March 5, 1963 E. B. DICKISON ETAL 3,080,054

ARTICLE GAUGING AND SORTING APPARATUS

Filed Sept. 7, 1960

4 Sheets-Sheet 1

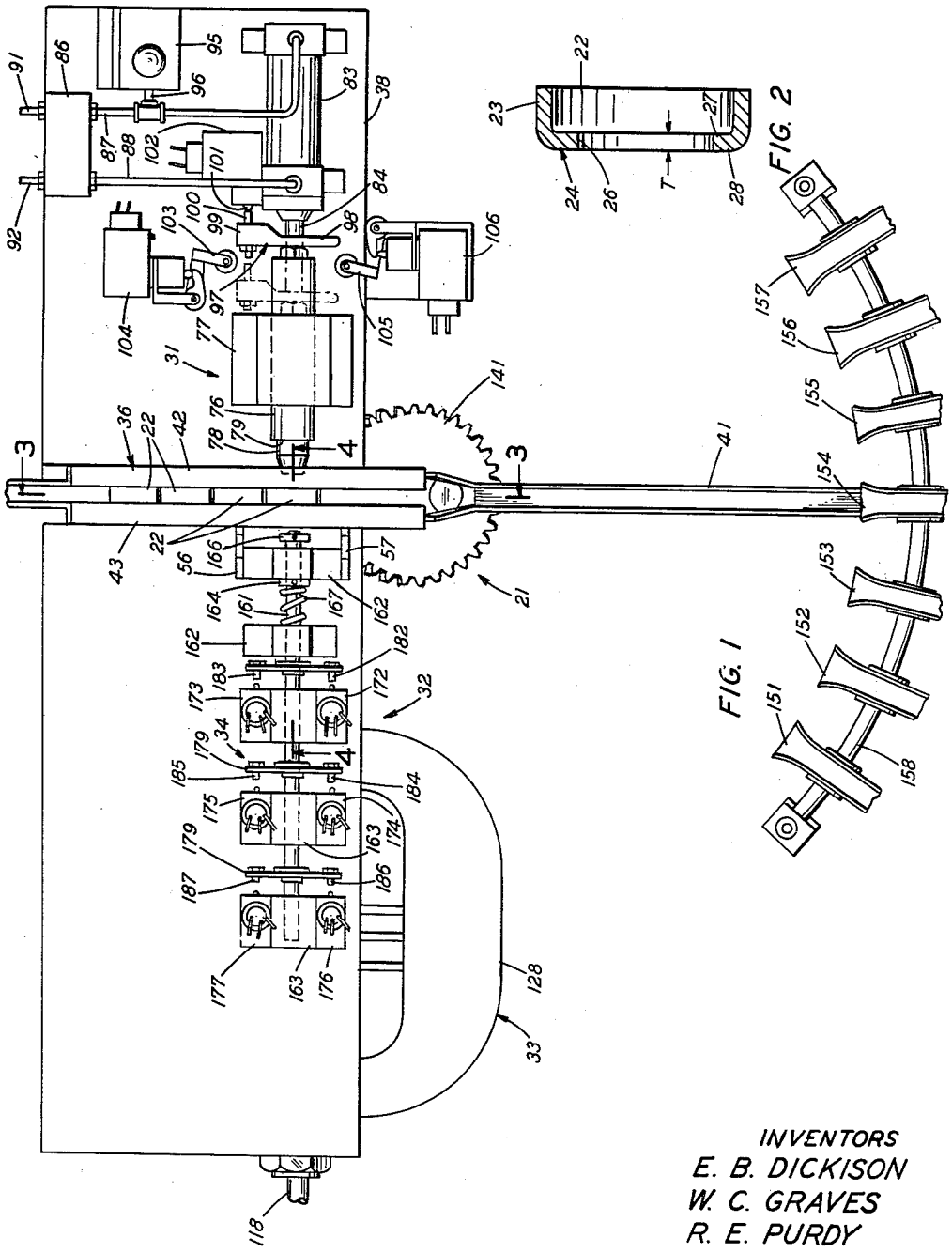


FIG. 1

FIG. 2

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Filed Sept. 7, 1960 4 Sheets-Sheet 2

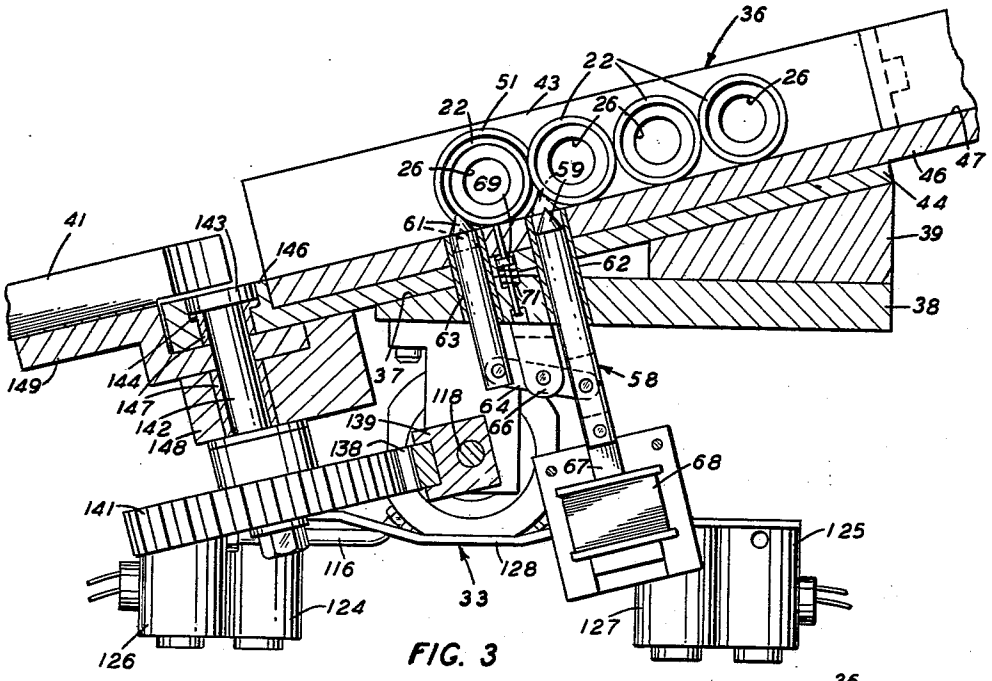


FIG. 3

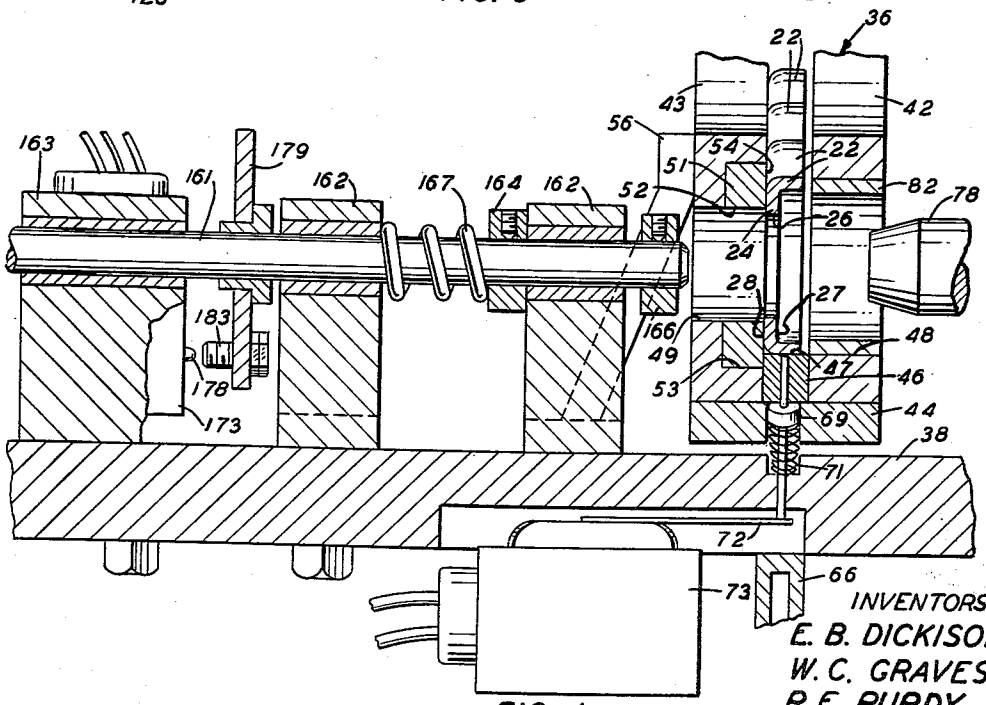


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ARTICLE GAUGING AND SORTING APPARATUS

