

Jan. 29, 1946.

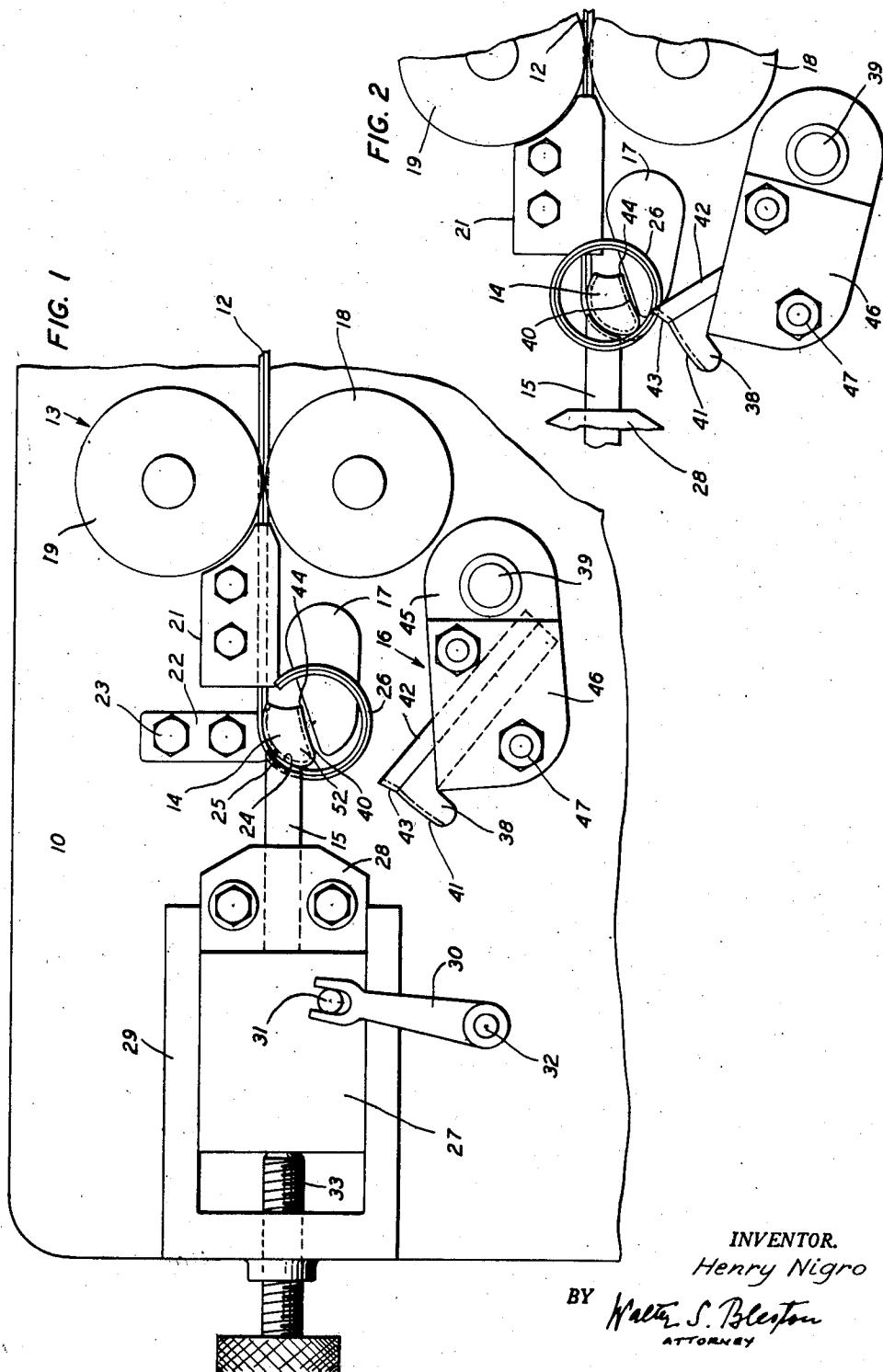
H. NIGRO

2,393,804

WIRE COILING MACHINE

Filed June 9, 1944

4 Sheets-Sheet 1



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WIRE COILING MACHINE
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2,393,804

