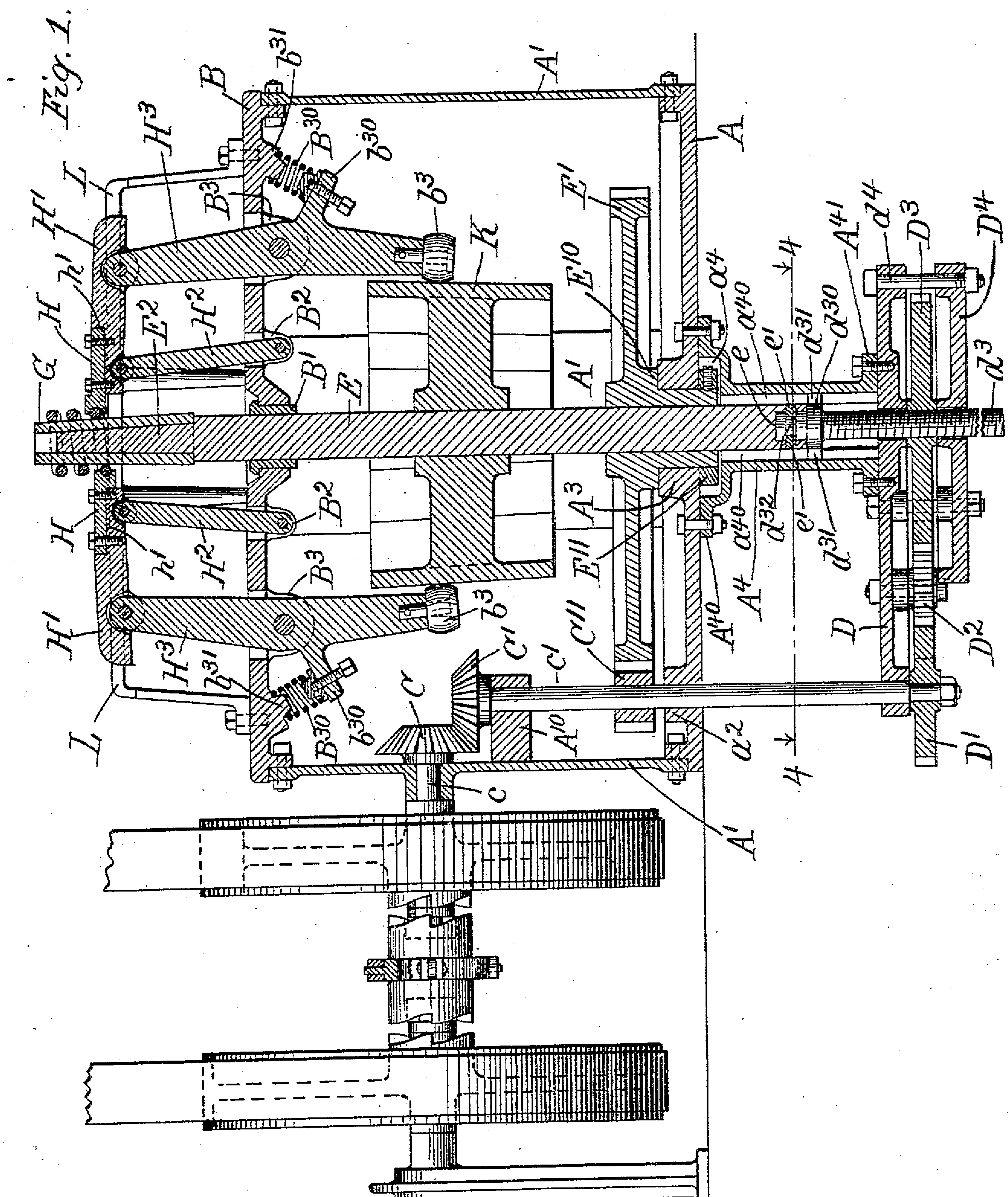
(No Model.) 2 Sheets—Sheet 1.

A. A. AMBLER.

MACHINE FOR COILING ANGULAR SPRINGS.

