

Jan. 10, 1956

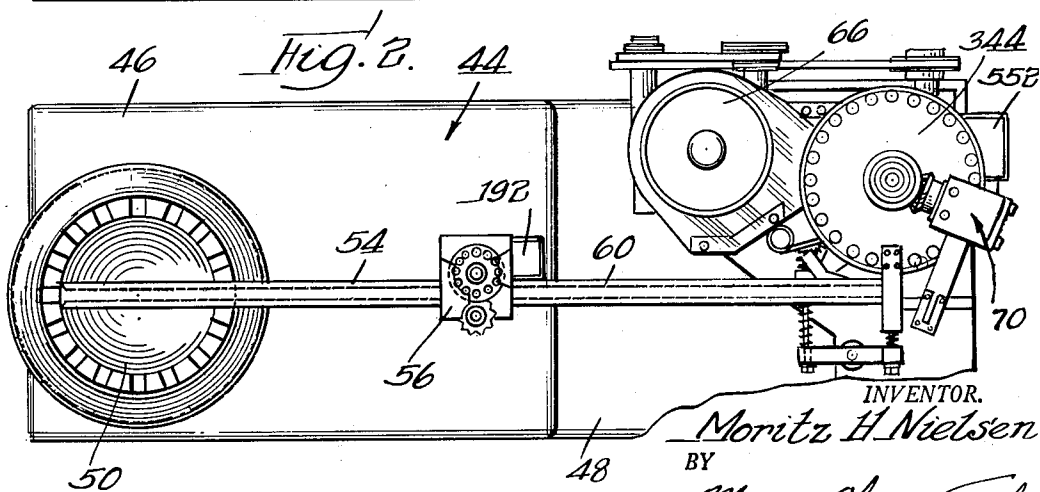
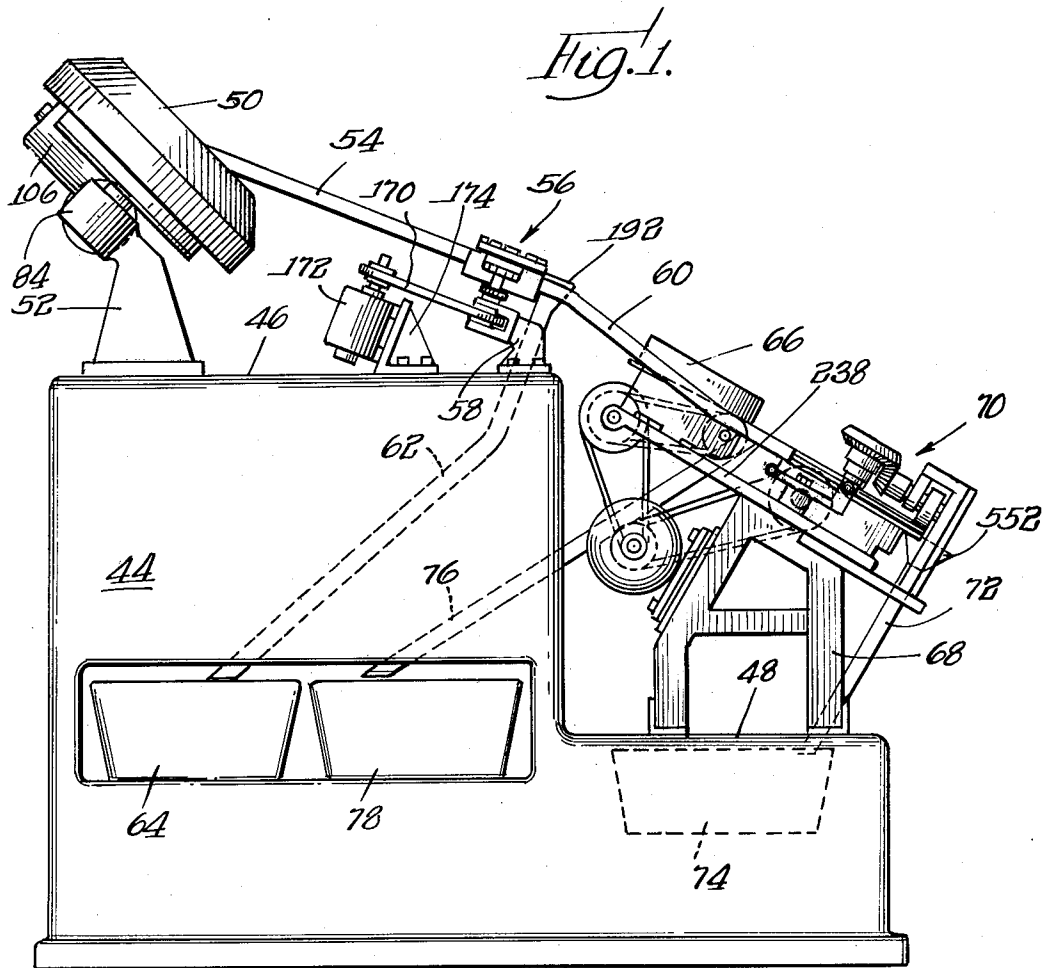
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 1



INVENTOR.

Moritz H. Nielsen

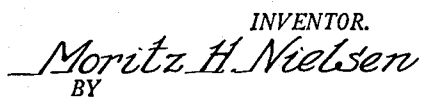
BY

Moore, Olson & Truitt
Atty.

M. H. NIELSEN

ASSEMBLY MACHINE AND METHOD

13 Sheets-Sheet 2



Moore, Olson & Treiber
Attys.

Jan. 10, 1956

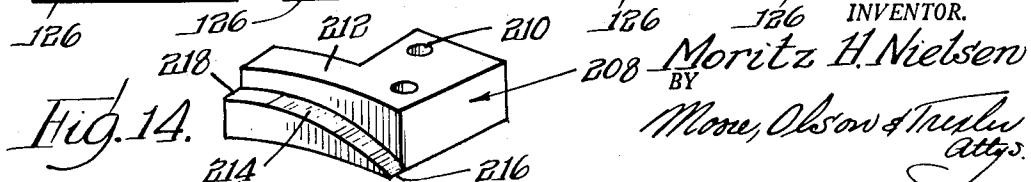
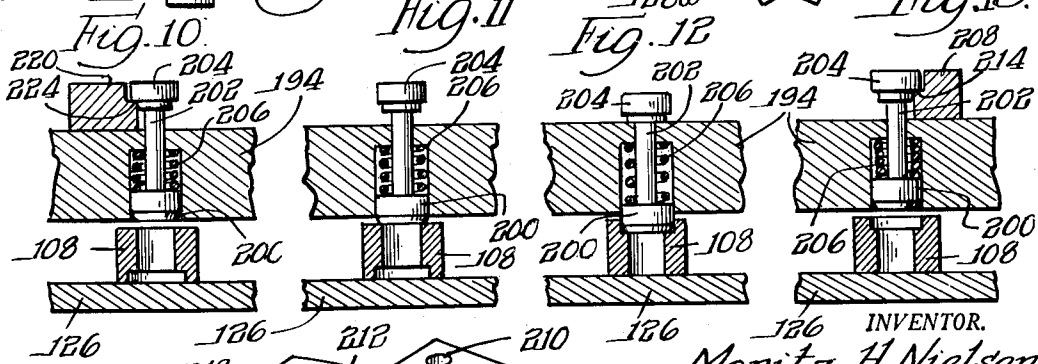
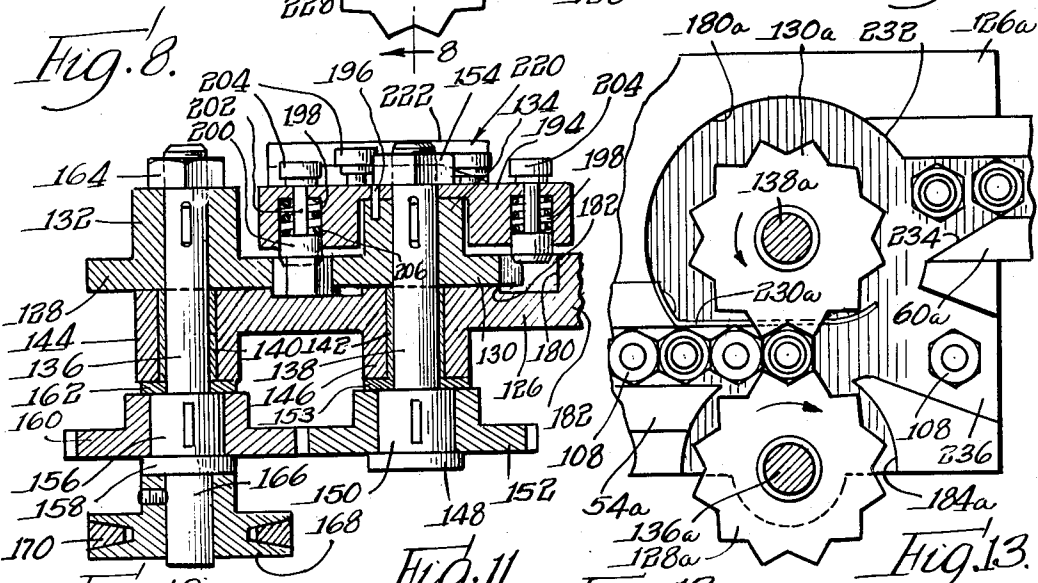
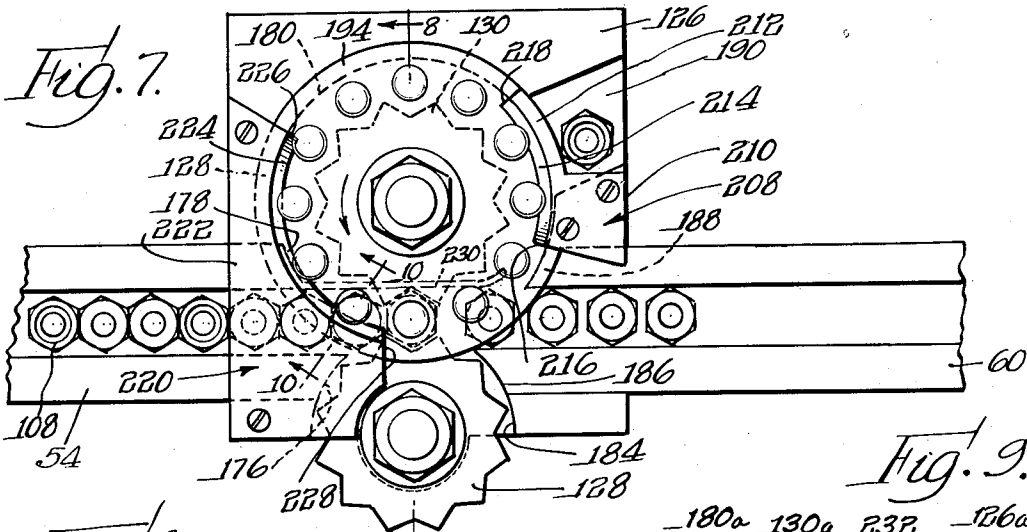
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 3



26 126 INVENTOR.
3 Moritz H. Nielsen
BY
More, Olson & Threlk
Attys.

Jan. 10, 1956

M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 5

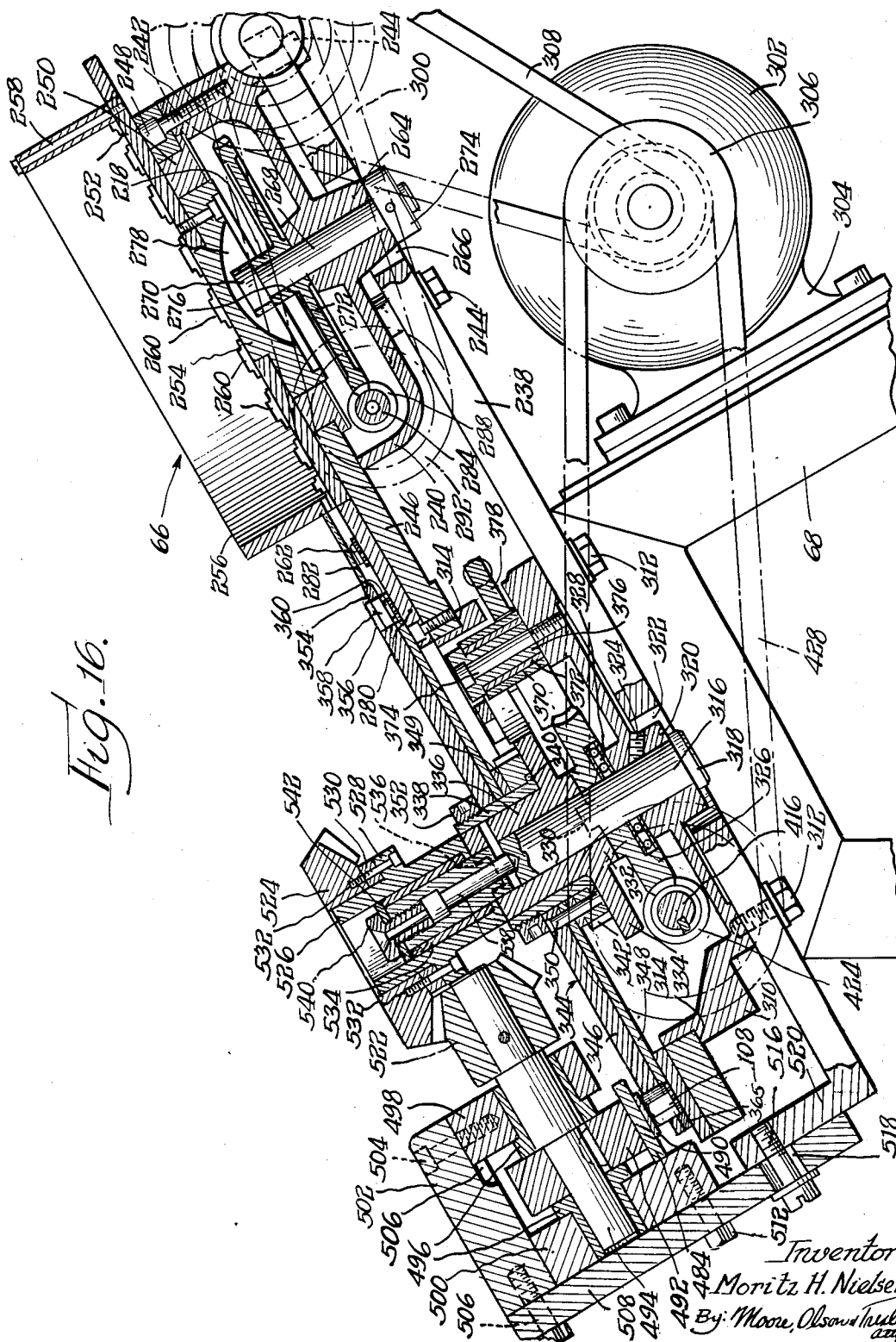


Fig. 16.