4 Sheets-Sheet 2

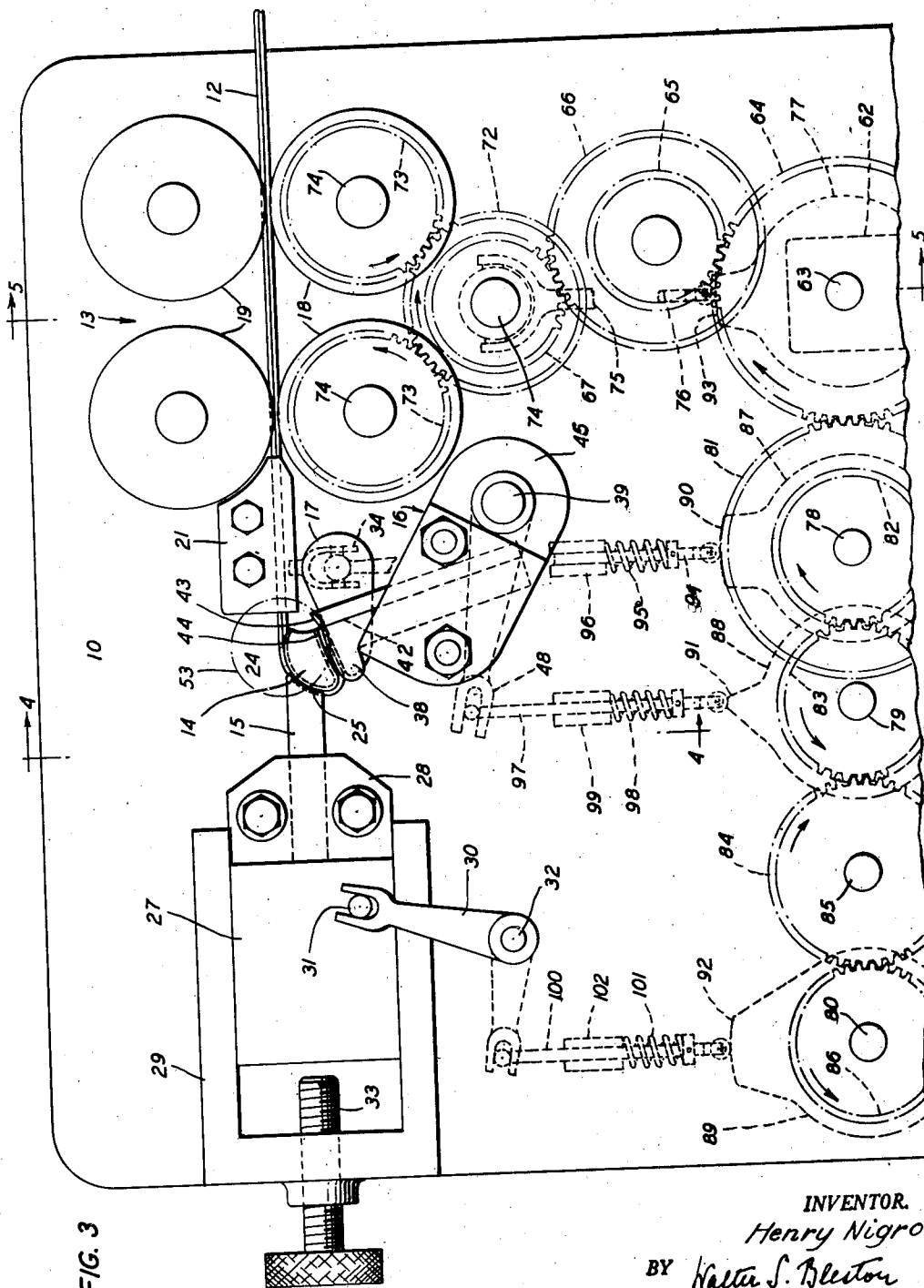


FIG. 3

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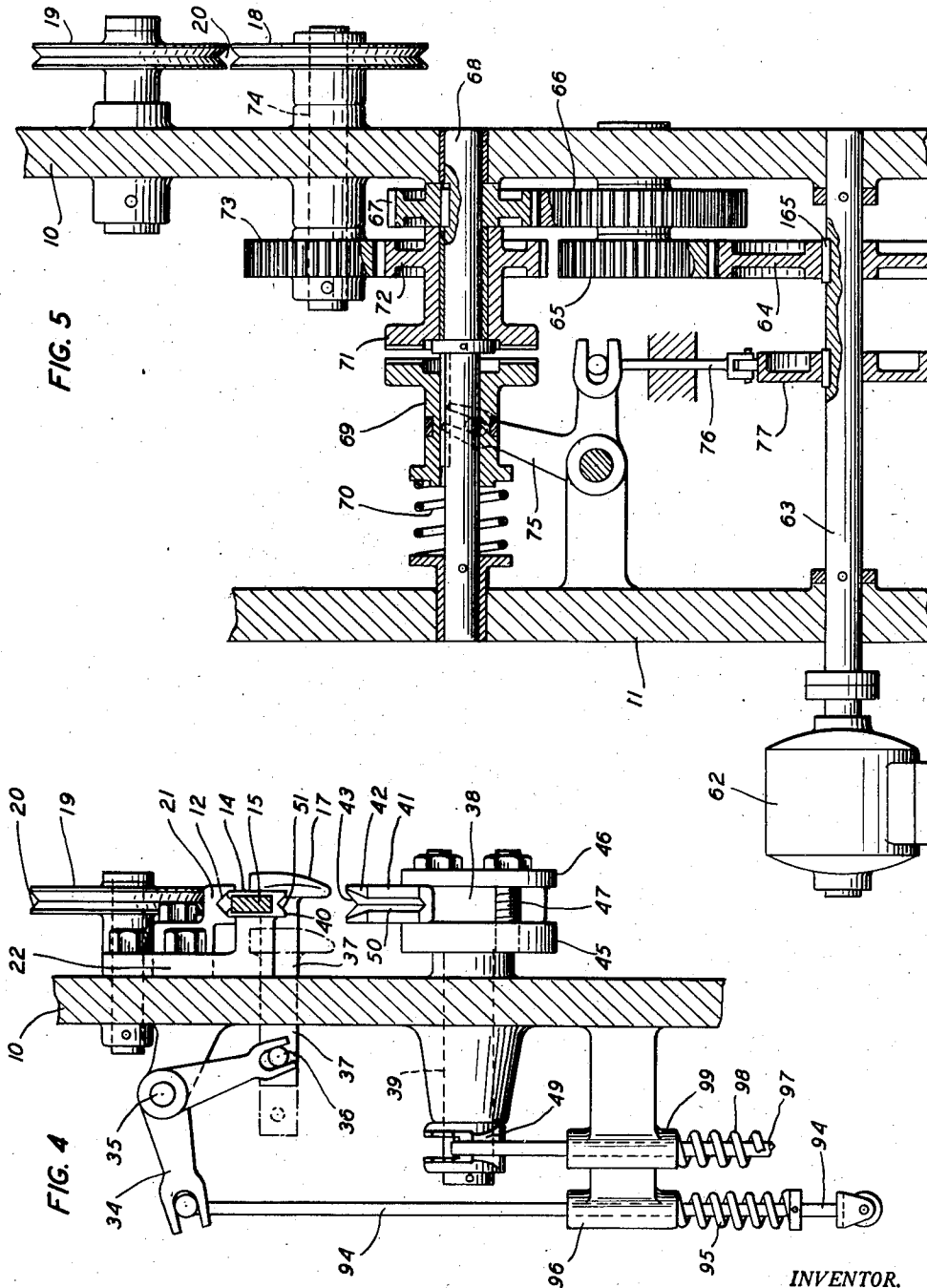
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2,393,804