Filed Sept. 7, 1960 4 Sheets-Sheet 3

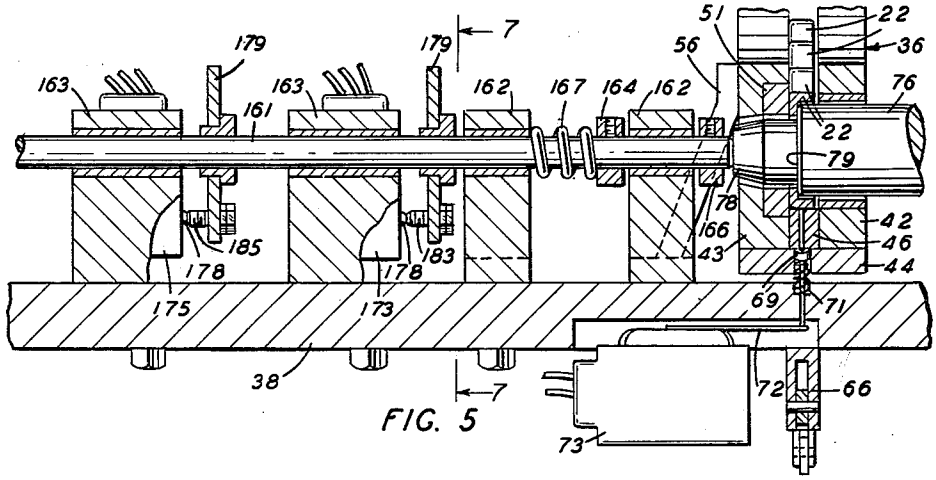


FIG. 5

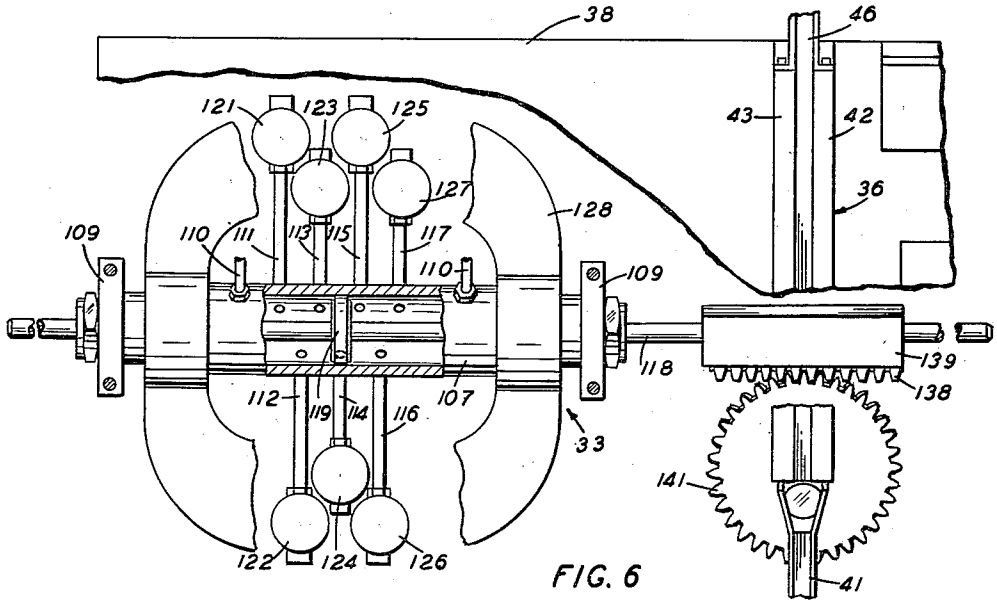


FIG. 6

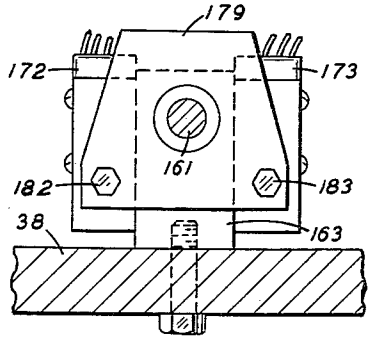


FIG. 7

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ARTICLE GAUGING AND SORTING APPARATUS

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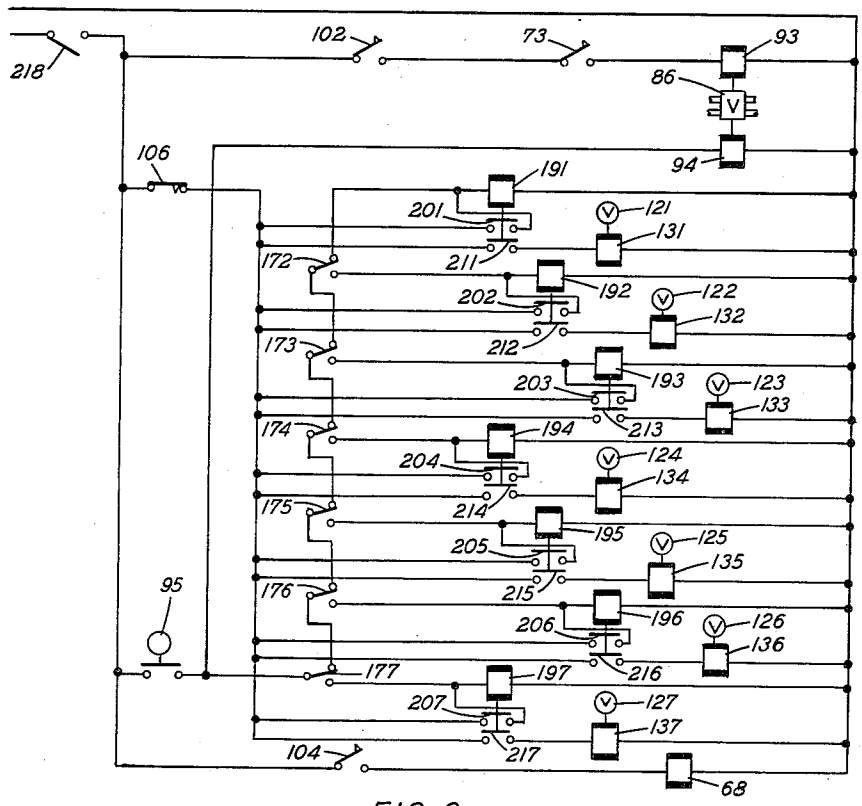


FIG. 8

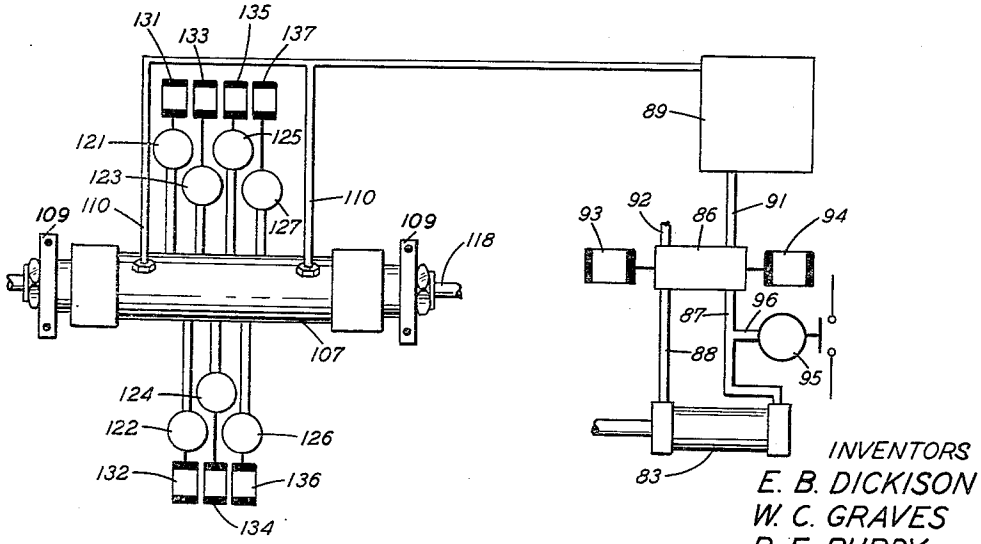


FIG. 9

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United States Patent Office

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Patented Mar. 5, 1963

3,080,054

ARTICLE GAUGING AND SORTING APPARATUS

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Filed Sept. 7, 1960, Ser. No. 54,521
10 Claims. (Cl. 209—88)

This invention relates to article gauging and sorting apparatus, and more particularly to apparatus for gauging desired dimensions of articles and for automatically sorting the articles into grades in accordance with the measured dimensions.

In the manufacture of telephone receivers, it is necessary to form receiver magnets having predetermined dimensions with close tolerances to insure substantially perfect mating of the receiver magnets with other parts of the receiver. To satisfy these requirements the dimensions of the receiver magnets must be closely checked and controlled during the manufacture thereof to insure that required tolerances are met. It has been observed that because of the tendency of tools, such as grinding wheels, to wear out during the manufacture of the receiver magnets, the dimensions of the receiver magnets tend to drift away from the desired nominal dimension. It has been further observed that by assembling the receiver magnets having oversize dimensions with mating parts having complementary undersize dimensions, or vice versa, a substantially perfect mating of the parts can be obtained. Accordingly, there is a need to provide an apparatus for gauging the critical dimensions of the receiver magnets and for automatically sorting the gauged receiver magnets into grades according to the gauged dimensions.

It is desirable to have receiver magnets separated automatically by the apparatus into a number of different grades, each individual grade embodying only articles falling into one predetermined range of dimensions. At the same time, the operator, by observing the relative number of receiver magnets in each grade, may determine at a glance the preponderating dimension and adjust the setting of the manufacturing tools to compensate for the drift away from the desired nominal dimension.