Inventor
Moritz H. Nielsen
By: Moore, Olson & Nielsen
attys

Jan. 10, 1956

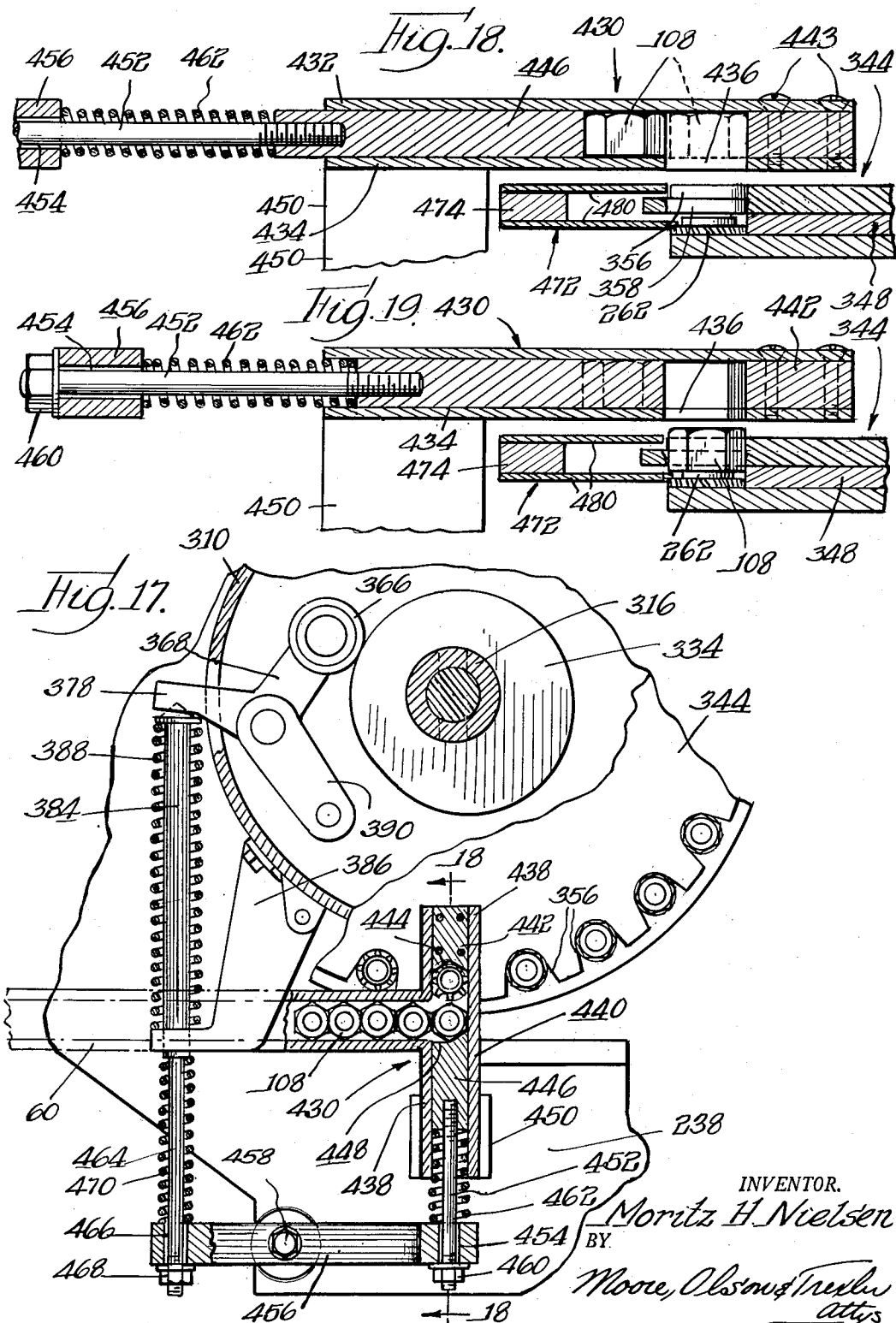
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 6



Jan. 10, 1956

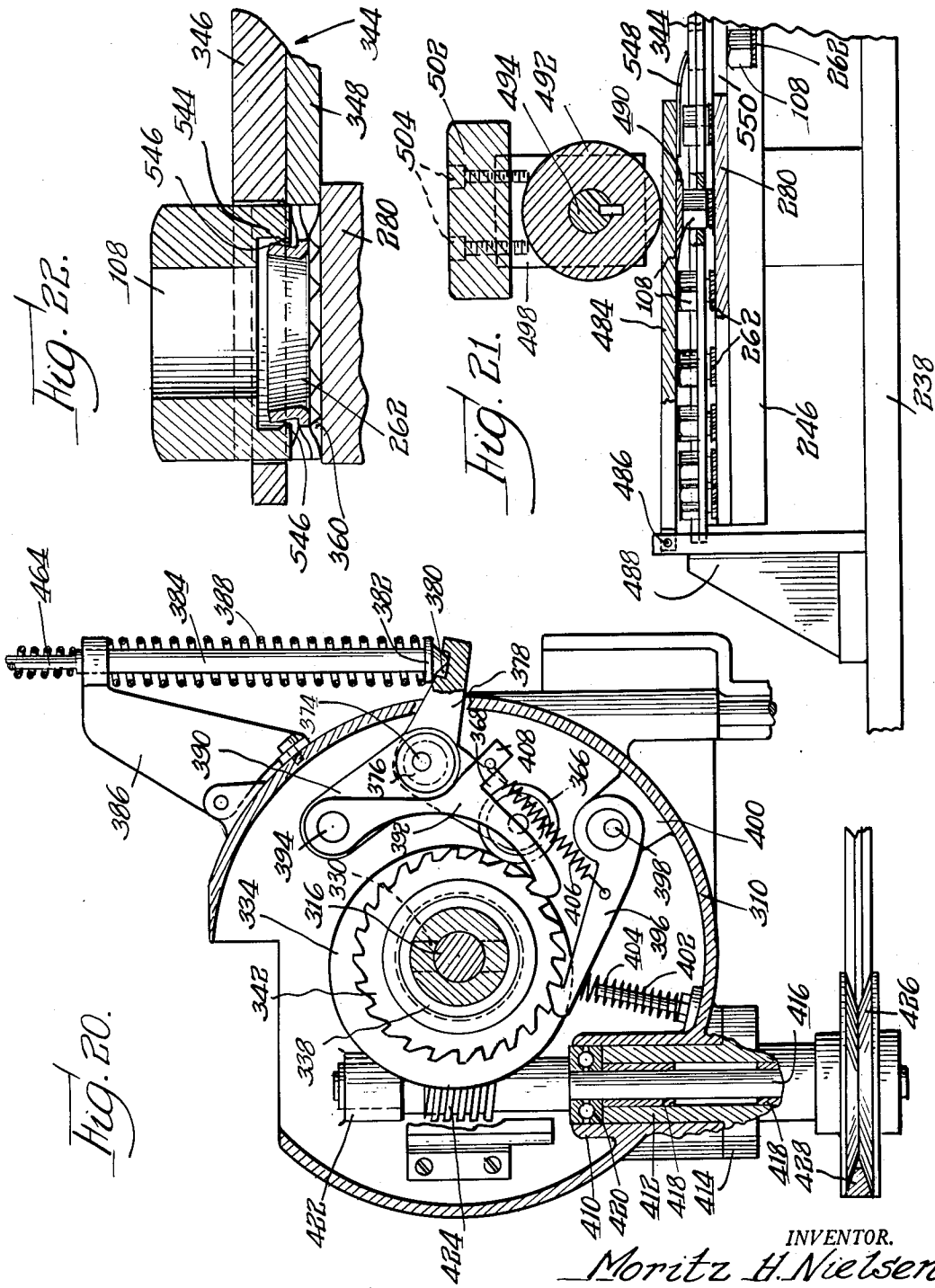
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 7

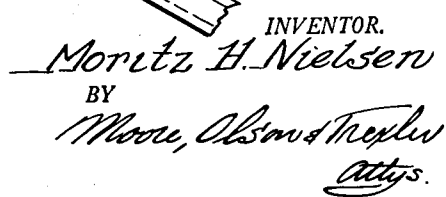


INVENTOR.
Moritz H. Nielsen
BY
Moore, Olson & Taylor
attys

M. H. NIELSEN

ASSEMBLY MACHINE AND METHOD

13 Sheets-Sheet 8



Jan. 10, 1956

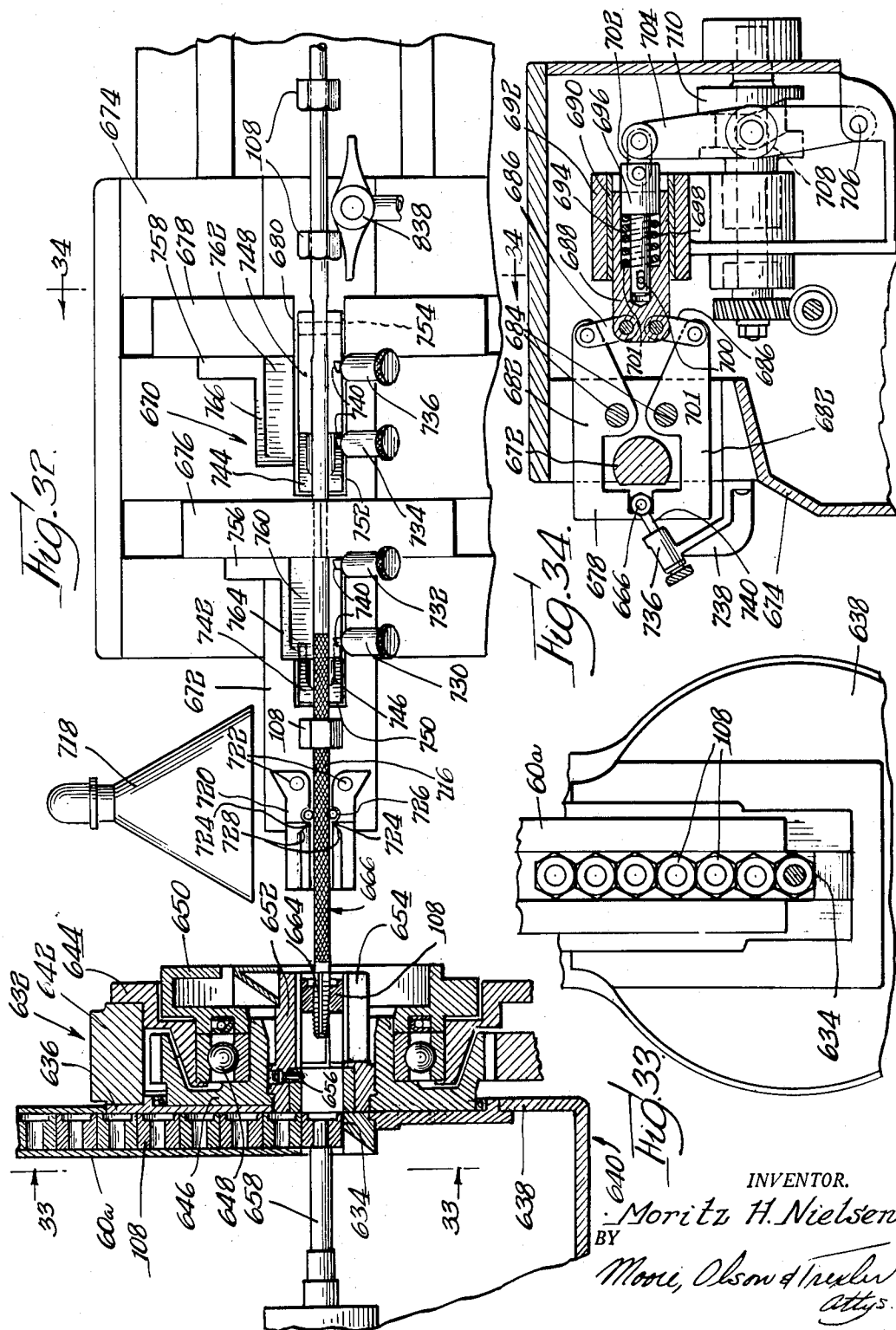
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 11



