Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 1

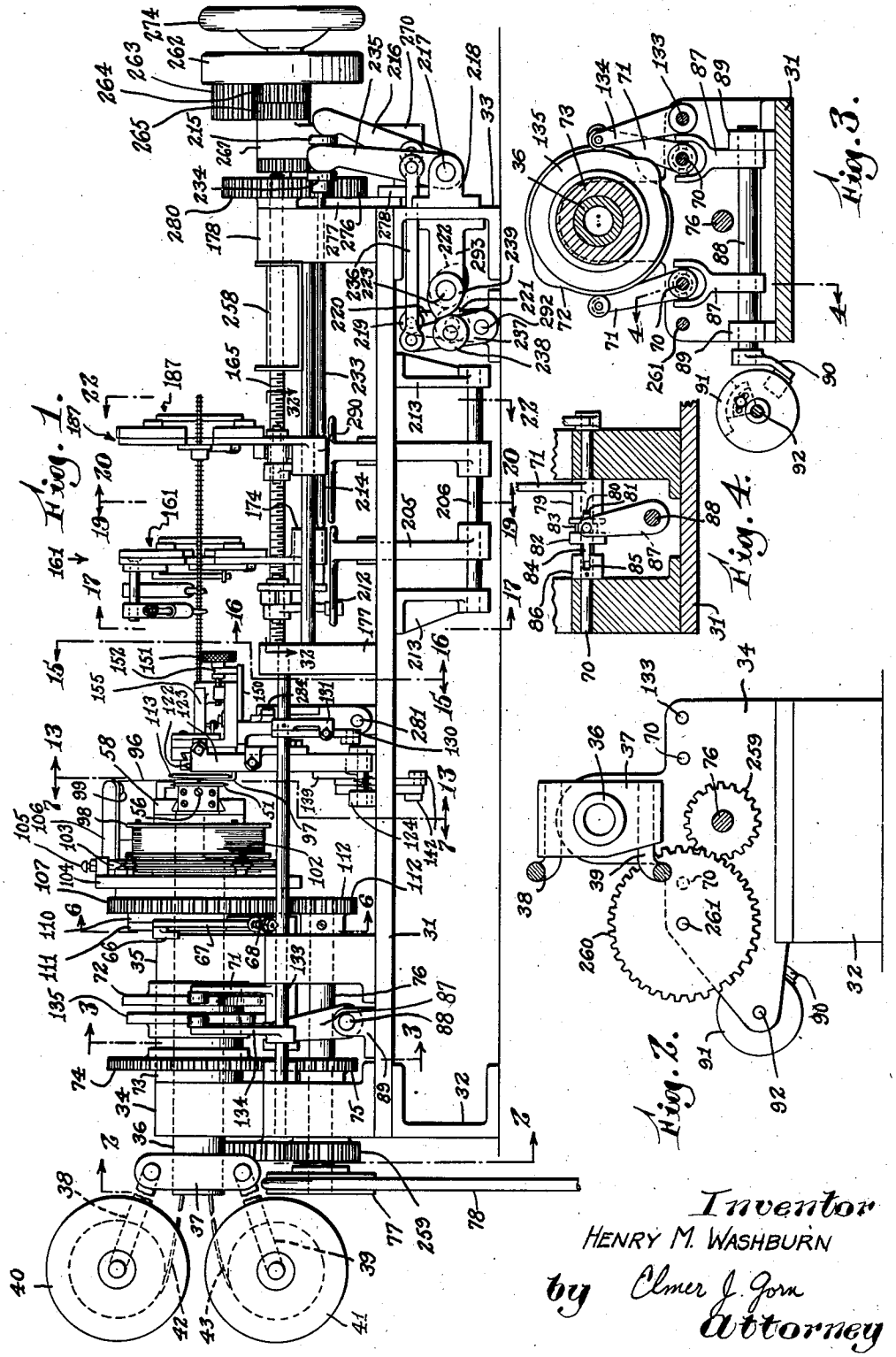


Fig. 1.

Fig. 3.

Fig. 4.

Fig. 2.

Inventor
HENRY M. WASHBURN
by Elmer J. Jorn
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 2

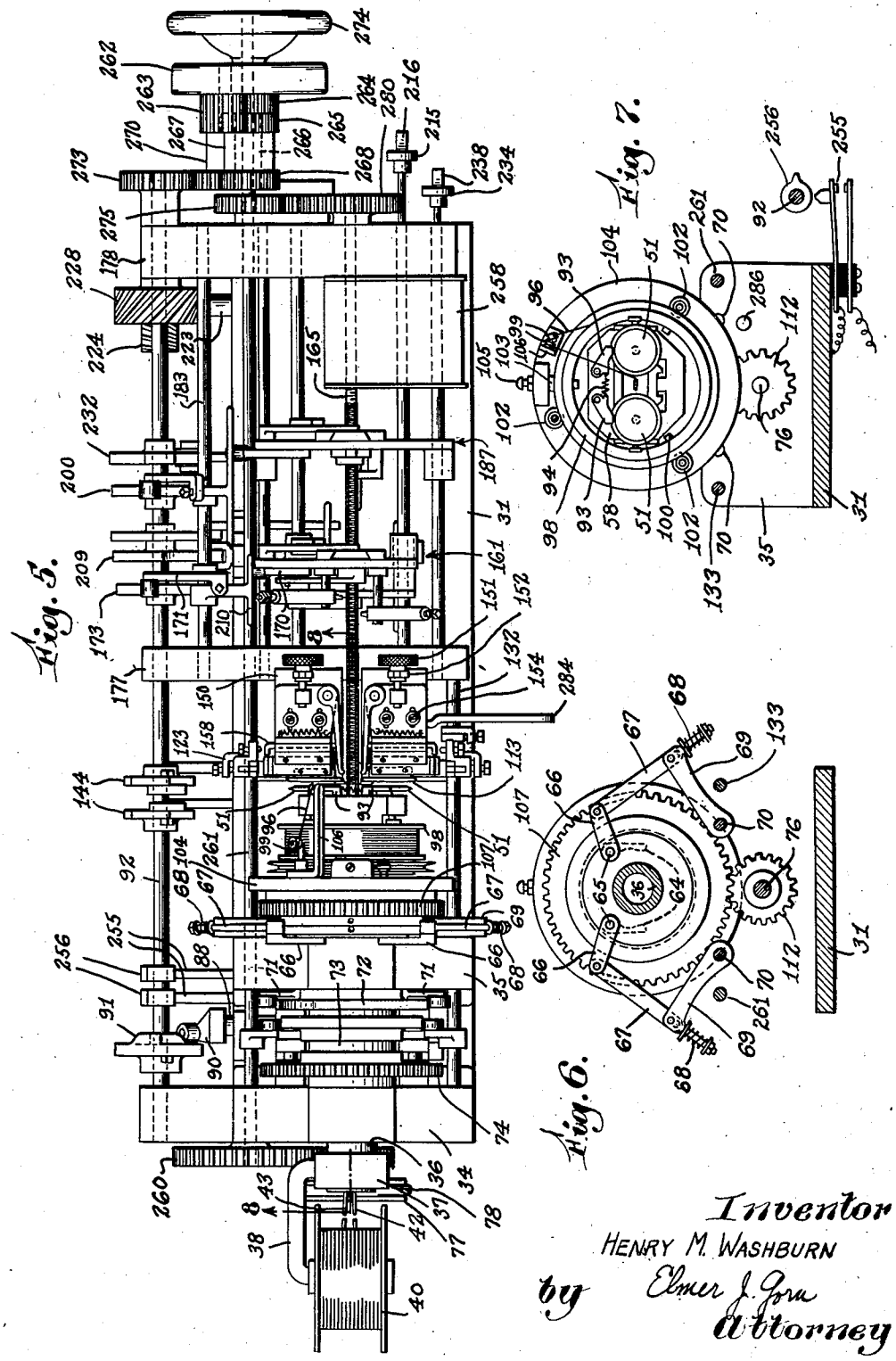


Fig. 5.



Fig. 7.



Fig. 6.

Inventor
HENRY M. WASHBURN
by Elmer J. Fox
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 3

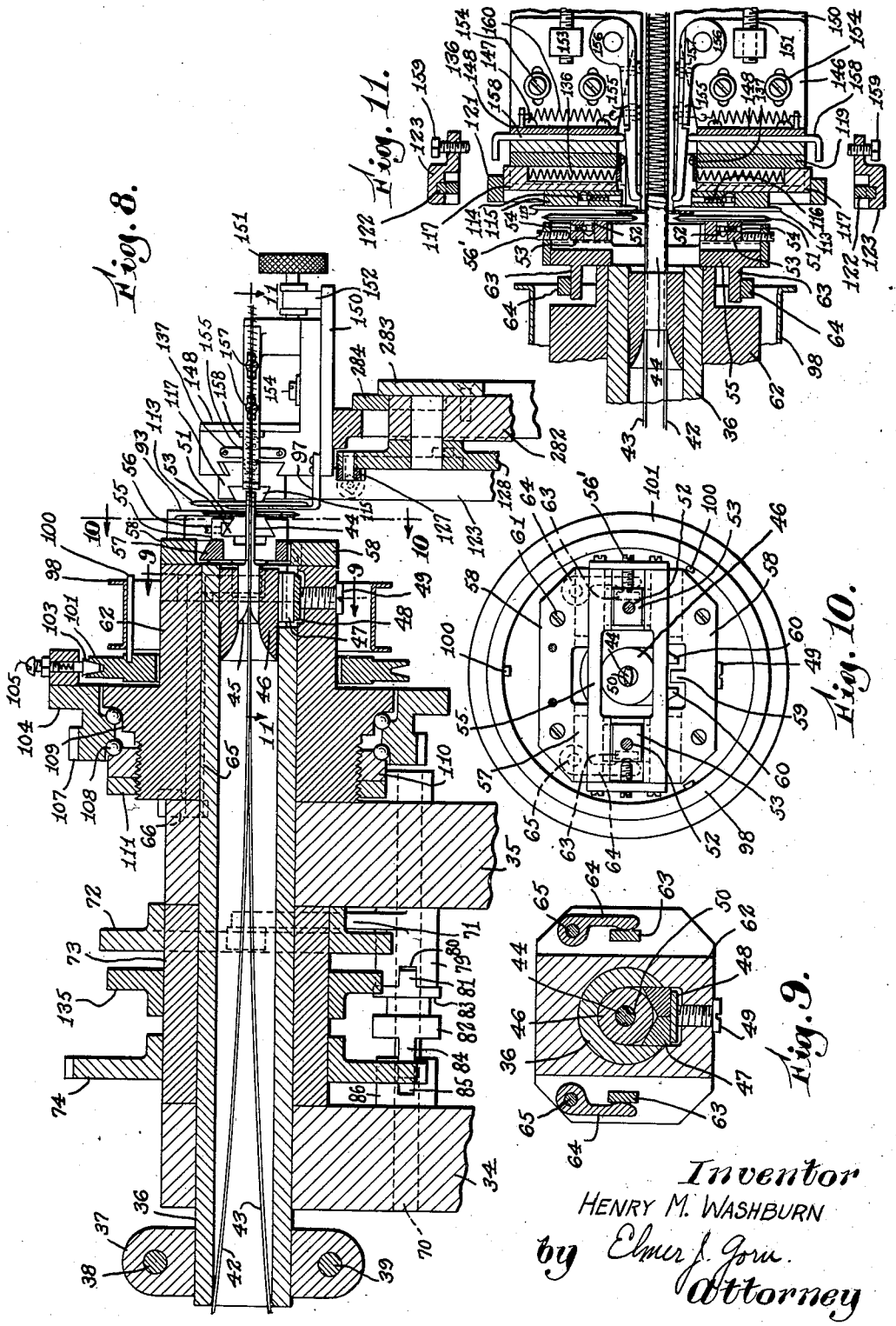


Fig. 8.

Fig. 11.

Fig. 10.

Fig. 9.