It is an object of the invention to provide new and improved article gauging and sorting apparatus.

It is another object of the invention to provide new and improved apparatus for gauging the dimensions of articles and for automatically sorting the gauged articles in accordance with the gauged dimensions.

Gauging and sorting apparatus illustrating certain features of the present invention may include gauging means for gauging a desired dimension of an article, the gauging means including a gauging element movable into and out of engagement with an article being gauged. The length of travel of the gauging element is dependent upon the magnitude of the dimension to be gauged. Movable guide means are provided for directing the article, after gauging, to any one of a plurality of receiving locations, each location corresponding to one discrete dimensional range. Also provided are means responsive to the movement of the gauging element for selectively positioning the guide means to direct the gauged article to a receiving location determined by the length of travel of the gauging element whereby the article is directed to the receiving location designated for receiving the grade of articles including the gauged dimension.

Other objects and aspects of the present invention will become more readily understood from the following detailed description of a specific embodiment thereof when read in conjunction with the appended drawings, in which:

FIG. 1 is a plan view of gauging and sorting apparatus embodying the present invention;

FIG. 2 is an axial section of a receiver magnet illustrating a dimension to be gauged;

FIG. 3 is an enlarged, fragmentary section taken along the line 3—3 of FIG. 1, with parts thereof broken away for clarity;

FIG. 4 is an enlarged, fragmentary section taken along the line 4—4 of FIG. 1, with parts thereof broken away for clarity;

FIG. 5 is a reduced, fragmentary section of apparatus shown in FIG. 4, with parts thereof in the gauging position;

FIG. 6 is an enlarged, fragmentary, plan view of a selecting mechanism forming part of apparatus shown in FIG. 1, with parts broken away for clarity;

FIG. 7 is a fragmentary section taken along the line 7—7 of FIG. 5;

FIG. 8 is a schematic diagram of an electrical control circuit for the gauging and sorting apparatus, and

FIG. 9 is a schematic diagram of a pneumatic circuit for the gauging and sorting apparatus.

Referring in detail to the drawings, and more particularly to FIG. 1 thereof, there is shown gauging and sorting apparatus, designated generally by the numeral 21, for gauging dimensions of articles, for example receiver magnets 22—22, one of which is shown in detail in FIG. 2, and for sorting the gauged receiver magnets into different grades in accordance with the gauged dimensions. Each of the receiver magnets 22—22 is in the form of a hollow cylindrical cup 23 having a bottom 24 provided with a central circular aperture 26. In the exemplary embodiment illustrated, the apparatus 21 is designed to measure the thickness of the bottom 24, designated in FIG. 2 as the distance (T) between the inner and outer faces 27 and 28, respectively.

The gauged receiver magnets 22—22 are then automatically sorted by the apparatus 21 into a desired number $(N+2)$ of grades, which include (N) "regular" grades and two "rejects" grades, according to the magnitude of the thickness (T). In this particular example, the apparatus 21 is preset to sort the receiver magnets 22—22 into five "regular" grades and two "reject" grades. The regular grades are designed to include receiver magnets 22—22 having bottoms 24—24, the thicknesses of which fall into a tolerance range $(t—Nd)$, where (t) is a maximum acceptable thickness of bottoms 24—24 of receiver magnets 22—22 and (d) is an allowable range of deviation for each grade. The first regular grade will include receiver magnets 22—22, the bottom thicknesses of which fall into a range from (t) to $(t—d)$, which includes the size (t) but excludes the size $(t—d)$. Similarly, each of the next consecutive grades will cover one range of dimensions, each inclusive of its upper limit, but exclusive of the upper limit of the next lower grade. The fifth regular grade then will cover a range from sizes $(t—4d)$ to $(t—5d)$, inclusive of the size $(t—4d)$, but exclusive of the size $(t—5d)$. The reject grades include an "oversize" and an "undersize" grade. The "oversize" grade includes receiver magnets 22—22, each having the bottom thickness greater than (t). The "undersize" grade includes all receiver magnets 22—22, each having the bottom thickness equal to or less than $(t—Nd)$, i.e. $(t—5d)$ for this particular example.

The apparatus 21 includes a gauging mechanism 31 and a sorting mechanism 32, the latter comprising a selecting mechanism 33 and a sensing mechanism 34. The gauging mechanism 31 is designed for positioning a series of receiver magnets 22—22 to be gauged in a gauging position, gauging the thickness of the bottom 24 of each individual receiver magnet 22, actuating the sensing mechanism 34 during the gauging operation, the degree of actuation depending on the respective gauged dimensions of the respec-

tive receiver magnets 22—22, and for delivering the gauged receiver magnet to the selecting mechanism 33.

The sensing mechanism 34 is designed for operating, upon actuation by the gauging mechanism 31, the selecting mechanism 33. The selecting mechanism 33 is designed for receiving the gauged receiver magnets 22—22 from the gauging mechanism and, in accordance with a signal received from the sensing mechanism 34, for sorting the gauged receiver magnets 22—22 into the respective grades according to the gauged dimensions of the receiver magnets.

Gauging Mechanism

The gauging mechanism 31 includes a chute, designated generally by the numeral 36, secured in an inclined position in a recess 37 (FIG. 3) in a top plate 38, by means of a beveled support 39. The chute 36 is provided to receive a single file of the receiver magnets 22—22 to be gauged, which are positioned on their sides. The chute 36 is inclined to insure free rolling of the receiver magnets 22—22 down the chute 36 into a gauging position and, after a gauging operation, into a movable sorting chute 41 of the selecting mechanism 33. A pair of side plates 42 and 43 are secured by suitable means to a base plate 44 on both sides of a track 46, made of a suitable wear-resistant material, such as a hardened stainless steel. The side plates 42 and 43 confine the receiver magnets 22—22, rolling down the chute 36 with the bottoms 24—24 adjacent to the side plate 43, to the area of a surface 47 of the track 46. A pair of circular apertures 48 and 49 (FIG. 4), aligned axially of each other in a position corresponding to the gauging position of the receiver magnets 22—22, are provided one in each of the side plates 42 and 43, respectively.

During the gauging operation, the receiver magnets 22—22 are axially aligned with the apertures 48 and 49 in the gauging position and are pressed against the side plate 43. To prevent an inaccurate measurement of the thickness of the bottom 24 of a receiver magnet 22 due to possible deformation and wearing of the side plate 43, an annular anvil plate 51 is provided. The anvil plate 51, made of a suitable hard, nonmagnetic material, resistant to impact, pressure and abrasion, for example, hardened stainless steel or the like, is provided with a central circular aperture 52 axially aligned with the apertures 48 and 49. The anvil plate 51 is mounted removably, for maintenance purposes, in a complementary recess 53 in the side plate 43 and is provided with a face 54 which serves as a reference surface for the measurement of the thickness of the bottom 24 of a receiver magnet 22. A pair of brackets 56 and 57 anchor the side plate 43 to the top plate 38 to prevent the possibility of lateral displacement of the side plate 43 during the gauging operation.

An escapement mechanism, designated generally by the numeral 58 (FIG. 3), is provided to retain the lowermost of the receiver magnets 22—22 in the chute 36 precisely in the gauging position, and, after the retained receiver magnet has been gauged, to allow the same to roll down the chute 36 toward and into the sorting chute 41. Simultaneously, the escapement mechanism 58 prevents the remaining receiver magnets 22—22, stacked in the chute 36, from rolling down the chute.

The escapement mechanism 58 includes detent pins 59 and 61 having tapered ends. The detent pins 59 and 61 are slidably positioned in bushings 62 and 63, respectively, mounted securely in holes extending through the base plate 44 of the chute 36 and also through the top plate 38. The detent pins 59 and 61 are connected to opposite ends of a lever 64 mounted pivotally at the center thereof to a U-shaped bracket 66 so that, when one of the detent pins 59 and 61 is extended above the surface 47 of the track 46, the other of the detent pins is retracted below the surface, depending upon whether the lever 64 is pivoted clockwise or counterclockwise. The detent pin 59 is connected to a plunger 67 of a normally-deenergized solenoid 68 in such a manner that, when the plunger 67 is in its normal, retracted position, shown in FIG. 3, the detent pin 59 is retracted below the surface 47 of the track 46. With the detent pin 59 retracted, the detent pin 61 is in an extended position protruding above the surface 47 of the track 46 so as to hold the leading receiver magnet 22 in a gauged position in precise axial alignment with apertures 48 and 49 in the side plates 42 and 43, respectively.

A pin-like detector element 69 (FIGS. 3, 4 and 5) is normally urged by a spring 71 into an extended position (not shown), wherein one end of the detector element extends above the surface 47 of the track 46. The other end of the detector element 69 is positioned in abutting contact with an actuating arm 72 of a normally open detector switch 73. When one of the receiver magnets 22—22 is in the gauging position, the detector element 69 is depressed by the weight of the receiver magnet to a position flush with the surface 47 of the track 46 and, when depressed, operates the actuating arm 72, so that the normally open detector switch 73 is closed to initiate a gauging cycle, as will be explained hereinafter in detail with respect to the operation of the apparatus.