Jan. 10, 1956

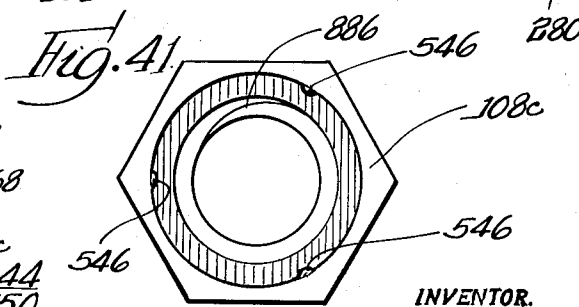
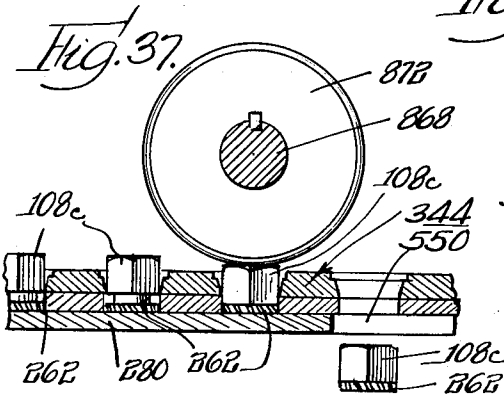
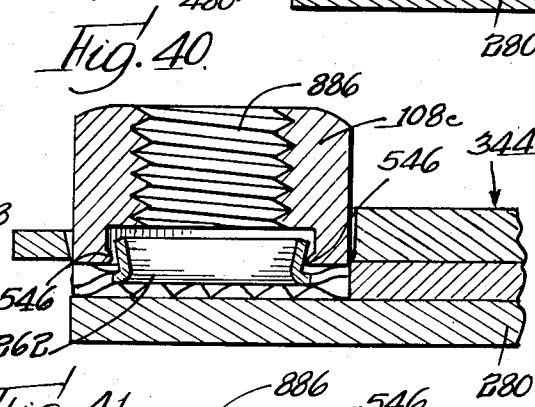
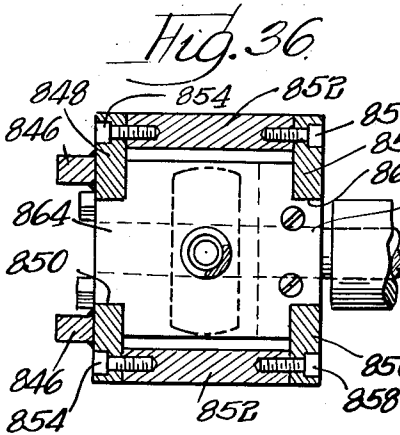
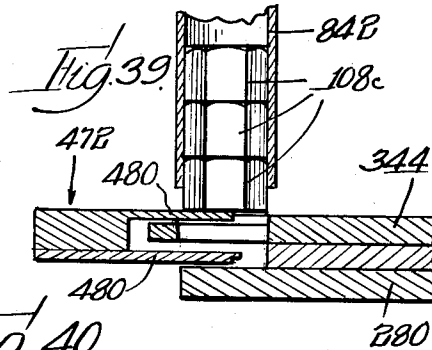
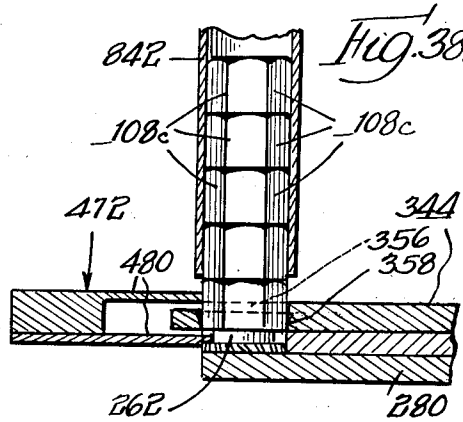
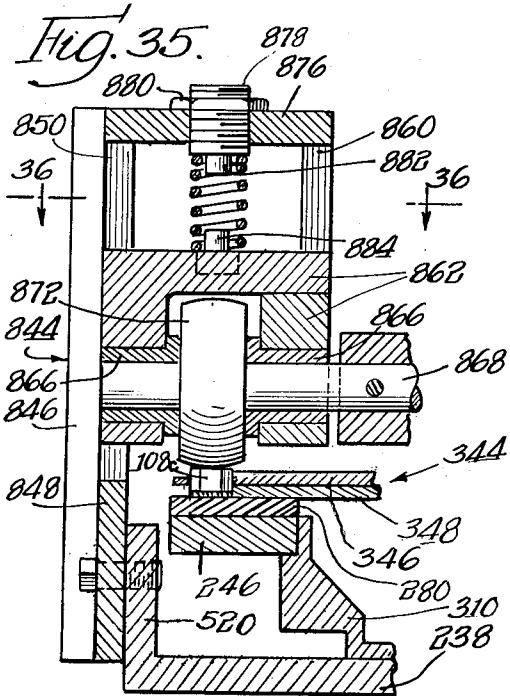
M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 12



INVENTOR.

Moritz H. Nielsen

BY

Moose, Olson & Neff
attys.

Jan. 10, 1956

M. H. NIELSEN

2,729,833

ASSEMBLY MACHINE AND METHOD

Filed Nov. 4, 1950

13 Sheets-Sheet 13

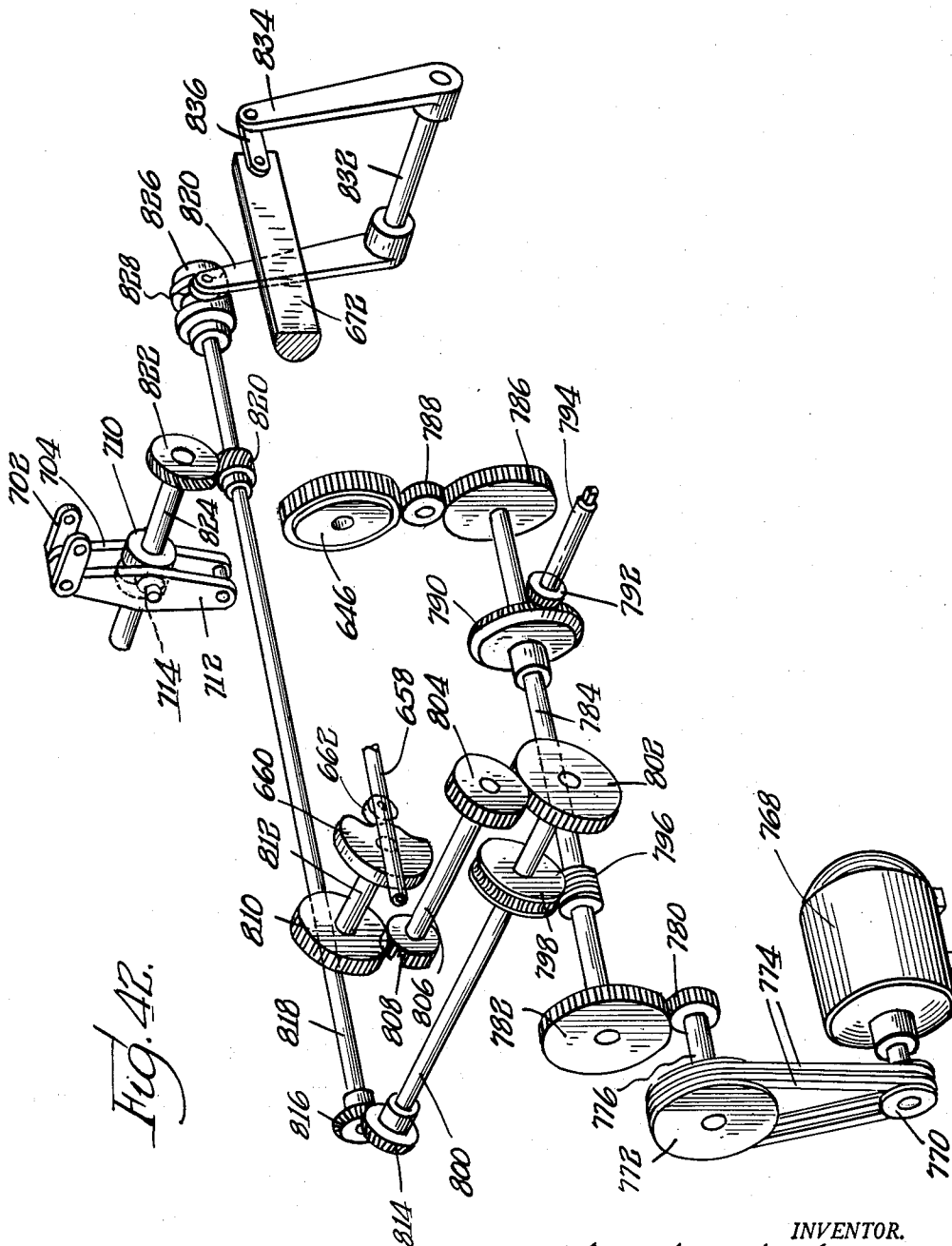


Fig. 42.

INVENTOR.

Moritz H. Nielsen

BY

Moore, Olson & Tupper
attys.

1

2,729,833

ASSEMBLY MACHINE AND METHOD

Moritz H. Nielsen, Chicago, Ill., assignor to Illinois Tool Works, Chicago, Ill., a corporation of Illinois

Application November 4, 1950, Serial No. 194,148

17 Claims. (Cl. 10—72)

This invention is concerned with a method and machine for manufacturing assembled nut element and washer units.

The present invention resides in a method and machine wherein individual nut elements from a random mass of nut elements are assembled with individual washers from a random mass of washers. The nut elements in the random mass may be threaded or unthreaded and, in the illustrative example shown and described herein, the nut elements in the random mass are unthreaded. In one modification of the invention, the unthreaded nut elements are assembled with washers and then are discharged from the machine following which they may be threaded in other apparatus, and in another modification the unthreaded nut elements are threaded immediately prior to assembly with the washers.

It is an object of this invention to provide an improved method and machine for assembling nut elements and washers.

A further object of this invention is the provision of a method and machine for assembling nut elements and continuous ring metallic lock washers.

A more specific object of this invention is the provision of a machine and method for inserting the skirt of a lock washer into a nut element permanently to secure said nut element and lock washer together as a unit.

It is a particular object of this invention to provide a method and apparatus for assembling toothed lock washers with discrete nut elements.

Yet another object of this invention is the provision of a machine and method for assembling nut elements and washers from random masses of nut elements and random masses of washers.

It is another object of this invention to provide apparatus for feeding a succession of washers along a predetermined path, for dropping nut elements into engagement with said washers, and thereafter forcing said nut elements and washers into telescopically assembled relation.

A still further object of this invention resides in the provision in apparatus for assembling nut elements and washers, of a disc for feeding individual washers and for receiving nut elements in alignment with said washers.

A further object of this invention resides in the provision in a machine for assembling nut elements and washers, of apparatus for sensing the orientation of nut elements and rejecting those which are improperly oriented.

A more specific object resides in the provision of apparatus as set forth in the foregoing object wherein means is provided for orienting improperly oriented nut elements.

Yet another object of the current invention resides in the provision of a method and apparatus for selecting unthreaded nut elements from a random mass, tapping the nut elements and thereafter telescopically assembling the nut elements with washers.

2

Other and further objects and advantages of the invention will be apparent when taken in connection with the accompanying drawings wherein:

Fig. 1 is a side view of a machine embodying the principles of my invention.

Fig. 2 is a top view of the machine.

Fig. 3 is an enlarged view partially in section of the nut hopper and nut selecting mechanism.

Fig. 4 is a top view of the mechanism of Fig. 3.

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 4.

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 4.

Fig. 7 is a further enlarged fragmentary view of the nut selecting mechanism.

Fig. 8 is a sectional view along the line 8—8 of Fig. 7.

Fig. 9 is a view similar to Fig. 7 showing a modification of the selecting mechanism.

Fig. 10 is a sectional view taken along the line 10—10 of Fig. 7.

Figs. 11—13 are similar to Fig. 10, showing the parts in different positions.

Fig. 14 is a perspective view of a cam member comprising a part of the nut selecting mechanism.

Fig. 15 is an enlarged plan view of the washer hopper and assembly mechanism.

Fig. 16 is a sectional view taken substantially along the line 16—16 of Fig. 15.

Fig. 17 is an enlarged plan view partially in section of a positive nut feeding mechanism.

Fig. 18 is a sectional view taken substantially along the line 18—18 of Fig. 17.

Fig. 19 is a view similar to Fig. 18 showing the parts in a different position.

Fig. 20 is a top view partially in section of the intermittent motion mechanism driving the assembly disc.

Fig. 21 is a sectional view taken along the line 21—21 of Fig. 15.

Fig. 22 is an enlarged sectional view of a nut element and washer immediately following assembly.

Fig. 23 is a fragmentary plan view showing a modified form of nut selector.