No. 563,835. Patented July 14, 1896.



Witnesses.
E. T. Wray.
Jean Elliott

Inventor.
Arthur A. Ambler
by Burton and Burton
his attys

THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

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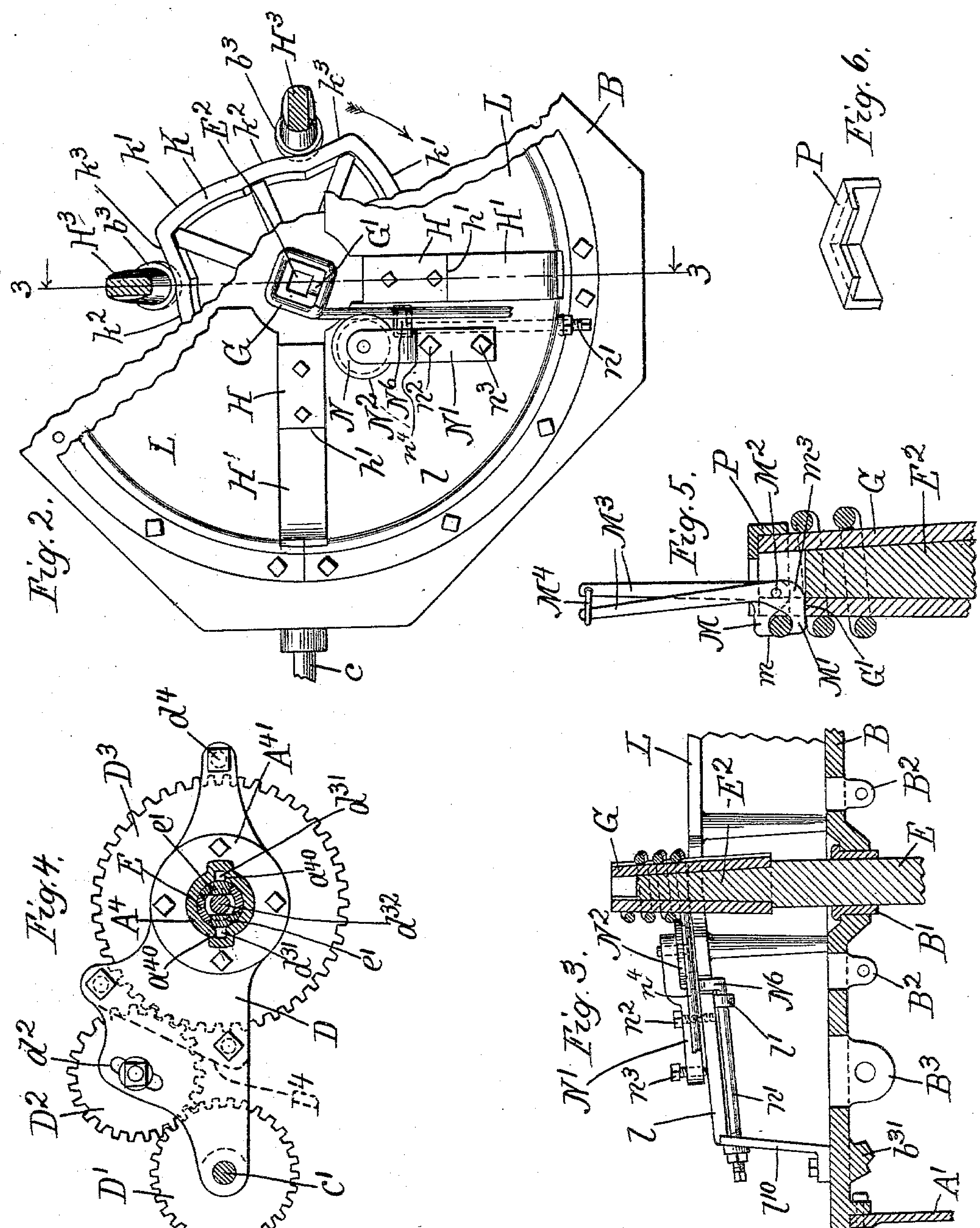

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UNITED STATES PATENT OFFICE.