Inventor
HENRY M. WASHBURN
by Elmer J. Gorn.
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 4

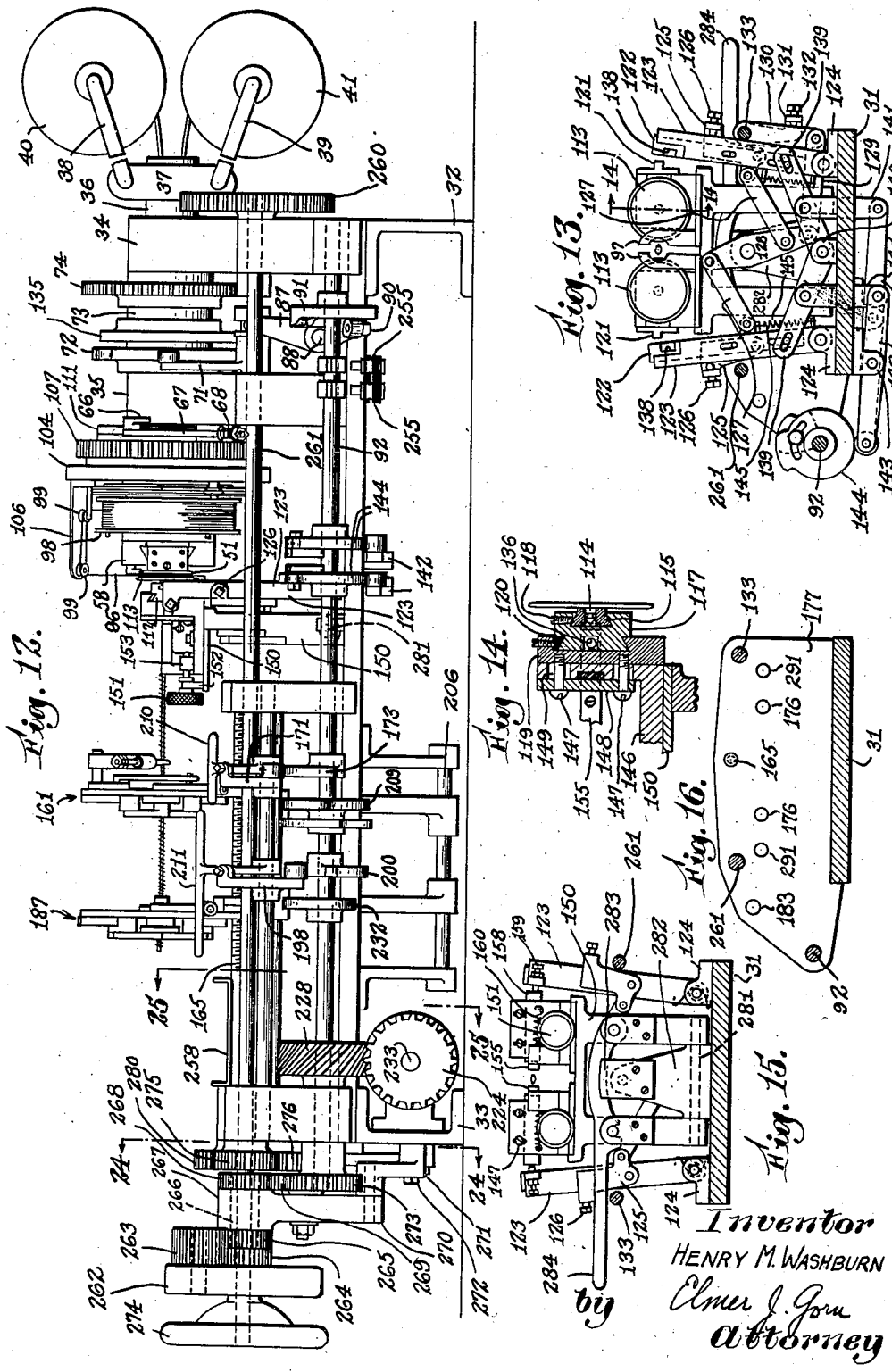


Fig. 12.



Fig. 13.



Fig. 14.



Fig. 16.



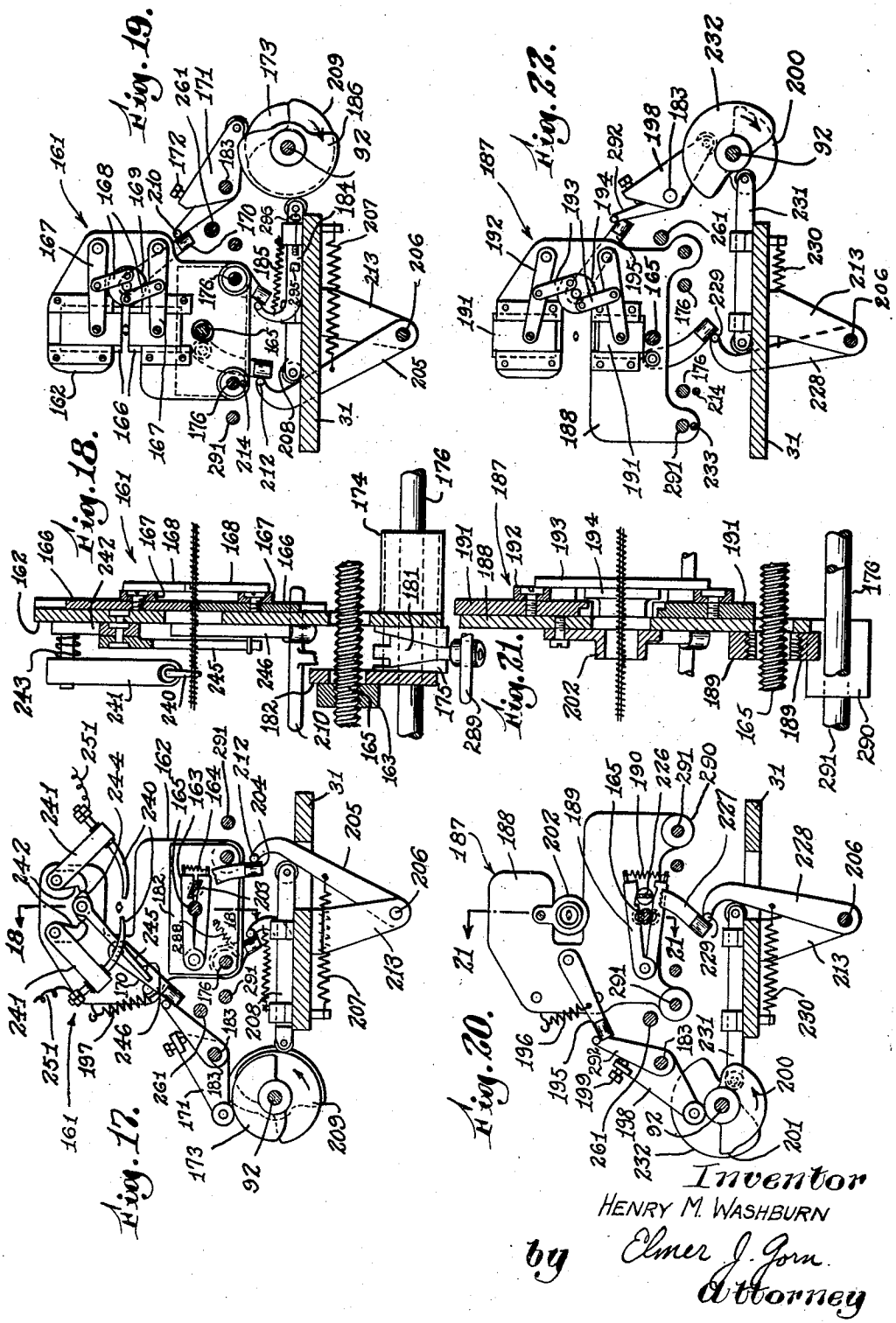
Fig. 15.

Inventor
HENRY M. WASHBURN
by Elmer J. Gorn
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 5

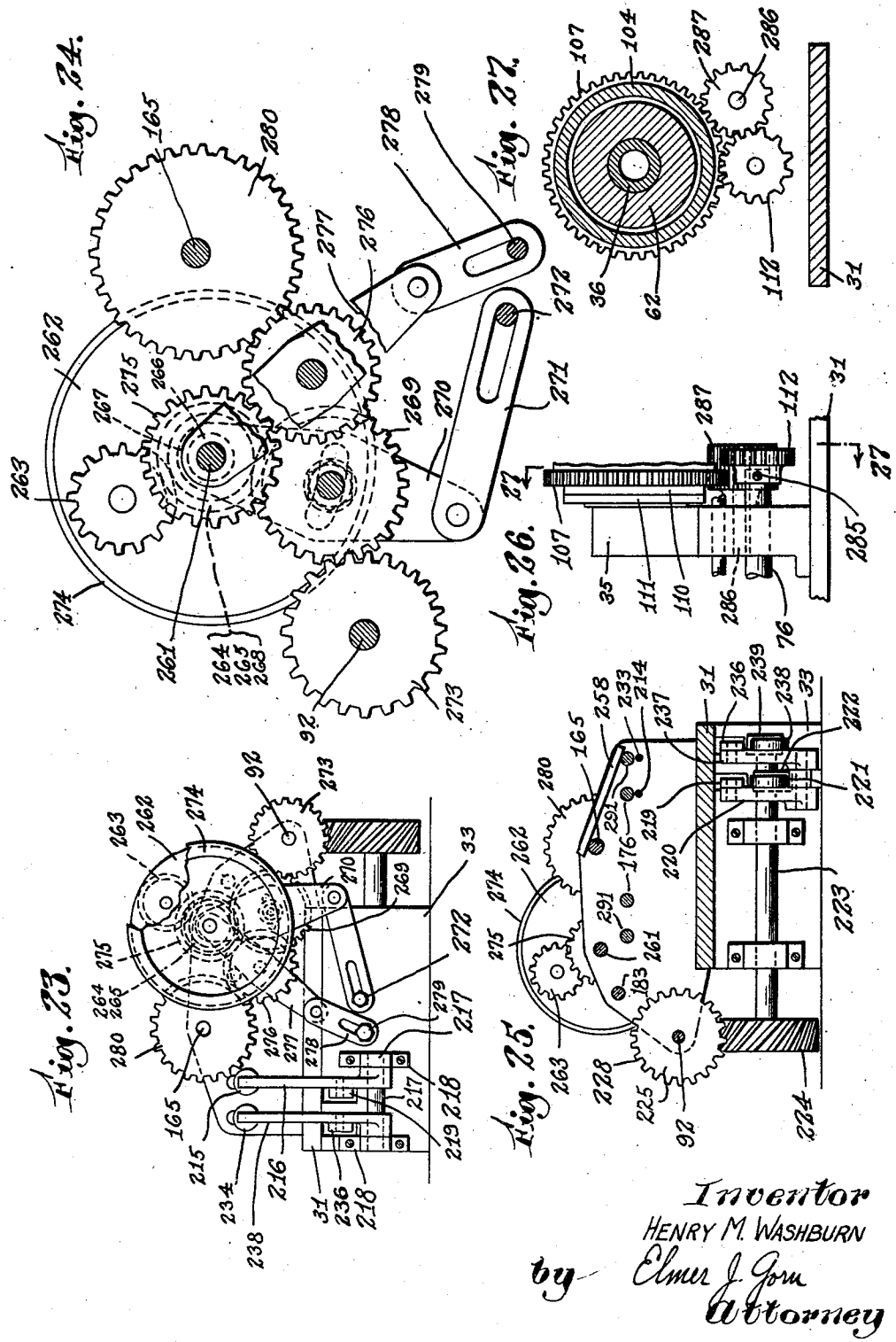



Inventor
HENRY M. WASHBURN
by Elmer J. Gorn
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 6