Fig. 24 is a view of a portion of the nut selector shown in Fig. 23 with certain parts removed for clarity of illustration.

Fig. 25 is a sectional view taken along the line 25—25 of Fig. 24.

Fig. 26 is a sectional view taken along the line 26—26 of Fig. 23.

Fig. 27 is a sectional view showing the telescoping mechanism of a modified form of the apparatus.

Fig. 28 is a fragmentary plan view of the mechanism of Fig. 27.

Fig. 29 is an enlarged sectional view of a portion of the telescoping mechanism of Fig. 27.

Fig. 30 is a sectional view showing a nut element and washer being secured in telescoping relation.

Fig. 31 is a side view similar to Fig. 1 showing a modified form of the apparatus wherein unthreaded nut elements are tapped prior to assembly with washers.

Fig. 32 is an enlarged sectional view of the tapping mechanism of the machine shown in Fig. 31.

Fig. 33 is a view taken along the line 33—33 of Fig. 32.

Fig. 34 is a sectional view taken along the line 34—34 of Fig. 32.

Fig. 35 is a sectional view showing a modified telescoping apparatus.

Fig. 36 is a sectional view taken along the line 36—36 of Fig. 35.

Fig. 37 is a side view of a portion of the apparatus of Fig. 35.

Fig. 38 is a sectional view of a gravity nut feeding apparatus.

Fig. 39 is a view similar to Fig. 38 showing the parts in a different position.

Fig. 40 is a sectional view of a threaded nut element and washer immediately following assembly.

Fig. 41 is a bottom view of the nut element and washer of Fig. 40; and

Fig. 42 is a perspective view showing the drive connections of the assembly machine shown in Figs. 31-34.

Referring first to Figs. 1 and 2 of the drawings for a general overall picture of apparatus embodying the principles of my invention, an assembly machine may be seen to include a base or pedestal 44 having upper and lower tables or supporting surfaces 46 and 48 respectively. An inclined nut feeding hopper 50 is supported by means of a base member 52 secured atop the upper table 46 by any convenient means, such as screws or bolts. A nut feeding chute 54 leads from the nut hopper 50 to a nut selector 56 supported by a bracket 58 on the upper table 46. The nut selector passes properly oriented nuts down a second nut feeding chute 60 and drops improperly oriented nuts through a discharge chute 62 into a removable container 64.

A washer hopper 66 is carried by a base 68 mounted atop the lower table 48 and feeds washers to an assembly mechanism 70 where they are assembled with nut elements from the second nut feeding chute 60. The assembled units of nut elements and washers are then dropped through a chute 72 into a container 74. Provision is made for feeding any excess washers from the hopper 66 through a discharge chute 76 to a receptacle 78 to prevent jamming of washers in the assembly mechanism.

The nut hopper

As shown in detail in Figs. 3-6, the nut hopper 50 includes a rotatable base plate 80 suitably secured to a hollow drive shaft 82 extending from a gear box 84 carried by the base member 52. The base plate 80 carries an annular spacer 86 atop its outer surface and the annular spacer, in turn, carries a collector ring 88. A hood 90 is fitted over the outer edge of the collector ring 88 and has a relatively large central opening 92. The top surface of the collector ring 88 is provided with a plurality of spaced radial grooves or slots 94, each of which is slightly wider than the diagonal of the nut elements to be handled.

Stationary shaft 96 extends co-axially with the hollow drive shaft 82 from the gear box 84 and slightly therebeyond, there being an anti-friction bushing 98 fitted between the two shafts. The dished out disc or plate 100 is non-rotatably fixed on the extending end of the stationary shaft 96 and fits within the central aperture of the collector ring 88. The upper edge of the periphery of the disc 100 substantially coincides at its lowest portion with the upper surface of the collector ring 88 as shown at 102 and is progressively relieved so as to lie slightly below the bottoms of the grooves 94 at its upper edge as shown at 104.

A motor 106 (Fig. 1) is carried by the base member 52 and acts through suitable gears in the gear box 84 to rotate the collector ring 88 and hood 90 through the intermediary of the hollow drive shaft 82, base plate 80, and annular spacer 86. As the collector ring and hood rotate, nut elements 108 from a random mass 110 on the collector ring 88 and within the hood 90 collect in the lower radial grooves or slots 94 as shown in Figs. 4 and 6. There is no tendency for the nut elements to leave the grooves 94 until the elements have been carried past the horizontal diameter of the collector ring 88. To prevent the nut elements from leaving the slots above this diameter, there is provided a baffle 112. The baffle 112 is substantially coincident with the inner edge of the collector ring 88 and is mounted on the disc or plate 100 by means such as screws or other fasteners

passed through a lateral ear 114 integral with the baffle 112. Also mounted on the plate 100 is a bracket 115 supporting the nut feeding chute 54.

The nut feeding chute 54 comprises a pair of spaced rails 116 secured atop an elongated plate 118 or, if desired, the plate and rails may be formed integrally. The top surface of the plate 118 is contiguous with and lies just slightly below the bottoms of the grooves 94 as the grooves reach their uppermost position so that nut elements 108 slide from the grooves 94 in the uppermost position into the chute 54. The uppermost ends of the rails 116 are beveled as at 120 to facilitate reception of nut elements, and the collector ring is rotated at a sufficiently low rate of speed that several nut elements may pass from each groove into the chute. The trailing rail 116 (the upper one in Fig. 4) may have its upper end relieved if desired positively to preclude any chance of nuts jamming against this end of the rail. In order to prevent nut elements which may be standing on edge or in any position other than flat on one face from passing into the chute 54, the baffle 112 is provided with an integral finger 122 extending past the receiving end of the chute 54 as best may be seen in Fig. 5. The chute 54 preferably is provided with a thin top plate 124 overlying the rails 116 positively to maintain nut elements 108 in proper position in the chute 54.

The nut selector

The nut elements 108, as fed through the chute 54, are of the counter-sunk type having a depending peripheral flange and may be either right side up, as shown in Figs. 10 and 11 or may be upside down, as shown in Figs. 12 and 13. The nut elements are fed by the chute 54 to the nut selector 56 where nuts which are right side up are passed on to the assembly mechanism and nuts which are upside down are dropped through the discharge chute 62 into the receptacle 64 from whence they may be transferred back to the nut hopper 50.

The nut selector, as shown generally in Figs. 1, 2 and 4 and in detail in Figs. 7-14, comprises a base or plate 126 carried on an upstanding portion of the bracket 38. A pair of star wheels 128 and 130 is mounted above the plate 126. The star wheels are provided with serrated peripheries and have integral upstanding hubs 132 and 134 which are keyed to shafts 136 and 138 respectively. The shafts 136 and 138 are journaled in sleeve bearings 140 and 142 extending through the plate 126 and through bosses 144 and 146 which may be integral with the plate 126 or may be separate sleeves secured to the plate in any desirable manner. The shaft 138 is provided at its lower end with a head 148 and a portion 150 of larger diameter than the remainder of the shaft. A pinion 152 is keyed to the enlarged portion 150 and is held tight against a washer 153 by a nut 154 threaded on the upper end of the shaft 138. The shaft 136 is provided with a portion 156 of enlarged diameter and a flange 158 similar to the enlarged portion and head of the shaft 138. A pinion 160 is keyed to the enlarged portion of the shaft 136 and is in driving engagement with the pinion 152. The pinion 160 is held against a washer 162 by means of a nut 164 threaded on the upper end of the shaft 136. The shaft 136 has a lower depending portion 166 to which a pulley wheel 168 is suitably secured. The pulley 168 is driven by a flexible belt 170 extending between it and the driving pulley of a motor 172 (Fig. 1) supported by a bracket 174 suitably secured to the upper table 46.

The lower end of the nut feeding chute 54 is arcuately beveled as at 176 and at 178, and fits within a slotted portion of the plate 126. The arcuate end 176 of the chute 54 is spaced very slightly from the star wheel 128 and the arcuate end 178 of the chute 54 is spaced somewhat from the periphery of the star wheel 130. The slot or guide track in the nut feeding chute 54 extends tangentially into a circular relieved portion 180 in the top surface of the plate 126, the star wheel 130 being carried in this relieved portion and spaced slightly above the

5

bottom surface thereof by a shoulder portion 182. The star wheel 128 fits in a semicircular relieved portion 184 in the top surface of the plate 126, this relieved portion being in part coextensive with the relieved portion 180 and forming a continuous arc with the arcuate end 176 of the nut feeding chute 54. The second nut feeding chute 60 is aligned with the chute 54 and fits in a suitable groove in the top of the plate 126. The chute 60 is of substantially the same construction as the chute 54 except that it is provided with a central portion of greater inclination than its end portions which are inclined at substantially the same angle as the chute 54. The cover plates or top retaining flanges of both of the chutes 54 and 60 have been omitted in Fig. 7 for clarity of illustration.

The top end of one of the rails of the chute 60 is formed as an arc 186 which is a continuation of the semicircular relieved portion 184, and the top end of the other rail is formed as an arc 188 which, like the arc 178, of the chute 54, forms a continuation of the circular relieved portion 180.

A further relieved portion or groove 190 is provided leading substantially radially from the circular relieved portion 180 to the funnel shaped open upper end 192 (Figs. 1, 2, and 4) of the discharge chute 62.

A disc or wheel 194 (Figs. 7 and 8) is mounted on the shaft 138 above the star wheel 130 and the bottom of this wheel is counterbored to receive the upstanding hub 134 of the star wheel 130 so that the bottom face of the disc 194 may be carried in spaced relation to the top face of the two star wheels. A pin 196 fixes the disc 194 to the star wheel 130 for rotation therewith, and the nut 154 clamps down against the top face of the disc 194. The disc 194 is provided with a plurality of equally spaced cylinders 198 opening downwardly of the disc. Pistons or plungers 200 are carried within the cylinders 198 on shafts 202 which extend upwardly through the disc where they are secured to shouldered heads 204. Coil springs 206 normally urge the plungers 200 downwardly, the lowestmost position being limited by abutment of the heads 204 against the top face of the disc 194.

A cam member 208 (Figs. 7 and 14) is secured to the base plate 126 and partially overlaps the disc 194. The cam member 208 comprises a mounting block 210 through which a pair of screws is passed and threaded into the plate 126 to secure the cam member in position. An arcuately extending arm 212 formed integrally with the mounting block 210 is provided with a cam surface 214 rising from the leading edge 216 to the trailing edge 218, the leading and trailing edge being determined relative to the direction of rotation of the disc 194.

A second cam member 220 (Figs. 7 and 8) is provided substantially diametrically opposite to the first one and comprises a mounting block 222 through which is passed a pair of screws to secure the cam member to the plate 126. The cam member 220 is provided with a cam surface 224 rising from its leading edge 226 to its trailing edge 228 which is positioned slightly to the upstream side of the center line of the star wheels 128 and 130. Both of the cam surfaces 214 and 224 comprise arcs of a single circle and have their innermost edges positioned slightly inwardly of the outermost portion of the heads 204.

As seen in Figs. 7 and 8, and particularly in the sequence diagrams of Figs. 10 and 11, the cam surface 224 of the cam member 220 engages beneath the shouldered portion of each head 204 and lifts it against the action of the spring 206 to raise the piston or plunger 200. Advance of the nut elements 108 is timed by the star wheels 128 and 130 which form, in effect, a succession of nut receiving pockets, as best seen in Fig. 7. The disc 194 and nut elements 108 thus advance in synchronized relation, and just as one of the plungers 200 becomes aligned with a nut element 108, it moves from the trailing edge 228 of the cam surface 224 and impinges against the top face of a nut element 108 under the action of the spring 206 as shown in Fig. 11. If

6

(as in Figs. 10 and 11) the nut element is right side up, that is with the countersunk face down, the plunger rides atop the nut element as the diameter of the plunger is somewhat greater than the bore of the nut element. An elongated leaf spring 230 extending from the arcuately beveled end 178 of the nut feeding chute 54 maintains the nut element 108 in alignment with the nut feeding chutes 54 and 60 and allows the plunger 200 to slide off the top of the nut element.

Should the nut element be upside down, as shown in Figs. 12 and 13, the plunger 200 enters the counterbore of the nut element under the action of the spring 206. The lower periphery of the plunger 200 is beveled to facilitate entry of the plunger into the counterbore of the nut element. Each nut element that is so engaged by a plunger 200 is carried from the straight forward path of the chutes 54 and 60 to pass the leaf spring 230. The leading edge 216 of the cam surface 214 then engages beneath the shouldered portion of the head 204 to lift the plunger from the nut element 108 and the nut element then slides through the groove 190 under the influence of gravity and drops into the open upper end 192 of the discharge chute 62 from whence it passes into the receptacle 64.

It is contemplated that the nut selector could be used with other types of longitudinally asymmetrical nut elements such as cone type nut elements and for the latter type the plungers 200 are provided with recesses in their lower faces interfitting with the cone ends of the nut elements. The remainder of the nut selector and the operation thereof remains as described heretofore.