WIRE COILING MACHINE

Filed June 9, 1944

4 Sheets-Sheet 3



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FIG. 6

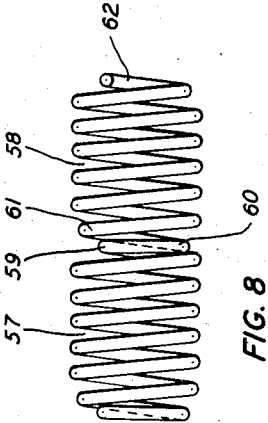
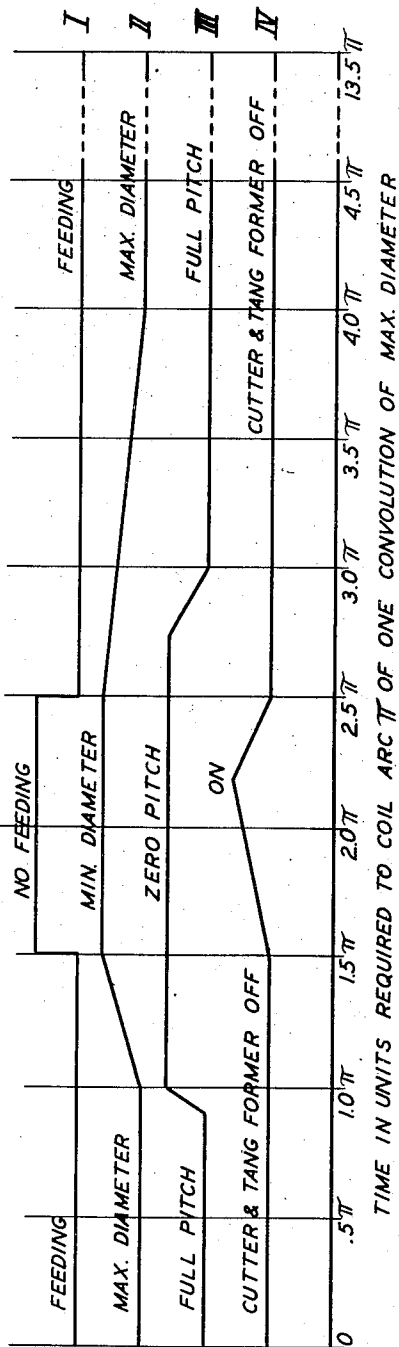


FIG. 8

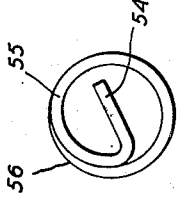


FIG. 7

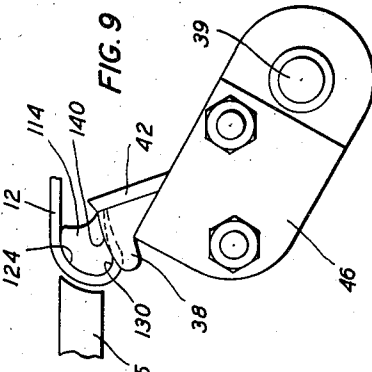


FIG. 9

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2,393,804

WIRE COILING MACHINE

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Application June 9, 1944, Serial No. 539,471

22 Claims. (Cl. 153—65)

The present invention relates to a machine for coiling wire in the shape of springs, and more particularly to a machine of the kind described in U. S. Patent No. 2,119,002 of May 31, 1938. In a machine of that type the wire is intermittently fed and passed between a stationary arbor and a cooperating tool, which is denoted as the coiling point. The position of the coiling point in relation to that point where the wire runs tangentially on the arbor defines the curve into which the wire is bent, and if the coiling point is stationary a cylindrical coil will be produced whereas by changing the relative position of the coiling point the diameter and hence the shape of the coil can also be changed. Another adjustable tool is provided to bend the wire convolution having left the coiling point, out of its plane so as to give the convolutions the desired pitch. In the automatically operating machine feeding is temporarily stopped when the desired length of a coil has been obtained, and a cutting tool moves against a sharp edge of the arbor so as to cut the wire at a distance behind the coiling point. After the cutting tool has returned to its original position, the feeding device is started again, and the subsequent coil will be produced in the manner just described.

Although the machine of the mentioned type is useful for the manufacture of springs of various forms, it is not fitted for the production of springs or coils which have a tang at one of their ends. Such tangs are frequently needed, for instance, where it is required to contract or expand a cylindrical or conical wire coil by torsion. An example of such coil is described in U. S. Patent No. 2,150,876 of March 14, 1939, as an element of a screw connection between a tapped member and an exteriorly threaded bolt or stud.

The invention aims, therefore, to provide means whereby a machine of the mentioned type can be rendered useful to produce tanged coils or springs in a continuous train of automatic operations.

The invention consists in that the stationary arbor cooperates not only with a coiling point to coil the wire but also with a periodically operative tool to form a tang, and that the tang of each coil may be formed before the cutting tool severs the precedingly completed coil from the subsequent one. The invention also consists in a combination of a tang-forming tool with a cutting tool for common movement. The invention, furthermore, contemplates to produce a substantially straight tang of a wire portion which was first bent into the shape of a coil convolution or part of a coil convolution, the diameter of such convolution or part convolution being either equal to or different from that of the major portion of the coil.

Further objects and details of the invention

will be apparent from the description given hereinafter and the accompanying drawings illustrating an embodiment thereof by way of example.

In the drawings,

Fig. 1 is a front elevation of a portion of a machine of the mentioned type provided with the tools and devices according to the invention;

Fig. 2 is a front elevation of parts shown in Fig. 1 in their relative position during another step of operation;

Fig. 3 is a front elevation similar to Fig. 1, the parts being shown in their relative position during a third step of operation;

Figs. 4 and 5 are partial cross-sections along lines 4—4 and 5—5, respectively, of Fig. 3;

Fig. 6 is a diagram illustrating the timing of the movement of several elements of the machine in relation to each other;

Fig. 7 is a front view of a tang-provided coil;

Fig. 8 is a side elevation of two coils as produced by the machine, and placed close to each other; and

Fig. 9 is a front elevation of a modified arbor and cooperative parts.

Referring now to the drawings, the illustrated machine has a frame with a front wall 10 and a rear wall 11. The conventional tools for coiling the wire 12 are arranged in front of the wall 10, and comprise in general a feeding device 13, an arbor 14, a coiling point or shoe 15, a cutting device 16, and a pitch tool 17. The feeding device essentially consists of a pair of driven rollers 18 and a pair of freely rotatable rollers 19. The rollers are grooved according to the cross-section of the wire to be coiled as clearly shown at 20 in Figs. 4 and 5, the rollers 18 being omitted in Fig. 4 in order to prevent overcrowding of the drawings. In the present example, the rollers are grooved for a diamond-shaped wire, but it will be clear that any other wire cross-section may be worked if the rollers are exchanged for such with corresponding grooves. A wire guide 21 is provided between the rollers and the arbor 14, so that the wire 12 is fed in a tangential direction to the top of the arbor which may be stationarily secured with its foot 22 to wall 10 by suitable means such as screws 23. One portion 24 of the arbor periphery is an arc which may be an arc of a circle, cooperating with a surface 25 of the shoe 15 which constitutes the coiling point. The surface of the shoe may be curved with a diameter similar to that of the arbor portion 24. If the wire to be coiled is round it is sufficient if one of the two cooperating members is grooved. For other wires, however, preferably both the arbor portion 24 and the shoe face 25 are grooved according to the wire cross-section in order to prevent the wire from turning about its own axis during the coiling.