ARTHUR A. AMBLER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE TITLE AND IMPROVEMENT COMPANY, OF SAME PLACE.

MACHINE FOR COILING ANGULAR SPRINGS.

SPECIFICATION forming part of Letters Patent No. 563,835, dated July 14, 1896.

Application filed July 8, 1895. Serial No. 555,332. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR A. AMBLER, a citizen of the United States, residing at Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in a Machine for Coiling Angular Springs, which are fully set forth in the following specification, reference being had to the accompanying drawings, forming a part thereof.

This machine is designed for the purpose of manufacturing springs coiled from wire or rod, not circularly, but in such manner that a plan of each coil is a regular polygon instead of a circle. The most useful form of such spring is square, and the machine illustrated is constructed for making such springs, but the modifications which would adapt it for making triangular or other regular polygonal springs will be obvious. Such springs cannot be formed by the ordinary process of coiling around a polygonal mandrel, as circular springs are formed by coiling around a cylindrical mandrel, because the recoil of the wire or rod between the angles as soon as the strain of the coiling ceases would immediately throw all the angles out of line and defeat the purpose of the angular form. The characteristics of this invention, therefore, are chiefly such as overcome this difficulty.

In the drawings, Figure 1 is a vertical section of my machine, axial with respect to the mandrel and at right angles to the direction of the incoming rod. Fig. 2 is a detail plan showing the hammers or rods in their proper relation to the mandrel and spring, the table and shield-cap being broken away to show one side of the hammer-operating cam below. Fig. 3 is a detail section at the line 3 3 on Fig. 2, the clenching-dies and hammers and the levers which operate them being omitted. Fig. 4 is a section at the line 4 4, showing a plan of the train which gives the endwise thrust to the mandrel. Fig. 5 is a detail vertical section of a mandrel and wire coiled thereon, the gripping-tongs being shown in elevation. Fig. 6 is a perspective of a block which may be employed to receive the first stroke or pressure of the hammers on two sides of the mandrel before the wire is fully coiled once around the latter.

A is the base, which is adapted to rest upon the floor, portions of the machine extending below.

A′ A′ are standards extending up from the base and supporting at the upper end the table B, which has bearings for the hammer-operating links and levers and other parts, as hereinafter described. In one of the standards A′ is journaled the shaft c of the gear C, which meshes with and drives the gear C′ on the vertical shaft c', which is journaled in a lug A^{10}, projecting from the standard A′, and also at a^2 in the base A. This shaft extends below the base and obtains a further bearing in the plate or gear-frame D, which has the remainder of the bearings for the train which operates the screw to give the endwise thrust to the mandrel.

E is the mandrel-shaft, which extends vertically at the center of the machine, being journaled at the center of the base A and at the center also of the table B, and having feathered connection with the large gear E′, which meshes with and is driven by a pinion C^{11}, fast on the shaft c' above the base A. The hub of this gear-wheel E′ is journaled in the central boss A^3 of the base A and constitutes a slide-bearing for the shaft E. It is stopped by its shoulder E^{10} upon the upper side of the central boss A^3 and by the collar E^{11}, which is made fast to its lower end, which protrudes through the base A.