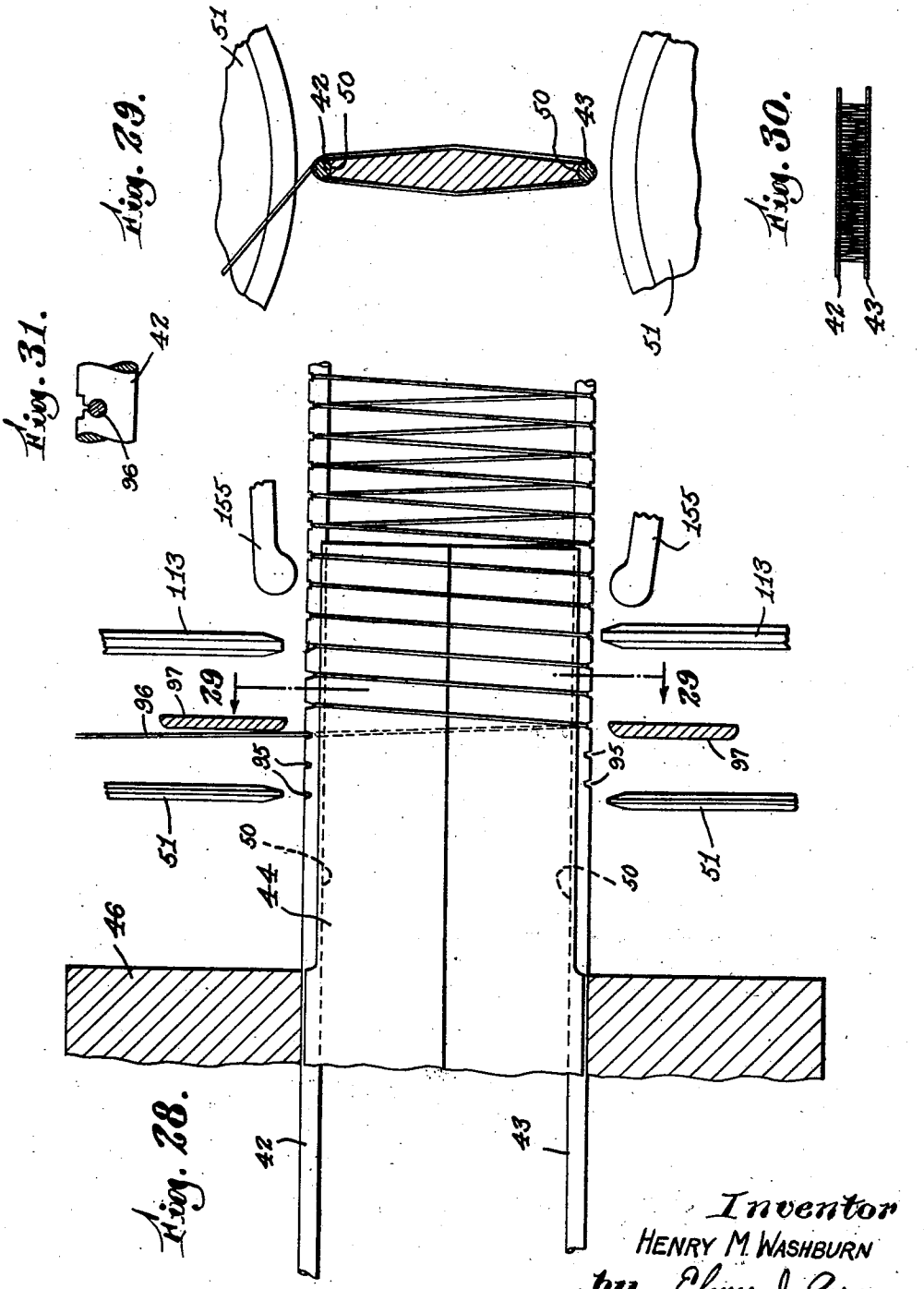



Inventor
HENRY M. WASHBURN
by Elmer J. Gorn
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 7

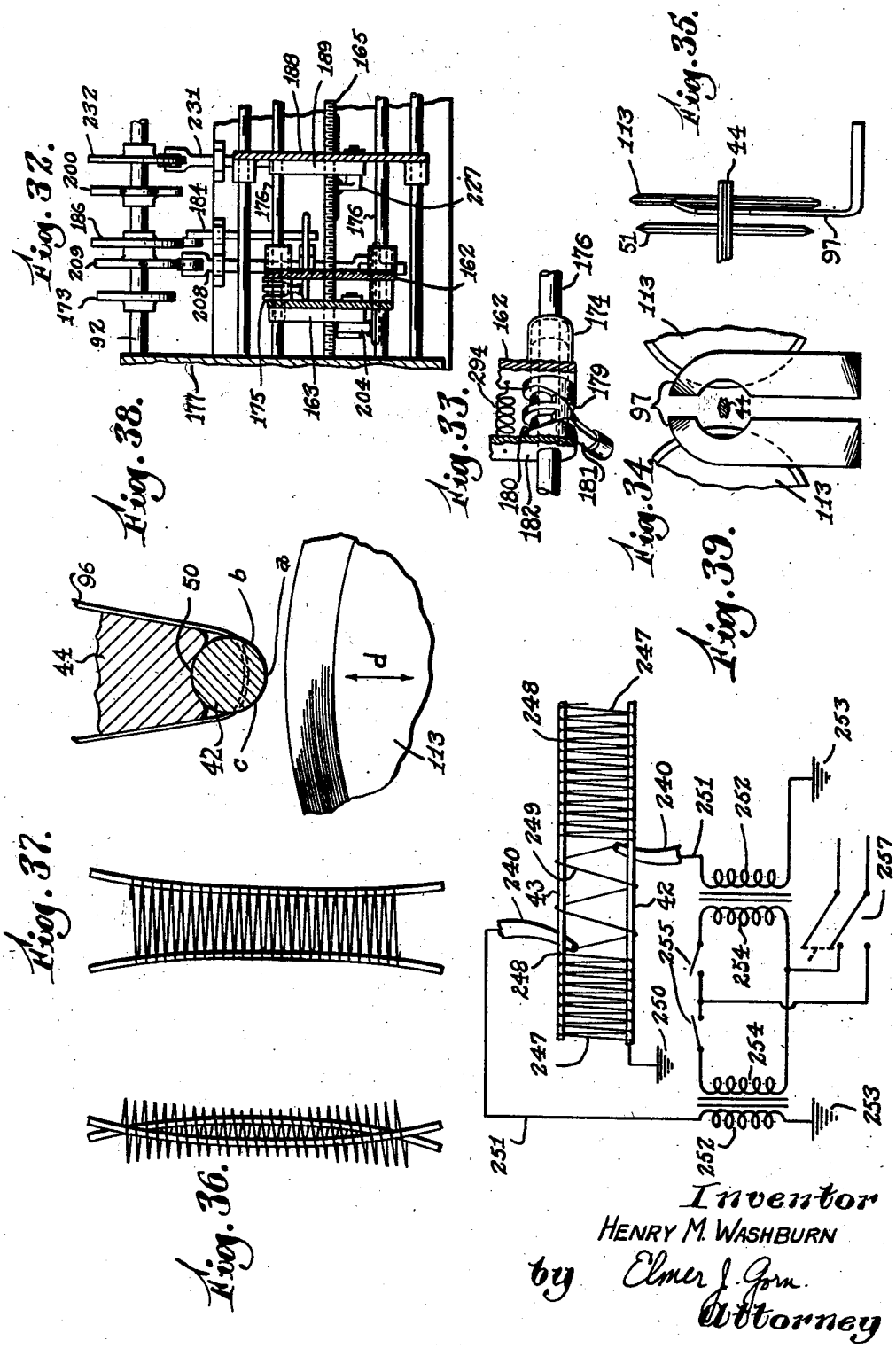



Inventor
HENRY M. WASHBURN
by Elmer J. Gorn.
Attorney

Nov. 28, 1939. H. M. WASHBURN 2,181,288

GRID-MAKING MACHINE

Original Filed Oct. 26, 1936 8 Sheets-Sheet 8




Inventor
HENRY M. WASHBURN
by Elmer J. Gorn.
Attorney

Patented Nov. 28, 1939 2,181,288

# UNITED STATES PATENT OFFICE

2,181,288

## GRID-MAKING MACHINE

Henry M. Washburn, Newtonville, Mass., assignor to Raytheon Production Corporation, Newton, Mass., a corporation of Delaware

Application October 26, 1936, Serial No. 107,647
Renewed April 21, 1939

27 Claims. (Cl. 140—71)

This invention relates to a novel grid-making machine adapted for the manufacture of the wound type of grid electrode as used in radio tubes and other types of electrical space discharge devices.

An object of this invention is to devise a machine to produce wound grids in which the side rods are perfectly straight as they come off the machine, and which are ready to be assembled in a tube without further shaping or straightening.

Another object of my invention is to devise such a machine which is fully automatic, and which has a very large rate of output.

Other objects relate to the general improvement of the organization and arrangement of mechanisms of such a grid-making machine, including, among other novel mechanisms, an improved arrangement for feeding the grids through the machine and for severing completed grids, a novel arrangement for changing the driving speed so as to control the pitch and number of turns in the completed grids, a novel arrangement for supporting a rotating wire-carrying spool in dynamic balance, and a novel arrangement for enabling the machine to produce right and left-hand wound grids.

The foregoing and other objects of my invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is a front elevation of the machine;

Fig. 2 is a section along line 2—2 of Fig. 1, showing the drive of the back shaft;

Fig. 3 is a section taken along line 3—3 of Fig. 1, showing the cam mechanism for the cutter knives, swedges, and grid-straightening hammers;

Fig. 4 is a section taken along line 4—4 of Fig. 3, showing the clutch-actuating mechanism for disengaging the cutter mechanism during the movement of the leg portion of the grid past the cutter position;

Fig. 5 is a plan view of the machine;

Fig. 6 is a section taken along line 6—6 of Fig. 1, showing the winding head drive and part of the cutter-actuating mechanism;

Fig. 7 is a section taken along line 7—7 of Fig. 1, showing the face of the winding head and the stripper timing switch;

Fig. 8 is an enlarged section taken along line 8—8 of Fig. 5, showing the construction of the winding head and of the swedge mechanism unit;

Fig. 9 is a section taken along line 9—9 of Fig. 8, showing the cutter-actuating rocker arms and the grid arbor chuck;

Fig. 10 is a section taken along line 10—10 of Fig. 8, showing the face of the winding head;

Fig. 11 is a transverse section taken along line 11—11 of Fig. 8, showing the mechanism involving the cutter knives, the swedges, and the actuating hammers in relation to the grid and its associated arbor;

Fig. 12 is a back elevation of the machine;

Fig. 13 is a section taken along line 13—13 of Fig. 1, showing the swedge mechanism unit;

Fig. 14 is a section taken along line 14—14 of Fig. 13, showing the adjustable swedge support;

Fig. 15 is a section taken along line 15—15 of Fig. 1, showing the lock and release mechanism for moving the swedge mechanism unit out of position for replacement of the winding wire spool;

Fig. 16 is a section taken along line 16—16 of Fig. 1, showing the relationship of the various shafts mounted in the bearing plate at the front end of the pull-out feed unit;

Fig. 17 is an enlarged section taken along line 17—17 of Fig. 1, showing one face of the front pull-out feed carriage carrying the stripper mechanism;

Fig. 18 is a section taken along line 18—18 of Fig. 17, showing further details of the associated mechanism;

Fig. 19 is an enlarged section taken along line 19—19 of Fig. 1, showing the other face of the front pull-out feed carriage;

Fig. 20 is an enlarged section taken along line 20—20 of Fig. 1, showing one face of the back pull-out feed carriage;

Fig. 21 is a section taken along line 21—21 of Fig. 20, showing further details of the associated mechanism;

Fig. 22 is an enlarged section taken along line 22—22 of Fig. 1, showing the other face of the back pull-out carriage;

Fig. 23 is an end view of the machine partly broken away, viewing the machine from the right of Fig. 1;

Fig. 24 is an enlarged section taken along line 24—24 of Fig. 12 showing the epicyclic gear train and its relation to the back shaft, the cam shaft, and the lead screw drive shaft;

Fig. 25 is a section taken along line 25—25 of Fig. 12, showing the mechanism for the return of the front and back pull-out feed carriages;

Fig. 26 is a fragmentary view of the winding head drive gear reversing mechanism;

Fig. 27 is a section taken along line 27—27 of Fig. 26;

Fig. 28 is an enlarged view of the grid arbor and the associated cutters, swedges, and grid-straightening hammers illustrating the formation of the grid;

Fig. 29 is a section along line 29—29 of Fig. 28;

Fig. 30 is a completed grid substantially full size;

Fig. 31 is an enlarged view of a swedged joint between a grid turn and one of the side rods;

Fig. 32 is a plan section on line 32—32 of Fig. 1;

Fig. 33 is a perspective view of the skip mechanism actuated during the winding of the loose turns on the grid;

Fig. 34 is an enlarged view of the winding wire lead-in plates;

Fig. 35 is a side view of the winding wire lead-in plates;

Figs. 36 and 37 are two views of grids illustrating defects which tend to occur in wound grids and which are eliminated by the present machine;

Fig. 38 is an enlarged view showing the relationship between the arbor, one of the side rods of the grid, and its associated swedge; and

Fig. 39 is a wiring diagram of the stripping mechanism.

The usual method of making wound grids at the present time is to cut a series of grooves in a pair of side wires, to wind a winding wire in these grooves, and to swedge the grooves over the winding wire. Grids made on the usual grid-making machine inevitably are produced with distorted side rods so that a subsequent straightening process is necessary. This straightening process usually consists of "hot stretching" the grids by heating the side rods to a relatively high temperature and giving them a slight stretch so as to straighten them out. This hot stretching produces an oxide coating on the grids, and tends to bake other impurities thereon, which oxides and impurities must be removed by hydrogen baking. This is not only expensive but unsatisfactory from various standpoints.

I have found that in machines which operate with relative rotation between the arbor on which the grid is formed and the swedging and cutting members, the side rods are given a twist or bow longitudinally which results in a curve of the side rods out of the plane of the grid, as illustrated in Fig. 36, which shows a completed grid viewed edgewise. I have found that the tendency for this type of distortion can be substantially eliminated by eliminating the relative rotation between the arbor and the cutting and swedging members, and causing the cutting and swedging members to contact with the side rods at the center thereof along the axis of the grid.

The elimination of the tendency to curve out of the plane of the grid still leaves a tendency for the side rods to curve in the plane of the grid, as illustrated in Fig. 37. This is probably due to the stretching of one side of the side rod during the cutting and swedging. I have provided mechanisms whereby this distortion of the side rods is also eliminated.