Now it will be clear that if wire 12 is fed by rollers 18 and 19 through guide 21 and between arbor 14 and coiling shoe 15 in their relative position shown in Fig. 1, the wire will be continuously subjected to the same bending stress so as to be coiled into a convolution 26. If the pitch tool 17 projects somewhat forward with respect to the plane of arbor and coiling shoe, a portion of the convolution just formed will slide on the front face of the pitch tool with the result that the convolution will be bent in a direction at right angles to said plane. Consequently, when the coiling continues the convolutions will be spaced from each other according to the spacing of the pitch member 17 from the said plane and a cylindrical coil of a predetermined pitch will be produced.

In the conventional machine the coiling shoe 15 and the pitch member 17 are adjustable in order to vary within limits the diameter and pitch of the coil. The diameter of the coil depends on the spacing of the coiling shoe from the arbor so that the closer the two are positioned in relation to each other the smaller will be the diameter of the coil produced, and the more the shoe is remote from the arbor the larger will be the coil diameter, provided the wire is constantly fed in tangential direction to the same point of the arbor. In order to adjust the relative position of the coiling shoe 15, it is secured to a carriage 27 by means of a halter 28. Carriage 27 can slide in a guide frame 29 and be actuated for to and fro movement by means of a lever 30 engaging a pin 31 and pivoted at 32. The guide frame 29 is also provided with a set screw 33 against which the carriage 27 can abut to define a desired maximum coil diameter as shown in Fig. 1. By shifting the carriage during the feeding to the right hand side in the drawings in a position as shown for instance in Fig. 3, the coil diameter will be reduced so as to form a conical coil portion tapering from a larger to a smaller diameter, and by returning the carriage to its abutting position an inverse taper will be formed. In order to alter the pitch of the coil the pitch member 17 can be shifted in a direction at right angles to the plane of the wall 10 as clearly shown in Fig. 4. Shifting can be accomplished by means of a bell crank lever 34 pivoted at 35 and engaging projections 36 on the shank 37 of the member 17. In Fig. 4 the member 17 is shown by solid lines in projected position whereas the dot and dash line contour indicates the member in retracted position. The conventional machine is also provided with a cutter which can be operated when a coil of desired length has been produced.

The conventional machine comprising parts as hereinbefore mentioned is capable of producing coils of various diameters either in cylindrical or conical form by moving the wire relatively to two substantially stationary members. However, this principle of operation is not readily applicable to provide a so produced coil with a tang. Now, in order to maintain, in the production of tang-provided coils, the continuity of operation prevailing in the conventional process of making tangless wire coils, the tang is made, according to the present invention, of a wire portion which previously had been bent into the form of a coil convolution or part of a coil convolution. In other words, a portion of the stock wire which originally was straight as in guide 21, is first curved to form a portion of a coil convolution and, then, bent back into the more or less

straight form of a tang. This forming of the tang may be accomplished by moving a tool in relation to the stationary arbor and a coil convolution which has already been formed by the cooperation of arbor and coiling shoe. In certain well-known cycles of operation in a process of making wire coils, a period exists in which the feeding is interrupted as, e. g. in the machine of the abovementioned Patent No. 2,119,002, in which a period of rest of the feeder mechanism is provided while the cutter is in operation. Where the present invention is to be applied to a process and machine of the just mentioned kind, it is advisable to accomplish the forming of the tang during such period of rest, and where the operation of a cutter constitutes a part of a cycle, it is another feature of the invention that the forming of the tang may be so combined or timed with the cutting that the tang may be completed or almost completed before it is severed from the preceding coil or the first part convolution of the subsequent coil.

A mechanism for forming a tang according to the invention either constitutes a separate machine, or it may be embodied in a coiling machine, or it may be constructed as an attachment to an existing machine of e. g. the type disclosed in the mentioned Patent No. 2,119,002. In the illustrated embodiment of the invention, the tang-forming parts and their accessories are so designed, that the foregoing statement will be readily understood. The tang-former of the illustrated machine comprises a tool 38 which can be reciprocated about a pivot 39 so as to cooperate with a substantially straight face 40 of the arbor 14. However, it is preferable to make the cooperating faces 41 of tool 38 and 40 of the arbor 14 very slightly curved for reasons to be explained hereinafter. These faces may also be grooved according to the wire cross-section as indicated at 50 and 51, respectively (Fig. 4). The tang former 39 may be combined with a cutter 42 for common movement so that the cutting edge 43 cooperates with an edge 44 of the arbor. Both the tang former and the cutter 42 are secured to a lever 45 by means of a plate 46 and screws 47 as clearly shown in Figs. 1 and 4. Lever 45 can be actuated by a lever arm 49 mounted on the pivot axle 39. The tang former operates in the following manner:

Let it be assumed that the feed rollers 18 and 19 are at a standstill and the various elements in the position of Fig. 1, the pitch member 17 being retracted. A coil has been formed and projects with convolution 26 forward from the wall 10 with the coil axis substantially at right angles to the wall. If now, the lever 45 is turned in a clockwise direction (Fig. 1) about the pivot 39, the cutting edge 43 will first contact the convolution 26 and, upon further movement, shift the convolution 26 upward and towards the right hand side so as to bend it about the round corner 52 of the arbor 14. This is shown in Fig. 2. When the movement of lever 46 continues the face 41 of tool 38 comes closer to the convolution 26 so as to press it against the face 40 of the arbor. Thereby, the tang is formed, with a slight upward curve according to the tool faces. Simultaneously the cutting edge 43 cooperates with arbor corner 44 so as to sever the preceding coil from that portion of the convolution 26 which is used to form the tang. The relative position of the parts is shown in Fig. 3 in which the dash and dot line circle 53 indicates the position of the preceding coil immediately before it has been cut

off and dropped down. If now, the lever 45 is returned to its original position and the pressure on the tang is released, the resiliency of the wire material will cause the tang to spring slightly backward so as to take the straight form of the tang 54 of the coil shown in Fig. 7. This springing effect is the reason why it is advisable to make the faces 40 and 41 slightly curved as stated hereinbefore. If now, the feeding is started again and the pitch member 17 moved back into its more or less protracted position, a new coil will be produced the forward end of which is constituted by the tang just formed.

