Dec. 23, 1941. C. PAULSON 2,267,129

TESTING APPARATUS

Filed July 10, 1940 7 Sheets-Sheet 1

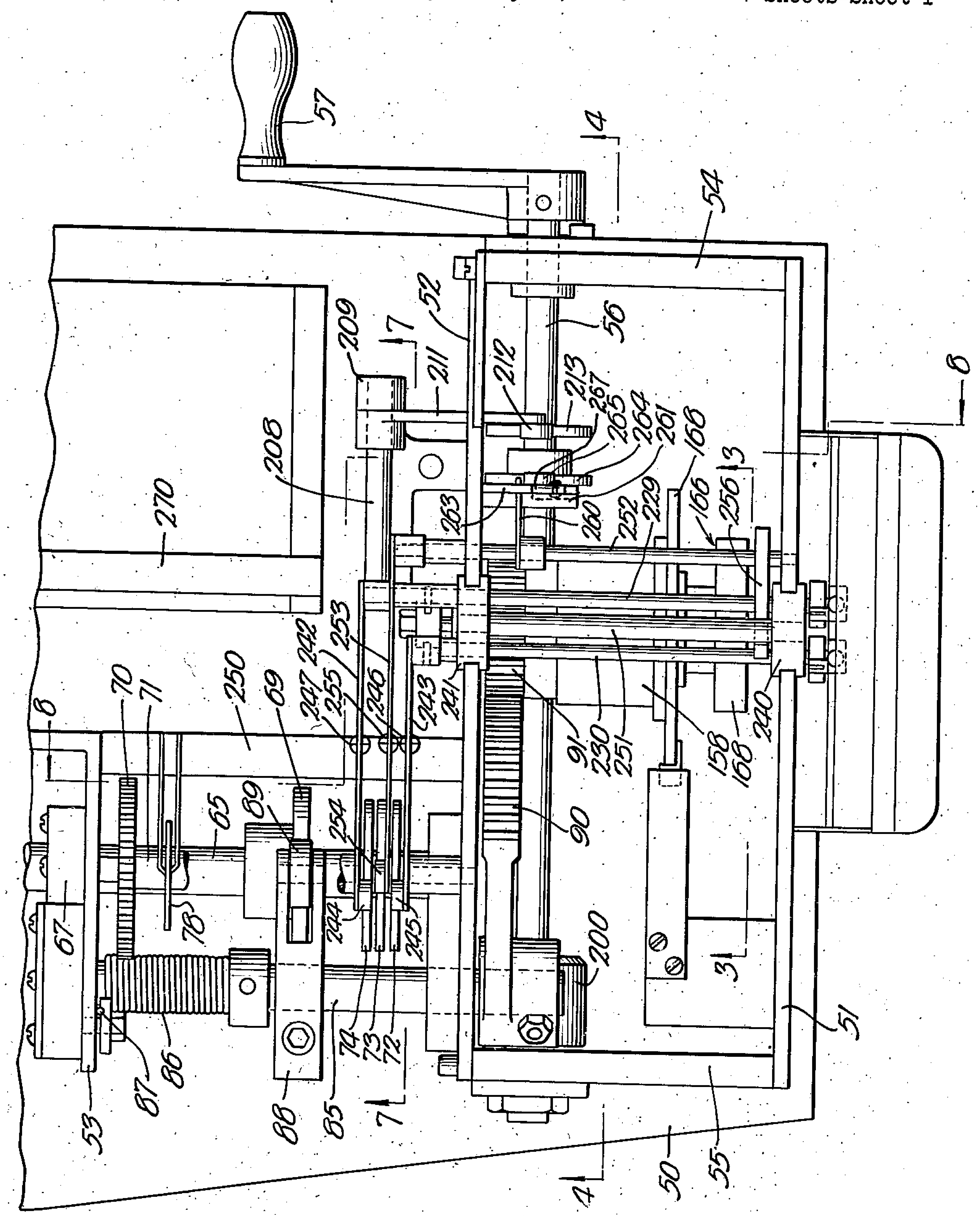


Fig. 1

INVENTOR.