In the drawings, 31 designates the bed plate of the machine which is supported by the bed plate supports 32 and 33. On the bed plate 31 is mounted the two winding head-supporting standards 34 and 35. In these standards is mounted a support tube 36 which is held stationary with respect to said support standards. On the outer end of the support tube 36 is mounted a support block 37 which carries two brackets 38 and 39. These brackets rotatably carry a pair of reels 40 and 41 from which are fed the side rod wires 42 and 43.

*Arbor structure*

In the inner end of the support tube 36 is mounted the arbor 44 upon which the grid is formed. The arbor 44 has a shank 45 which fits tightly into an adapter 46, whereby the arbor is rigidly carried by said adapter. The arbor and its adapter are clamped in the support tube 36 by a split V-block 47. This split V-block is forced against the adapter 46 by means of a set screw 49 which bears against the V-block base plate 48. The set screw 49 is mounted in the main head 62 which is likewise carried by the support tube 36. The arbor 44 is provided with a pair of side grooves 50 in which the side rod wires 42 and 43 lie and through which they are fed into the grid-forming position. As will be seen from Figs. 8 and 11, the inner ends of the arbor 44 and the arbor shank 45 are tapered so as to facilitate the threading of the side rod wires 42 and 43 into the grooves 50. The arbor 44 is slightly tapered so as to decrease in thickness toward its outer end. Since the minor diameter of the grid which is formed depends upon the thickness of the arbor in the grid-forming position, very fine adjustments in the exact diameter of the grid can be secured by moving the arbor longitudinally in the support tube 36. The clamping arrangement afforded by the members 47, 48 and 49 permit this adjustment to be made. Of course it is to be understood that the substantial size of the grid is determined in each case by the size of the arbor which is readily removable from the support tube 36 so that various sizes of arbors can readily be used.

*Cutter mechanism*

Mounted at the sides of the arbor 44 are the two cutters 51. The cutters are carried by hubs 52 which are received in hub blocks 53. The hubs 52 and consequently the cutters 51 are rotatably retained in the hub blocks 53 by means of a ball-bearing backed by a spring and plug, as indicated at 54. The cutter hub blocks 53 are slidably mounted in the cutter slide carriage 55, whereby their position in said cutter slide carriage can be adjusted. The cutters are affixed in their adjusted position by means of set screws 56'. The cutter slide carriage is slidably supported in the main head 62 by means of gibs 57 retained in place against the front face of the main head 62 by means of cover blocks 58. In order to limit the motion of the cutter slide carriage 55, this carriage is provided with a pair of stops 60 between which is arranged a stop 59 which is formed as part of the lower cover block 58. The cover blocks 58 are retained in place on the main head 62 by means of screws 61.

Due to the above support arrangement, the two cutters 51 are adapted to slide as a unit back and forth in the plane of the grid, that is, in the plane in which the grooves 50 lie. In order to reciprocate the cutters 51, a pair of rocker arms 64 push against two projections 63 formed on the back of the cutter slide carriage 55. The rocker arms 64 are mounted on the ends of two rocker arm shafts 65, which in turn are rotatably mounted in the main head 62. The rocker arm shafts 65 project through the main head 62, and carry at the opposite ends thereof the two back

rocker arms 66. As shown in Fig. 6, each back rocker arm 66 has pivoted to the outer end thereof a rocker arm link 67. To the opposite end of each link 67 is pivoted a link-actuating arm 69 connected to the link 67 by a slot-and-pin arrangement. In order to maintain the pin of each link-actuating arm 69 in the forward position, a takeup spring 68 is provided on each rocker arm link 67. Each link-actuating arm 69 is mounted on a cutter-actuating shaft 70. As shown in Fig. 3, each cutter-actuating shaft 70 is driven by means of a cutter-actuating arm 71 mounted thereon. Each cutter actuating arm 71 drives its respective cutter-actuating shaft through an intermittent clutch mechanism, which will be described below. The cutter-actuating arms 71 are in turn driven by a cutter-actuating cam 72, as shown in Fig. 3. The cutter-actuating cam 72 is rigidly carried by a cam-bearing sleeve 73 onto which it is pressed tight. The cam-bearing sleeve 73 is rotatably mounted on the support tube 36. In order to drive the cutter-actuating cam 72, the cam-bearing sleeve has also pressed thereon a cam drive gear 74. As shown in Fig. 1, the gear 74 is in turn driven by a gear 75 which is mounted on the drive shaft 76 journaled in the support standards 34 and 35. The drive shaft 76 is driven from some suitable source of motive power through a drive pulley 77 and drive belt 78.

Upon rotation of the drive shaft 76, the cutter-actuating cam 72 is rotated through the gears 75 and 74, respectively. The cam 72 is provided at diametrically opposite points with a projection and a depression. Therefore, upon rotation of the cam 72, the cutter-actuating arms 71 are rocked back and forth once during each complete revolution of the cam 72. This in turn oscillates the slide carriage rocker arms 64 through the intermediary of the linkage, as shown on Fig. 6. The oscillation of the rocker arms 64 acting upon the projections 63 likewise oscillates the cutter slide carriage 55 carrying the cutters 51. Since the rocker arm links 67 are driven by the link-actuating arms 69 through the intermediary of the takeup springs 68, any tendency of the cam 72 to over-drive the slide carriage is taken up by the pin-and-slot connection between the link-actuating arms 69 and the rocker arm links 67. This takeup is necessary since the travel of the cutter slide carriage 55 is limited by the stops 59 and 60. Upon the reciprocation of the cutters 51, as described above, the cutters will cut notches 95 in the two side wires 42 and 43, as illustrated clearly in Fig. 28.

In order to compensate for different widths of arbors and to adjust for different depths of notches 95, the set screws 56 may be released and the position of the cutter hub blocks 53 adjusted by means of adjusting screws 56', illustrated in Figs. 10 and 11. The cutters are then retained in their adjusted position by tightening down on the set screws 56.

Each grid which is formed contains a definite number of turns of wire which is rigidly connected by a swedging operation to the side wires 42 and 43. After the winding of a grid has been completed, it is desirable that a few loose turns be wound around the side wires 42 and 43 before the succeeding grid is formed. The portion of the grid upon which these loose turns are wound is called the "leg" portion. During the travel of the leg portion of the grid past the cutters, it is desirable that the cutters shall be idle. In order to accomplish this I have provided the cutters with an intermittent drive mechanism, which includes the clutch arrangement between the cutter-actuating arm 71 and the cutter-actuating shaft 70, as mentioned above. This clutch arrangement is shown most clearly in Figs. 3 and 4. Each cutter-actuating arm 71 is mounted upon a hub 79, which in turn is provided with a recess 80 into which a tongue 81 of the sleeve 82 is adapted to be received. The sleeve 82 is rotatably mounted on the cutter-actuating shaft 70, and is driven therefrom by means of a sleeve 86 pinned onto the shaft 70. The sleeve 82 is provided with an elongated tongue 84 which fits into an elongated slot 85 in the sleeve 86. By shifting the sleeve 82 to the left in Fig. 4, the tongue 81 may be moved out of the recess 80, thus disconnecting the shaft 70 from the cutter-actuating arm 71. In order to accomplish the shifting of the sleeve 82, it is provided with a circumferential groove 83 into which fit a pair of pins carried by a clutch throw-out lever arm 87 carried by the cross-shaft 88. This cross-shaft is mounted in bearings 89 carried by the base plate 31. The cross-shaft 88 is rocked by means of a cam arm 90 cooperating with a clutch throw-out cam 91 driven from the main cam shaft 92. The driving mechanism for this cam shaft constitutes a special feature of this invention, and will be described below. As shown most clearly in Fig. 5, the cam 91 is provided with a raised portion which pushes against the arm 90 once during each revolution of the main cam shaft 92, and thus disengages each cutter-actuating shaft 70 from its respective cutter-actuating arm 71. During the time of this disengagement, the cutters are inactive and do not form any notches 95. The cam 91 is so disposed on the main cam shaft 92 that this disengagement occurs during the passage of the leg portion of the grid past the cutters. The cam 91, as indicated in Fig. 3, is adjustable so that the initiation of the inactive period of the cutters and the duration of this inactive period can be varied at will.

In order to avoid excessive wear and replacement of the cutters 51, I provide each cutter in circular form with a continuous cutting edge around its periphery. I also provide means for continuously rotating the cutters so as to provide a new cutting edge to the side wires 42 and 43 for each successive notch 95. As shown in Fig. 7, this mechanism consists of two cutter-rotating fingers 93 which are pivoted at one end to the upper cover block 58 and urged toward the cutters by means of a bias spring 94. Each cutter-rotating finger 93 frictionally bears against the edge of a cutter 51 at a point slightly inside of the center. As the cutters are reciprocated back and forth underneath the fingers 93, a pawl-and-ratchet effect is produced which gives to each cutter 51 a series of thrusts which produces a slight rotation of each cutter between each cutting operation.

*Winding mechanism*

After the notches 95 have been cut into the side rod wires 42 and 43, a winding wire 96 is laid into these notches and wound around the side wires 42 and 43 so as to form the grid. In order to guide the winding wire 96 into the notches 95, I provide two lead-in plates 97 at the proper location adjacent the notches 95, as shown in Fig. 28. These lead-in plates may be conveniently mounted upon the swedge assembly frame 150, as shown, for example, in Fig. 8, and

are disposed around the arbor 44, as shown most clearly in Figs. 34 and 35. The winding wire 96 is fed from a winding wire spool 98 over pulleys 99 carried by a pulley arm 106 mounted on the winding head 104. In order that the winding wire spool 98 be dynamically balanced, it is mounted concentrically with its axis of rotation upon three spool support pins 100 carried in the spool support ring 101, as shown in Fig. 8. The spool support ring is rotatably mounted on three rollers 102 which are received in a peripheral groove around the edge of the spool support ring, as shown in Figs. 7 and 8. The rollers 102 are in turn carried by the winding head 104. In order to place the proper tension upon the winding wire 96 as it is laid into the notches 95, there is provided a spool brake 103 which is likewise carried by the winding head 104. The spool brake engages the peripheral groove in the spool support ring 101. The pressure with which said brake bears upon the spool ring may be adjusted by the spring-and-screw adjustment 105.

In order to drive the winding head 104, there is formed integral therewith a gear 107. The winding head itself is rotatably mounted upon the main head 62 through the intermediary of ball bearings 108. One series of the ball bearings 108 is received in the ball race 109 formed on the main head 62. Another series of the ball bearings 108 is received in a ball race ring 110 which is adjustable along the main head 62. The ball race ring 110 may be locked in position by means of the lock nut 111. The gear 107 is driven by a gear 112 mounted on the drive shaft 76.

Upon rotation of the drive shaft 76, the winding head 104 is driven through the intermediary of the gears 112 and 107. The winding head thereupon carries the pulley arm 106 around so as to wind the winding wire 96 around the side rods 42 and 43 and into the notches 95. The pull exerted by the winding wire 96 upon the winding wire spool 98 causes said winding wire spool, together with the spool support ring, to rotate in the rollers 102. As pointed out above, the proper tension is maintained on the winding wire 96 by means of the brake 103.

Since the winding wire spool 98 is mounted concentrically with its axis of rotation, it is at all times in dynamic balance independent of the amount of wire which it carries. Therefore, winding wire spools having large amounts of wire can be placed upon the machine without any inconvenience whatsoever, and thus decrease the idle time of the machine which arises from the necessity of replenishing the winding wire.

*Swedge mechanism*

After the winding wire 96 is placed in the notches 95, the notches are swedged around the winding wire 96 so as to rigidly fix the winding wire in the side rods 42 and 43. This swedging is illustrated in Figs. 28 and 31. In order to accomplish this swedging, I provide the machine with two swedges 113 on opposite sides of the arbor 44. As shown in Fig. 11, each swedge 113 is carried by a swedge hub 114 which is received in a swedge hub block 115. These swedges are rotatably retained in the swedge hub block 115 by means of an arrangement 116, consisting of a ball bearing backed by a spring and plug. The swedge hub blocks 115 are slidably mounted in the swedge slide blocks 117. By adjusting the position of the swedge hub block 115 in the swedge slide block 117, a coarse adjustment of the depth of the swedging operation is obtained. The swedge hub blocks 115 are retained in their adjusted position by means of set screws 118, as shown in Fig. 14. The swedge slide blocks are in turn slidably mounted in support blocks 119 which in turn are carried by the swedge assembly carriage 146 through an adjustable connection which will be described below. Between the support blocks 119 and the slide blocks 117 is provided an adjustable bearing 120 so that any wear in the bearing is readily compensated for, whereby the swedges are maintained accurately in their desired operating position.

