherein the said actuating means comprises a plate cam

movable into and out of engagement with cam follower means on said feed jaw means to effect the opening and closing thereof.

7. Filament coiling apparatus as specified in claim 1 wherein the advance movement of said feed jaw means toward said coiling spindle by the said actuating means is momentarily interrupted during the operation of said cutter means to sever the said predetermined length of filament wire from the remainder of the supply thereof on said spool.

8. Filament coiling apparatus as specified in claim 1 wherein the said feed jaw means comprises a pair of primary feed jaws adapted to grip the free end portion of the filament wire held by said retention means and a pair of secondary feed jaws adapted to grip the portion of the filament wire trailing from said primary feed jaws during the advance movement thereof toward said coiling spindle, said primary and secondary feed jaws being reciprocable relative to one another toward and away from said coiling spindle, and said actuating means being operative to terminate the advance movement of and open the said primary feed jaws upon insertion of the leading end of the severed filament wire length into the guide opening in the coiling spindle and to thereafter continue the advance movement of said secondary feed jaws and the said severed filament wire length held therein to thereby carry the said leading end of said wire length completely through the guide opening in the coiling spindle so as to project therefrom.

9. In filament coiling apparatus of the type comprising a mandrel and a coiling spindle having a guide opening for the filament wire to be coiled around said mandrel, a base, wire feeding means comprising support means on said base for rotatably mounting a supplying spool of filament wire, retention means mounted on said base between said supply spool and said coiling spindle and adapted to frictionally hold in place the filament wire with drawn from said spool through said retention means, filament wire transport means comprising a slide member slidably mounted on said base for reciprocating movement toward and away from said coiling spindle in a direction longitudinally of the said guide opening therein, feed jaw means mounted on said slide member between said retention means and said coiling spindle and adapted to grip the filament wire held by and projecting forwardly from said retention means toward said coiling spindle, feed jaw operating means coacting with said feed jaw means to open and close the latter, slide actuating means coacting with said slide member to reciprocate it, said feed jaw operating means and said slide actuating means operating in timed relation to close the said feed jaw means in the retracted position thereof so as to grip the end of the filament wire held by and projecting forwardly from said retention means and to then advance the said slide member and the closed feed jaw means thereon toward said coiling spindle to withdraw a predetermined length of the filament wire from said spool and insert the leading end thereof into the said guide opening in the coiling spindle, said filament wire transport means constituting the sole means operative to withdraw the filament wire off said spool and advance it endwise toward the coiling spindle, cutter means mounted on said base between said retention means and said coiling spindle and operative to sever the said predetermined length of filament wire from the remainder of the supply thereof on said spool, and cutter actuation means coacting with said cutter means to actuate the latter in timed relation with the advance movement of said slide member and the feed jaw means thereon toward said coiling spindle.

10. Filament coiling apparatus as specified in claim 9 and comprising, in addition, means mounting said coiling spindle independently of said wire feeding means for rotation about the axis of said mandrel to coil the said severed wire length therearound, and rotary drive means coacting with the said coiling spindle to rotate the latter.

11. Filament coiling apparatus as specified in claim 10 wherein the said coiling spindle consists solely of a die provided with the said guide opening for the said wire length.

12. Filament coiling apparatus as specified in claim 9 wherein the said feed jaw operating means comprises a plate cam movable into and out of engagement with cam follower means on said feed jaw means to effect the opening and closing thereof.

13. Filament coiling apparatus as specified in claim 9 wherein said slide actuating means is operative to momentarily interrupt the advance movement of said slide member and associated feed jaw means during the operation of said cutter means to sever the said predetermined length of filament wire from the remainder of the supply thereof on said spool.

14. Filament coiling apparatus as specified in claim 9 wherein the said feed jaw means comprises a pair of primary feed jaws mounted on said slide member and adapted to grip the free end portion of the filament wire held by said retention means and a pair of secondary feed jaws adapted to grip the portion of the filament wire trailing from said primary feed jaws during the advance movement thereof toward said coiling spindle, said apparatus further comprising a subslide slidably mounted on said base for reciprocating movement independently of said slide member toward and away from said coiling spindle in a direction longitudinally of the said guide opening therein, said secondary feed jaws being mounted on said subslide, and subslide actuating means coacting with said subslide to reciprocate it independently of said slide member toward and away from said coiling spindle, said feed jaw operating means and said slide and subslide actuating means operating in timed relation to close said secondary feed jaw means so as to grip the said predetermined wire length portion of the filament wire during the withdrawal thereof by said primary feed jaws and to then advance the said subslide in unison with said slide member and subsequently terminate the advance movement of said slide member and open the said primary feed jaws upon insertion of the leading end of the severed filament wire length into the guide opening of the coiling spindle while continuing the advance movement of said subslide and associated secondary feed jaws to thereby carry the leading end of said wire length completely through the said guide opening so as to project from the coiling spindle.

15. Filament coiling apparatus as specified in claim 14 wherein the said slide actuating means and said subslide actuating means are operative to momentarily interrupt the said advance movement in unison of said slide member and said subslide during the operation of said cutter means to sever the said predetermined length of filament wire from the remainder of the supply thereof on said spool.

16. Filament coiling apparatus as specified in claim 14 wherein at least one of the jaws of each pair of said primary and secondary feed jaws comprises a spring-loaded pivoted jaw, the said pivoted jaws being respectively pivoted on said slide member and said subslide.

17. Filament coiling apparatus comprising a table, a bedplate mounted on said table, a slide head mounted on said bedplate and having a mandrel axially slidable therein, a coiling spindle rotatably mounted on said bedplate in opposed relation to said mandrel for rotation about the axis thereof to coil a filament wire therearound, said bedplate being slidable on said table for adjustment thereon in a direction parallel to the axis of said mandrel to permit location of the coiled sections of filaments formed thereon to various coil lengths in the same axial centered position relative to said table, an operating lever pivoted on said bedplate and connected to said mandrel to effect sliding movement thereof, a drive shaft mounted on said table and carrying a cam engageable with said operating lever to effect pivotal movement thereof, and a sleeve on said shaft slidable thereon but rotatively in-

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terlocked therewith, said cam being fixedly secured on
said sleeve and said sleeve being rotatably mounted on
but locked against axial movement relative to said bed-
plate whereby the said cam occupies the same positional
relation to the said operating lever in any adjusted posi-
tion of the bedplate relative to the table.

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