A^4 is a cylindrical hanger or sleeve which has at the upper end the flange A^{40}, by which it is secured fast to the under side of the base A. The shaft E obtains bearing on said sleeve below said base A. This hanger has at its upper end the cavity a^4 to accommodate the collar E^{11}. The plate or gear-frame D is secured to the lower end of this hanger A^4, the hanger having a suitable flange A^{41} for that purpose. On this frame D are mounted the gears D′, D^2, and D^3, the last gear of which, D^3, is interiorly threaded at the center and operates as a nut or screw-block to coöperate with the thrust-screw d^3, which is screwed through it and actuated endwise by the rotation of the gear. This thrust-screw d^3 is journaled in the frame D and also in the yoke D^4, which is suspended from the frame below the train of gears and made rigid with the frame by the suspending-bolt d^4. The upper end of the thrust-screw d^3 has a flange d^{30}, whose diameter is equal to that of the shaft E, and lugs d^{31} d^{31}, projecting at opposite points from the flange, which take into grooves a^{40} in opposite sides of the bore of the sleeves A^4, so that as the shaft is thrust upward it is guided by the engagement of said lugs d^{31} in said grooves. Above the flange d^{30} the shaft d^3 enters a socket e in the lower end of the shaft E, and a portion which thus enters the shaft has an annular groove d^{32}, into which segmental splines e' e' are adapted to enter, the shaft E being provided with slots at opposite sides to receive the splines, which are inserted after the thrust-screw shaft d^3 has been inserted in the socket of the shaft E. These splines enable the screw-shaft d^3 to pull down the shaft E as well as to thrust it upward. The splines may be secured in place by any convenient means, though they are not liable to escape after the parts are entirely assembled, being retained by the sleeve A^4. Above the bearing provided at B' in the table B for the shaft E said shaft is reduced and squared at the portion E^2, and in the form illustrated is also slightly tapered and receives the hollow mandrel G, which in cross-section and axial section corresponds to the form of the spring to be coiled, said spring being square with a slight taper or gradual reduction of the coil from the bottom toward the top. It will be understood that as to the form, both in axial and transverse section, the mandrel and the reduced portion of the shaft on which it is mounted will be subject to modification, according to the form of the spring to be produced.

H H H H are hammers or dies mounted on carriages H' H', &c., which are carried upon the upper ends of links H^2 and levers H^3, respectively, which are fulcrumed in suitable lugs B^2 B^2, &c., and B^3 B^3, &c., respectively, on the table B, these lugs projecting from the under surface of the table and the table being apertured to permit the links and levers H^2 and H^3 to protrude upward through the table.

K is a cam rigid with the shaft E and having as many faces as there are hammers or dies and sides of the springs, which, in the present drawings, are four. The four levers H^3 H^3, &c., extend down to the horizontal plane of this cam, and at their lower ends are provided with rolls b^3, which bear against the cam-surface and adapt the cam to actuate the levers outward, according to the shape of the cam. The springs B^{30} B^{30} seat between the lugs b^{30} b^{30} and the bosses b^{31} b^{31}, respectively, on the under side of the table B, and by their reaction from compression tend to hold the rolls b^3 at the lower end of the levers H^3 against the cams, and to cause them, therefore, to follow the contour of the cam as the latter revolves. The cam-faces are shaped so as to give the carriages H' a reciprocating motion, which will be presently further explained in detail. The carriages are positively guided in this reciprocating motion between the parallel edges of the quadrant caps L L L l, (the last of which differs from the other three in a respect hereinafter explained,) which are mounted upon the top of the table B.

The ends of the hammers H H H H may be provided with a groove corresponding to the form of the rod which is being coiled, or they may be flat, as preferred. If they have grooves, it is evident that the four sides of a coil of the square spring in the process of formation must not be all at the same level, but must have the inclination and be respectively set at the level of the side of the coil which is to be struck or pressed. The carriages may, however, be made identical in form and level, the hammers being adjusted on them, as the case may require, according to the pitch of the spring. As illustrated, opposite hammers are made alike, but with the groove in such relation to the plane of the seat h', provided for the hammer on the carriage, that by mounting the hammers in reverse positions on the opposite carriages, respectively, the level of the grooves is made to differ, as required, by the pitch of the spring. Ordinarily, hammers may be adjusted by thin washers interposed between them and their seats on the carriages, and, in fact, ordinary flat-headed hammers requiring no adjustment but only sufficient breadth to cover all ordinary ranges of pitch of the spring serve every purpose.