In order to slide the blocks 117 within the support blocks 119 so as to bring the swedges 113 into contact with the side wires 42 and 43, and thus produce the swedging action referred to above, I provide the slide blocks 117 with projections 121, as shown in Figs. 11 and 13. Each swedge is driven by an impact arm 122 which delivers a blow to the projection 121. Each impact arm is mounted upon a carrier arm 123 which in turn is pivoted at its lower end to a block 124 carried by the base plate 31. Pivoted upon each carrier arm 123 is an actuating arm 125 provided with an adjustable driving pin 126 engaging the carrier arm 123. The adjustment afforded by the pin 126 controls the depth of the stroke of the carrier arm 123 which in turn provides for a depth adjustment for each swedge and also for the hammer mechanism which will be described below. The actuating arm 125 has pivoted thereto a link 127 which connects it to an oscillating arm 128 pivoted approximately at its midpoint on the swedge assembly support standard 282. The oscillating arm is extended at one end thereof, which end has pivoted thereto a connecting link 129 which is connected in turn to the rocker arm 130. The rocker arm 130 is carried on a rocker arm shaft 133 journaled in the standards 34 and 35. Said rocker arm 130 is free to rotate around said rocker arm shaft. The rocker arm is driven through a driving arm 131 which is carried by the rocker arm shaft 133 and moves therewith. The driving connection between the driving arm 131 and the rocker arm 130 is provided by means of an adjustable driving pin 132. Since the rocker arm 130 drives both impact arms 122, an adjustment of the driving pin 132 provides a simultaneous depth adjustment of both swedges and both hammer mechanisms. The rocker arm shaft 133 is oscillated by means of the swedge-actuating cam 135, as shown in Fig. 3. The driving connection between the cam 135 and the shaft 133 is afforded by means of the swedge-actuating arm 134 rigidly connected to the shaft 133. The cam 135 is provided with a projection which by reacting upon the arm 134 oscillates the shaft 133 once during each revolution of said cam. The cam 135 is rigidly mounted upon the cam bearing sleeve 73 which, as described above, is driven by the gears 74 and 75 from the driving shaft 76, and thus is synchronized with the winding head 104.

When the cam 135 is rotated, as described above, and the arm 133 is oscillated, each impact arm 122 deals a blow to the respective projections 121, which in turn slide the swedge slide blocks 117 carrying the swedges 113 in toward the side rods 42 and 43, thus causing the swedges 113 to impart to the side rods 42 and 43 a swedging blow which swedges the side rods around the winding wire, as indicated in Fig. 28. Since both impact arms 122 are driven simultaneously by

the same driving mechanism, the swedges likewise move simultaneously in toward the side rods and deliver their swedging blows on opposite sides of the arbor 44 at the same instant. Thus the thrusts upon the opposite sides of the arbor 44 are balanced, and any tendency for causing the said arbor to weave from side to side is eliminated.

After the swedging blow has been delivered by the swedges 113, the swedges are each moved back from the arbor 44 by means of a spring 136 received in a recess in the swedge slide block 117 and bearing against a plate 137 fastened to the swedge slide support block 119.

In order to deactivate the swedges during the passage of the leg portions of the grids past the swedging position, each impact arm 122 is provided with a recess 138, and means are provided for raising each impact arm 122 so as to bring said recess 138 opposite its respective projection 121. Thus when the impact arms 122 are oscillated in their raised position, each projection 121 is received in a recess 138, and no impact blow is delivered thereto. Thus the swedges under these conditions are not actuated. In order to raise each impact arm 122, a link 139 is provided with an elongated slot through which passes a pin which is rigidly connected to the lower end of the arm 122. Each carrier arm 123 is likewise provided with elongated slots through which the pins connected to the impact arm 122 pass so as to permit a sliding movement of the impact arm 122 in said carrier arm 123. Each link 139 is pivoted at its lower end to a fulcrum block 140 carried by the bed plate 31. Each link 139 likewise has pivoted to it at an intermediate point an actuating link 141, which in turn is pivoted at its lower end to an actuating lever 142. Each actuating lever is pivoted at an intermediate point thereon to a pivot block 143 carried by the lower face of the bed plate 31. Of course the bed plate 31 is provided with openings, not shown, through which the actuating links 141 can project. The actuating levers 142 are driven by a swedge throw-out cam 144 which in turn is rigidly carried by the main cam shaft 92.

Upon rotation of the cam shaft 92 and the cam 144, the outer end of each actuating lever 142 is depressed when the raised portion of the cam 144 comes into contact therewith. Through the linkage described above, the outer end of each link 139 is raised, and thus each impact arm 122 is likewise raised. In this manner the swedges are deactivated during the passage of the leg portion of the grid past the swedging position. As shown in Fig. 13, the cam 144 is adjustable so that the initiation of the inactive period of the swedges and the duration of said inactive period may be varied at will. The slot-and-pin arrangements described above and shown most clearly in Fig. 13 permit the oscillation of the carrier arms 123 and the impact arms 122, in either the raised or lowered position of the links 139. After the raised portion of the cam 144 has traveled beyond the levers 142, each impact arm 122 is returned to its lower or active position by means of a spring 145.

As described above, the operating points on both the swedges and the cutters are oscillated in the plane passing through the centers of the side rods 42 and 43, and likewise strike the side rods at points lying in this plane. As described above, this arrangement substantially eliminates the tendency for the side rods to be distorted in the manner as indicated in Fig. 36. However, due to inequalities in the arbor grooves, inequalities in the size of the side rods, wearing of the arbor grooves, and various other more or less obscure reasons, some tendency usually remains for the side rods to be bowed, as shown in Fig. 36. I have found that these slight residual tendencies can be compensated for by adjustments of the swedges 113. In order to illustrate this action, reference may be had to Fig. 38. Theoretically the swedge 113 is reciprocated along the line of the arrow *d*, and impacts one of the side rods 42 at the center thereof, indicated at the point *a*. If the side rod 42 as it comes from the machine is bowed in such a direction as to be concave at the left and convex at the right, I have found that if the swedge 113 is shifted laterally in the direction toward the point *b*, the distortion can be eliminated and the side rod 42 will come off the machine perfectly straight. Likewise if the side rod 42 comes off the machine with a concavity at the right and a convexity at the left of Fig. 38, shifting of the swedge 113 laterally to the left will eliminate this distortion. In shifting the swedge 113 laterally in either direction, its motion of travel during operation along the direction of the line *d* is undisturbed. The shifting merely causes the swedge to bear more heavily on one side or the other of the side rod 42, and thus compensate for the tendency to produce the distortions described.

The adjustment of the swedges 113, as described above, is accomplished in my machine by vertically adjusting the position of said swedges. As shown in Fig. 14, the swedge support blocks 119 are adjustably supported on the swedge assembly carriage 146. The support block 119 is retained in place on said carriage 146 by means of screws 147 passing through elongated holes 149 in the swedge assembly carriage, and being retained by a cover plate 148. By loosening the screws 147 and shifting the support block 119 up or down, the swedge 113 may be adjusted to impact the side rods exactly along the line of their centers or slightly above or below in order to produce the compensations described in connection with Fig. 38. The swedges are maintained in their adjusted position by tightening down on the screws 147.

There is provided a further adjustment so that the swedges may be adjusted laterally along the arbor 44 in order to bring the swedges exactly opposite the notches 95 during the swedging action. In order to accomplish this lateral adjustment, each swedge assembly carriage 146 is adjustably mounted upon the swedge assembly frame 150, as shown in Figs. 8 and 11. Each swedge assembly carriage 146 is also provided with a block 153 into which is tapped a micrometer adjustment screw 151. Each micrometer adjustment screw is in turn rotatably carried by a yoke 152 mounted upon the swedge assembly frame 150. By rotating the micrometer adjustment screw 151, the position of each of the swedges 113 laterally in the machine can be adjusted very gradually. The swedge assembly carriage is firmly retained in this adjusted position by means of hold-down screws 154 which pass through elongated slots in the swedge assembly carriage 146, and are tapped into the swedge assembly frame 150.

The construction as described above, together with the adjustments therefor, eliminates the type of distortion as illustrated in Fig. 36. However, as stated above, a tendency still exists for the side rods to be bowed in the plane lying along

the centers of the side rods, as illustrated in Fig. 37. I have found that if there is provided, as shown in Fig. 28, hammers 155 which strike the side rods 42 and 43 simultaneously with the swedges 113, the tendency for the distortion as illustrated in Fig. 37 is eliminated. This effect produced by the hammers 155 is probably due to two reasons. First, the hammers may actually bend the side rods 42 and 43 back into a straight condition after they have been bent out of this condition by the action of the cutters 51 and the swedges 113. Second, by holding the side rods firmly in contact with the arbor 44 during the time the swedging action takes place, the side rods may be held in their straight condition and be prevented from being bent out of that position by the swedges 113.

As shown in Fig. 11, the hammers 155 are adjustably mounted upon hammer hubs 156, which in turn are carried and pivoted upon the swedge assembly carriage 146. The hammers 155 are retained on the hubs 156 by means of screws 157 which pass through enlarged holes in the hammers 155, and are tapped into the hammer hubs 156. This permits the hammers to be adjusted both laterally and vertically for purposes to be described below. The hammers are actuated by hammer-actuating slides 158 which are retained in place on the swedge assembly carriages 146 by means of the cover plates 148. These hammer-actuating slides are free to slide transversely in the swedge assembly carriages 146. The outer end of each hammer-actuating slide 158 is bent over to provide a portion which is adapted to be engaged by the adjustable hammer-actuating pins 159. These hammer-actuating pins 159 are carried by the carrier arms 123. As described above in connection with the actuation of the swedges 113, the carrier arms 123 are constantly rocked back and forth by a linkage connected with the rocker arm shaft 133. As each carrier arm 123 is rocked back and forth, the pin 159 strikes the end of the hammer-actuating slide 158, and thus pushes the hammer 155 into engagement with the side rods 42 and 43. As the pins 159 leave the slides 158, the hammers 155 and the slides 158 are pulled away from the arbor 44 by the springs 160. Since each pin 159 is independently adjustable, the intensity of the stroke of each hammer can be independently varied.

I have found that if all the curvature is not taken out of the side rods by means of the adjustment of the swedges 113, any slight residual curvature may be entirely eliminated by adjusting the hammers 155 which have a convex impact surface, both laterally and vertically, along the side rods 42, which acts to eliminate said curvature in the same manner as indicated for the swedges 113 in Fig. 38. Such adjustment, as pointed out above, is provided by the screw and enlarged hole arrangement between the hammers 155 and the hammer hubs 156.

By proper adjustment of the swedges and hammers in the mechanism which I have described above, the completed grids which leave the arbor 44 are perfectly straight, and when ejected from the machine are ready to be assembled in tubes without any further straightening action.

*Pull-out feed mechanism*

In my machine I have provided a novel arrangement for feeding the grids through the machine so as to make the action of the machine entirely automatic. This feed mechanism comprises two pull-out feed carriages 161 and 187 which alternately engage the side rods 42 and 43 with the winding wire wound thereon, and pull the grid structure through the machine in the manner as will be described below.

The front pull-out feed carriage 161 includes a carriage frame 162 which is mounted upon outer bearing sleeves 174. Each outer bearing sleeve 174 is in turn slidably mounted upon an inner bearing sleeve 175, which in turn is slidably mounted upon a bearing rod 176 carried by the front and rear bearing plates 177 and 178. One of the outer bearing sleeves 174 carries a cam portion 179, as shown in Fig. 33. The inner bearing sleeve 175 associated therewith carries a cam portion 180. Intermediate the two cam portions 179 and 180 is located a spreading member 181. This spreading member is rotatably mounted upon the exterior of said inner bearing sleeve 175. The spreading member 181 when actuated produces a skip action which will be described below. However, the spreading member 181, in the position as indicated in Fig. 18, merely acts as an intermediate thrust member between the inner and outer bearing sleeves 175 and 174. Thus as the inner bearing sleeve 175 is moved along to the right in Fig. 18, the outer bearing sleeve 174 is likewise pushed along to the right, and thus the front pull-out feed carriage 161 is moved in the proper direction for feeding the grids through the machine.

In order to produce the feeding movement of the inner bearing sleeves 175, said bearing sleeves have mounted thereon a plate 182. The plate 182 carries a split nut 163 pivoted at one end thereof to the plate 182, as shown in Fig. 17. A biasing spring 164 connected to the other end of the split nut 163 biases the two halves thereof so as to clamp the lead screw 165. The drive of this lead screw also constitutes a novel feature of my invention, and will further be described below. Thus, when the lead screw 165 is rotated, the split nut 163 will be carried forward along said lead screw, and this in turn will move the front pull-out feed carriage in a forward direction to feed the grids through the machine.