An elongated, cylindrical gauging element 76 is mounted slidably, coaxially of the apertures 48 and 49 in a bearing support 77 mounted on the top plate 38. The gauging element 76 is provided with a reduced, tapered nose portion 78 and an annular shoulder portion 79. The gauging element 76 is designed to be moved from its normal retracted position shown in FIGS. 1 and 4 through a guide bushings 82, mounted in the aperture 48 in the side plate 42, into extended positions, such as the position shown in FIG. 5.

The gauging element 76 is moved so that the nose 78, the maximum diameter of which is less than the diameter of the aperture 26 of a receiver magnet 22, passes through the guide bushing 82, the last-mentioned aperture, the aperture 52 in the anvil plate 51 and the aperture 49 in the side plate 43, until the shoulder 79 engages the inner face 27 of the receiver magnet. In this extended position, the distance between the shoulder 79 and the face 54 of the anvil plate 51 is equal to the thickness of the bottom 24 of the receiver magnet 22. The nose 78 is of such length that, when the shoulder 79 is removed from the face 54 of the anvil plate 51 a distance equal to or less than a maximum acceptable thickness (t) of the bottom 24 of the receiver magnet 22, the nose protrudes beyond the face 54 sufficiently to cause actuation of the sensing mechanism 34, as will be explained hereinafter in detail.

A double-acting fluid cylinder 83, for example, an air cylinder, is mounted securely on the top plate 38 axially of the gauging element 76. A piston rod 84 of the air cylinder 83 is operatively connected to the gauging element 76 so that the gauging element is moved with the piston rod between the retracted and the extended positions. A solenoid-actuated valve 86, which is connected by means of air lines 87 and 88 to the air cylinder 83, controls the reciprocable movement of the piston rod 84, and, therefore, the movement of the gauging element 76 between the retracted and the extended positions thereof. The valve 86, connected to a suitable supply 89 (FIG. 9) of a fluid, such as air, under pressure, by means of an inlet line 91, is provided with an exhaust line 92 connected to a suitable exhaust muffler (not shown). The valve 86 is actuated by means of an advance solenoid 93 and a retract solenoid 94 (FIGS. 8 and 9) to produce the advance and the retract movements of the piston rod 84, respectively.

A normally open pressure switch 95 is connected to the air line 87 by means of an air line 96. The normally open pressure switch 95 is designed to be adjusted to close when the pressure in the air line 87 exceeds by a predetermined amount a preselected, normal operating pressure. For example, if the normal operating pressure in the air line 87 is 40 p.s.i., the pressure switch 95 may be adjusted to operate when the pressure in the lines 87 and 96 rises to 45 p.s.i. during the gauging operation.

In a gauging operation, during the advance stroke of the piston rod 84, the shoulder 79 of the gauging element 76 contacts the inner face 27 of the receiver magnet 22 being gauged and urges the receiver magnet 22 against the anvil plate 51. Since the air is continuously supplied to the air cylinder 83 through the air line 87, the pressure of the air in the lines 87 and 96 rises above the normal operating pressure of the apparatus. When the air pressure in the lines 87 and 96 increases to the operating pressure of the pressure switch 95, the pressure switch, which is connected electrically to the retract solenoid 94 of the valve 86 closes and energizes the retract solenoid 94, causing reversal of the operation of the air cylinder 83. The pressure switch 95 is also connected to control the sensing mechanism 34.

A trip arm, designated generally by the numeral 97, is mounted securely on the piston rod 84 for reciprocable movement therewith. The trip arm 97 is provided with a reduced portion 98 and an enlarged portion 99. A threaded rod 100 is mounted adjustably in the enlarged portion 99 of the trip arm. At the end of the retract stroke of the piston rod 84, the threaded rod 100 actuates a plunger 101 of a normally open switch 102 to close the latter when the piston rod 84 is in its retracted position. The switch 102, upon closing, energizes, when the detector switch 73 is closed, the advance solenoid 93 of the valve 86 to cause advance movement of the piston rod 84 and, therefore, movement of the gauging element 76 into its extended position.

The enlarged portion 99 of the trip arm 97 actuates a one-way actuating arm 103 designed to momentarily close a normally open switch 104 during the movement of the piston rod 84 into its retracted position only. The switch 104, upon closing, energizes the solenoid 68 of the escapement mechanism 58 to cause counterclockwise pivotable movement of the lever 64 so that the detent pin 59 is extended above and the detent pin 61 is retracted below the surface 47 of the track 46. The reduced portion 98 of the trip arm 97 actuates a one-way actuating arm 105 designed to momentarily open a normally closed switch 106 during the movement of the piston rod 84 into its extended position only.

Selecting Mechanism

The selecting mechanism 33 (FIG. 6) of the sorting mechanism 32 includes an air cylinder 107 mounted securedly to the top plate 38 by means of support brackets 109—109. The air cylinder 107 is provided with two air inlet ports 110—110 and a plurality of air outlet ports 111 to 117, inclusive, spaced uniformly along the length of the air cylinder 107 intermediate of the inlet ports 110—110. A piston rod 118, having an attached piston element 119, is mounted slidably through the ends of the air cylinder 107 axially thereof. The piston element 119 fits tightly within the air cylinder 107 and is sufficiently long to close overlappingly and seal any one of the individual outlet ports 111 to 117, inclusive, when the piston element is moved in alignment therewith.

A plurality of normally closed, solenoid-actuated valves 121 to 127, inclusive, are mounted on a support plate 128 which is attached to the air cylinder 107. Each of the valves 121 to 127, inclusive, is connected to a corresponding one of the outlet ports 111 to 117, inclusive, respectively. A plurality of normally deenergized solenoids 131 to 137 (FIGS. 8 and 9), inclusive, selectively control the associated valves 121 to 127, inclusive, respectively. The solenoids 131 to 137, inclusive, are arranged to be selectively energized by the sensing mechanism 34 in a manner hereinafter to be described in detail.

Suitable fluid, such as compressed air, is supplied simultaneously at the same pressure to both inlet ports 110—110. Since the outlet ports 111 to 117, inclusive, are normally closed by associated valves 121 to 127, inclusive, respectively, an equilibrium of pressures normally exists on opposite sides of the piston element 119. If one of the outlet ports 111 to 117, inclusive, is opened by the associated one of the valves 121 to 127, inclusive, the equilibrium of pressures is upset and the piston element 119 moves in the direction of the lower pressure until the piston element closes overlappingly the open outlet port, whereupon the equilibrium is restored. The piston element 119 then remains in this overlapping position until a different one of the outlet ports 111 to 117, inclusive, is opened, whereby the equilibrium of pressures is upset again. In this manner, by actuating selected ones of the valves 121 to 127, inclusive, it is possible to control the position of the piston element 119 within the air cylinder 107.

A rack 138 is mounted securely in a block 139, which, in turn, is mounted adjustably on the rod 118 for reciprocable movement therewith. A pinion gear 141, mounted on a shaft 142 (FIG. 3) for rotation therewith, meshes with the rack 138 so that reciprocable movement of the rack is translated into oscillatory movement of the shaft. The shaft 142 having an enlarged portion 143, which fits into a recess 144 in an enlarged dependent portion 145 of the base plate 44 of the chute 36, is mounted rotatably in bushings 147—147, one of which is mounted in the base plate 44 of the chute 36 and the other in a spacer 148 secured to the base plate.

The sorting chute 41 is mounted on a support bracket 149, one end of which fits into the space formed between the base plate 44 and the spacer 148. Since the shaft 142 is also keyed to the support bracket 149 of the sorting chute 41, the oscillatory movement of the pinion gear 141 produces corresponding pivotable movement of the sorting chute 41. The linear movement of the piston element 119 relative to the respective outlet ports 111 to 117, inclusive, is, therefore, translated by means of the piston rod 118, the rack 138, the pinion gear 141 and the shaft 142 into corresponding pivotable movement of the sorting chute 41. The free end of the sorting chute 41 then moves along a circular arc to a position determined by the equilibrium position of the piston element 119.

A plurality of receiving chutes 151 to 157 (FIG. 1) inclusive, each associated with one discrete position of the sorting chute 41, are spaced upon a support frame 158 along the arc of pivoting of the free end of the sorting chute 41. The spacing is such that, when the piston element 119 is in overlapping relationship with one of the outlet ports 111 to 117, inclusive, the sorting chute 41 is in alignment with one of the receiving chutes 151 to 157, associated with that outlet port.

Each of the receiving chutes 151 to 157, inclusive, is designed, when aligned with the sorting chute 41, to receive only one selected grade of the receiver magnets 22—22, i.e. only the receiver magnets 22—22 having one selected range of bottom thicknesses. For example, the receiving chute 151 associated with the outlet port 111 is designed to receive the receiver magnets 22—22 having "oversize" thicknesses of the bottoms 24—24 thereof, i.e. thicknesses in excess of (t). The receiving chutes 152 to 156, inclusive, associated each with one of the outlet ports 112 to 117, inclusive, respectively, are each designed to receive only one regular grade of the receiver magnets 22—22. The receiving chute 157 is designed to receive all "undersize" receiver magnets 22—22, i.e. receiver magnets having bottoms 24—24, the thickness of which is equal to or less than (t—5d).