In many instances, particularly if the coil is to be used as an insert for screw connections, it is desirable that the coil convolution, or a substantial portion thereof, immediately following the tang be of a smaller diameter than the larger portion of the coil. The change from smaller to larger diameter should occur gradually so that the tang provided coil end convolution forms a spiral as shown in Fig. 7 where the spiral form of the first convolution is denoted by 55 and the larger cylindrical part of the coil with maximum diameter by 56. The other end of the coil, however, should not differ in diameter from the larger coil portion. As stated hereinbefore, the change in diameter of the coil can be brought about by varying the spacing of the coil shoe 15 from the arbor 14, but obviously, movement of the shoe in the one direction in order to increase the diameter must be followed or preceded by a movement in the opposite direction in order to insure continuity of the cycles of operation. Considering on the other hand, the shape of two coils placed close to each other as shown in Fig. 8 to be produced in two consecutive cycles, there is an increase of the diameter between a tang and the maximum diameter of the one adjacent coil whereas a convolution of maximum diameter is directly adjacent to the other tang end. In other words, there is no apparent coil length in which a reduction of the diameter takes place in order to permit the increase between the tangs and the cylindrical coil portions, as it is seemingly necessary if continuity of operation is desired. According to the invention, this difficulty can be overcome by reducing the diameter of a coil portion immediately following the desired length of a first coil and selecting the length of the said portion so that it is approximately equal to the length of wire required for forming the tang. If this is done, and the connected coils are severed between the front end of the tang of the second coil and the rear end of the preceding coil, the latter will end with a maximum diameter whereas the following coil has the desired forward end of a tang and a first convolution with increasing diameter. In Fig. 8, the first coil is denoted by 57 and the second coil by 58. Both coils are shown connected with each other so that they may be severed from each other at 59. If this is done the portion 60 of the coil 58 forms a tang followed by a convolution 61 of increasing diameter and the rear end 62 of the coil has the same diameter as the preceding convolution. It is to be noted, however, that Fig. 8 is only illustrative insofar as in practice there need not be two complete coils connected to each other because severing of the coil 57 from the subsequent coil at the point 59 may occur at the time when only a small portion of the convolution 61 is completed. Furthermore, the coils of Fig. 8 are shown as produced of a round wire in contradistinction to the diamond-shaped wire 12. This is done in order

to indicate that the cross-section of the wire is immaterial as far as the present invention is concerned except for what has been stated with reference to the grooves of arbor and coiling shoe, and that practically any desired wire cross-section may be used, provided the cross-section is such that coiling between arbor and shoe is possible.

The forming of coils in the indicated manner requires a special timing of the movements of the various machine elements. This can be accomplished by drives of various well-known and suitable types. However, it is required that a certain relationship between the actuations of the different parts is maintained. In the illustrated embodiment a drive has been shown which is useful to accomplish the desired results. The particular drive is selected in this example because it illustrates with particular clearness all requirements although it is possible to reduce the number of parts by using some other drive which accomplishes the same functions. The drive shown in Figs. 3, 4 and 5 comprises a motor 62 driving a main shaft 63 with a gear wheel 64 secured thereto by key 165. Wheel 64 is part of a transmission constituted by gear wheels 65, 66 and 67 driving an intermediate shaft 68 (Fig. 5). The movable member 69 of a releasable clutch is splined on shaft 68 and a spring 70 is so arranged as to urge member 69 into engagement with the other clutch member 71 which is freely rotatable on the same shaft 68. Clutch member 71 is connected with a gear wheel 72 which meshes with two gear wheels 73 secured to the shafts 74 of the rollers 18 respectively. Clutch member 69 can be disengaged from member 71 by a forked crank lever 75 actuated by a tappet 76 which is in engagement with the cam 77 secured to the drive shaft 63. Thus, it will be clear that if tappet 76 cooperates with the lower portion of the cam 77 clutch member 69 will engage member 71 so that rollers 18 will be driven from shaft 63 through transmission 64 to 67, shaft 68, clutch 69, 71 and gear wheels 72 and 73. When the tappet 76 is in engagement with a higher portion of the cam 77 the clutch 69 will be disengaged so that rollers 18 will come to a standstill.

Motor 62 is also geared to drive three additional cam shafts 78, 79 and 80. For this purpose gear wheel 64 is in mesh with wheel 81 (Fig. 3) secured to shaft 78 which carries another wheel 82 engaging a wheel 83 on shaft 79. Wheel 83 drives a wheel 84 on an auxiliary shaft 85, and wheel 84 meshes with a wheel 86 secured to shaft 80. The diameter of wheel 64 is equal to that of wheel 81, and the diameters of the wheels 82, 83 and 86 are equal to each other so that the shafts 63, 78, 79 and 80 rotate with the same R. P. M. although in different directions. Cams 87, 88 and 89 are mounted on the shafts 78, 79 and 80, respectively, and their crests 90, 91 and 92 and the crest 93 of cam 77 are differently shaped as will be explained hereinafter. Cam 87 actuates a tappet 94 provided with a spring 95 and guided by a bracket 96. The tappet engages the bell crank lever 34 of the pitch member 17 so as to retract the latter when the tappet is raised by the cam crest 90 and to protract it when the tappet is lowered by the action of the spring 95. In a similar manner, the tang-forming tool lever 45 and the coiling shoe lever 30 are operated by cam 88 and tappet 97 with spring 98 and guide 99, and by cam 89 and tappet 100 with spring 101 and guide 102, respectively.