C. Paulson

BY Emery Robinson

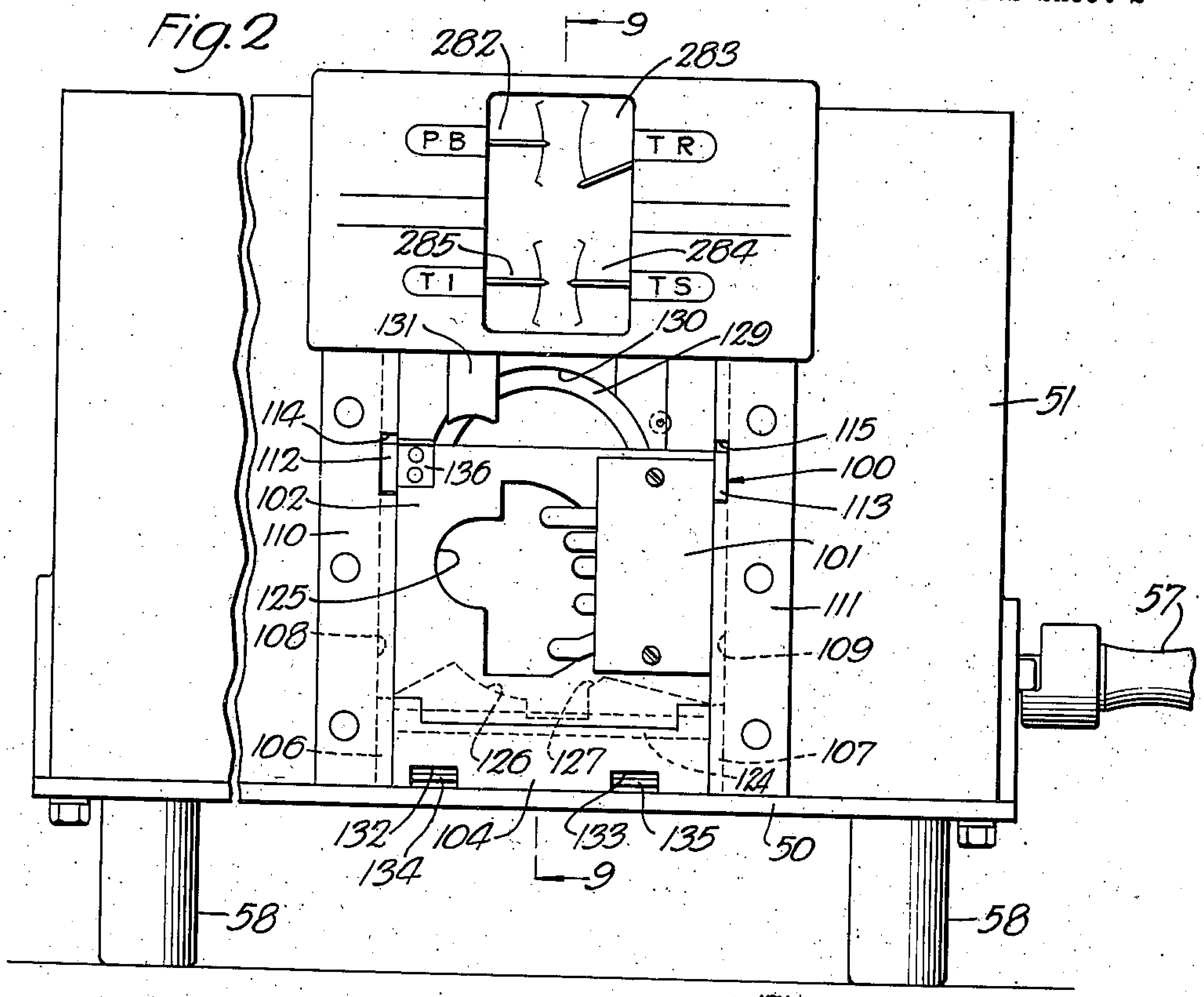
ATTORNEY.