Sensing Mechanism

The sensing mechanism 34 (FIGS. 1, 4 and 5) of the sorting mechanism 32 includes an elongated actuator rod 161 mounted slidably in a plurality of bearing supports 162—162 and bearing supports 163—163 which are mounted on the top plate 38 to the left of the chute 36. The actuator rod 161 is mounted coaxially of the apertures 48 and 49 in the side plates 42 and 43, respectively, in such a manner that the nose 78 of the gauging element

76 may strike the actuator rod 161 during a gauging operation and push the actuator rod axially thereof from right to left, as viewed in FIGS. 1, 4 and 5.

A pair of stop collars 164 and 166, mounted adjustably on the actuator rod 161 are positioned to limit the axial movement of the actuator rod in either direction. The stop collar 164 is adjusted to allow the gauging element 76 to contact and actuate the actuator rod 161 when the shoulder 79 of the gauging element 76 reaches a position removed from the face 54 of the anvil plate 51 a distance slightly greater than (*t*), to insure a desired degree of pretravel of the actuator rod. The stop collar 166 is adjusted to allow a similar degree of overtravel of the actuator rod 161 when the shoulder 79 of the gauging element 76 moves beyond a position removed a distance (*t*—5*d*) from the face 54 of the anvil plate 51. A compression spring 167, mounted axially about the actuator rod 161 between the collar 164 and the bearing support 162, urges the actuator rod from left to right as viewed in FIGS. 1, 4 and 5, into a normal position shown in FIGS. 1 and 4, whereat the stop collar 164 abuts the bearing support 162 adjacent thereto.

A plurality of single-pole, double-throw, snap-action precision switches 172 to 177, inclusive, for example, pin plunger switches, class Z, type BZ–R19, manufactured by the Micro Switch, a Division of Minneapolis-Honeywell Regulator Company, Freeport, Illinois, are mounted on opposite sides of each of the bearing supports 163—163 in parallel relationship to the actuator rod 161. Each of the switches 172 to 177, inclusive, is provided with normally closed and normally open contacts and with individual pin plungers 178—178 (FIGS. 4 and 5). The pin plungers 178—178 are designed, upon being pushed inwardly of the switches, to actuate the associated switches 172 to 177, inclusive, to open the normally closed contacts and to close the normally open contacts of the respective switches. The switches 172 to 177, inclusive, are so constructed that any one of the switches is actuated only when the individual pin plungers 178—178 associated therewith move inwardly thereof a precise, predetermined distance, which is preferably the same for all the switches.

A plurality of transversely extending bracket plates 179—179 are mounted adjustably on the actuator rod 161 for reciprocating movement therewith. A plurality of finely threaded actuator lugs 182 to 187, inclusive, are mounted in pairs at the opposite ends of each of the bracket plates 179—179 in precise, axial alignment with the respective pin plungers 178—178 of the respective switches 172 to 177, inclusive. The bracket plates 179—179 are adjustable axially of the actuator rod 161 relative to the switches 172 to 177, inclusive, to provide for a coarse, preliminary setting of the actuator lugs 182 to 187, inclusive, relative to the respective pin plungers 178—178.

The actuator lugs 182 to 187, inclusive, are, further, individually precision adjustable axially of the corresponding pin plungers 178—178 of the respective switches 172 to 177, inclusive, to provide for a final accurate setting of the respective actuator lugs relative to the associated pin plungers. The actuator lugs 182 to 187, inclusive, are preset to contact and actuate the associated pin plungers 178—178 consecutively at predetermined intervals during the axial movement of the actuator rod 161 from right to left as viewed in FIG. 5. In this particular example, the actuator lugs 182 to 187, inclusive, are preset to actuate the respective switches 172 to 177, inclusive, respectively, precisely when the shoulder 79 of the gauging element 76 reaches positions relative to the face 54 of the anvil plate 51, corresponding to the upper limits of each consecutive grade, with the exception of the oversize grade. For example, the switch 172 is actuated when the shoulder 79 of the gauging element 76 reaches a position removed a distance (*t*) from the face 54 of the anvil plate 51. Similarly, the switches 173, 174, 175, 176 and 177 will be actuated when the shoulder 79 of the gauging element reaches successively the positions (*t*—*d*), (*t*—2*d*), (*t*—3*d*), (*t*—4*d*) and (*t*—5*d*), respectively.

The switches 172 to 177, inclusive, are connected to each other electrically in series, in the normally closed position, as is shown in the electrical circuit diagram illustrated in FIG. 8. A relay 191 is connected to a normally closed contact of the switch 172, and relays 192 to 197, inclusive, are connected to the normally open contacts of the switches 172 to 177, inclusive, respectively. Relays 191 to 197, inclusive, upon energization, lock themselves through their normally open contacts 201 to 207, inclusive, and close their normally open contacts 211 to 217, inclusive, to energize the associated solenoids 131 to 137, inclusive, respectively.

The switch 177 is also connected in series electrically to the normally open pressure switch 95 so that all of the switches 172 to 177, inclusive, are connected in series with the pressure switch. Accordingly, so long as the pressure switch 95 remains open, even assuming that a main switch 218 (FIG. 8) is closed, none of the relays 191 to 197, inclusive, will be energized. When the pressure switch 95 is closed and none of the switches 172 to 177, inclusive, are actuated, for example, during the gauging of oversize receiver magnets 22—22, the relay 191 will be energized, causing energization of the associated solenoid 131 of the valve 121. Energization of the solenoid 131 results in the opening of the outlet port 111, the linear movement of the piston element 119, in alignment with the outlet port 111, and the corresponding pivotable movement of the sorting chute 41 in alignment with the receiving chute 151.

When one or more of the switches 172 to 177, inclusive, are actuated serially, beginning with the switch 172, the normally closed contact of each actuated switch is open and a normally open contact thereof is closed so that each actuated switch breaks the original series circuit and connects the remaining unactuated switches with relays associated with the actuated switches. Accordingly, only the relay associated with the last-actuated switch will be connected in series with the remaining unactuated switches and the pressure switch 95, resulting in actuation of the solenoid associated with the last-actuated switch and alignment of the sorting chute 41 with the respective receiving chute, depending on which of the switches 172 to 177, inclusive, was actuated last during the gauging operation.

Operation

For the purposes of description, it is assumed that the main switch 218 of the electrical control circuit shown in FIG. 8 is closed. It is also assumed that there are no receiver magnets 22—22 in the chute 36. Therefore, the detector element 69 is in its extended position above the surface 47 of the track 46, so that the detector switch 73 is open. The piston rod 84 of the air cylinder 83, and therefore, gauging element 76 are in the retracted position shown in FIGS. 1 and 4. The threaded rod 100 of the trip arm 97 is so adjusted that, when the piston rod 84 is in the retracted position, the plunger 101 is actuated by the threaded rod, so that the switch 102 is closed. The normally open switch 104 is open at this time, and therefore, the solenoid 68 of the escapement mechanism 58 is deenergized. Accordingly, the plunger 67 of the escapement mechanism 58 is in its retracted position so that the detent pin 59 is retracted and the detent pin 61 is extended.

It is also assumed that during the preceding gauging operation, the switches 172 to 174, inclusive, were actuated and, when the pressure switch 95 was actuated, a circuit of the relay 194 was completed through the switches 177 to 174, inclusive, resulting in energization of the relay 194, closing of the contacts 204 and 214 thereof and energization of the solenoid 134. The energization of the solenoid 134, in turn, resulted in actuation of the valve 124, opening of the outlet port 114 and positioning of the piston valve 119 in overlapping relationship to the outlet port 114, so that the sorting chute 41 is now aligned

with the receiving chute 154. The relay 194 and the solenoid 134 will continue to be energized and, therefore, the outlet 114 will continue to be open, as long as the main switch 218 and the normally closed switch 106, which is provided to reset in the beginning of the operation any one of the relays 191 to 197, inclusive, energized during the preceding gauging operation, are kept closed. Since the gauging element 76 is in its retracted position, the actuator rod 161, carrying the bracket plates 179—179, is urged by the spring 167 into the retracted position from left to right, as viewed in FIGS. 1, 4 and 5, so that the stop collar 164 abuts the bearing support 162 thereby preventing any further rightward movement of the actuator rod. In this position of the actuator rod 161, none of the actuator lugs 182 to 187, inclusive, actuate any of the switches 172 to 177, inclusive, respectively.

A plurality of the receiver magnets 22—22, to be gauged and sorted into respective grades, are now delivered into the chute 36 either manually by an operator or by suitable, automatic delivery means (not shown). The receiver magnets 22—22 are placed in the chute 36 in such a manner that the outer face 28 of the bottom 24 of each of the receiver magnets abuts the side plate 43, as shown in FIGS. 1, 3, 4 and 5. Since the detent pin 61 of the escapement mechanism 58 is in its extended position shown in FIG. 3, the lowermost of the receiver magnets 22—22 in the chute 36 is aligned axially with the apertures 48 and 49 in the side plates 42 and 43, respectively, of the chute 36, with the gauging element 76, and with the actuator rod 161. The lowermost of the receiver magnets 22—22 depresses the detector element 69 below the surface 47 of the track 46 whereby the detector switch 73 is closed.