In order for the front pull-out feed carriage to engage the grids, it is provided with a pair of clamp slides 166 which are supported so as to slide vertically on the front carriage frame 162, as indicated in Fig. 19. In order to actuate the clamp slides, a clamp slide lever 167 is pivoted at one end to each of said clamp slides 166. The other end of each of the clamp slide levers 167 is pivoted on the front pull-out carriage frame 162. Each lever 167 has pivoted at an intermediate point thereon a link 168, which in turn is pivoted to a bell crank 169 carried by and adapted to rotate on the front carriage frame 162. The bell crank 169 is provided with an arm 170 and is actuated by means of a cam rocker arm 171 mounted upon a rod 183 carried by the front and rear bearing plates 177 and 178. Since the carriage 161 travels along the machine and the rocker arm 171 is stationary, said rocker arm is provided with an extension face 210 extending along the machine, as shown in Fig. 5. The outer end of the arm 170 is provided with a roller which permits easy motion along the extension face 210. The extension face 210 is carried by an arm which likewise is mounted upon the rod 183. In order to provide for different thicknesses of wire, for wear on the cam slides 166, and for adjustment of the clamping action, an adjustment thrust pin 172 is provided between the rocker arm 171 and the arm carrying the exten-

sion face 210. The rocker arm 171 is actuated by means of a riser cam 173 mounted upon the main cam shaft 92, as shown in Fig. 17. As the cam shaft 92 revolves in the direction as indicated by the arrow and the end of the rocker arm 171 is pushed up by the raised portion of the cam, as shown, the arm 170 of the bell crank lever will be rotated so as to cause the clamp slides 166 to clamp the grid between them. In this way the grids are effectively clamped by the front pull-out feed carriage 161, and are carried along by the carriage 161 as it travels forward along the machine. Thus, during the forward travel of the front feed carriage 161, the grids are advanced through the machine. The clamping action of the clamp slides 166 is so adjusted that the clamping takes place on a leg portion of the grid. Thus any distortion which occurs on the winding wire 96 does not injure the grids inasmuch as this portion of the winding wire is later stripped from the grid and is discarded. As the cam shaft rotates further, the rocker arm 171 drops from the raised portion of the cam 173, and a retracting spring 197 pulls upon the arm 170 of the bell crank, and thus rotates the bell crank so as to pull the clamp slides 166 away from the grid and thus release the grid. As will be described below, just prior to this release, the back pull-out feed carriage will have engaged the grid and will continue the feed action thereof through the machine.

As indicated in Fig. 39, between the tight or normal turns 247 of the grid there are wound a few loose turns 249 on the leg portion of the grid. Since the loose turns 249 are subsequently stripped off and thrown away, the wire of these loose turns is wasted. Therefore it is desirable to increase the pitch of the turns 249 so as to waste as little wire as possible. In order to produce this action, the grids are advanced through the machine at a more rapid rate during the time that the loose turns 249 are wound on the side wires 42 and 43. This increased rate of feeding is produced by the skip mechanism to which I have referred briefly above. This skip mechanism includes the spreading member 181 between the two cam portions 179 and 180 on the two bearing sleeves 174 and 175, as shown, for example, in Fig. 33. During a part of the time when the front feed carriage 161 is feeding the grids through the machine, the spreading member 181 is rotated so as to quickly separate the front carriage frame 162 from the plate 182. The spreading member 181 is actuated during this time by means of a pull rod 184. The actuation of the pull rod 184 is produced by means of a tension spring 185 which tends to pull upon the pull rod 184 and rotate the spreading member 181 so as to produce the skip action described. The action of the spring 185 is restrained by means of a cam 186 mounted upon the main cam shaft 92. As the cam 186 rotates in the direction as indicated by the arrow in Fig. 19, the end of the pull rod 184 drops from the raised portion of the cam to the depressed portion thereof, whereupon the spring 185 exerts its tension upon the pull rod 184, and thus rotates the spreading member 181 so that it quickly separates the two cam portions 179 and 180, and thus rapidly advances the front carriage frame 162 along the machine. Due to this action, the rate of feeding of the grid through the machine is increased, and thus the pitch of the wire 96 wound on the side rods 42 and 43 is increased.

The length of the leg portion of the grid can be adjusted by adjusting the distance which the spreading member 181 advances the frame 162. This distance can be adjusted by adjusting the amount of rotation of the spreading member 181. As will be seen from Figs. 18 and 33, the further the member 181 is rotated the farther apart the cam surfaces 179 and 180 will be forced which in turn determines the skip travel of the frame 162. In order to provide this adjustment, the depressed portion of the cam 186 is set sufficiently deep to provide for the maximum travel of the pull rod 184 and consequently of the spreading member 181. The pull rod 184 is usually stopped before it reaches the bottom of the depressed portion of the cam 186 by the stop 295 cooperating with the adjustable screw 296. The stop is mounted on the pull rod 184 and the screw is tapped into a block carried by the bed plate 31, as shown in Fig. 19. By adjusting the screw 296, the amount which the pull rod 184 travels under the action of spring 185 may be adjusted. In this way the rotation of the spreading member 181 and consequently the length of the leg portion of the grid can be adjusted.

The cam 186 is so arranged that the rotation of the spreading member 181 occurs during the passage of the leg portion of the grid past the winding position. The spreading action, as described above, occurs only during the time that the pull rod 184 drops from the raised to the depressed portion of the cam 186. Subsequent to this action, the plate 182 will cause the front carriage frame 162 to be moved along the machine at the normal rate. After the back feed carriage has taken control of the feeding of the grids and the clamp slides have released the grid, the cam 186 pushes upon the rod 184 and moves it into the position as shown in Fig. 19, during which time the spring 185 is put under a tension so as to be ready for its next spreading operation. At this time the spreading member 181 is returned to its position, as shown in Fig. 18, by means of a retracting spring 288, as shown in Fig. 17. Upon return of the spreading member 181 to the position as shown in Fig. 18, the front carriage frame 162 is pulled back toward the plate 182 by means of a tension spring 294, as shown in Fig. 33. This reestablishes the relationship between the front carriage frame 162 and the plate 182, as shown in Fig. 18. The pull rod 184 is slidably retained on the base plate 31 while the front feed carriage carrying the spreading member 181 moves along the machine with respect thereto. In order to permit this relative motion and still maintain the operative relationship between the pull rod 184 and the spreading member 181, said pull rod is provided with an extension face 289, which extends along the machine a sufficient distance to be maintained in operative relationship to the spreader member 181 which is provided with a roller at its outer end so as to permit easy motion along the extension face 289. The return of the front carriage frame 162 to its original position will be described below.

The back feed carriage 187 which takes control of the feeding of the grids through the machine when the front feed carriage 161 releases such control, includes a front carriage frame 188 which is carried by bearing sleeves 290 slidably mounted upon bearing rods 291. The back feed carriage is fed along the machine by means of a split nut 189 which is pivoted at one end thereof to the back carriage frame 188, as shown in Fig. 20. A biasing spring 190 biases the two halves of the split nut 189 so as to engage and

clamp the lead screw 165, whereby the back feed carriage is advanced along the machine. The back feed carriage is also provided with clamp slides 191 slidably mounted upon the frame 188, as shown in Fig. 22. The edge of the lower clamp slide 191 is sharpened to produce a cutting edge. In this way the clamp slides 191 constitute not only a clamp but also a cutter which severs the grids after they have been completed and are ready to be ejected from the machine. The clamp slides are actuated by means of levers 192 which are pivoted at one end to the slides 191 and at the other end to the frame 188. Intermediate the ends of the levers 192 are pivoted connecting links 193 which in turn are pivotally connected to a bell crank 194. The bell crank 194 is supported upon and adapted to rotate in the frame 188. The bell crank 194 is provided with an arm 195. The arm 195 is actuated to cause the clamp slides 191 to engage the grid by means of a cam rocker arm 198, which drives an actuating arm 292 through an adjustable driving pin 199, whereby adjustments may be made for different sizes of grids and also for wear on the clamp slides 191. The arms 198 and 292 are also mounted upon the rod 183. The rocker arm 198 is in turn actuated by a riser cam 200 mounted upon the cam shaft 92. As shown in Fig. 20, when the cam 200 rotates in the direction as indicated by the arrow, the first raised portion of said cam which comes into contact with the arm 198 moves said arm so as to actuate the bell crank 194, and thus cause the clamp slides 191 to clamp the grid, whereby the back feed carriage may feed said grid through the machine. During this feeding operation, the clamp slides 191 engage the grid to such an extent that the cutting edges thereof extend about half way through the side wires. The cam 200 is so related to the cam 173 that the slides 199 clamp the grid just prior to the release of the grid by the clamps 166 of the front feed carriage. After the back feed carriage has substantially completed its feeding motion along the machine, the rocker arm 198 comes into contact with a cam face 201 on the cam 200. This causes an additional actuation of the rocker arm 198 which moves the clamp slides 191 an additional amount sufficient to shear through the side rods, and thus cut off the completed grid. As shown in Fig. 1, the machine may be provided with a trough 258 into which the completed grids drop and through which they may be removed from the machine. In order to prevent the back feed carriage from dropping the severed end of the incomplete grid which is being fed toward the back feed carriage, it is provided with a grid-centering guide 202, as shown in Fig. 20. Although this guide does not clamp the grid, it slidably supports the same during the period of time in which the clamp slides 191 are retracted from the sides of the grid.

When the front feed carriage has completed its feeding travel through the machine, the clamp slides 166 are released as described above. In order to permit the front feed carriage to be returned to its original position, the split nut 163 is released from the lead screw 165 by means of a spreader 203. This spreader consists of a tongue which extends between the two halves of the split nut, as shown in Fig. 17, and which when rotated spreads the two halves of the split nut against the action of the biasing spring 164. The spreader 203 is pivoted in the plate 182, and is provided with a spreader arm 204. The spreader 203 is actuated by means of its arm 204 from a lever 205 which is pivoted on a shaft 206 carried by shaft brackets 213 which are mounted on the lower face of the bed plate 31. The lever 205 is provided with an actuating spring 207 which tends to rotate the lever 205 so as to actuate the spreader 203 to release the split nut 163. The action of the spring 207 is restrained by means of a push rod 208 which is slidably supported on the bed plate 31. The outer end of the push rod 208 rides upon the closing cam 209 which is likewise carried on the main cam shaft 92. As the cam 209 rotates in the direction as indicated by the arrows in Figs. 17 and 19, the end of the push rod 208 drops off the raised portion of the cam onto its depressed portion, whereupon the actuating spring 207 pulls upon the lever 205 and rotates the spreader 203 so as to separate the two halves of the split nut 163. This action releases the front feed carriage from the lead screw 165, whereupon the front carriage is ready to be returned to its initial position. The cam 209 is so arranged that this releasing action takes place shortly after the clamp slides 166 have released the grid. In order to produce relative sliding motion between the lever 205 and the spreader arm 204, the lever 205 is provided with an extension face 212 extending along the machine sufficiently so that the lever 205 is maintained in active engagement with the arm 204 throughout the travel of the front feed carriage 161 through the machine.

In order to return the front feed carriage to its original position, a return thrust rod 214 is slidably mounted in the rear bearing plate 178, as shown, for example, in Fig. 1. The inner end of the thrust rod 214 engages the end of one of the outer bearing sleeves 174. The outer end of the thrust rod 214 is provided with a head 215 against which a rocker arm 216 is adapted to push. The rocker arm 216 is journaled upon a stub shaft 217 carried by brackets 218 mounted upon the bed plate support 33. The rocker arm 216 has pivotally connected thereto a link 219 which in turn is pivoted to the end of a cam rocker arm 220. The cam rocker arm 220 is journaled at its lower end on a stub shaft 292. Rocker arm 220 carries a roller 221 which is adapted to cooperate with a return cam 222 carried by the return cam shaft 223. The return cam shaft is carried by brackets 293 mounted upon the bed plate support 33. As shown in Fig. 25, the return cam shaft 223 is driven by a right-angled gear 224 which engages a right-angled gear 225 mounted upon the main cam shaft 92. As the cam shaft 92 rotates and drives the return cam shaft 223, the cam 222 pushes upon the roller 221, thus rocking the arm 222 to the left. This causes the rocker arm 216 to push in against the head 215 of the thrust rod 214, whereupon the inner end of the thrust rod 214 pushes upon the end of the bearing sleeve 174 which returns the front carriage 162 to its original position. Also through the intermediary of the spreading member 181, the plate 182 carrying the split nut 163 is likewise returned to its original position. This action occurs shortly after the split nut 163 has been released from the lead screw 165. Thereupon the front feed carriage is in a position to again assume control of the feed of the grids through the machine.

After the front carriage has released the grid and the back carriage has assumed control and continued the feeding to the extent of cutting off the completed grid, the front carriage again takes control of the feeding action by the push

rod 208 riding up onto the raised portion of the cam 209, whereupon the lever 205 releases the spreader 203. Due to the relationship between the ends of the split nut 163 and the spreading member 203, as shown in Fig. 17, the biasing spring 164 forces the spreading member 203 to rotate back into the position shown in Fig. 17, and also causes the two halves of the split nut 163 to clamp the lead screw 165, whereupon the front carriage is then again fed along the machine. Just after this action, the clamping members 166 clamp the grid as described above.