In a modification of my invention to be described later, it is necessary that nut elements should be delivered with the counterbored faces up, as will be explained subsequently. For this purpose, I have provided the modification of the nut selector shown in Fig. 9. Similar parts of this modification are identified by the same numerals as heretofore with the addition of the subscript "a" to obviate the necessity of duplicated explanation. In Fig. 9 the disc and cam members have been omitted for clarity of illustration as they are identical with those shown and described heretofore. A base plate 126a is provided with a circular relieved portion 180a and with a semicircular relieved portion 184a in overlapping relation. A groove accommodates the lower end of a nut feeding chute 54a identical with the chute 54 and a leaf spring 230a extends longitudinally from the inner rail of the chute. A second nut feed chute 60a is provided in a groove in the position of the groove 190 in the modification heretofore shown and described. The upper end of one of the chutes 60a comprises an arc 232 which is a continuance of the periphery of the relieved portion 180a and the upper end of the other rail is chamfered at 234 to facilitate the entrance of nut elements into the chute 60a. A substantially radial groove 236 is formed in the base plate 126 in substantially the same location occupied by the nut feeding chute 60 in the earlier described modification. Star wheels 128a and 130a are mounted on shafts 136a and 138a and rotate in synchronism as set forth hereinbefore. Operation of the modification of Fig. 9 is identical with that of the earlier modification except that nuts having their counterbored faces up are delivered to the second nut feeding chute 60a while nuts that have their counterbored faces down pass through the groove 236 to be returned to a discharge receptacle.

The washer hopper

The washer hopper 66 is shown in detail in Figs. 15 and 16 and is carried by a plate 238 supported by the base 68. A hollow substantially cup shaped housing 240 is provided with a plurality of radially extending ears or lugs 242 abutting against the plate 238. The lugs 242 are provided with tapped bores which receive bolts 244 passed through the plate 238 to secure the

housing in position. A bearing plate 246 having a smoothly finished upper surface is secured atop the housing 240 by countersunk screws or bolts 248 threaded into the ears or lugs 242. The bearing plate 246 clamps a shouldered bearing ring 250 against a shoulder in the housing 240. A ring-like plate 252 fits atop the bearing ring 250 and bearing plate 246 and is secured to a central block or plate 254. A cylindrical wall 256 extends upwardly from the periphery of the ring-like plate 252 and is secured to this plate by screws or bolts 258 passing through the wall 256 and threaded into the plate. The bottom edge of the cylindrical wall 256 is provided with a plurality of spaced apertures 260 complementary in shape to the skirted washers 262 (one of the washers being shown in profile in Figs. 18 and 19) and are slightly larger than the washers. The apertures cause the hopper to act as a selector as only washers having their flanges up can fit through the apertures as the wall 256 rotates.

The lower wall of the housing 240 is provided with a boss 264 extending downwardly through an aperture 266 in the plate 238 and upwardly a short distance above the bottom wall of the housing. A short shaft 268 is journaled in the boss 264 and has an enlarged head 270 securing a worm wheel 272 down against the top of the boss 268. A retaining collar 274 is pinned to the lower end of the shaft 268 to secure it in position. The worm wheel 272 is provided with an upwardly extending hub 276 which is keyed to the shaft 268 to cause the shaft to rotate with the wheel. The head 270 of the shaft 268 is square and is received in a flat sided slot 278 to cause the center block or plate 254, the ring like plate 252, and the cylindrical wall 256 to rotate. Such rotation (at a relatively low speed to prevent jamming due to centrifuging) causes a mass of washers in the hopper 66 to sift through the apertures 260 and down a plate 280 carried atop the bearing plate 246 and contiguous with the periphery of the ring like plate 252. A transparent plastic guard plate 282 is spaced above the plate 280 by spacers 283 to maintain the washers 262 flat against the plate 280. The transparency of the guard plate 282 allows any jam to be located instantaneously.

A shaft 284 is journaled in suitable bearings 286 in the side wall of the housing 240 and carries a worm 288 in driving engagement with the worm wheel 272. A retaining member 290 is pinned to one end of the shaft and a plurality of integral pulleys 292 is pinned to the other end of the shaft (the pulleys being indicated in dot-dash lines in Fig. 16 to show the relative position of this and the other driving members). A second multiple pulley 294 is carried by a stub shaft 296 suitably carried by a mounting block 298 supported by the plate 238. A belt 300 extends between the multiple pulleys 292 and 294. A drive motor 302 is supported by a bracket 304 carried by the base 68 and is provided with a multiple pulley 306. A belt 308 extends between the pulleys 306 and 294. The belt 300 is placed over whichever of the pulleys are necessary to drive the hopper at the proper speed.

The assembly mechanism

A housing casting 310 (Figs. 16, 17 and 20) is supported by the plate 238 to which it is secured as by bolts 312 and is provided with an upper peripheral shoulder 314 which underlies the lower portion of the bearing plate 246, this plate being apertured to accommodate the open upper end of the housing casting 310. An upstanding shaft 316 having a head 318 at its lower end is carried in a boss 320 on the lower portion of the housing casting 310, which boss is accommodated by an aperture 322 in the plate 238. The shaft 316 is secured in place by a set screw 324 and a worm wheel 326 is journaled on the shaft with an anti-friction bearing 328 between the worm wheel and boss 320. The worm wheel 326 has an integral hub having a pair of upstanding lugs 330 interfitting with slots in the depending hub 332 of a cam 334. The cam has

an upstanding integral sleeve 336. A bearing sleeve 338 having a peripheral flange 340 at its lower end and threaded at its upper end fits over the top portion of the sleeve 336 and rests against the top face of the cam 334.

A ratchet wheel 342 fits about the bearing sleeve 338 and has a shouldered portion receiving the peripheral flange 340. A washer advancing or driving disc 344 comprising a pair of plates 346 and 348 is spaced from the ratchet 342 by a washer or spacer 349 and fits about the bearing sleeve 338. The washer driving disc 344, the spacer 349, and the ratchet wheel 342 are secured together for simultaneous rotation by a pin 350 and these parts all are clamped together by a retaining ring 352 threaded on to the upper end of the sleeve 338.

The plate 346 of the washer drive disc 344 (Figs. 15 and 16) has a lower portion 354 having a periphery coinciding with the lower edge of the transparent plastic cover plate 282. An upper portion of the plate 346 has a slightly reduced diameter and is provided with a plurality of peripheral slots or notches 356. Apertures 358 extend completely through the plate 346 concentrically with the notches 356 and both the apertures and the notches have substantially the same diameter as the washers 262. The lower plate 348 of the washer driving disc 344 is of the same diameter as the upper portion of the top plate 346 and is provided with notches 360 similar to the notches 356. Washers 262 sliding down the plate 280 fit beneath the plate 346 of the washer driving disc and are received in the notches 360 of the lower plate 348 as the washer driving disc is rotated intermittently. Excess washers sliding across the plate 280 and not received in any of the notches 360 are advanced under the force of gravity and rotation of the disc 344 through a space 362 adjacent one of the spacers supporting the transparent cover plate 282 and fall into the funnel-like open upper end 364 of the discharge chute 76 which returns the excess washers to the receptacle 78. A retaining ring segment 365 (Fig. 16) is provided from the space 362 to the telescoping mechanism to prevent washers from leaving the notches 360 under the action of centrifugal force when the disc is operated at high speeds. The segment may be secured to the plate 280 by any suitable means such as screws.

The washer driving disc 344 is driven intermittently by mechanism shown in Figs. 16 and 20 and including the cam 334 and ratchet wheel 342 mentioned heretofore. A cam follower roller 366 is carried on the end of an arm 368 extending from and fixed to a sleeve 370. The sleeve 370 is mounted on a bearing 372 which is secured in position by a screw 374 extending through a rotatable plug 376 and threaded into the base of the housing casting 310. The screw is eccentric relative to the plug 376 so that the positioning of the plug relative to the cam 334 can be varied.

A second arm 378 fixed on the sleeve 370 is provided with a bearing cup 380 in which the conical end cap 382 of an abutment rod 384 bears. The other end of the rod is received in and guided by an aperture in a bracket 386 suitably secured to the side wall of the housing casting 310. A coil spring 388 is compressed between the end of the bracket 386 and the end of the arm 378 normally to maintain the roller 366 in contact with the cam 334. This in turn maintains the tooth of pawl 392 normally in engagement with the teeth of ratchet wheel 342 and serves both to advance the disc 344 and to index the disc as will be apparent hereinafter.

A third arm 390 is fixed to the sleeve 370 and has a pawl 392 pivoted at its outer end as at 394. A second pawl 396 is pivotally mounted at 398 on a bracket 400 extending inwardly from the side wall of the housing casting 310. The pivotal connection 398 may include a collar or sleeve and a bolt or screw eccentrically mounted therein similar to the pivotal connection 374, 376 to provide for adjustment of the pawl 396. A coil spring 402, which is guided

in position by a rod 404 is compressed between the side wall of the housing casting and the end of the pawl 396 so as normally to maintain this pawl in engagement with the ratchet wheel 342. A tension spring 406 extends between the pawl 396 and a laterally extending arm 408 on the pawl 392 so as normally to maintain this pawl also in engagement with the ratchet wheel 342.

A cylindrical extension or base 410 (Fig. 20) is provided in the side wall of the housing casting and this extension receives a sleeve 412 having a flange 414. A shaft 416 is mounted in the sleeve 412 by means of sleeve bearings 418 and a thrust bearing 420, the sleeve 412, shaft 416, and bearings 418 and 420 sliding as a unit into the cylindrical extension 410 where they may be secured by any suitable means, such as by passing screws through the flange 414 and threading them into the cylindrical extension 410. The inner extremity of the shaft 416 is journaled in a suitable bearing 422 upstanding from the bottom of the housing casting 310 and a worm 424 is keyed or otherwise fixed to the shaft 416 for rotation therewith. The worm 424 is in driving engagement with the worm wheel 326 on the disc drive shaft 316. A pulley 426 is secured to the outer end of the shaft 416 and a driving belt 428 extends between this pulley and the pulley 306 on the drive motor 302.

The pulley 426 and drive shaft 416 are driven continuously by the motor 302 and act through the worm 424 and worm wheel 326 to drive the cam 334 continuously. As the high spot of the cam approaches the cam follower roller 366, the arms 368, 378, and 390, and the sleeve or cylinder 370 are pivoted in a counter-clockwise direction against the action of the spring 388. This causes the pawl 392 to ratchet backwards past one tooth of the ratchet wheel 342, the pawl 396 preventing retrograde movement of the ratchet wheel 342. Movement of the high spot of the cam 334 past the cam follower roller 366 allows the arms 368, 378 and 390 to pivot clockwise under the action of the spring 388 and this causes the pawl 392 to advance the ratchet wheel 342 in a counter-clockwise direction. The pawl 396 ratchets backwards over the teeth of the ratchet wheel 342 and acts as an index properly to position the ratchet wheel 342. Movement of the ratchet wheel in this manner causes intermittent rotation of the washer driving or advancing disc 334 to which it is secured.

It is contemplated that nut elements 108 might be advanced from the second nut feeding chute 60 into proper position on the washer drive disc 344 to be telescoped with the washers 262 by gravity alone, but in one form of the invention I utilize a positive nut feeding mechanism 430 as shown in Figs. 17-19. The lower end of the nut feeding chute 60 is terminated by a nut element shifting mechanism disposed transversely thereof and including an upper horizontal plate 432 and a lower horizontal plate 434, the latter being provided with an aperture or discontinuity 436. Side plates 438 extend at right angles from the rails of the nut feeding chute 60, and these plates and a side plate 440 are suitably secured to the edges of the horizontal plates 432 and 434. The inner ends of the aforementioned plates overlie the washer driving or advancing disc 344 and the aperture 436 in the lower plate is aligned with the succession of apertures 358 and notches 356 in the washer driving disc.

The extreme inner end of the space defined by the plates 432, 434, 438, and 440 is closed by a plug 442 secured therein by any suitable means, such as screws 443. The end of the plug facing the space defined by the plates is provided with a vertical V-shaped face 443 complementary to the nut elements 108. The outer end of the space defined by the aforementioned walls is closed by a slide block or plunger 446 which is reciprocal within the space. The inner end of the plunger 446 is provided with a face 448, one portion of which forms a continuation of the nut feeding chute 60 and a second portion of which forms an angle of approximately 150 degrees therewith

to receive one side of a nut fed from the chute 60. The parts of the positive nut feeding mechanism 430 described heretofore are suitably supported by a bracket 450 upstanding from the supporting plate 238. A connecting rod 452 is threaded into the outer end of the plunger or slide block 446 and the outer end of the connecting rod fits through an aperture 454 in the end of a lever 456. The aperture 454 is somewhat larger in diameter than the connecting rod 452 in order that the lever 456 can pivot about its vertical pivot 458 without binding of the connecting rod and lever. A nut 460 is threaded on the outer extremity of the connecting rod 452 with a washer interposed between the nut and the lever 456 and a coil spring 462 is compressed between the end of the lever and the outer end of the plunger or slide block 446, the spring 462 encircling the connecting rod 452.

A connecting rod 464 threadably engages the outer end of the plunger or rod 384 (see also Fig. 20) and the outer end of this connecting rod fits through an enlarged bore 466 in the end of the lever 456 opposite to the bore 454. As the connecting rod 464 and the connecting rod 452 are on different levels, the former being below the washer driving or advancing disc 344 and the latter being above the disc, it is apparent that the arms of the lever 456 are offset vertically relative to one another. A nut 468 is threaded on the outer extremity of the connecting rod 464 with a washer interposed between the nut and the lever 456. The connecting rod 464 is smaller in diameter than the rod 384, and a compression spring 470 encircling the connecting rod 464 is compressed between the outer end of the rod 384 and the lever 456.