Dec. 23, 1941. C. PAULSON 2,267,129

TESTING APPARATUS

Filed July 10, 1940 7 Sheets-Sheet 2

Fig. 2



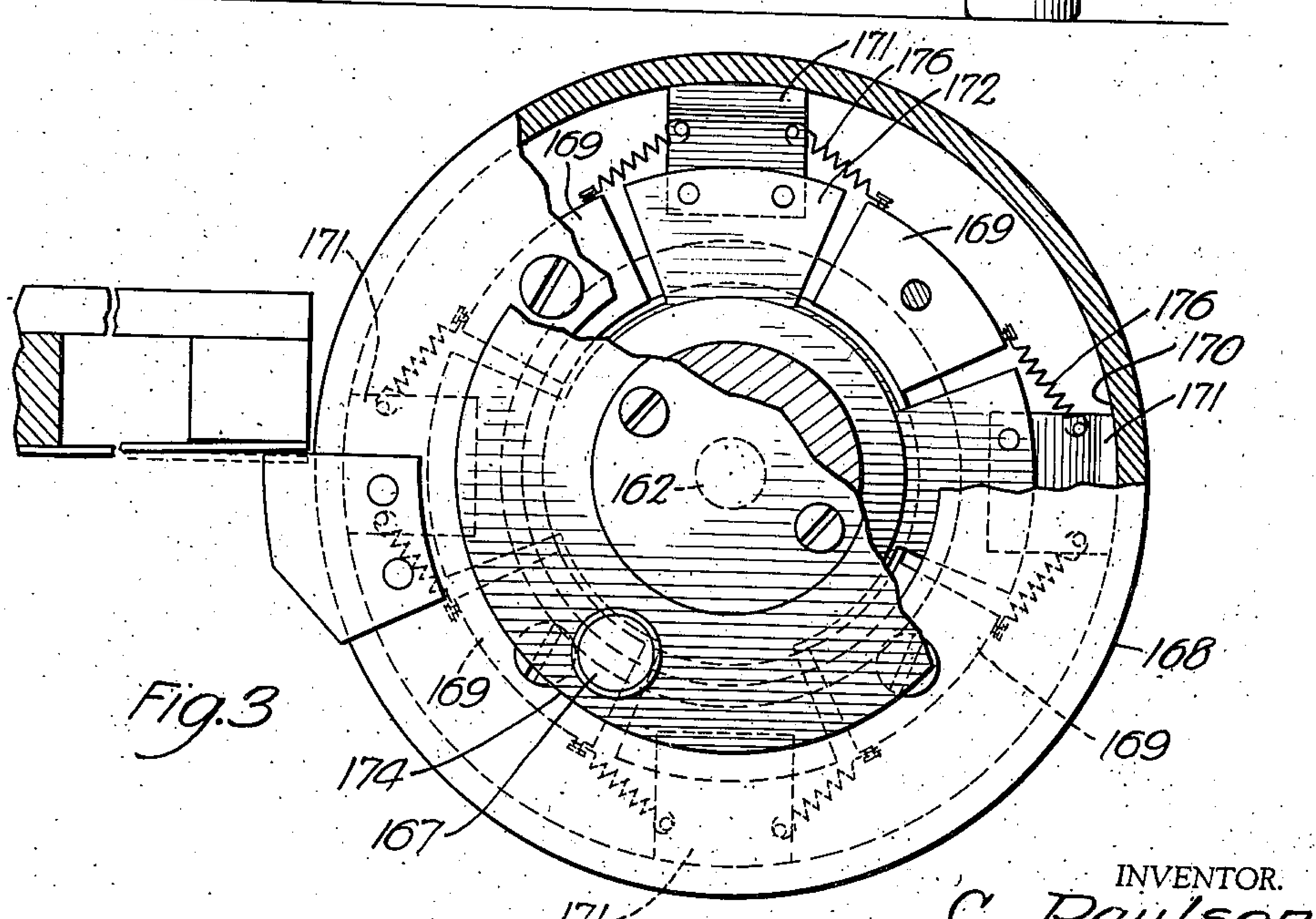


Fig. 3