The correct shape and relative position of the

cams can be ascertained by the following considerations. Obviously, each cycle comprises at least one period in which the wire is fed and coiled, and another period in which no feeding occurs in order to permit reciprocating movement of the cutting tool severing a completed coil from the wire destined to form a subsequent coil. The time required for one cycle will be a minimum if the tang-forming operation coincides with the movement of the cutter. If it is assumed, for instance, that the movement of the cutting tool requires a length of time equal to that in which one-half convolution of the maximum coil diameter can be formed, then, the entire time of a cycle can be expressed in units of wire length or in units of arcs of a coil convolution. In the present example an arc of $180^\circ = \pi$ has been selected as such unit. If it is further assumed that the length of the tang is to be approximately equal to an arc of 90° , and the coil portion with increasing diameter equal to an arc of approximately 270° of a convolution with maximum diameter, and that the coil shall have five and a half convolutions of maximum diameter, then, the total length of a cycle will be equal to 13.5π . A cycle of this kind is illustrated in Fig. 6. In this diagram line I relates to the operation of the feeding device 13, line II to the movement of the coiling shoe 15, line III to that of the pitch member 17, and line IV to the reciprocation of the tang-forming and cutting tool 16. As the zero point of the diagram that instant of the cycle has been selected where four convolutions of maximum diameter of a coil have been completed. Consequently, feeding continues uniformly for a length of 1.5π to be interrupted for a length of 1π , so as to start again at point " 2.5π " and to continue to the end of the cycle. It has been stated hereinbefore, that the tang is to be formed of a portion of a wire convolution with decreasing diameter and that its length shall be equal to an arc of $90^\circ = .5\pi$. This decrease must be completed before the tang-former operates during the "no-feeding" period. Hence, line II indicates the change of the diameter between the points " 1.0π " and " 1.5π ," whereas the increase of the diameter to its original size occurs between the points " 2.5π " and " 4π ." As it is desired that the tang is located in a plane at right angles to the coil axis, the pitch tool should be inoperative during the time the wire portion with decreasing diameter is coiled. On the other hand, the wire portion with increasing diameter should be coiled with pitch, but will require some time after feeding starts at point " 2.5π " until it reaches the active face of the pitch member. Thus line III indicates, close to " 1.0π ," a preferably zero pitch and near " 3.0π " a reverse change of position which may occur somewhat less rapidly. Line IV, finally, indicates the movement of the tang-forming and cutting tool between the points " 1.5π " and " 2.5π ," i. e. during the "no feeding" period. The motion is more slowly during the working stroke than during the return stroke.

In Fig. 3, the cams 77, 87, 88 and 89 are shown shaped substantially according to the diagram of Fig. 6. The correlation of points of lines I to IV and of the cams can be easily ascertained if it is considered that the cycle of 13.5π of Fig. 6 corresponds to the 360° peripheries of the cams, which in the present embodiment are geared to rotate with the same R. P. M.

The machine operates in the following manner: The free end of a wire 12, taken from a supply is passed between the feeding rollers 18 and 19,

through the guide 21 and between the arbor 14 and coiling shoe 15. This is best accomplished when all tappets are in their lowered positions. Then, motor 62 may be started, whereupon the wire will be automatically fed by the device 13 and convolutions will be coiled. The first crest of a cam to reach its tappet is the crest 90 of cam 87 which retracts the pitch member 17 to inoperative position. Immediately thereafter, cam 89 causes shoe 15 to move towards arbor 14 whereby the coil diameter will be reduced. When the shoe has reached its position close to the arbor, feeding is interrupted owing to the action of cam 77. Simultaneously cam 88 begins to lift its tappet 97 thereby turning the lever 45 with its tools 38 and 42. This movement causes the forming of a tang and cutting of the preceding convolutions as hereinbefore described. The first coil, thus cut off, is scrap since it is neither of the desired length nor provided with a tang, the tang just formed belonging to the subsequent coil. After the tools 38 and 42 have completed their operation, lever 46 returns to its original position. When this is reached or shortly before that time, tappet 76 drops from crest 93 of cam 77 to start the feeding device, and simultaneously tappet 100 begins to slide down the long slope of its cam 89, thereby gradually retracting the shoe 15 to its end position where it abuts against screw 33. Thus the coil diameter increases from its minimum to maximum. Shortly after the starting of the feeding device, tappet 94 will be lowered so that the pitch member will be protracted under the action of spring 95. When all tappets are again in their lowermost positions, convolutions of the desired maximum diameter will be coiled. When the coil has obtained the desired length, operation of the tools will start again in the manner just described so that the cutting tool will sever a complete coil from the tang of the subsequent coil.

In forming coils with a tang and increasing diameter at one end, another mode of operating the machine may be used also with satisfactory result. This requires a slightly modified arbor form and some change in the above-described timing. It has been stated with reference to Fig. 3 that the arbor portion 24 which cooperates with shoe 15 may be formed according to an arc of a circle. Now, in the modification shown in Fig. 9, the portion 124 of the arbor 114 is an arc of a spiral increasing its radius from the bend 130 of the tang-forming face 140 to the point where the wire 12 runs on the arbor. The arc 124 is so shaped that it substantially corresponds to the first portion of the convolution 55 in Fig. 7. The machine may, then, be so operated and timed that first a cylindrical coil of desired maximum diameter is produced by cooperation of the arbor 114 and shoe 15 in the described manner. During this step the wire will contact these two members each substantially in one point only. In other words there will be a gap between the wire and a portion of the arbor arc 124. When sufficient wire has been coiled, feeding is stopped and lever 45 with tang-former 38 and cutter 42 turned about its pivot 39 into the position of Fig. 9. In so doing these tools move in a path having a component substantially parallel to the arbor face 140 and another component substantially perpendicular to the first one. On account thereof, the engagement of the said tools with the wire is of a frictional character so that the wire portion opposite the arc 124 will be brought into close contact therewith

and will be accordingly bent into the shape of the first portion of a convolution with increasing diameter such as 55 in Fig. 7. While this occurs, the shoe 15 may be moved towards the arbor into such a position that it can continue forming the convolution 55 by returning to its original position when feeding is started again after lever 45 has been swung back in anti-clockwise direction. It will be clear that in the manner just described the tang is formed of a wire portion originally coiled with the maximum diameter of the coil whereas in the first described manner the tang portion was originally a part of a convolution with decreasing diameter. Both methods have in common that the length of the coil portion with increasing diameter can be selected as desired. If this length is very short, i. e. less than approximately 90°, the forming may be accomplished on the arbor arc 124 alone without movement of the shoe 15 which may be held stationary according to the maximum diameter of the coil. The means for timing the various parts of the machine do not require additional explanation. Their construction and arrangement will be apparent in view of the description given hereinabove.

It has been stated that in the modification just described with reference to Fig. 9, the one portion of the arbor periphery should be shaped according to a spiral. However, this appears to be necessary only if a very high grade of accuracy of the uniformity of increase of the first coil convolution is required. Otherwise, the arbor portion here in consideration may be an arc of a circle or any other suitable curve depending on the resiliency of the wire material provided the arbor diameter is by no means larger, preferably appreciably smaller than the smallest diameter of the first coil convolution. If, then, the tang-forming tool starts its operation it will not only straighten the portion of the convolution which it engages, but will also bend the subsequent coil portion towards the arbor thereby decreasing the diameter of that portion. This bending may be assisted by the shoe 15, so timed that it is simultaneously moved towards the arbor. Or the bending by the tang-forming tool may be followed by such movement of the shoe. In any event, if the tang, as stated before, is formed of a coil portion of originally maximum diameter, the movement of the shoe towards the arbor should be so timed that it occurs while the feeding device is in operation, and preferably while the tang-forming tool is moving. This will permit shortening the time to a minimum during which the feeding device is standing still, or in other words, it will permit raising of the output of the machine to a maximum.