As the rod 384 reciprocates in timed relation with the washer advancing disc 344 under the action of cam 334 and spring 338, it acts through spring 470, lever 456, and spring 462 periodically to advance the plunger or slide block 446, the slide block being retracted positively by connecting rod 452, lever 456, and connecting rod 464. Nut elements 108 which are advanced by gravity through the nut feeding chute 60 (part of this chute being shown in dot-dash lines in Fig. 17 to show the parts below it in greater clarity) are advanced from a position of alignment with the chute 60 (Figs. 17 and 18) into alignment with a washer in the momentarily stationary disc 344 (dotted lines in Fig. 18) from which position it drops into engagement with a washer 262 as shown in Fig. 19.

A washer detector is provided in each modification of the invention to prevent the feeding of a nut to the washer advancing disc when no washer is in position to be assembled therewith. The washer detector 472 (Figs. 15, 18 and 19) in the embodiment now being described includes an arm 474 pivotally mounted on a bracket 476 extending from the side wall of the housing casting 310. A coil spring 478 is compressed between the tail end of the arm 474 and the side wall of the housing casting to urge the arm in a counter-clockwise direction as viewed from above. The arm is provided with a detector head comprising a pair of spaced apart plates 480. The lower of these plates bears against the outer edge of the plate 348 of the washer advancing disc 344 and against the peripheries of washers 262 present in the notches 360. If no washer is present in a notch, the inner end of the lower plate 480 moves into the notch and the inner end of the upper plate moves beneath the aperture 436 to prevent a nut element 108 from being dropped. The plates 480 are provided with an inclined edge 482 to allow the lower plate to be cammed out of an empty notch 360 upon further rotation of the disc 344.

The nut elements 108 as dropped upon the washers 262 are not telescoped with the washers, but merely rest atop them, and further apparatus is provided for telescoping the nuts and washers. The telescoping apparatus is shown in Figs. 15, 16, 21 and 22 and includes an arm 484 pivoted at one end at 486 to a bracket 488

upstanding from the plate 238. An abutment member 490 is welded to or formed integral with the arm 484 near the free end thereof and rides atop the succession of nuts passed therebeneath by the driving disc 344. A cam 492 engages the top surface of the arm 484 directly above the abutment member 490 and is keyed to a shaft 494 for rotation therewith. The shaft 494 is journaled in suitable bushings 496 fitting in bores in plates 498 and 500. The plate 498 depends from a supporting plate 502 to which it is connected by means of bolts 504 and a tooth and slot connection 506. The supporting plate 502 is secured as by bolts 506 to an upstanding wall 508. The wall 508 also supports the plate 500 by means of screws or bolts 512. The upstanding wall 508 is secured by a plurality of screws 516 fitting through slots 518 therein and threaded into a flange 520 upstanding from the plate 238.

A bevel gear 522 is pinned to the outer end of shaft 494 and is engaged with a bevel gear 524. The bevel gear 524 is mounted on a sleeve 526 having a circumferential flange 528. A spacer 530 is interposed between the bevel gear and the flange 528 and a plurality of screws 532 pass through the flange and spacer and are threaded into the bevel gear 524 to secure the gear to the sleeve 526. Spacers 530 of varying thicknesses are utilized to maintain the bevel gears 522 and 524 in proper engagement when the nut telescoping mechanism is raised or lowered by means of the screw in slot connection 518 to accommodate nuts of different thicknesses. The sleeve 526 is mounted on the shaft 316 with a suitable sleeve bearing 534 located between the shaft and sleeve and the sleeve 526 is rotated by the upstanding sleeve 336 of the cam 334 by means of a tooth and slot connection 536. The upper end of the shaft 316 is provided with a lubricating bore 538 and the upper end of this bore is tapped to receive an oil filler plug 540 which is screwed down against a washer 542 which, in turn, bears against the upper end of the sleeve bearing 534 to maintain the bevel gear 524 on the shaft 316 and in engagement with the bevel gear 522. Transverse oil holes in the shaft 316 and sleeve 336 communicate with the lubricating bore 538 properly to lubricate the bearing surfaces of the sleeve 336.

The cam 492 is rotated continuously in synchronism with the cam 334, and hence in timed relation with the intermittent motion of the washer driving or advancing disc 334. Each time the disc 334 is stationary, there is a nut element positioned directly below the abutment member 490 and the high spot on the cam forces the arm 484 down to telescope the nut element 108 with the washer 262.

A telescoped nut element 108 and washer 262 are shown in detail in Fig. 22. The washer 262 in the notches 360 in the lower plate 348 of the driving disc 344 rides atop the bearing plate 280. The washer 262 illustrated is of the metallic continuous ring type having radially directed twisted locking teeth and a substantially axially directed skirt flared slightly outwardly. The nut elements 108 are provided with depending skirts or flanges 544 fitting about the flared skirt of the washer 262. Each nut element skirt 544 is provided with a plurality of inwardly directed protuberances 546 which engage the skirt of the washer and maintain the washer and a nut element in telescoped relation. Alternately, the nut element skirt could be provided with a continuous inwardly directed flange, the flare of the washer skirt could be omitted, and the washer skirt could be provided with a plurality of protuberances directed outwardly.

A spring finger 548 extends from the free end of the arm 484 and pushes assembled nut elements and washers downwardly from the disc 344, the bearing plate 280 being relieved for this purpose at 550. The assembled nut elements and washers then fall into the funnel shaped open upper end 552 (Figs. 1 and 2) of the chute 72 through which they pass to the receptacle 74.

In order that more of the nuts which are supplied to the nut selector than those which are right side up may be utilized I have provided the modified nut selector shown in Figs. 23-26. In the nut selector 56b shown in these figures, the nut elements that reach the nut selector in inverted position are inverted and supplied to the feeding disc 344 in right side up position. The nut selector comprises a plate 126b having substantially circular relieved portions wherein are mounted star wheels 130b and 128b, the star wheels being mounted on shafts 136b and 138b as in the modification described previously. As in the previous form, the shafts are mounted in suitable sleeve bearings 140b and 142b fitted in bosses 144b and 146b depending from the plate 126b. Gears 160b and 152b on the lower ends of the shafts are in engagement to rotate the star wheels in synchronism, and the shaft 136b is provided with a suitable pulley (not shown) to drive the star wheels. The nut feeding chute 54 fits into a slot in the plate 126b and is suitably curved at its lower end to provide extensions of the substantially circular relieved portions 180b and 184b in which the star wheels are mounted. The second nut feeding chute 60b continues from the lower edge of the plate or block 126b in line with the first nut feeding chute 54, and nut elements 108 which are right side up continue directly into the chute. A wheel 194b is secured to the shaft 136b above the star wheel 128b and is provided with a plurality of pistons or plungers 200b fitting within cylinders 198b and urged downwardly by springs 206b. A cam member 220b extends over nearly half the periphery of the disc or wheel 194b and has a cam surface 224b which, at its leading edge 226b, lifts the heads 204b which act through the pins or connecting rods 202b to lift the plungers 200b. When the heads reach the trailing edge 228b of the cam surface 224b, the plungers are allowed to drop into contact with the uppermost faces of nut elements 108 supplied by gravity from the feed chute 54. Nut elements which are right side up are deflected from the plungers by a leaf spring 230b and continued down the chute 60b, while those which are inverted are engaged by the plungers 200b as in the previous modification, and are carried past the spring 230b until the heads 204b are lifted by the cam surface 224b. The nut elements 108 then pass through a substantially U-shaped passageway 554 in a member 556 extending downwardly from the plate or block 126b. The U-shaped passageway inverts the nut elements supplied to it and passes them into a nut feeding chute 558 similar to the chute 60b. The chutes 60b and 558 extend practically into contact with the periphery of the upper plate 346 of the driving or advancing disc 344. Nut elements in the chute 60b are retained in the chute against the force of gravity by abutting the periphery of the plate 346 until a notch or groove 356 stops in alignment with the open lower end of the chute 60b. This allows one nut element to slide into the aligned notch and to drop into engagement with a washer 262. Nut elements 108 in the chute 558 are maintained therein by abutment against the periphery of the plate 346 and also by abutment against nut elements 108 supplied to the notches 356 by the chute 60b. If insufficient nut elements are supplied through the chute 60b, notches will be left vacant and nut elements will slide into these notches under the influence of gravity. Surplus nut elements supplied to the chute 60b pass through a slot or groove 190b and drop into the open upper end of the discharge chute 62 to be returned to the receptacle 64. Excess nut elements supplied to the U-shaped passageway 554 and feed chute 558 pass out through an aperture 560 in the rear of a member 566 and fall into the open upper end (not shown) of a branch of the discharge chute 62 to return such nut elements to the receptacle 64.

It is to be understood that in the modification described heretofore, the second nut feeding chute 60 could

supply nut elements directly to the notches 356 under the influence of gravity as in the modification of Figs. 23-26 rather than through the intermediary of the positive nut feeding mechanism 430.

The type of nut element described heretofore has had a depending skirt or flange within which a substantially axially extending skirt or flange on a washer has been fitted, the nut elements and washers being maintained in telescoped assembled relation by means of protuberances on either the nut element or washer skirt or flange. My apparatus is adapted also to assemble nut elements and washers wherein each washer is provided with a substantially conical flange or skirt, and a depending skirt on each nut element fits inside the washer skirt to secure the washer and nut element in assembled relation. The modification of my apparatus for operating upon such washers and nut elements is shown in Figs. 27-30.

In this modification, certain of the parts are identical with those disclosed heretofore and identical identifying numerals are used. Additionally, certain of the identical parts which are not essential to an understanding of the modification have been omitted from the drawings for clarity of illustration. The parts which are identical with those shown heretofore include the main mounting or supporting plate 238, the upstanding stationary shaft 316, the worm wheel 326 thereon engaging the worm 424 on the shaft 416, the cam 334 and sleeve 336 connected to the worm wheel 326 for rotation therewith, the feeding disc 344, the ratchet wheel 342, the sleeve 338, and retaining ring 352. A cam 562 is mounted on the upper end of the shaft 316 and is fixed to the sleeve 336 by suitable means, such as a tooth and slot connection so that the cam will be driven by the sleeve in synchronism with the cam 334 and hence in timed relation with the driving or advancing disc 344. The cam is held down upon the shaft 316 by an oil filler plug 540 similar to that used in securing the bevel gear 524 in position. The oil filler plug bears against a washer 564 and it is contemplated that a cap screw might be used rather than the oil filler plug.

A bracket 566 is secured to the plate 238 by any suitable means, such as bolts 568 passing through the lower wall 570 of the bracket and threaded into the plate 238. The upstanding portion 572 of the bracket supports upper and lower transverse arms 574 and 576. These arms are provided with aligned sleeve bearings 578 and 580 in which a push rod 582 is mounted. Lateral studs 584 on a central block 586 of the push rod fit within slots 588 in a slotted lever arm 590 which is pivoted at 592 on an upstanding lug or ear 594 on the lower transverse plate 576. A coil spring 596 is compressed between the outer end of the lever 590 and the lower transverse plate 576, there being suitable bores provided in the plate and in the lever to receive the extremities of the spring. A plug 598 fits within the plate 574 and carries the bearing 578 in order that there may be a sufficient aperture in the plate 574 to allow the studs or lugs 584 and block 586 of the push rod 582 to pass through this plate. The inner end of the lever 590 is provided with a cam follower in the form of a threaded rod 600 having a rounded nose bearing against the cam surface 602 of the cam 562. A jam nut 604 is provided to lock the cam follower 600 in any desirable adjusted position.

The supporting plate 246 is provided with a depending cylinder 606 which is aligned with the push rod 582. The cylinder 606 is provided with an elongated anvil 608 having a circumferential flange 610 bearing against the bottom of the cylinder 606 and preventing movement of the anvil downwardly. A retractable cylindrical block 612 is carried within the cylinder 606 and an aligned aperture in the plate 246. A coil spring 614 encircles the anvil 608 and is compressed between the flange 610 and the retractable block 612 to force the block upwardly. The upper end or head 616 of the retractable block 612 is of reduced

diameter and fits in an aperture in the bearing plate 280, the shoulder 618 between the head and the remainder of the block limiting upward movement thereof. Under normal quiescent conditions the top of the head 616 is level with the top surface of the bearing plate 280. The upper end or tip 620 of the anvil likewise is on a level with or below the top surface of the bearing plate 280, and is substantially cylindrical in configuration and has a beveled upper edge to insure proper entry of the anvil into a nut element. A frusto-conical shoulder 618 lies between the tip 620 and the remainder of the anvil 608.

Each partially assembled washer and nut element unit comes to rest in alignment with the push rod 582 and anvil 608 as the disc 344 stops between movements, as shown in Fig. 27. The cam 562 then pivots the lever 590 to force the push rod 582 down against the top surface of a nut element 108d as shown in Fig. 29. This forces the retractable block 612 down against the action of coil spring 614. The tip 620 of the anvil 608 pilots the nut element relative to the anvil and the frusto-conical shoulder 618 engages the depending central skirt 622 of nut element 108d and swages the skirt outwardly to overlap the conical flange or skirt 624 of washer 262d. Continued rotation of cam 562 allows spring 596 to pivot lever 590 clockwise as shown in Fig. 27 to remove the push rod 582 from the top of the nut element. This allows the spring 614 to raise the retractable block 612 to return the assembled washer and nut element to the level of the top face of bearing plate 280 so that further rotation of the driving or advancing disc 344 may move the assembled unit to a discharge station. Such discharge station is not shown but may include a relieved portion of bearing plate 246 as in the earlier modification and further may include a leaf spring to deflect assembled units from the advancing disc 344.