After the back feed carriage has completed its feeding and severing action, as described above, it is released from the lead screw 165 and returned to its original position. In order to release the back feed carriage from the lead screws 165, the split nut 189 is likewise provided with a spreader 226, as shown in Fig. 20. This spreader is mounted on a spreader arm 227 provided at its end with a roller which rolls along an extension face 229 of a lever 228. The lever 228 is journaled on the bearing shaft 206 which, as described above, is carried by the shaft brackets 213. The lever 228 is actuated by a tension spring 230 which pulls upon the lever 228 and causes the spreader arm 227 to actuate the spreader member 226 to separate the two halves of the split nut 189, and thus release the back carriage from the lead screw 165. The action of the actuating spring 230 is normally restrained by the push rod 231 which is slidably mounted on the bed plate 31. The outer end of the push rod 231 rides upon the closing cam 232. When the end of the push rod 231 is on the raised portion of the cam 232, the split nut is maintained in its clamping position on the lead screw 165. However, when the end of the push rod 231 drops down on the depressed portion of the cam 232, the actuating spring 230 is permitted to come into operation, whereupon the split nut 189 is released from the lead screw 165, as described above. This release occurs just after the clamping members 191 have completed their severing operation.

After the split nut 189 has been released from the lead screw 165, the back carriage is returned to its original position by a thrust rod 233 which is slidably carried by the rear bearing plate 217, as shown, for example, in Fig. 1. The inner end of the thrust rod 233 bears against one end of one of the bearing sleeves 290 while the outer end is provided with an operating head 234 against which a rocker arm 235 is adapted to push. The rocker arm 235 is journaled at its lower end on the stub shaft 217, and is connected by means of a link 236 to the cam rocker arm 237. This cam rocker arm is journaled at its lower end on the stub shaft 292. The rocker arm 237 is provided with a roller 238 which cooperates with a return cam 239 which is mounted upon the return cam shaft 223. As the return cam shaft 223 is rotated from the main cam shaft 92 through the gears 225 and 224, as described above, the cam 239 pushes against the roller 238 and thus actuates the rocker arm 235 which pushes upon the thrust rod, and thus pushes the back feed carriage back along the machine to its original position, whereupon it is ready to assume the control of the feeding of the grids through the machine just prior to the time when the front carriage releases its control thereof.

Due to the arrangement as described above, the front and back carriages alternately assume control of the feeding of the grids through the machine, each carriage clamping the grid just prior to the release by the other carriage and thus overlapping in cycle. As a result the grids are fed continuously. Since each carriage need travel only a distance slightly greater than one-half the length of the individual grid, the overall length of the machine is considerably shortened over that type of machine in which a feeding member travels the length of a relatively large number of grids. Furthermore, due to the feeding action described, the machine can be made entirely automatic, and can turn out large numbers of grids without the necessity of stopping the machine at any time.

*Stripping mechanism*

Before the grids are completed, the loose turns 249 illustrated in Fig. 39 must be removed from the grid. In accordance with present-day practice, this is usually done after the grids have been removed from the machine. The present arrangement, however, affords a mechanism whereby this severing or "stripping" is accomplished automatically. In order to accomplish the stripping, the machine is provided with two electrodes 240 mounted as shown in Figs. 17 and 18. The electrodes 240 are carried by electrode arms 241 insulated therefrom. The arms 241 are pivotally mounted on the front carriage frame 162, and are provided with extensions 242 which are adapted to contact with the actuating cam 244. Each electrode arm 241 is provided with a biasing spring 243 which urges the electrodes 240 toward the grid which is adapted to pass between the outer ends of said electrodes. The cam 244 is pivotally mounted upon the front carriage frame 162, and is provided with a cam arm 245, the outer end of which contacts the actuating pin 246 mounted upon the arm 170 of the bell crank 169. Thus when the arm 170 is actuated so as to clamp the grid between the clamp slides 166, the electrodes 240 are brought into contact with the grid, as will be more clearly pointed out in connection with Fig. 39. As shown in this figure, each grid consists of a series of normal turns 247 swedged at points 248 to the side wires 42 and 43. Between the normal turns 247 are wound a few loose turns 249. The electrodes 240 contact with the first and last loose turn at a point very near the respective side wire 42 or 43. The machine itself is grounded, as indicated at 250. Each electrode 240 is also provided with a conductor 251 which leads through a transformer secondary 252 to a ground 253. Each secondary 252 is also provided with a primary winding 254 connected by means of a main switch 257 to some suitable source of alternating current. Each primary 254 is controlled by a switch 255. After the electrodes 240 have come into contact with the loose turns of the grid, the switches 255 are closed, whereupon the primary and secondary windings 254 and 252 are energized. Upon the energization of the secondary windings, current passes from each electrode 240 through a short length of winding wire to one of the side rods. The current passing through this small portion of the winding wire burns it away, and thus it leaves it disconnected from the tight portion of the wound grid. This leaves all of the loose turns 249 free so that when the grid is severed, as pointed out above, these loose turns will fall off. I have found that the voltage of the secondary windings 252 may be between three and ten volts, five volts being a good working average for most kinds of wire. Of

course it is to be understood that during this action the switch 257 is in its closed position.

In order to actuate the switches 255 at the proper time, these switches are mounted upon the bed plate 31, as shown in Fig. 7, and are each closed by means of a switch cam 256 mounted upon the cam shaft 92. Thus, by orienting the cam 256 upon the cam shaft 92, the closure of the switches 255 takes place at the proper time, that is, shortly after the electrodes 240 have come into contact with the loose turns of the grid.

*Driving mechanism*

As previously pointed out, the driving mechanism for the cam shaft 92 constitutes a special feature of this invention. In order to drive the cam shaft, as shown in Fig. 2, the drive shaft 76 carries a gear 259 which engages a gear 260 mounted upon the back shaft 261 which extends throughout the length of the machine and thus is carried by the support standards 34 and 35 and the bearing plates 177 and 178. The opposite end of the back shaft extends through the stationary bearing 267, as shown in Figs. 1 and 5. As shown in Figs. 23 and 24, at the opposite end of the machine from the gear 260, the back shaft carries the epicyclic gear train pinion plate 262. This plate has mounted thereon to one side thereof, the pinion gear 263. This pinion gear meshes with a gear 264 rotatably mounted upon the stationary bearing 267, as shown in Figs. 1 and 5. Non-rotatably mounted upon the stationary bearing 267 is a stationary gear 265 differing from gear 264 by one tooth. The gears 264 and 265 are of the same diameter. The gear 263 also meshes with the stationary gear 265. Due to the fact that the gears 264 and 265 differ from each other by one tooth, as the back shaft 261 is rotated, the gear 264 is advanced one tooth for each rotation of said back shaft. Connected to the gear 264 and floating on the back shaft and stationary bearing 267 is the floating sleeve 266, which at its inner end carries a gear 268 having the same number of teeth as 264. Thus the gear 268 rotates in synchronism with the gear 264. As shown in Figs. 23 and 24, an intermediate gear 269 meshes with the gear 268. The gear 269 is mounted upon an arm 270 which is swiveled about the shaft 261 as a center. The arm 270 is provided with an adjustment link 271 which is provided with an elongated slot through which passes a lock bolt 272 carried by the support 33. Thus the gear 269 may be moved to a limited extent around the back shaft 261 and locked in its adjusted position by means of the lock bolt 272. Meshing with the intermediate gear 269 is the main cam shaft change gear 273 which is rigidly mounted upon the main cam shaft 92. The adjustment of the intermediate gear 269, described above, is necessary to take care of various sizes of the change gear 273.

As pointed out above, the winding head 104 is driven from the drive shaft 76 which also drives the back shaft 261. The gear ratios are so adjusted that the winding head 104 makes one complete revolution for each revolution of the back shaft 261. However, the main cam shaft 92 determines the formation of individual grids; that is, during each complete revolution of the cam shaft 92, a complete grid is formed. The number of turns of winding wire in a complete grid is therefore determined by the number of revolutions which the winding head 104 makes for each revolution of the cam shaft 92. The driving mechanism for the cam shaft described above affords a particularly flexible and simple control for the number of turns in each complete grid. Since, as has been pointed out above, the gear 264, and consequently the gear 268, advance one tooth for each revolution of the back shaft 261, said gears 264 and 268 will also advance one tooth for each revolution of the winding head 104. Since the gear 268 through the intermediary of the gear 269 drives the cam shaft 92, the number of revolutions which the winding head or the back shaft 261 makes for each revolution of the cam shaft 92 will be determined by the number of teeth in the main cam shaft change gear 273. Thus, simply by selecting a change gear of a certain number of teeth, the grid will have that number of turns. Therefore, by my arrangement, the number of turns in the grid may be determined by a very rapid and simple adjustment of the machine. In order to permit adjustment of the position of various parts of the machine, when it is not being driven, the back shaft 261 is provided with a hand wheel 271.

As pointed out above, the drive of the lead screw 165 also constitutes a special feature of this invention. In order to drive the lead screw 165, the back shaft 261, as shown in Figs. 5 and 12, is provided with a gear 275. This gear, as shown in Fig. 24, meshes with an intermediate gear 276 which is carried on an arm 277 swiveled about the back shaft 261 as a center. The arm 276 is also provided with an adjustment link 278 having an elongated slot through which passes a lock-down bolt 279 received in the support 33. Therefore, the position of the intermediate gear 276 around the back shaft 261 can be adjusted and said gear can be locked in its adjusted position by means of the lock bolt 279. The lead screw 165 is provided with a lead screw change gear 280 which is engaged by the intermediate gear 276.

This results in the fact that the gear 280 advances one tooth for each tooth on the gear 275. By replacing the gear 280 with other size gears, a very fine adjustment of the speed of travel of the lead screw 165 can be secured. The adjustment of the gear 276 is necessary in order to take care of various sizes of the gear 280.

*Winding spool replacement*

In order to replace the winding wire spool 98, the assembly carrying the swedges and hammers is mounted so as to rotate out of place in front of the winding head, whereupon the winding wire spool may be slipped off the pins 100 and replaced by a full spool.

As shown most clearly in Fig. 15, in order to accomplish this rotation, the swedge assembly frame 150 is pivoted on a pivot pin 281 mounted in the swedge assembly support standard 282, which in turn is carried by the bed plate 31. The swedge assembly frame 150 is normally locked in position by means of a locking handle 284 pivoted at one end thereof on the swedge assembly frame 150. The locking handle normally locks behind a plate 283 which is mounted upon the swedge support standard 282.

If it is desired to release the swedge assembly from in front of the winding head, it is merely necessary to raise the outer end of the locking handle 284, whereupon the swedge assembly frame may be rotated out of position. Inasmuch as all of the drive for the swedges and the hammers occurs through impact members rather than through any direct connection, this rotation can

be accomplished without disturbing the driving members.

*Reversal of grid winding*

In some instances it may be desirable to reverse the direction in which the winding wire is wound upon the side wires **42** and **43**. This is accomplished by reversing the direction of rotation of the winding head **104**. In order to accomplish this reversal, the machine may be provided with the reversing mechanism shown in Figs. 26 and 27. In this mechanism a stub shaft **286** carried by the standard **35** is provided, which in turn carries an intermediate gear **287**. This intermediate gear is provided with a double-width face, and meshes with both the gear **107** which drives the winding head and also with the gear **112** which is mounted on the drive shaft **76**. The gear **112** is provided with a set screw **285** so that it may be slid along the drive shaft **76** for a limited distance and set in its adjusted position. Normally the gear **287** is removed from the stub shaft **286** and the gear **112** meshes with the gear **107** to drive said gear and winding head directly as discussed above in connection with the normal drive of the winding head. To accomplish the reversal of winding, the gear **287** is mounted on the stub shaft **286** and the gear **112** is slid out along the drive shaft **76** so that it is no longer in direct engagement with the gear **107**. In this position the drive shaft **76** drives the gear **107** through the intermediary of the gears **112** and **287**, respectively. Under these conditions the gear **107** will be driven in the reverse direction from that in which it was driven directly by the gear **112**.

This invention is not limited to the particular details of construction as described above, as many equivalents will suggest themselves to those skilled in the art. For example, grids of the type having but a single side rod could be made upon such a machine, in which case but a single cutter, swedge and hammer need be employed. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In a grid-making machine, a substantially stationary winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, cutting means for cutting notches in said side rod, into which notches said winding wire is adapted to be laid, swedging means for swedging said rod upon said winding wire, and means for moving said cutting and swedging means into engagement with said side rod to deliver cutting and swedging strokes respectively to said rod, said cutting and swedging means being mounted to move in a direction to deliver the force of said cutting and swedging strokes along a line passing substantially through the center of said side rod.