In the foregoing, the operation of the machine in forming coils with a tang and increasing diameter has been described. It is, of course, also possible to use the machine for the production of entirely cylindrical coils with tang. In that event it is merely necessary to remove the cam 83, so that the shoe 15 remains, in an adjusted position, abutting against screw 33. The operation of the other tools need not be changed. Furthermore, in the described machine, each completed coil is severed from the subsequent coil while the latter is in its first stage of production. In certain instances, however, it may be preferable to produce a series of connected coils, particularly if a cut surface of certain character is desired which cannot be obtained by cooperation of a cutter with the arbor. In that event

it will be necessary only to remove the cutting tool 42 whereupon connected coils of the desired shape will be turned out by the machine. However, all the mentioned modifications have in common that the tang is formed of a wire portion which was originally straight, then, coiled into at least a portion of a convolution, and finally straightened out again into the shape of the desired tang, and that the consecutive coils are severed from each other between the one end of a tang and the adjoining convolution after the shaping of the tang has been completed.

Although I have described only one embodiment of my invention, it will be apparent to those skilled in the art that many alterations and modifications thereof may be made without departing from the spirit and essence of the invention, which shall be limited only by the scope of the appended claims.

I claim:

1. In a machine of the type described including a stationary arbor and a coiling member in cooperative relation to said arbor, for coiling a wire passed between a curved peripheral face portion of said arbor and said member, the combination of a substantially straight peripheral face portion of said arbor, said substantially straight face portion being, in the direction of the wire movement, subsequent to said curved face portion, a tool movable in relation to said substantially straight face of said arbor and across the path of a wire convolution coiled between said curved face of said arbor and said member, said tool having a face according to said substantially straight arbor face and cooperative therewith to bend a portion of said convolution into the form of a tang, and means operatively associated with said tool to render it periodically effective to cause the tool face to engage said portion of a convolution whereby to press said portion against said substantially straight arbor face, thereafter releasing the tang thus formed.

2. In a machine of the type described, the combination of a stationary arbor having two working faces of its periphery, the first one being curved, the second one adjoining the first one and being substantially diametrical with respect thereto, a coiling member in cooperative relation to the first one of said arbor faces, so as to coil a wire passed between said first arbor face and said coiling member, a tool having a face adapted to cooperate with said second arbor face, means to guide said tool in a path across a wire convolution formed between said arbor and said coiling member, said path having one component substantially parallel to said second arbor face and another component substantially perpendicular thereto, and means to reciprocate said tool so as to cause said tool to urge a portion of said convolution against said first arbor face owing to said first path component and to press another portion of said convolution in the shape of a tang between said tool face and said second arbor face owing to the other path component.

3. In a machine of the type described, the combination of a stationary arbor having two working faces of its periphery, the first one being curved, the second one adjoining the first one and being substantially diametrical with respect thereto, and having a sharp edge at its end remote from said first face, a coiling member in cooperative relation to said first arbor face so as to coil a wire passed between said first arbor face and said coiling member, a tool movable across the path of a coil formed by said arbor

and said coiling member, and having a face cooperative with said second arbor face so as to engage a portion of said coil intermediate its free end and the coiling member, means to reciprocate said tool so as to press said coil portion against said second arbor face and to substantially straighten it in the form of a tang, and a cutter adapted to cooperate with said arbor edge, to sever the wire between said tang and the preceding coil convolution.

4. A device as claimed in claim 3 wherein said tool and said cutter are combined and said means is operative to reciprocate said tool and said cutter simultaneously.

5. A device as claimed in claim 3 wherein of the coacting faces of the tool and arbor, one such face is slightly concave and the other one slightly convex.

6. In a machine of the type described, the combination of a stationary arbor having two working faces of its periphery, the first one being curved, the second one adjoining the first one and being substantially diametrical with respect thereto, and having a sharp edge at its end remote from said first face, a coiling member in cooperative relation to said first arbor face so as to coil a wire passed between said first arbor face and said coiling member, a tool movable across the path of a coil formed by said arbor and said coiling member, and having a face cooperative with said second arbor face so as to engage a portion of said coil intermediate its free end and the coiling member, a pivoted means adapted to hold said tool, the pivot of said means being located eccentrically with regard to the arbor center and towards the side remote from said coiling member, and operative means for oscillating said pivoted means about the pivot axis whereby said tool when engaging said coil portion will cause friction tending to pull the wire between the coiling member and arbor in the direction of the coiling.

7. In a machine of the type described including a stationary arbor, a coiling member cooperative with said arbor for coiling a wire passed between said arbor and said member, and a retractable and projectable pitch member adapted to bend a formed convolution out of its original plane, the combination of a tool movable in relation to said arbor and across the path of a wire convolution coiled between said arbor and said coiling member, said arbor and said tool having cooperating faces to bend a portion of said convolution into the form of a tang, first operative means in connection with said tool to reciprocate it so that said tool face engages said portion of a convolution and presses it against said arbor face and, then, releases the tang thus formed, second means to reciprocate said pitch member, and a drive for said first and said second means, said drive comprising timing elements so as to cause retraction of said pitch member prior to a reciprocation of said tool, and projection of said pitch member after the reciprocation of said tool.

8. In a machine of the general type described, including wire coil forming mechanism, a tool movable about an axis, and constituting a combined wire cutter and tang-forming tool, a stationary member having an edge and a face for cooperation with said cutter and said tang-former respectively, and means for actuating the tool in timed relation to the coil-forming mechanism of the machine to cause substantially simultaneous

cooperation of said cutter and tang-former with said stationary member.

9. The method of forming a wire coil with adjacent arcuate and straight portions which consists in so coiling a wire stock as to form alternately first and second coiled portions of desired length and angular extent, periodically deflecting said second portions out of the curve line of said first portions and subjecting the wire of the deflected portions to a straightening pressure.

10. The method of forming a coiled wire unit with adjacent arcuate and rectilinear portions, which consists in so feeding a wire stock against an abutment as to form an arcuate portion and periodically deflecting parts of the arcuate formed stock, in a direction toward the center on which the arc is drawn, and subjecting such deflected portions to a pressure tending to straighten the wire of such portions.