The rod or wire to be coiled is gripped to the mandrel in a manner which will now be described. The end of the rod is given a right-angle bend, which constitutes the first angular bend of the spring and adapts the rod to be applied to one end of the mandrel. The side of the mandrel against which the offset end is lodged has a notch G', and the mandrel extends above the shaft E the full extent of the depth of this notch. Grip-tongs are made, as shown in Fig. 5, whose jaws M M' are adapted to grip between them the rod thus coiled, the jaws coming to a feather-edge at a plane which exposes the surface of the rod, as seen at m in Fig. 5. The jaws are crossed and pivoted together by the pintle M^2, which projects at both sides, the distance between the projecting pintle and the rod which is grasped between the jaws being equal to the thickness of the wall of the mandrel, and the handles M^3 M^3 are bent up near enough to the pintle so that the heel m^3 is within the mandrel, being above the squared end of the shaft G. Suitable means, such as the link M^4, being provided to secure the upper ends of the handles together, making the jaws grip tightly the bent end of the rod, the tongs thus gripping the rod are inserted in the square opening of the upper end of the mandrel, the rod passing outside and the pintle passing inside of the notched side of the mandrel, the jaws lodging in the notch G' and the handles extending upward above the square opening, as described. The rod thus runs in against one face of the mandrel adjacent to the notched face, and in order to hold it firmly, so that the rotation of the mandrel will bend it around the next angle, a guide and check roller N is provided journaled on a stem N', which is secured upon the top of one of the quadrant caps l. This roller has a flange N^2 at its upper edge, which overhangs the rod as it runs into the mandrel, and it will be set so that its groove and flange together properly guide the rod to the mandrel, the rod being supported on the under side, if necessary, by an eccentric cam N^6 on a shaft n', mounted in the lugs l' on the under side of the top web of the quadrant l and adapted to be adjusted by a key or handle at the end which protrudes through the vertical wall or standard l^{10} of said quadrant-cap. The rod being secured to the mandrel, as described, and the machine put in operation, the mandrel revolving continuously folds the rod around it, and during each quarter-turn the hammers are given one reciprocation by the cam K, assisted by the retracting-springs B^{30}, the cam being so set on its shaft with its faces so related to the faces of the mandrel that the hammers are each driven to the innermost limit of their stroke at the instant that the faces of the mandrel respectively are parallel with the heads of the hammers, or, in the structure shown, at right angles with the stroke of the hammers. The cam-faces are so shaped that immediately after giving the full pressure to the rod at said inner limit of the stroke of the hammers the latter are quickly withdrawn, so that the mandrel, revolving continuously, is not especially impeded by the presence of the hammers, notwithstanding that the latter are all at the same instant giving their utmost pressure to the four sides of the coil on the mandrel, and are theoretically, therefore, holding the mandrel at absolute rest for that instant. In order that the strokes or pressure of the hammer on the two sides about which the wire is folded at the commencement of the operation may be compensated by the strokes or pressure of the hammers on the opposite sides, respectively, before the wire has folded about said opposite sides, I prefer to interpose any convenient filling-piece to take the place of the wire on the two vacant sides and receive the strokes of the hammers on those sides. In Fig. 6 I have represented a corner-block P, which serves this purpose. The mode of its use will be obvious from its form and the representation of its use in Fig. 5. It is merely placed upon the upper end of the mandrel during the first rotation, and may be removed after one complete coil has been wound about all four sides of the mandrel. While the mandrel is thus revolving, it is also being thrust endwise by the thrust-screw d^3, operated by the train above described, the train being so constructed with respect to the rotary speed of the mandrel that the endwise thrust of the latter corresponds to the pitch of the spring to be coiled, carrying up in each rotation the end of the rod, which is gripped to the mandrel, and all coils already formed the distance from center to center of successive coils.