Since, at this time, the normally-open switch 102 in the circuit of the advance solenoid 93 of the valve 86 associated with the air cylinder 83 is also closed, the advance solenoid 93 is energized upon closing of the detector switch 73 to actuate the valve 86, so that the fluid, delivered through the fluid line 87 into the air cylinder 83, forces the piston rod 84 from the retracted position (FIGS. 1 and 4) toward an extended position (FIG. 5), whereby the piston rod moves the gauging element 76 therewith toward its extended gauging position shown in FIG. 5. During the movement of the piston rod 84 from the retracted position, the reduced portion 98 of the trip arm 97 actuates the one-way actuating arm 105 of the normally closed switch 106, opening momentarily the latter, which results in deenergization of the previously energized relay 194. Deenergization of the relay 194 results in opening of the contacts 204 and 214 thereof, which, in turn, results in deenergization of the solenoid 134. Deenergization of the solenoid 134 results in closing of the valve 124 and, therefore, of the outlet port 114, so that all of the outlet ports 111 to 117, inclusive, are now closed.

The gauging element 76, during its movement from the retracted toward the extended position, passes through the guide bushing 82 mounted in the aperture 48 in the side plate 42 of the chute 36 so that the shoulder 79 of the gauging element comes in contact with the inner face 27 of the lowermost of the receiver magnets 22—22 retained in gauging position in the chute 36 by the detent pin 61 of the escapement mechanism 58. The reduced nose portion 78 of the gauging element 76 moves through the aperture 48 in the side plate 42, the aperture 26 in the receiver magnet 22 being gauged, the aperture 52 in the anvil plate 51, the aperture 49 in the side plate 43, and moves adjacent to the actuating rod 161.

If it is assumed that the receiver magnet 22 being gauged has a thickness of the bottom 24 thereof equal to (t), the nose portion 78 of the gauging element will move into contact with the actuator rod 161 so that the gauging element 76 will push the actuator rod 161 and all of the bracket plates 179—179, carrying the actuator lugs 182 to 187, inclusive, from right to left, as viewed in FIGS. 1 and 4, until the shoulder 79 of the gauging element 76 engages the inner face 27 of the receiver magnet 22 held against the face 54 of the anvil plate 51 so that the shoulder 79 is spaced a distance (t) from the face 54. When the gauging element 76 reaches this position, the actuator lug 182 has exerted sufficient pressure upon the pin plunger 178 associated with the switch 172 to open the normally closed contact and to close the normally open contact thereof, so that the relay 191 is disconnected and the relay 192 is connected in series to the normally open pressure switch 95.

Since the air under pressure continues to be supplied from the source of supply 89, the piston rod 84 is continued to be urged in the direction from right to left as shown in FIG. 5, and therefore, urges the gauging element 76 against the inner face 27 of the receiver magnet 22. As a result, there is a build-up of the fluid pressure in the fluid line 87, which is transmitted through the line 96 to the pressure switch 95, causing the pressure switch to be closed, thereby completing the circuit through the switches 177 to 172, inclusive, and through the relay 192. The relay 192 then locks itself through its normally open contact 202, and simultaneously closes its normally open contact 212 in the circuit of the solenoid 132 of the valve 122, to energize the solenoid 132 so that the valve 122 opens the outlet port 112.

Because of the now open outlet port 112, the pressures on opposite sides of the piston element 119 are unbalanced and the piston element begins to move in the direction of the lower of the pressures, from the position originally occupied thereby in front of the outlet port 114 to the outlet port 112, until the piston element closes overlappingly the outlet port 112 and the pressures on both sides of the piston element are again balanced. The movement of the piston element 119 is, in turn, translated into rotary movement of the sorting chute 41, which moves into alignment with the receiving chute 152, designed to receive the receiver magnets 22—22 having thicknesses of the bottoms 24—24 thereof falling into a range of dimensions between (t) and $(t-d)$, exclusive of $(t-d)$. The chute 36, therefore, is now connected by means of the sorting chute 41 with the receiving chute 152.

Simultaneously, with the completion of the circuit of the switch 172, the pressure switch 95 completes a circuit of the retract solenoid 94, which operates the valve 86 of the air cylinder 83 to reverse the operation of the air cylinder 83 so as to withdraw the gauging element 76 from the extended gauging position. During the movement of the piston rod 84 into the retracted position, the enlarged portion 99 of the trip arm 97 operates the one-way actuating arm 103 of the normally open switch 104 to momentarily close the latter whereby the solenoid 68 of the escapement mechanism 58 is energized.

Upon energization of the solenoid 68, the detent pin 61 moves below the surface 47 of the track 46, allowing the gauged receiver magnet 22 to roll down the chute 36. Simultaneously, the detent pin 59 moves above the surface 47 of the track 46, preventing the remainder of the receiver magnets 22—22 in the chute 36 from rolling down the chute 36, so that only the gauged receiver magnet is allowed to roll down the chute 36 into the sorting chute 41, and thence through the receiving chute 152, now aligned with the sorting chute 41, into a tote box (not shown) associated therewith.

Since the switch 104 associated with the solenoid 68 of the escapement mechanism 58 was operated only momentarily, the solenoid 68 is deenergized again so that the plunger 67 and, therefore, the detent pins 59 and 61 return to their normal positions shown in FIG. 3. Accordingly, the next of the receiver magnets 22—22, which was previously in contact with the pin 59, rolls down into the gauging position in abutment with the pin 61. This receiver magnet 22 depresses the detector element 69 to actuate the actuating arm 72 of the normally open detector switch 73, so as to close the latter. Meanwhile,

the piston rod 84 of the air cylinder 83 continues to move to its retracted position, so that the threaded rod 100 on the trip arm 97 again closes the switch 102, completing the circuit through the advance solenoid 93. At this time, the gauging operation of the next receiver magnet 22, retained by the detent pin 61 of the escapement mechanism 58 in the gauging position, can start anew.

Assuming that this time a receiver magnet 22 having a thickness of the flange 24 equal to $(t-4d)$ is to be gauged, the piston rod 84 of the air cylinder 83 begins to move the gauging element 76 from the retracted to the extended position thereof. During this movement, the switch 106 is momentarily operated, opening the previously closed contacts 202 and 212 of the relay 192 and, therefore, deenergizing the solenoid 132 so as to cause closing of the outlet port 112. The gauging element 76 then, while being advanced, again moves the actuator rod 161 to actuate by means of the actuator lugs 182 to 186, inclusive, of the switches 172 to 176 (FIG. 5), inclusive, associated therewith so as to open the normally closed contact and to close the normally open contacts of the respective switches. The pressure switch 95 is then closed in a manner similar to that described for the previous receiver magnet 22, to complete the circuit through the switches 177 to 176.

Since the switch 175, and all the preceding switches 174, 173 and 172, are now disconnected from the pressure switch 95 because the circuit between each previously actuated switch was broken when the normally open contact of each consecutive switch was closed, only the relay 196 associated with the switch 176 will be energized. The relay 196 then closes its contacts 206 and 216, and energizes the solenoid 136 of the valve 126, which results in opening of the outlet port 116 of the air cylinder 83.

The opening of the outlet port 116 again results in an unbalance of pressures acting on the piston element 119 which is now initially in alignment with the outlet 112 because of the previous cycle. The piston element 119 now moves into alignment with the outlet 116 whereby the pressures on both sides of the piston element are balanced again. The movement of the piston element 119 results in the movement of the sorting chute 41 from its previous position in alignment with the receiving chute 152 into a new position in alignment with the receiving chute 156, designed to receive receiver magnets 22—22 having thicknesses of the bottoms 24—24 thereof falling into a range between $(t-4d)$ and $(t-5d)$ but exclusive of $(t-5d)$.

Because the circuit of the retract solenoid 94 is also completed by the pressure switch 95, the gauging element 76 is retracted, and switches 102 and 104 are actuated again. The escapement mechanism 58 is then operated again in the manner previously described so that the gauging operation will again take place on the next successive receiver magnet 22 in a manner similar to that described hereinabove.

It is obvious that, should there be more than one consecutive receiver magnets 22—22 having bottoms 24—24 thereof the thicknesses of which fall into a range of dimensions incorporated by one grade thereof, the piston element 119 and, therefore, the sorting chute 41 will remain in the same position, although the gauging mechanism 31, the sensing mechanism 34 and the respective solenoids and associated valves of the selecting mechanism 33 will go through their respective movements.

Now it is assumed that a receiver magnet 22 next to be gauged has a bottom 24, the thickness of which is greater than (t), i.e. that the receiver magnet 22 to be gauged is an oversize receiver magnet. The gauging operation will then begin similarly to the gauging operation described hereinabove with respect to the preceding receiver magnets 22—22. During the gauging of oversize receiver magnets 22—22, the actuator rod 161 might or might not be moved at all, so that none of the switches 172 to 177, inclusive, are operated, depending on the final gauging position of the shoulder 79 of the gauging element 76 relative to the exposed face 54 of the anvil plate 51.