11. The method of forming a wire coil to include adjacent arcuate and rectilinear portions, which consists in so feeding a wire stock against an abutment as to form the wire stock into arcuate convolutions, periodically straightening portions of the stock by deflection of such portions out of their normal pattern of curvature thence subjecting the deflected portions to a straightening pressure, interrupting the feed of the wire stock while subjecting it to straightening pressure, and severing the wire stock to cut away a completed coil unit, while the feed is interrupted and substantially during the straightening period.

12. The method of forming in continuous cycles of operation, wire coils, each of which having a tang at one of its ends, which comprises coiling a first length of wire according to the desired shape of a coil, continuing coiling a second length of wire according to the desired length of the tang, continuing coiling first and second lengths of wire, applying pressure to each second length of coiled wire so as to straighten the wire while still connected with its preceding and subsequent first lengths of wire, and severing the wire at one end of the so formed tangs before said pressure is relieved.

13. The method of forming, in continuous cycles of operation, wire coils each of which having a cylindrical portion, a tang at one of its ends and a tapering portion intermediate said tang and said cylindrical portion, which comprises coiling a first length of wire while gradually changing the diameter during the coiling to produce the desired taper and then, maintaining the diameter constant to form a desired cylindrical portion of the coil, continuing coiling a second length of wire substantially equal to that of the desired tang while changing the diameter so as to produce an opposite taper, continuing coiling in the stated manner alternately first and second lengths, straightening the convolutions formed of said second lengths, and severing the wire at one end of each second length.

14. In a machine of the type described including a stationary arbor, a coiling member cooperative with said arbor for coiling a wire passed between said member and said arbor, and adjustable as to its spacing from said arbor to change the diameter of the coil to be formed, and an intermittently operating feeding device, the combination of a tool movable in relation to said arbor and across the path of a wire convolution coiled between said arbor and said coil-

ing member, said arbor and said tool having co-operating faces to bend a portion of said convolution into the form of a tang, first means operative to start and stop said feeding device, second means operative to reciprocate said coiling member, third means to reciprocate said tool so that said tool face engages said portion of a convolution and presses it against said arbor face, and, then releases the tang thus formed, and a drive for said first, second and third means, said drive comprising timing elements so as to cause one reciprocation of said tool during each period of rest of said feeding device, and to cause a movement of said coiling member in the one direction immediately preceding said period of rest and a movement of said coiling member in the opposite direction subsequently to said period of rest.

15. A device as claimed in claim 14 wherein said timing elements comprise a cam in operative connection with said coiling member, said cam having one slope for shifting said coiling member in the one direction and another slope for shifting it in the other direction, the length and shape of the one slope and the speed of the cam being so selected in relation to the speed of said feeding device that the coiling member will be moved from a first to a second end position during the time a wire length will be fed according to the length of a desired tapering portion of a coil to be formed, and the length and shape of the other slope being so selected that the coiling member will be moved from said second to said first end position during the time a wire length will be fed substantially according to the length of said tang.

16. A device as claimed in claim 14 further comprising a cutter in connection with said tool and movable simultaneously therewith so as to sever a completed coil from the remainder of the wire in the machine during the period of rest of the feeding device.

17. A device as claimed in claim 14 further comprising a retractable and projectable pitch member adapted to bend a formed convolution out of its original plane, and a fourth means to reciprocate said pitch member, said drive being adapted to operate said pitch member in timed relationship to said other means so as to cause projection of said pitch member into operative position shortly before said coiling member is moved in its one direction, and to cause retraction of said pitch member shortly after said coiling member starts to move in the opposite direction.

18. In a machine of the type described including a stationary arbor, a coiling member cooperative with said arbor for coiling a wire passed between said member and said arbor, and adjustable as to its spacing from said arbor to change the diameter of the coil to be formed, and an intermittently operating feeding device, the combination of a tool movable in relation to said arbor and across the path of a wire convolution coiled between said arbor and said coiling member, said arbor and said tool having cooperating faces to bend a portion of said convolution into the form of a tang, first means operative to start and stop said feeding device, second means operative to reciprocate said coiling member, third means to reciprocate said tool so that said tool face engages said portion of a convolution and presses it against said arbor face, and, then releases the tang thus formed, and a drive for said

first, second and third means, said drive comprising timing elements so as to cause one reciprocation of said tool during each period of rest of said feeding device, and to cause a movement of said coiling member in the one direction during said period of rest, and a movement of said coiling member in the opposite direction subsequently to said period of rest.

19. In a machine of the type described, the combination of a stationary arbor having two working faces of its periphery, the first one being curved substantially according to an arc of a spiral decreasing in diameter towards the second one, said second one adjoining the first one and being substantially diametrical with respect thereto, a coiling member in cooperative relation to the first one of said arbor faces, so as to coil a wire passed between said arbor face and said coiling member, a tool having a face adapted to cooperate with said second arbor face and being movable across the path of a wire convolution formed between said arbor and said coiling member, and means to reciprocate said tool so as to press a portion of said convolution in the shape of a tang between said tool face and said second arbor face.

20. In a machine of the type described, the combination of a stationary arbor having two working faces of its periphery, the first one being curved, the second one being adjacent and substantially diametrical with respect thereto and constituting a die face of an extension substantially according to the length of a coil portion intended to be subjected to a tang-forming operation, a coiling member in cooperative relation to the first one of said arbor faces so as to coil a wire passed between said first arbor face and said coiling member, and a reciprocable tool constituting a punch-like member to cooperate with said second arbor face and having a working face shaped according to said second arbor face and being parallel thereto when the tool is in a working end position, said tool having a path of movement across the path of a wire convolution formed between said arbor and said coiling member so as to engage said coil portion and to press it against said second arbor face when moving in the one direction of its reciprocation.

21. A device as claimed in claim 20 wherein said second arbor face and said punch face are provided with grooves the cross-sections of which substantially complement each other to the cross-sectional shape of the wire.

22. An attachment for a wire coiling machine of the coiling-point-and-arbor type, comprising a tool including a punching face and a cutting edge projecting from said face, said edge and said face being adapted for cooperation with a correspondingly shaped edge and face respectively of the arbor of the machine for which the attachment is destined, so as to cut the wire stock and to press a portion of a previously formed coil convolution in a manner to form a tang thereof, and means to operate said tool along a path intersecting the curve line of certain of the coil convolutions, said cutting edge and said punching face being so arranged in relation to each other and to said path that said edge is leading said face when the tool is operated and that completion of the cutting slightly precedes the completion of the pressing operation.

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