When the spring to be coiled is tapering and requires a tapering mandrel, as shown, no other means for depressing the pitch of the spring is necessary beside the means for determining the endwise thrust of the mandrel. This thrust may be varied by substituting gears of different sizes for the gear D', the intermediate gear D^2 having its bearings suitably adjusted in the slot d^2, provided for that purpose in the frame D, according to a method familiar in change-speed gear-trains. The relative position vertically of the four hammers will be adjusted according to the pitch determined by the change-gear train. No particular means of adjustment is shown and any suitable means may be employed, the mere blocking up of the hammers different distances on the carriages being an obvious and usually satisfactory one. As the tapering mandrel advances upwardly, the limit of the upward stroke of the hammers must be varied accordingly, and for this purpose the cam has vertical taper corresponding to that of the mandrel, but in the reverse direction—that is, narrowing downward—whereas the mandrel narrows upward, as is necessary because the levers H^3, whose upper ends carry the hammers inward, are actuated outward at their lower ends by the cams to produce the inward movement of the hammers.

The shape of the cam-faces may in general be such as to produce a simple reciprocating motion of the hammers—that is to say, there must be an eccentric portion to force the lower ends of the levers outward as the cam revolves, and another eccentric portion to permit the levers to return inward as the rotation continues, such portions alternating throughout the entire circuit of the cam. In detail, however, it is desirable that the outward movement, which gives the inward working movement to the hammers, shall, at least at the inward limit of the hammer's stroke, be sufficiently gradual to be as powerful as possible, and it is more especially necessary that the portion which corresponds to and permits the retreating movement of the hammers shall be as abrupt as possible, so that the hammers may withdraw from the mandrel as promptly as possible when the work of their stroke is done. A further feature in this cam is that intermediate of the two eccentric portions, one of which gives the inward thrust and the other of which permits the retreating movement of the hammers, I have located a non-eccentric portion—that is, a portion which does not give or permit any movement to the hammers while said portion is passing the end of the lever. The purpose of this construction is that whereas, at the completion of the hammer's working stroke, the incoming rod is continuous with the last-laid side of the last coil of the spring, and that thereafter immediately, as the mandrel's rotation continues, a new bend has to be made in the wire around the angle of the mandrel. The severest strain in such bending is experienced just after the bending commences and during the next sixty degrees of rotation of the mandrel, the point at which the wire is held against the guide-pulley being so related to to the advancing corner of the mandrel around which the coil is being made that the strain becomes easier as the mandrel revolves through the remaining thirty degrees, which will bring the next corner of the mandrel to the rod. In order to equalize the work of the machine throughout the entire action, therefore, I give the cam the concentric portion k^2, occupying from thirty to forty-five degrees, which will be in contact with the levers H^3 while the mandrel is making the part of its rotation, which involves the severest work, as above stated, and after that severest work is passed the cams begin to do their work of moving the hammers inward. Each face of the cam, therefore, has three portions; k', eccentric in a direction to force the lower ends of the levers H^3 outward; k^2, concentric and adapted to do no work upon the levers, and a portion k^3, abruptly eccentric in a direction to permit the lower ends of the levers to return inward in obedience to the springs B^{30}.

If the spring to be coiled were to be without taper longitudinally and would require a straight mandrel instead of the tapering mandrel shown, it would not in all cases be safe to rely upon the endwise thrust of the mandrel to determine the pitch, because after several coils were wound the grip of the coils upon the straight mandrel might not be sufficient to produce the initial flexure of the rod at the point where it runs from the guide-roll. I prefer, therefore, to provide means for determining the pitch independent of and supplemental to the thrust of the mandrel. For this purpose the bracket or arm N', in which the flanged roller N^2 is journaled, is secured to the top web of the quadrant-table l by a screw n^2, which is inserted through the bracket-arm and screwed into the table, and another screw n^3, inserted through the tail of the arm, impinges against the top of the table and is adapted to be protruded more or less through the said arm. It will be understood that the corner n^4 of the bracket, or any suitable point beyond the screw n^2 toward the roller N^2, bearing upon the top of the table, the adjustment of the two screws n^2 and n^3 will control the angle at which the wheel N^2 stands and the lead of the rod or wire as it enters the rod or mandrel, and thereby will control the pitch of the spiral which is wound by the rotation of the mandrel. I do not limit myself to this particular mode of adjusting the pitch or tilt of the roller, and many other simple modes will be suggested to any mechanic, but I claim the adjustability of the pitch of the roller, by whatever means obtained, as the means for determining the pitch of the spring. It will be understood that the thrust of the mandrel should be made to correspond with the adjustment of the roller—that is, to produce the same pitch.