Modification including tapping of nut elements

The modification of my apparatus for tapping the nut elements after selection and prior to assembly with washers is shown in Figs. 31-34 and 42. For convenience of reference, and brevity of explanation, those parts which are identical with those disclosed heretofore are identified by the same numerals as used heretofore while those parts which are similar to or analogous to parts heretofore disclosed are identified by the same numerals with the addition of the subscript "c."

As shown in general in Fig. 31, the modified assembly machine includes a base or pedestal 626 having an upstanding portion 628 on which is mounted a table 630. A nut hopper 50 is supported by a bracket 52 and is driven by a motor 106 acting through the gears in a gear box 84. Nut elements are fed from the hopper 50 through a nut feeding chute 54a as disclosed heretofore to a nut selector 56a (this being the modification shown in Fig. 9 for delivering nuts with their countersunk faces up) supported by a bracket 58 on the table 630. The nut selector 56a is driven by an electric motor 172 supported by a bracket 174 mounted on the table 630, there being a belt 170 extending between pulleys on the motor and on the nut selector. Properly oriented nuts pass through the feed chute 60a while those which are inverted pass through a discharge chute 62 to a receptacle (not shown).

The nut feeding chute 60a, at its lower end, feeds into a tapping head 632 (see also Fig. 32). The nut feeding chute 60a is vertical adjacent the tapping head 632 and the bottom end of the chute is flat as at 634 so that nut elements will lie against the flat bottom under the influence of gravity. A mounting plate 636 is secured by any suitable means in an upstanding flange 638 of an upstanding portion 640 of the pedestal 626. A supporting member 642 extends outwardly from the plate 636.

A retaining ring 644 is secured by the supporting member 642 and a tapping head gear 646 (see also Fig. 42) is journaled in the retaining ring by means of a ball bearing 648. A front distributing ring 650 is threaded on to a

portion of the gear 646 and provides for lubrication of nut elements as will be apparent hereinafter.

A driving jaw 652 is fixed within the tapping head gear 646 for rotation therewith and the bottom nut element in the nut feeding chute 60a stops in alignment with the central bore of the driving jaw. The driving jaw is provided with three axially extending arms 654 which are arranged in an annular row and have surfaces adapted to engage the corners of nut elements and thereby to rotate the nut elements. Such driving jaws are well known in the art and a similar jaw is disclosed in the patent to Pearson 2,090,698. The jaw is provided with three inwardly extending spring edged shunting pins 656, such as those shown by Pearson to align nut elements properly with the arms 654.

A plunger or nut driving rod 658 is arranged in axial alignment with the driving jaw 652 and on the opposite side of the nut feeding chute 60a therefrom. The plunger 658 periodically is advanced by a cam 660 (Fig. 42) and is retracted by a spring (not shown) urging a cam follower roller 662 carried by the plunger 658 into engagement with the cam 660. The threading end or die 664 of a tapping rod 666 extends into the driving jaw 652, and nut elements advanced by the plunger 658 are threaded on to the die to tap the nuts.

An upstanding portion 668 of the pedestal 626 supports stripping mechanism 670 for shifting nut elements along the tapping rod 666 to feed them to the assembly mechanism 70c. The stripping mechanism 670 comprises a slide block 672 mounted in a support 674 and periodically reciprocable therein by mechanism later to be described. The tapping rod 666 is supported alternately by two pairs of jaws 676 and 678 (see also Fig. 34). The jaws 676 and 678 alternately close upon flats 680 on the tapping rod 666 and are carried by arms 682 pivotally supported at 684 on the support 674. The tail ends of the arms 682 have links 686 pivotally connected to them and to a slide 688. The slide 688 is carried in a bearing 690 in a boss 692 which preferably is an integral part of the support 674. The slide 688 is provided at the end opposite the links 686 with a cylindrical bore 694 within which fits a piston 696. A connecting rod 698 extends from the piston 696 into a reduced portion of the bore where it is secured by a pin in slot connection 700. A coil spring 701 is compressed within the bore 694 and bears against the inner end of the piston 696. A pivotal link 702 secures the piston to a rocking arm 704 which is pivoted at 706 to the support 674. A cam roller 708 fits in a groove in a cam 710 periodically to reciprocate the slide 688 to make and break the toggle comprised of the links 686 to cause the jaws 678 to clamp and unclamp the tapping rod 666. The jaws 676 are opened and closed in timed relation with the jaws 678 by similar mechanism including a rocking arm 712 mounted on the other side of the cam 710 and having a cam roller 714 fitting in the groove in the cam.

The tapping rod 666 is knurled and spiraled at 716 adjacent the die 664 to clear shavings and chips from the nut elements fed therealong and a spraying head 718 is provided above the tapping rod to direct an oil and air spray on to the tapped nut elements to aid in cleaning the nut elements and further to lubricate them to facilitate their passage throughout the remainder of the mechanism. Threaded nut elements are first advanced along the tapping rod 666 by a pair of starter fingers 720 pivoted at 722 to the slide block 672 near the forward end thereof. The starter fingers include knife edges 724 extending transversely from the starter fingers 720 to lie on opposite sides of the tapping rod 666. Two springs (which are not shown) urge the fingers 720 about their pivots 722 to force the knife edges 724 toward the tapping rod 666. Fixed pins 726 extending from the slide block 672 engage recesses in the fingers 720 and prevent the knife edges 724 from ever contacting the tapping rod. Camming surfaces 728 to the left of the knife edges

cause the fingers 720 to pivot against the action of their springs when the slide block is moved to the left and the camming surfaces encounter nut elements on the tapping rod. When the slide block is moved back to the right, the knife edges engage between adjacent nut elements and feed one or more of the nut elements to the right.

A plurality of similar stops 730, 732, 734 and 736 (Fig. 32) are mounted on brackets 738 (Fig. 34) secured to the support 674. Each of the stops includes a plunger 740 which is spring urged toward the tapping rod 666. The leading edge (the left edge in Fig. 32) of each plunger is located at a greater distance from the tapping rod 666 than is the trailing edge to form a cam surface so that nut elements which are advanced along the tapping rod can be pushed beyond the stops by camming the plungers 740 back against the action of their biasing springs. The trailing edges of the plungers prevent nut elements from retrograde movement along the tapping rod.

Further advance of nut elements along the tapping rod is brought about by stripper claws 742 and 744. The claws 742 and 744 normally extend outwardly from the face of the slide block 672 and lie above and below the tapping rod. The claws are mounted on similar arms 746 and 748 fitting within recesses 750 and 752 in the front face of the slide block. Each of the arms is pivoted as at 754 and is urged outwardly by a spring (not shown). The outer faces of the claws 742 and 744 are provided with cam surfaces which force the claws and the arms with which they are integral into the recesses 750 and 752 when the slide block is moved to the left and the claws encounter nut elements or another camming surface shortly to be disclosed.

The jaws 676 and 678 carry brackets 756 and 758 having depending flanges 760 and 762 and horizontal reinforcing flanges 764 and 766. The rear faces of the depending flanges 760 and 762 are flat and spaced only slightly from the front face of the slide block 672 except for the right ends which are beveled to provide cam surfaces cooperable with the claws 742 and 744.

The tapping head 632 and stripping mechanism are driven in timed relation by the driving mechanism shown in Fig. 42. The driving mechanism includes a motor 768 (see also Fig. 31) mounted in the base or pedestal 626. The motor acts through pulleys 770 and 772 and belts 774 to drive a jackshaft 776 journaled in a suitable bearing 778 in the base or pedestal 626. A pinion 780 on the jackshaft drives a large gear 782 on a worm shaft 784. A gear 786 on the opposite end of the worm shaft 784 drives an idler gear 788 and the idler gear, in turn, drives the tapping head gear 646. A bevel gear 790 is keyed or pinned to the worm shaft 784 adjacent the end on which the gear 786 is mounted and a small bevel gear 792 on a stub shaft 794 is meshed with the bevel gear 790. The end of the stub shaft 794 extends slightly from the upstanding portion 628 of the base or pedestal 626 and is provided with a non-circular portion to accept a crank in order to adjust the parts to the proper positions to start an operation.

A worm 796 is secured to the worm shaft 784 for rotation therewith and drives a worm wheel 798 fixed to a transverse shaft 800. A spur gear 802 secured to the end of the shaft 800 drives a second spur gear 804 secured on the end of a second transverse shaft 806. A spur gear 808 on the other end of the second transverse shaft 806 is in driving engagement with a spur gear 810 secured to a cam shaft 812 on which the cam 660 is secured.

A bevel gear 814 is fixed on the end of the transverse shaft 800 opposite the spur gear 802 and is in driving engagement with a bevel gear 816 fixed to the end of an elongated shaft 818. Near its opposite end, the shaft 818 carries a spiral gear 820 which drives a spiral gear 822 fixed on the cam shaft 824 which carries the aforementioned cam 710. The shaft 818 also carries a cam 826 on the end opposite the bevel gear 816 and a cam follower

roller 828 on the end of a rocker arm 830 fits in a groove in the cam 826. The rocker arm 830 oscillates a rocker shaft 832, and this, in turn, rocks a rocker arm 834 secured by a pivotal link 836 to the end of the slide block 672 to reciprocate the slide block.

In Fig. 32, the slide block 672 has reached the extreme limit of its movement toward the tapping head. The jaws 676 are closed on the tapping rod 666 and the lowered bracket 756 maintains the stripper claws 742 in retracted position in the recess 750. The starter fingers 720 have been cammed apart by nut elements fed on to the tapping rod by the tapping head (such nuts being omitted in Fig. 32 in order best to show the parts of the apparatus). The claws 744 lie above and below the tapping rod.

Movement of the slide block 672 to the right causes the starter fingers 720 to move nut elements along the tapping rod past the stop 730, the plunger 740 being cammed backwards against the action of its spring. Inertia causes the nut elements to slide along the tapping rod until they encounter the stop 732. The stripper claws 742 ride along the back surface of the bracket 756 while the stripper claws 744 shift nut elements along the tapping rod past the stop 736. A jet 838 is located to the right of the jaws 678 and directs air against the nut elements to clean the nut elements and may aid in advancing the nut elements farther along the tapping rod.

With the slide in its extreme rightmost position, the cam 710 acts to close the jaws 678 and to open the jaws 676. The slide then returns to the leftmost position as shown in Fig. 32. The lowered bracket 758 cams the claws 744 away from the tapping rod and maintains them in retracted position. The claws 742 are cammed into partially retracted position by nut elements held on the tapping rod by the stop 730.

Meanwhile the cam 660 has operated to shift additional nut elements on to the tapping rod. The cam 660 advances the plunger 653 rapidly until a nut element pushed by the plunger is nearly in contact with the die 664. The cam then moves the plunger more slowly toward the die until the first complete thread of the die has cut into a nut element, the plunger and driving jaw 652 being operated in proper timed relation to thread the nut element on to the die. The cam 660 then allows a spring (not shown) to retract the plunger. The bottom nut element 108c, which has been resting on the plunger, then drops into the position shown in Fig. 32 and is ready to be advanced on to the die 664. Continued rotation of the driving jaw 652 threads each nut element along the die after the plunger has been retracted and the nut elements so threaded along the die push the preceding nut elements along the tapping rod into position to be encountered by the starting fingers 720.

The next movement of the slide block to the right causes the starting fingers 720 to move one or more nut elements along the tapping rod while the stripper claws 742 move nut elements past the stops 732 and 734, the nut elements coming to rest against other nut elements on the rod. The stripper claws 744 move along the back of the bracket 758 in their retracted position. When the slide block has reached its extreme rightmost position, the cam 710 acts to open the jaws 678 and to close the jaws 676. Return movement of the slide block to the left causes the stripper claws 742 to cam along the back of the bracket 756 and causes the stripper claws 744 to cam over the edges of nut elements held against the stop 734. The parts then are in the position shown in Fig. 32, and continued operation is as just described.

In order to supply cutting oil to the die, the plunger 653 is hollow and cutting oil is fed through a flexible conduit 840 (Fig. 31) into the plunger. This is in addition to the cutting oil supplied from the front distributor ring 650.

The nut elements advanced along the tapping rod 666 pass into a tube 842 (Figs. 31, 38 and 39) through which they pass to assembly mechanism 70c identical with that

disclosed heretofore except for the structure supplying nuts to the advancing disc 344 and the mechanism for telescoping the nut elements and washers.

Although a positive feeding mechanism similar to that shown heretofore could be used, I prefer to use gravity feeding structure for delivering nuts to the advancing disc 344. The tube 842 terminates slightly above the top of the disc 344 as seen best in Figs. 38 and 39. The tapping rod preferably is extended nearly to the advancing disc inside the tube 832. The tube surrounds and supports the nut elements and the tapping rod extension prevents the nuts from tumbling within the tube. Each time the disc comes to rest, one of the grooves 356 and the aperture 358 aligned therewith stop in alignment with the tube 842 and a nut element fits in the groove and aperture and rides atop a washer 262 as shown in Fig. 38. When the disc advances, the next succeeding nut element slides from the one advanced with the disc, rides along the top of the disc, and drops into the next groove and aperture as the disc comes to rest.