2. In a grid-making machine, a substantially stationary winding arbor having a pair of supporting surfaces at opposite sides thereof, each to support a side rod upon which a winding wire is to be wound to form a grid, cutting means for cutting notches in said side rods, into which notches said winding wire is adapted to be laid, swedging means for swedging said rods upon said winding wire, and means for moving said cutting and swedging means into engagement with said side rod to deliver cutting and swedging strokes respectively to said side rods, said last-named means normally moving said cutting and swedging means in a direction to deliver the force of said cutting and swedging strokes along a line passing substantially through the center of the associated side rod.

3. In a grid-making machine, a substantially stationary winding arbor having a pair of supporting surfaces at opposite sides thereof, each to support a side rod upon which a winding wire is to be wound to form a grid, cutting means for cutting notches in said side rods, into which notches said winding wire is adapted to be laid, a pair of swedges for swedging said rods upon said winding wire, means for moving said cutting means to deliver cutting strokes to said side rods, and means for moving said swedges to deliver swedging strokes to said side rods, both of said last-named means normally moving said cutting means and swedges in a direction to deliver the force of said cutting and swedging strokes along a line passing substantially through the center of the associated side rod.

4. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, and holding means adapted to engage said side rod at a point adjacent to the point at which said swedge comes into contact with said side rod, said holding means holding said side rod in intimate contact with the supporting surface of said arbor during swedging to prevent the action of the swedge from bending said side rod away from said supporting surface.

5. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form a grid, feeding means for advancing said side rod with said winding wire thereon through said machine, cutting means for cutting notches in said side rod, into which notches said winding wire is adapted to be laid, swedging means for swedging said rod upon said winding wire, means for moving said cutting and swedging means into engagement with said side rod to deliver cutting and swedging strokes respectively to said side rod, said strokes tending to bend said side rod out of a straight line, and means for bending said side rod in a direction reverse to that of the bend due to said cutting and swedging means an amount sufficient to cause said side rod to be straight.

6. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, feeding means for continuously advancing said side rod with said winding wire thereon through said machine, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said strokes tending to bend said side rod out of a straight line, and means operating during the continuous feeding of said side rod for bending said side rod in a direction reverse to that of the bend due to said cutter and swedge, an amount sufficient to cause said side rod to be straight.

7. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said strokes tending to bend said side rod out of a straight line, and a straightening member for delivering straightening strokes to said side rod after the cutting and swedging thereof, whereby said side rod in the completed grid is straight.

8. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said strokes tending to bend said side rod out of a straight line, and a straightening member for delivering straightening strokes to said side rod after the cutting and swedging thereof, said straightening member being adapted to contact said side rod and hold it in intimate contact with the supporting surface of said arbor during swedging.

9. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said means normally moving said cutter and swedge in a direction to deliver the force of said cutting and swedging strokes along a line passing substantially through the center of said side rod, said strokes tending to bend said side rod out of a straight line, a straightening member for delivering straightening strokes to said side rod after the cutting and swedging thereof, and means for moving said straightening member in a direction to deliver the force of its straightening blows along a line passing substantially through the center of said side rod.

10. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said means normally moving said cutter and swedge in a direction to deliver the force of each of said cutting and swedging strokes along a line passing substantially through the center of said side rod, and means for adjusting said swedge transversely with respect to said side rod to shift the direction of the force of the swedging strokes through said side rod to one side of the center of said side rod.

11. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said means normally moving said cutter and swedge in a direction to deliver the force of each of said cutting and swedging strokes along a line passing substantially through the center of said side rod, said strokes tending to bend said side rod out of a straight line, a straightening member for delivering straightening strokes to said side rod after the cutting and swedging thereof, means for moving said straightening member in a direction to deliver the force of its straightening strokes along a straight line passing substantially through the center of said side rod, and means for adjusting said swedge and straightening member transversely with respect to said side rod to shift the direction of the force of the swedging and straightening strokes through said side rod to one side of the center of said side rod.

12. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said means normally moving said cutter and swedge in a direction to deliver the force of each of said cutting and swedging strokes along a line passing substantially through the center of said side rod, said strokes tending to bend said side rod out of a straight line, a straightening member for delivering straightening strokes to said side rod after the cutting and swedging thereof, means for moving said straightening member in a direction to deliver the force of its straightening blows along a line passing substantially through the center of said side rod, means for adjusting said swedge and straightening member transversely with respect to said side rod to shift the direction of the force of the swedging and straightening strokes through said side rod to one side of the center of said side rod, and means for adjusting said straightening member longitudinally along said side rod with respect to said swedge.

13. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, winding means for carrying the winding wire around said side rod and winding said wire upon said side rod, feeding means for advancing said side rod with said winding wire thereon through said machine, and means for deactivating said cutter and swedge during predetermined intervals to prevent said cutter and swedge from contacting said side rod during said intervals, whereby the turns of said winding wire wound on said side rod during said intervals are left loose.

14. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, two feeding members for feeding said side rod through said grid-forming mechanism, said feeding members being con-

structed to feed said side rod alternately and to overlap in cycle, whereby a continuous feeding of said side rod is produced.

15. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, two feeding members for feeding said side rod through said grid-forming mechanism, each of said feeding members being constructed to engage and pull said side rod through said grid-forming mechanism during the feeding cycle of said feeding member, said feeding members being constructed to feed said side rod alternately and to overlap in cycle, whereby a continuous feeding of said side rod is produced.

16. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, a front feeding means for grasping said side rod wire as it comes from said winding mechanism, means for moving said front feeding means a limited distance forward along said machine, means for releasing said side rod wire from said front feeding means after a predetermined length of travel, a back feeding means mounted in front of said front feeding means for grasping said side rod wire prior to its release by said front feeding means, means for moving said back feeding means a limited distance forward along said machine, means for releasing said side rod wire from said back feeding means after said front feeding means has grasped said side rod wire, and means for returning said front and back feeding means to their initial positions along said machine after they have released said side rod wire.

17. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including winding means for carrying the winding wire around said side rod and winding said wire upon said side rod, feeding means for grasping said side rod wire as it comes from said winding mechanism, means for moving said feeding means forward along said machine, and skip means for quickly increasing the rate of travel of said feeding means during a portion of its forward travel to increase the pitch of said winding wire on the leg portions of the grids.

18. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including winding means for carrying the winding wire around said side rod and winding said wire upon said side rod, feeding means for grasping said side rod wire as it comes from said winding mechanism, means for moving said feeding means forward along said machine, and skip means for quickly increasing the rate of travel of said feeding means during a portion of its forward travel to increase the pitch of said winding wire on the leg portions of the grids, an actuating member for operating said skip means, a stop member for limiting the extent of travel of said actuating member, and means for adjusting said stop member to vary the extent of said leg portion.

19. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, a front feeding means for grasping said side rod wire as it comes from said winding mechanism, means for moving said front feeding means a limited distance forward along said machine, means for releasing said side rod wire from said front feeding means after a predetermined length of travel, a back feeding means mounted in front of said front feeding means for grasping said side rod wire prior to its release by said front feeding means, means for moving said back feeding means a limited distance forward along said machine, means for releasing said side rod wire from said back feeding means after said front feeding means has grasped said side rod wire, means for returning said front and back feeding means to their initial positions along said machine after they have released said side rod wire, and cutting means travelling with said back feeding means for severing a completed grid from said elongated side rod wire at substantially the end of the forward travel of said back feeding means.

20. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, a feeding mechanism, driving means for moving said feeding means bodily along said machine for feeding said side rod through said grid-forming mechanism, a cutting mechanism for severing completed grids from said side rod, said cutting mechanism being mounted on said feeding mechanism, whereby said cutting mechanism moves along said machine in synchronism with said feeding mechanism, and means for actuating said cutting mechanism to perform its severing action.

21. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including means for fastening said winding wire to said side rod wire by means of a tight connection at each successive turn for a predetermined number of turns to form tight turns and for leaving said winding wire unattached to said side rod wire for a predetermined number of turns to form loose turns, feeding means for advancing said side rod with said winding wire thereon through said machine, and means for severing the first and last loose turn of each such group of turns at the last tight connection of the preceding group of tight turns and the first tight connection of the succeeding group of tight turns, respectively.

22. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including means for fastening said winding wire to said side rod wire by means of a tight connection at each successive turn for a predetermined number of turns to form tight turns and for leaving said winding wire unattached to said side rod wire for a predetermined number of turns to form loose turns, feeding means for advancing said side rod with said winding wire thereon through said machine, and means for passing current through a short section of the first and last loose turns immediately adjacent the last tight connection of the preceding group of tight turns and the first tight connection of the succeeding group of tight turns, respectively, to melt said short sections and disconnect said loose turns from the rest of the grid structure.

23. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including winding means for carring the winding wire around said side rod and winding said wire upon said side rod, feeding

means for advancing said side rod with said winding wire thereon through said machine, additional mechanisms for completing individual grids, rotatable timing means controlling said mechanisms to produce a complete grid for each revolution of said timing means, a driving member rotating said winding means and rotating the carrying member for a pinion gear of an epicyclic gear train in synchronism with each other, said pinion gear meshing with a stationary and a rotatable gear of the same diameter but differing from each other by a single tooth, and a driving gear driven from said rotatable gear so as to advance one tooth for each advance of one tooth on said rotatable gear, said driving gear driving said timing means in synchronism therewith, whereby the number of teeth on said driving gear determines the number of winding wire turns in each completed grid.

24. In a grid-making machine, a grid-forming mechanism adapted to wind a winding wire around an elongated side rod wire to form successive grids, including winding means for carrying the winding wire around said side rod and winding said wire upon said side rod, feeding means for advancing said side rod with said winding wire thereon through said machine, additional mechanisms for completing and severing individual grids from said side rod wire, rotatable timing means controlling said mechanism to produce a complete grid for each revolution of said timing means, a driving member rotating said winding means and rotating the carrying member for a pinion gear of an epicyclic gear train in synchronism with each other, said pinion gear meshing with a stationary and a rotatable gear of the same diameter but differing from each other by a single tooth, and a driving gear driven from said rotatable gear so as to advance one tooth for each advance of one tooth on said rotatable gear, said driving gear driving said timing means in synchronism therewith, whereby the number of teeth on said driving gear determines the number of winding wire turns in each completed grid, said driving gear being removable and driven from said rotatable gear by an adjustable drive, whereby a driving gear of any predetermined number of teeth can be connected to said timing means.

25. In a grid-making machine, a winding arbor having a longitudinal axis and a pair of supporting surfaces parallel to said axis, each adapted to support a side rod upon which a winding wire is to be wound to form a grid, a winding head for carrying the winding wire around said side rod and winding said wire upon said side rod, and a spool carrying a quantity of said winding wire from which said wire is led to said winding means, said spool being removably mounted on said winding head with its axis concentric with said longitudinal axis of said arbor and adapted to rotate around its axis, a pair of cutters for cutting notches in said side rods into which notches said winding wire is adapted to be laid, a pair of swedges for swedging said rods upon said winding wire, a carriage, said swedges being mounted on said carriage, said carriage being pivoted to rotate from a normal position in front of said winding head to permit replacement of said winding wire spool, and driving means mounted on said machine and disconnected from said swedges but being adapted to drive said swedges solely by impact members, whereby said rotation of said carriage can occur without disturbing said driving means.

26. In a grid-making machine, a grid-forming mechanism adapted to wind and secure a winding wire around an elongated side rod wire to form successive grids, including winding means for carrying the winding wire around said side rod and winding said wire upon said side rod, feeding means for advancing said side rod with said winding wire thereon through said machine, and means for driving said winding means from said driving shaft including a reversible gear mechanism for determining the direction of winding of said winding wire on said side rod wire.

27. In a grid-making machine, a winding arbor having a supporting surface to support a side rod upon which a winding wire is to be wound to form a grid, a cutter for cutting notches in said side rod into which notches said winding wire is adapted to be laid, a swedge for swedging said rod upon said winding wire, and means for causing said cutter and swedge to deliver cutting and swedging strokes respectively to said side rod, said cutter being circular and having a cutting edge around its periphery, said cutter during its cutting strokes being adapted to move alternately in a forward and reverse direction, a relatively stationary actuating member, said cutter during its movement in one of said directions moving past said actuating member, said actuating member operatively engaging said cutter during its travel in one of said directions to impart to said cutter a rotation sufficient to advance the active portion of the cutting edge slightly beyond the preceding active portion of said cutting edge, said cutter being adapted to travel in the opposite direction without being operatively engaged by said actuating means.

HENRY M. WASHBURN.

CERTIFICATE OF CORRECTION.

Patent No. 2,181,288. November 28, 1939.

HENRY M. WASHBURN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 12, second column, line 16, claim 11, strike out the word "straight"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of January, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.