I have used the word "hammer" in the foregoing description to identify the plungers or pressure-dies which operate upon the wire or rod to force it against the mandrel; but it will be observed that the action is not necessarily a blow, as distinguished from a pressure, and the word "hammer" in the foregoing description and in my claims I do not design to have understood in any sense so limited as not to include parts which operate by pressure, as distinguished from a blow, since, in fact, the former is the mode of action of the said devices, herein called "hammers."

I claim—

1. In a machine for coiling angular springs, in combination with an angular mandrel and means for rotating the mandrel to fold the wire or rod about the angles thereof successively; a hammer and mechanism for driving it against the wire or rod between the consecutive angles of the mandrel and for withdrawing the hammer from the wire, said mechanism being timed to cause the hammer to act upon and withdraw from the wire between the times of folding the latter about said consecutive angles and to remain so withdrawn during the folding; substantially as set forth.

2. In a machine for coiling angular springs, in combination with an angular mandrel and means for rotating it to coil the wire or rod thereabout, two or more hammers adapted to be driven against the wire or rod on the mandrel, mechanism for driving them being so timed to act against adjacent sides simultaneously: substantially as set forth.

3. In a machine for coiling angular springs, in combination with the angular mandrel and means for holding the wire or rod to be coiled thereto, means for rotating the mandrel to fold the wire or rod about its angles successively; a hammer adapted to be driven against the rod or wire on the mandrel, and mechanism for so driving it timed with respect to the rotary motion of the mandrel to bring the hammer home on the wire or rod at the instant when the mandrel-face is parallel with the hammer-head: substantially as set forth.

4. In a machine for coiling angular springs, in combination with an angular mandrel and means for holding the wire or rod to be coiled thereto, and means for rotating the mandrel to fold the wire or rod about its angles successively, and means for advancing the mandrel longitudinally simultaneously with such rotation; a hammer and mechanism adapted to drive it against the wire or rod on the mandrel, timed with respect to the rotary motion of the latter to bring the hammer-head against the wire between the times of folding said consecutive angles: substantially as set forth.

5. In a machine for coiling angular springs,

in combination with the angular mandrel and means for holding the wire or rod thereto, means for rotating the mandrel to fold the wire or rod about its angles successively; a plurality of hammers and mechanism for driving them toward the mandrel from different directions, one of said hammers being located and adapted to act against the wire between the last angle folded and the incoming wire, and the remaining hammers being located and adapted to act on the wire between the folded angles; whereby each angle is set by one hammer before the next angle is folded, and subsequently further set by successive blows of the other hammers: substantially as set forth.

6. In a machine for coiling angular springs, in combination with a mandrel and means for rotating it to coil the wire thereabout, hammers adapted to be advanced toward the several faces of the mandrel, the mechanism for so advancing it being timed so that opposite hammers make simultaneously strokes, whereby the mandrel is relieved from sideward pressure on account of the pressure of the hammers: substantially as set forth.

7. In a machine for coiling angular springs, in combination with the mandrel, means for gripping the wire thereto, and means for rotating the mandrel to coil the wire thereabout, and hammers adapted to be advanced from opposite directions toward the mandrel, means for so advancing them timed to make the action of opposite hammers on the wire simultaneous: substantially as set forth.

8. In a machine for coiling spirals, a mandrel and means for holding the wire or rod to be coiled thereto, means for rotating the mandrel, in combination with mechanism for giving the mandrel positive longitudinal thrust simultaneously with its rotation, mechanism for varying said rotary and endwise movements of the mandrel with respect to each other at will, to determine the pitch of the spiral: substantially as set forth.

9. In a machine for coiling angular springs, in combination with an angular mandrel, means for rotating it and means for thrusting it endwise, said means for producing said two movements of the mandrel being variable with respect to each other at will; means for gripping the rod to be coiled to the mandrel, a hammer adapted to be advanced against the rod on the several faces of the mandrel, to fix the angles of the coils: substantially as and for the purpose set forth.