A washer detector 472 similar to that described heretofore is included, and if no washer is present in a slot, the lower plate 480 fits into the bottom groove and the top plate 480 fits into the upper groove and underlies the stack of nut elements 108c to prevent the bottom nut from dropping into the advancing disc.

To prevent operation of the washer hopper and assembly mechanism in the event no nut elements are in the tube 842 or in the event there are insufficient nut elements to cause proper feeding, I have provided a microswitch 843 (Fig. 31) mounted on the tube 842. The actuating member of the microswitch extends into tube 842 and suitable connections (not shown) are provided to interrupt the circuit of the motor driving the washer hopper and assembly mechanism if the actuating member encounters no nut elements.

The mechanism for telescoping the nut elements and washers advanced by the disc 344 approximates that shown in Figs. 16 and 21 and includes a bracket 844 having upstanding arms 846 welded or otherwise suitably secured to a slotted wall 848 which is bolted to the upstanding flange 520 on the end of plate 238. The wall 848 provides a guideway 850. Side walls 852 are secured to the plate or wall 848 by means such as bolts 854 and flanges 856 parallel to the slotted wall 848 are secured as by bolts 858 to the side walls to form a guideway 860 opposite the guideway 850. A roller slide block 862, which is substantially U-shaped and is constructed in two parts to facilitate assembly of other parts therewith, is provided with longitudinally extending tongues 864 fitting within the guideways 850 and 860. The depending arms of the U-shaped roller slide block 862 carry bushings 866 within which is journaled a shaft 868. The shaft 868 carries a bevel gear 870 (Fig. 31) in driving engagement with the bevel gear 524 disclosed in the earlier embodiment of the assembly mechanism. A roller 872 is keyed to the shaft 868 between the bushings 866 for rotation therewith and a coil spring 874 forces the roller slide block 862 down. The top plate 876 of the telescoping mechanism is provided with a threaded plug 878 bearing against the spring 874 in order that the pressure exerted by the spring may be varied. A locking nut 880 is threaded on the top end of the plug 878 to lock the plug in position, and protuberances 882 and 884 are provided on the lower end of the plug and on the upper surface of the roller slide block properly to position the coil spring 874.

Toothed lock washers 262 are fed from the washer hopper 66 to the driving disc 344 in the same manner as in the modifications disclosed previously and threaded nut elements are aligned with the washers as shown in Fig. 38 and as described in conjunction therewith. As the disc 344 rotates intermittently, the roller 872 moves along the upper surface of the disc until it encounters a nut element 108c. The nut element 108c is pressed down

by the roller 872 into telescoped relation with a washer 262 as shown in Figs. 35, 37, 40 and 41. The spring 874 allows the roller to move upwardly slightly as it first encounters each nut element to prevent excessive shock from occurring. The bevel gears 524 and 870 are provided with relatively long teeth so that the roller may shift up and down slightly and so that nut elements of different heights can be accommodated without the teeth being disengaged.

Figs. 40 and 41 show an assembled nut element 108c and toothed lock washer 262 in detail. The nut element is similar to that shown in Fig. 22 except that it is provided with internal threads 886. The inwardly directed protuberances 546 on the washer skirt may be seen to be three in number in the illustrative embodiment and this has been found in practice to be a sufficient number securely to grip the flared, substantially axially extending skirt on the lock washer.

The plate 280 (Fig. 37) is relieved at 550 as disclosed heretofore to allow the telescopically assembled units to fall from the disc 344. A leaf spring (not shown) may be provided if desired to augment gravity in causing the assembled units to drop.

From the foregoing, it may be seen that I have provided an improved method and machine for assembling nut elements and lock washers. Blank nut elements are selected from a random mass and are assembled with toothed lock washers likewise selected from a random mass. In one modification of my invention, the nut elements are tapped prior to assembly with the washers, and in another modification the nut elements are not so tapped, but are tapped after assembly by any suitable means constituting no part of this invention. My invention contemplates feeding nut elements into engagement with washers by gravity or by a positive feed, and is applicable with equal facility to produce washer and nut element assemblies wherein a washer skirt fits within a bore of a nut element or wherein a depending skirt on a nut element fits within and overlies a conical washer skirt. My invention contemplates feeding only nut elements which are delivered from a hopper right side up or inverting those nut elements which are upside down and feeding all of the nut elements.

It will be obvious that changes may be made in the form, construction and arrangement of the parts without departing from the spirit of the invention or sacrificing any of its advantages, and the right is hereby reserved to make all such changes as fairly fall within the scope of the following claims.

I claim:

1. A mechanism for assembling nut elements and washers comprising a rotary washer feeding disc including a lower portion having outwardly opening recesses and an upper portion having substantially continuous rim cylindrical apertures overlying said recesses for properly centering nut elements, means overlying said disc in axial alignment with said apertures in succession for feeding nut elements axially into said apertures for axial alignment with washers in the recesses of said disc, means for delivering washers in predetermined position into said recesses, and means for pressing the aligned nut elements and washers into telescopic assembled relation.

2. A mechanism for assembling nut elements and washers comprising a rotary washer feeding disc including a lower portion having outwardly opening recesses and an upper portion having substantially continuous rim cylindrical apertures overlying said recesses for properly centering nut elements, means overlying said disc in axial alignment with said apertures in succession for gravitationally feeding nut elements axially into said apertures for axial alignment with washers in the recesses of said disc, means including an inclined surface in the plane of the lower surface of the washer feed disc for delivering washers in predetermined position into said recesses, and

means for pressing the aligned nut elements and washers into telescopic assembled relation.

3. Apparatus for producing permanently assembled washers and nut elements comprising means for feeding washers successively along a predetermined path, means for selecting nut elements from a random mass, means for tapping the selected nut elements successively, means for feeding the tapped nut elements from said tapping means along a path approaching the washer feeding path at an assembling station, and means at said assembling station for feeding the tapped nut elements and said washers in timed relation relatively into telescopic engagement.

4. Apparatus for producing permanently assembled washers and nut elements comprising a rotatable disc having a plurality of arcuately spaced peripheral recesses, means for supplying washers successively to the recesses of said disc, means for rotating said disc, a tapping rod, means for feeding untapped nut elements successively along said tapping rod to tap said nut elements, a tube receiving said tapping rod at one end and terminated at the other end above said disc, means for feeding nut elements from said tapping rod successively through said tube into axial alignment with washers in the recesses of said disc, and means for telescoping the aligned washers and nut elements.

5. Apparatus for producing permanently assembled washers and nut elements comprising a rotatable disc having a plurality of arcuately spaced peripheral recesses, means for supplying washers successively to the recesses of said disc, means for rotating said disc, a tapping rod, means for feeding untapped nut element successively along said tapping rod to tap said nut elements, a guideway extending from said tapping rod and terminating above said disc, the recesses in said disc successively being aligned with said guideway, means for feeding nut elements from said tapping rod successively through said guideway into axial alignment with washers in the recesses of said disc, and means for telescoping the aligned washers and nut elements.

6. Apparatus for producing permanently assembled washers and nut elements comprising an intermittently operable disc having a plurality of recesses arcuately spaced therein, means for rotating said disc intermittently past a plurality of stations arcuately spaced from one another, means for supplying washers from a random mass successively to the recesses in said disc at one of said stations, means for supplying nut elements from a random mass successively to the recesses in said disc at another of said stations arcuately spaced from the washer supplying station, said nut elements being aligned with and contacting the washers at the nut element supplying station, and means operable in timed relation with the rotation of said disc to telescope the contacting washers and nut elements in said recesses at yet another of said stations arcuately spaced from the washer and nut element supplying stations, said telescoping means including a roller, means for supporting said roller above the disc, means limiting the approach of said roller towards said disc, spring means urging said roller towards said disc against said limiting means to take up shocks, and means for rotating said roller in timed relation with the rotation of said disc.

7. Apparatus for producing permanently assembled washers and nut elements comprising an intermittently operable disc having a plurality of recesses arcuately spaced therein, means for rotating said disc intermittently past a plurality of stations arcuately spaced from one another, means for supplying washers from a random mass successively to the recesses in said disc at one of said stations, means for supplying nut elements from a random mass successively to the recesses in said disc at another of said stations arcuately spaced from the washer supplying station, said nut elements being aligned with and contacting the washers at the nut element supplying station, and means operable in timed relation with the rotation of said disc to telescope the contacting washers and nut ele-

ments in said recesses at yet another of said stations arcuately spaced from the washer and nut element supplying stations, said telescoping means including a plate overlying and substantially parallel to said disc and shiftable toward and away from said disc, a generally flat section on said plate adapted to contact nut elements successively, a cam contacting said plate for shifting said plate periodically towards said disc, and means for driving said cam in timed relation with the rotation of said disc.

8. Apparatus for manufacturing permanently assembled nut elements and washers, comprising means for feeding washers with substantially conical flanges along a predetermined path in succession with the flanges directed substantially upwardly, means for feeding nut elements having central, substantially axially extending skirts along a predetermined path in succession with the skirts oriented in a given direction, means for successively depositing the nut elements on top of the washers in axial alignment therewith and with the nut element skirts oriented downwardly and the washer flanges oriented upwardly, means for feeding the aligned nut elements and washers along a predetermined path with the nut elements supported on the washers to effect settling and proper nesting of the nut element skirts within the washer flanges, and means for thereafter expanding the nut element skirts below the washer flanges permanently to retain the nut elements and washers in telescopically assembled relation.

9. Apparatus as set forth in claim 8 wherein the means for feeding the aligned nut elements and washers comprises means for feeding the aligned nut elements and washers along an inclined path.

10. Apparatus as set forth in claim 8 wherein the means for depositing the nut elements on top of the washers comprises means for gravitationally dropping the nut elements.

11. Apparatus as set forth in claim 10 wherein the means for feeding the aligned nut elements and washers comprises a rotary disc, wherein the nut element feeding means comprises means feeding the nut elements generally tangentially of said disc to a point radially displaced from the periphery of the disc, and the dropping means comprises means for shifting the nut elements radially inwardly to a position above said disc.

12. Apparatus as set forth in claim 8 wherein the nut element feeding means comprises means for feeding nut elements along said predetermined path with the skirts oriented either up or down, and means for displacing from said path nut elements having their skirts upwardly directed.

13. Apparatus as set forth in claim 12 and further including means for inverting the nut elements displaced from said predetermined path and delivering the inverted nut elements to said depositing means.

14. Apparatus as set forth in claim 8 wherein the skirt expanding means comprises a flaring tool having a substantially conical section.

15. Apparatus as set forth in claim 8 wherein the means for feeding the aligned nut elements and washers comprises a rotary disc including a lower portion having outwardly opening recesses for receiving washers and an upper portion having apertures for receiving nut elements,

said apertures overlying said recesses, means underlying some but not all of the recesses and apertures in said disc for supporting the washers and nut elements in the recesses and apertures, and means for rotating said disc, said washers and nut elements falling from said disc after enlargement of the nut element skirts as the washers and nut elements pass beyond said supporting means.

16. The method of manufacturing permanently assembled nut elements and washers which comprises selecting washers having substantially conical flanges from a random mass of such washers with the flanges oriented in a predetermined direction, feeding the washers so selected along a predetermined path with the flanges directed generally upwardly, selecting nut elements having central, axially extending skirts from a random mass of such nut elements with the skirt elements oriented in a predetermined direction, feeding the nut elements so selected along a predetermined path with the skirts directed generally downwardly, depositing the nut elements on top of the washers in axial alignment therewith and with the nut element skirts oriented downwardly and the washer flanges oriented upwardly, feeding the aligned nut elements and washers along a predetermined path with the nut elements supported on the washers while vibrating the nut elements and washers, the nut elements being heavier than the washers thereby settling with the nut element skirts nesting within the washer flanges, and thereafter expanding the nut element skirts outwardly beneath the washer flanges permanently to retain the nut elements and washers in telescopically assembled relation.

17. The method set forth in claim 16 wherein the step of feeding the nut elements and washers in axial alignment comprises supporting the nut elements and washers laterally and feeding them along an inclined path.

References Cited in the file of this patent

UNITED STATES PATENTS

482,910	Wrenshall	Sept. 20, 1892
1,606,432	Herkenhine	Nov. 9, 1926
1,739,422	Schmidt	Dec. 10, 1929
1,861,889	Stoll	June 7, 1932
1,897,116	Friedman	Feb. 14, 1933
1,905,715	Ingram et al.	Apr. 25, 1933
1,946,820	Stoll	Feb. 13, 1934
1,993,474	Brackett	Mar. 5, 1935
2,086,128	Hackbarth	July 6, 1937
2,183,600	Werner	Dec. 19, 1939
2,225,645	Olson	Dec. 24, 1940
2,248,183	Mulvany	July 8, 1941
2,257,217	Bailey	Sept. 30, 1941
2,273,782	Irwin	Feb. 17, 1942
2,273,783	Irwin	Feb. 17, 1942
2,284,690	Stern	June 2, 1942
2,286,066	Davis	June 9, 1942
2,303,005	Swangren	Nov. 24, 1942
2,307,132	Hufferd	Jan. 5, 1943
2,321,548	Hanneman	June 8, 1943
2,343,798	Poupitch	Mar. 7, 1944
2,379,564	Cole	July 3, 1945
2,398,659	Mead	Apr. 16, 1946
2,577,020	Large	Dec. 4, 1951