The pressure switch 95 is then actuated, as described hereinabove with respect to the preceding receiver magnets 22—22, to complete the circuit of the relay 191 through all of the switches 177 to 172, inclusive. Energization of the relay 191 results in energization of the solenoid 131, opening of the outlet port 111, and movement of the piston element 119 from the previous position occupied thereby, in alignment with one of the outlet ports 111 to 117, inclusive, such as outlet port 116, to a new position in alignment with the outlet port 111. Movement of the piston element 119 results in the movement of the sorting chute 41 from a previous position in alignment with the chute 156, into a new position in alignment with the chute 151, associated with receiver magnets 22—22 having oversize thicknesses of the bottoms 24—24 thereof.

Similarly, if any of the receiver magnets 22—22 being gauged have bottoms 24—24, thicknesses of which are equal to or less than $(t-5d)$, i.e. are "undersize," all of the switches 172 to 177, inclusive, will be actuated. Should the thickness of the bottom 24 of a receiver magnet be equal to or infinitesimally less than $(t-5d)$, the pressure switch 95 will complete in the usual way, described hereinabove, the circuit of the relay 197, which will result in alignment of the sorting chute 41 with the receiving chute 157 designed to receive the receiver magnets 22—22 having bottoms 24—24, thicknesses of which are equal to, or even less than, $(t-5d)$. Should the "undersize" thickness of the bottom 24 of a receiver magnet 22 be such that the shoulder 79 of the gauging element 76 will fail to engage the inner face 27 of the receiver magnet 22 being gauged, the gauging element will tend to urge the actuator rod 161 from right to left so as to tend to bring the shoulder 79 of the gauging element 76 into engagement with the inner face 27 of the receiver magnet 22 being gauged. However, the stop collar 166 is so adjusted as to allow only a relatively small overtravel of the actuator rod 161 beyond a position corresponding to a $(t-5d)$ position of the shoulder 79 relative to the face 54 of the anvil plate 51 to prevent damage to the switches 172 to 177, inclusive. Accordingly, the stop collar 166 will resist any further axial movement from right to left of the actuator rod 161, and therefore, of the gauging element 76, so that the pressure switch 95 will be actuated, completing the circuit of the relay 197.

The gauging operation will be repeated for various receiver magnets 22—22 until the supply of the receiver magnets 22—22 is exhausted so that the detector element 69 remains in its extended position and, therefore, the detector switch 73 remains open causing interruption of the circuit of the advance solenoid 93. The gauging operation can be started again by inserting a new supply of the receiver magnets 22—22 into the chute 36 to depress the detector element 69.

The operator, by observing the relative number of the gauged receiver magnets 22—22 in a certain grade thereof, may determine whether the manufacturing tool needs adjustment, and the direction and magnitude of any necessary adjustment, so as to maintain a desired quality control. The receiver magnets 22—22 may then be refinished, if necessary, to the desired dimension, or may be used with mating parts of telephone receivers having complementary dimensions to produce a substantially perfectly interfitting telephone receiver assembly.

It is manifest that the above-described arrangements are simply illustrative of the principles of the invention. Other arrangements may be devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. Apparatus for gauging a dimension of each of a series of articles and for sorting the articles into a number of grades according to the respective gauged dimensions

of the articles, which comprises a gauging element positioned at a gauging station and movable intermittently into and out of engagement with an article thereat, movable guide means for directing the gauged articles individually from the gauging element to a plurality of locations, each location corresponding to one grade of the articles, a fluid cylinder having a movable piston, said piston being connected operatively to the guide means whereby movement of the piston causes corresponding movement of the guide means, means tending to maintain an equilibrium of pressures on opposite sides of the piston so as to tend to hold the piston stationary, a plurality of means operable selectively for tending to unbalance said equilibrium of pressures so as to tend to force the piston in a direction of the lower of the unbalanced pressures until the equilibrium of pressures is restored, a plurality of electrical switches, an electrical control circuit interconnecting said switches with individual of said unbalancing means, an actuator rod arranged for movement by the gauging element as the latter moves into engagement with the article to be gauged, and a plurality of switch-actuating members mounted fixedly on the actuator rod for cooperation with corresponding ones of said switches, said switches and said switch-actuating members being arranged so that the switches are actuated in a predetermined sequence for operating selectively one of said unbalancing means, the number of switches actuated during the gauging of an article depending on the dimension of said article gauged and determining the selection of the unbalancing means to be operated, so that said guide means is being moved by said piston upon operation of the selected unbalancing means to direct the gauged articles from the gauging means to a location designated for receiving the grade of articles including the gauged dimension.

2. Apparatus for gauging a dimension of each of a series of articles and for sorting the articles into a number of grades according to the respective gauged dimensions of the articles, which comprises means for feeding articles serially to a gauging station, a gauging element positioned at the gauging station and movable intermittently into and out of engagement with successive articles, means for discharging an article from the gauging station after a gauging operation thereon, a plurality of receptacles for receiving the different grades of articles, movable guide means for directing an article from the gauging station to a selected one of the receptacles, a fluid cylinder having a movable piston, means operatively connecting the guide means to the piston whereby movement of the piston causes corresponding movement of the guide means, said cylinder also having a pair of primary ports, one adjacent to each end thereof, and a plurality of secondary ports spaced intermediate of the primary ports and along the length of the cylinder, fluid supply means communicating with the primary ports for tending to maintain a balance of pressures on opposite sides of the piston so as to tend to hold the piston stationary, individual valve means connected to each of the ports for selectively opening their respective ports to a pressure lower than the pressure of said fluid supply means so that the piston is forced to occupy a position covering the open secondary port, a plurality of electrical switches, an electrical control circuit interconnecting said switches and the individual valve means, an actuator rod arranged for movement by the gauging element as the latter moves into engagement with the article to be gauged, and a plurality of switch-actuating members mounted fixedly on the actuator rod for cooperation with corresponding ones of said switches, said switches and switch-actuating members being arranged so that the switches are actuated in a predetermined sequence, the number of switches actuated during the movement of the actuator rod by the gauging element depending upon the dimension of the article being gauged and determining the selection of the valve means to be operated so that said guide means is moved by said piston upon operation of the selected valve means to direct the gauged article from said gauging station to the receptacle designated for receiving the grade of articles including the gauged dimension.

3. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles each having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an elongated gauging element positioned at a gauging station and movable reciprocably into and out of engagement with the bottom of an article positioned thereat, said gauging element having a reduced leading end portion thereof designed to pass through the central aperture in the bottom of said article during the gauging, said gauging element also having a shoulder formed between the body thereof and the reduced portion, means for moving said gauging element reciprocably relative to the gauging station, a plurality of receptacles for receiving the different grades of articles, a sorting chute pivotable into a plurality of positions for delivering in a selected position the gauged article from the gauging station to a selected one of said receptacles, a fluid cylinder having a movable piston, means mechanically connecting the sorting chute to the piston whereby movement of the piston causes corresponding movement of the sorting chute, said cylinder also having a pair of primary ports, one adjacent to each end thereof, and a plurality of secondary ports spaced uniformly intermediate of the primary ports and along the length of the cylinder, fluid supply means communicating with the primary ports for tending to maintain an equilibrium of pressures on opposite sides of the piston so as to tend to hold the piston stationary, individual solenoid-operated valve means connected to each of the secondary ports and actuatable for selectively opening the respective secondary port to a pressure lower than the pressure of said fluid supply means so that the piston is forced to occupy a position covering the open secondary port, a plurality of sensitive electrical switches, individual switches being associated with corresponding valve means, an actuator rod mounted slidably axially of said gauging element and adjacent to the switches, means for resiliently urging said actuator rod into a position whereat said actuator rod is normally contacted by the reduced portion of the gauging element as the shoulder thereof is moved into engagement with the article being gauged, the total axial movement of the actuator rod being related directly to the thickness of the bottom of the article, a plurality of switch-actuating lugs mounted fixedly on said actuator rod for cooperation with corresponding ones of said switches, said switches and switch-actuating lugs being arranged so that the switches are actuated during the movement of the actuator rod in a predetermined sequence, the number of switches actuated during the movement of the actuator rod by the gauging element is dependent upon the thickness of the bottom of the article being gauged, and an electrical control circuit interconnecting said switches for actuating said valve means individually, the circuit being arranged to actuate only the valve means associated with the switch last to be actuated during the gauging of the article so as to cause pivotable movement of the sorting chute to a position whereat said gauged article is directed to a receptacle designated for receiving the grade of articles including the gauged thickness.

4. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles having central apertures therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an apertured anvil member positioned at a gauging station and provided with a reference surface for supporting an article, an axially movable, elongated gauging element positioned at the gauging station coaxially with respect to the aperture in the anvil member, said gauging element having a reduced end portion designed to move through the central aperture in the

bottom of an article and the aperture in the anvil member during the gauging, said gauging element also having a shoulder formed between the body thereof and the reduced end portion, means for moving said gauging element toward the anvil member so that said shoulder is moved into engagement with the bottom of the article and urges the article against said reference surface, a plurality of receptacles for receiving the different grades of articles, a pivotable sorting chute for delivering the gauged article to a selected one of said receptacles, means for pivoting said sorting chute between positions whereat said sorting chute delivers the gauged articles to a selected one of said receptacles, a plurality of means individually energizable for controlling said pivoting means, a plurality of sensitive electrical switches, individual switches being associated with corresponding control means, an actuator rod mounted slidably axially of said gauging element and adjacent to the switches, means for resiliently urging said actuator rod into contact with the reduced portion of the gauging element as the shoulder thereon is moved into engagement with the article being gauged, the gauging element causing axial movement of the actuator rod by an amount dependent on the thickness of the bottom of the article, a plurality of switch-actuating lugs mounted fixedly on said actuator rod for cooperation with corresponding ones of said switches, said switches and switch-actuator lugs being arranged so that the switches are actuatable in a predetermined sequence during the gauging of an article, the number of switches actuated during the movement of the actuator rod by the gauging element being dependent upon the thickness of the bottom of the article being gauged, an electrical control circuit interconnecting said switches so that each consecutively actuated switch in said sequence renders the circuit of each precedingly actuated switch ineffective, and pressure sensitive means responsive to the pressure exerted by said gauging element on said article for completing the circuit of a switch actuated last by said switch-actuating lugs during the gauging of the article to energize the control means associated with said last-actuated switch so as to pivot said sorting chute into a position whereat said gauged article is directed to a receptacle designated for receiving the grade of articles including the gauged thickness of the bottom thereof.

5. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles having central apertures therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an apertured anvil member positioned at a gauging station and provided with a reference surface for supporting an article, an axially movable, elongated gauging element positioned at the gauging station coaxially with respect to the aperture in the anvil member, said gauging element having a reduced end portion designed to move through the central aperture in the bottom of an article and the aperture in the anvil member during the gauging of the article, said gauging element also having a shoulder formed between the body thereof and the reduced end portion, means for moving said gauging element toward the anvil member so that said shoulder is moved into engagement with the bottom of the article and urges the article against said reference surface, a plurality of receptacles for receiving the different grades of articles, a pivotable sorting chute for delivering the gauged article to a selected one of said receptacles, a fluid cylinder having a movable piston, means mechanically connecting the sorting chute to the piston whereby movement of the piston causes corresponding movement of the sorting chute, said cylinder also having a pair of primary ports, one adjacent to each end thereof, and a plurality of secondary ports spaced uniformly intermediate of the primary ports and along the length of the cylinder, fluid supply means communicating with the primary ports for tending to maintain an equilibrium of pressures on opposite sides of the piston so as to tend to hold the piston stationary, a plurality of solenoid-operated valves, each valve being connected to a corresponding one of the secondary ports and actuatable for selectively opening the respective secondary port to a pressure lower than the pressure of said fluid supply means so that the piston is forced to occupy a position covering the open secondary port, a plurality of sensitive electrical switches, individual switches being associated with corresponding individual valves, an actuator rod mounted slidably axially of said gauging element and adjacent to the switches, means for resiliently urging said actuator rod into contact with the reduced portion of the gauging element as the shoulder thereon is moved into engagement with the article being gauged, the gauging element causing axial movement of the actuator rod by an amount dependent on the thickness of the bottom of the article, a plurality of switch-actuating lugs mounted fixedly on said actuator rod for cooperation with corresponding ones of said switches, said switches and switch-actuator lugs being arranged so that the switches are actuatable in a predetermined sequence during the gauging of an article, the number of switches actuated during the movement of the actuator rod by the gauging element being dependent upon the thickness of the bottom of the article being gauged, an electrical control circuit interconnecting said switches so that each consecutively actuated switch in said sequence renders the circuit of each precedingly actuated switch ineffective, and pressure sensitive means in said control circuit responsive to the pressure exerted by said gauging element on said article for completing the circuit of a switch actuated last by said switch-actuating lugs during the gauging of the article to energize the selected one of said valves associated with said last-actuated switch so as to cause said sorting chute to pivot into a position whereat said gauged article is directed to a receptacle designated for receiving the grade including the gauged thickness.

6. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles each having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an elongated gauging element positioned at a gauging station and movable reciprocably into and out of engagement with an article positioned thereat, said gauging element having a reduced leading end portion thereof designed to pass through the central aperture in the bottom of said article during the gauging, said gauging element also having a shoulder formed between the body thereof and the reduced portion, means for moving said gauging element toward the gauging station so that the reduced nose portion moves through the central aperture of the article and said shoulder is moved into engagement with the bottom of the article, the length of movement of the gauging element being directly proportional to the thickness of the bottom of the article, movable guide means for directing the article after gauging to any one of a plurality of receiving locations, and means responsive to the advancement of the reduced end portion of the gauging element as the shoulder thereof is moved into engagement with the article for moving the guide means in accordance with the length of travel of the gauging element to direct the gauged article to a selected one of the receiving locations designated to receive the grade of articles including the gauged thickness.

7. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles each having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an elongated gauging element positioned at a gauging station and movable reciprocably into and out of engagement with an article positioned thereat, said gauging element having a reduced leading end portion thereof designed to pass through the central aperture in the bottom of said article during the

gauging, said gauging element also having a shoulder formed between the body thereof and the reduced portion, means for moving said gauging element toward the gauging station so that the reduced nose portion moves through the central aperture of the article and said shoulder is moved into engagement with the bottom of the article, the length of movement of the gauging element being directly proportional to the thickness of the bottom of the article, movable guide means for directing the article after gauging to any one of a plurality of receiving locations, a fluid-operated driver operable for moving the guide means to direct the gauged article to a selected one of the receiving locations, valve means for operating the driver to control the degree of movement of the guide means, and control means actuatable by the reduced end portion of the gauging element as the shoulder thereof moves into engagement with the article for controlling the valve means in accordance with the length of travel of the gauging element so that the gauged article is directed to a receiving location, designated to receive the grade of articles including the gauged thickness.

8. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles each having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an elongated gauging element positioned at a gauging station and movable reciprocably into and out of engagement with an article positioned thereat, said gauging element having a reduced leading end portion thereof designed to pass through the central aperture in the bottom of said article during the gauging, said gauging element also having a shoulder formed between the body thereof and the reduced portion, means for moving said gauging element toward the gauging station so that the reduced nose portion moves through the central aperture of the article and said shoulder is moved into engagement with the bottom of the article, the length of movement of the gauging element being directly proportional to the thickness of the bottom of the article, movable guide means for directing the article after gauging to any one of a plurality of receiving locations, a fluid-operated driver operable for moving the guide means to direct the gauged article to a selected one of the receiving locations, and valve means for operating the driver to control the degree of movement of the guide means, and a plurality of electrical switch means actuatable in a preselected pattern by the reduced end portion of the gauging element as the shoulder thereof moves into engagement with the article for controlling selectively the valve means in accordance with the length of travel of the gauging element so that the gauged article is directed to a receiving location, designated to receive the grade of articles including the gauged thickness.

9. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an apertured anvil member positioned at a gauging station and provided with a reference surface for supporting an article, an axially movable elongated gauging element positioned at the gauging station coaxially with respect to the aperture in the anvil member, the gauging element having a reduced leading end portion designed to move through the central aperture in the bottom of an article and the aperture in the anvil member during the gauging, the gauging element also having a shoulder formed between the body thereof and the reduced end portion, means for moving the gauging element toward the anvil member so that the reduced nose portion moves through the central aperture of the article and the shoulder is moved into engagement with the bottom of the article and urges the article against the reference surface, the length of movement of the gauging element being directly proportional to the thickness of the bottom of the article, movable guide means for directing the article after gauging to any one of a plurality of receiving locations, and means responsive to the movement of the reduced end portion of the gauging element as the shoulder thereof is moved into engagement with the article for selectively positioning the guide means to direct the gauged article to a receiving location determined by the length of travel of the gauging element so that the article is directed to a receiving location designated to receive the grade of articles including the gauged dimension.

10. Apparatus for gauging the thickness of the bottom of each of a series of cup-shaped articles having a central aperture therethrough and for sorting the articles into a number of grades according to the respective gauged thicknesses, which comprises an apertured anvil member positioned at a gauging station and provided with a reference surface for supporting an article, an axially movable elongated gauging element positioned at the gauging station coaxially with respect to the aperture in the anvil member, the gauging element having a reduced leading end portion designed to move through the central aperture in the bottom of an article and the aperture in the anvil member during the gauging, the gauging element also having a shoulder formed between the body thereof and the reduced end portion, means for moving the gauging element toward the anvil member so that the reduced nose portion moves through the central aperture of the article and the shoulder is moved into engagement with the bottom of the article and urges the article against the reference surface, the length of movement of the gauging element being directly proportional to the thickness of the bottom of the article, pressure sensitive means responsive to the pressure exerted by the gauging element on the article for actuating the moving means to retract the gauging element out of engagement with the article, movable guide means for directing the article after gauging to any one of a plurality of receiving locations, and means responsive to the movement of the reduced end portion of the gauging element as the shoulder thereof is moved into engagement with the article for selectively positioning the guide means to direct the gauged article to a receiving location determined by the length of travel of the gauging element so that the article is directed to a receiving location designated to receive the grade of articles including the gauged dimension.

References Cited in the file of this patent

UNITED STATES PATENTS

1,203,261	Powers	Oct. 31, 1916
1,663,539	Bellinger	Mar. 27, 1928
2,398,997	Berry	Apr. 23, 1946
2,407,062	Darrah	Sept. 3, 1946
2,493,147	Kasper	Jan. 3, 1950
2,504,505	De Tar	Apr. 18, 1950
2,937,749	Strzala	May 24, 1960