10. In a machine for coiling springs, a vertical mandrel and means for holding the wire or rod to be coiled thereto, and means for rotating the mandrel, in combination with a fixed guide for the wire or rod to be coiled, and mechanism for giving the mandrel positive endwise thrust during its rotation: substantially as set forth.

11. In a machine for coiling springs, a vertical mandrel and means for rotating it, and means for holding the wire or rod to be coiled thereto; whereby its rotation effects the coiling, and an adjustably-fixed guide for the rod to be coiled, whereby its lead onto the mandrel is determined: substantially as and for the purpose set forth.

12. In a machine for coiling angular springs, in combination with the mandrel, the shaft by which it is carried and rotated, hammers suitably supported and guided to have movement toward and from the mandrel, a cam-wheel rotated by the mandrel-shaft having cam-sections corresponding in number to the mandrel-faces and hammers, the levers fulcrumed on the frame connected to the hammers respectively and exposed to the action of the cam-wheel, said cam-wheel being constructed and adapted in its several parts to advance the hammers toward the mandrel simultaneously: substantially as set forth.

13. In a machine for coiling angular springs, in combination with a tapered mandrel, means for rotating it and means for thrusting it longitudinally; hammers adapted to be advanced toward it to set the angles of the spring coiled thereon, the cam which actuates said hammers carried by the mandrel-shaft in its longitudinal movement and tapered correspondingly to the mandrel: substantially as set forth.

14. In a machine for coiling springs, the mandrel having the notch G′ and a recess in its upper end, in combination with the tongs having their jaws adapted to lodge in the notch and protrude therefrom laterally and grip the wire lying on the outer surface of the mandrel, the pintle of the tongs projecting at both sides and adapted to engage behind the mandrel-wall, whereby said wall is embraced between the pintle on the inner side thereof and the rod or wire of the spring on the outer side; the handles of said tongs extending upward from the pintle within the horizontal compass of the mandrel: substantially as set forth.

15. In a machine for coiling springs, the base A and the sleeve-hanger A^4, rigid therewith and extending downwardly therefrom, and the gear-frame D secured to the lower end of the hanger, the vertical shaft E journaled at the center of the base, the gear E′ feathered on said shaft and journaled in the base, the shaft c' journaled in the base and in the gear-frame D, a pinion on said shaft which drives the gear E′, and a gear on the same shaft which drives the train on the gear-frame D, said train terminating in the gear D^3; the screw-shaft d^3 screwed through the hub of said gear and having swivel connection with the shaft E, whereby a rotary movement and an endwise-thrusting movement are communicated to said shaft E′: substantially as set forth.

16. In combination substantially as set forth, the base A, the gear E′ above the base having its hub journaled in said base and the collar E^{11} secured to the hub below the base, the sleeve-hanger A^4 flanged at the upper end

and provided with a cavity to accommodate the collar, and bolted to the base beyond the collar; the shaft E, feathered to the gear E' and journaled in the sleeve-hanger; the gear-bracket D secured to the lower end of the hanger and the train thereon adapted to give the shaft an endwise thrust: substantially as set forth.

17. In combination substantially as set forth, the shaft E and the sleeve-hanger A^4, in which the shaft is journaled, the screw-shaft d^3 and the gear screwed onto it and adapted by rotating to drive it endwise, the upper end of said screw-shaft being swiveled to the end of the shaft G, and provided with the lugs d^{31}, the sleeve-hanger having grooves a^4 adapted to receive said lugs to prevent the screw-shaft from rotating while it is thrust endwise: substantially as set forth.

18. In combination substantially as set forth, the screw-shaft d^3, the shaft E and its bearings; the screw-shaft being inserted in a socket at the lower end of the shaft E and provided with an annular groove within said socket, and splines e' inserted laterally in the shaft E and entering said groove.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 27th day of June, 1895.

ARTHUR A. AMBLER.

Witnesses:
G. A. GOETSCH,
CHAS. S. BURTON.