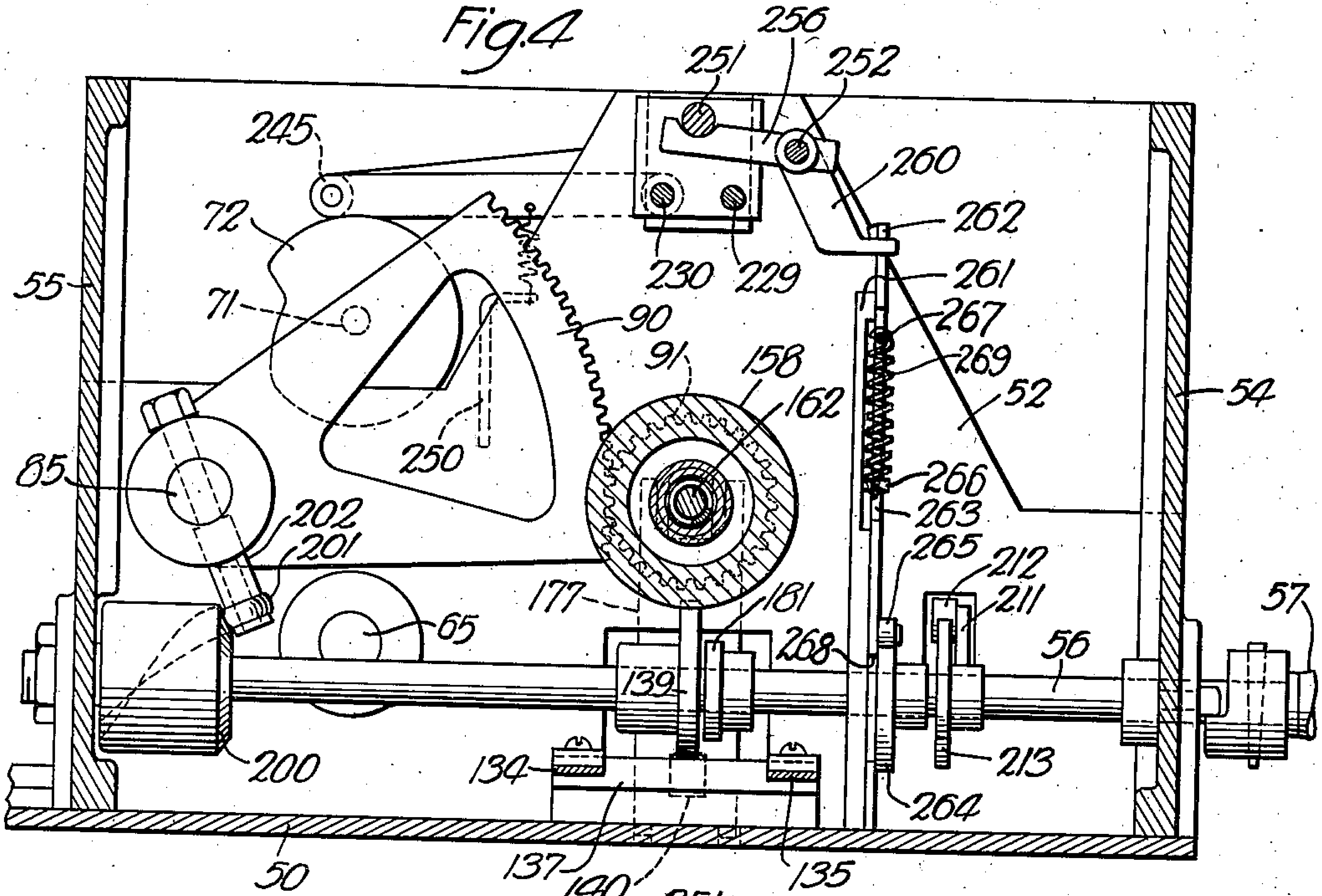
INVENTOR.
C. Paulson
BY
Emery Robinson
ATTORNEY.

Dec. 23, 1941. C. PAULSON 2,267,129

TESTING APPARATUS

Filed July 10, 1940 7 Sheets-Sheet 3

Fig.4



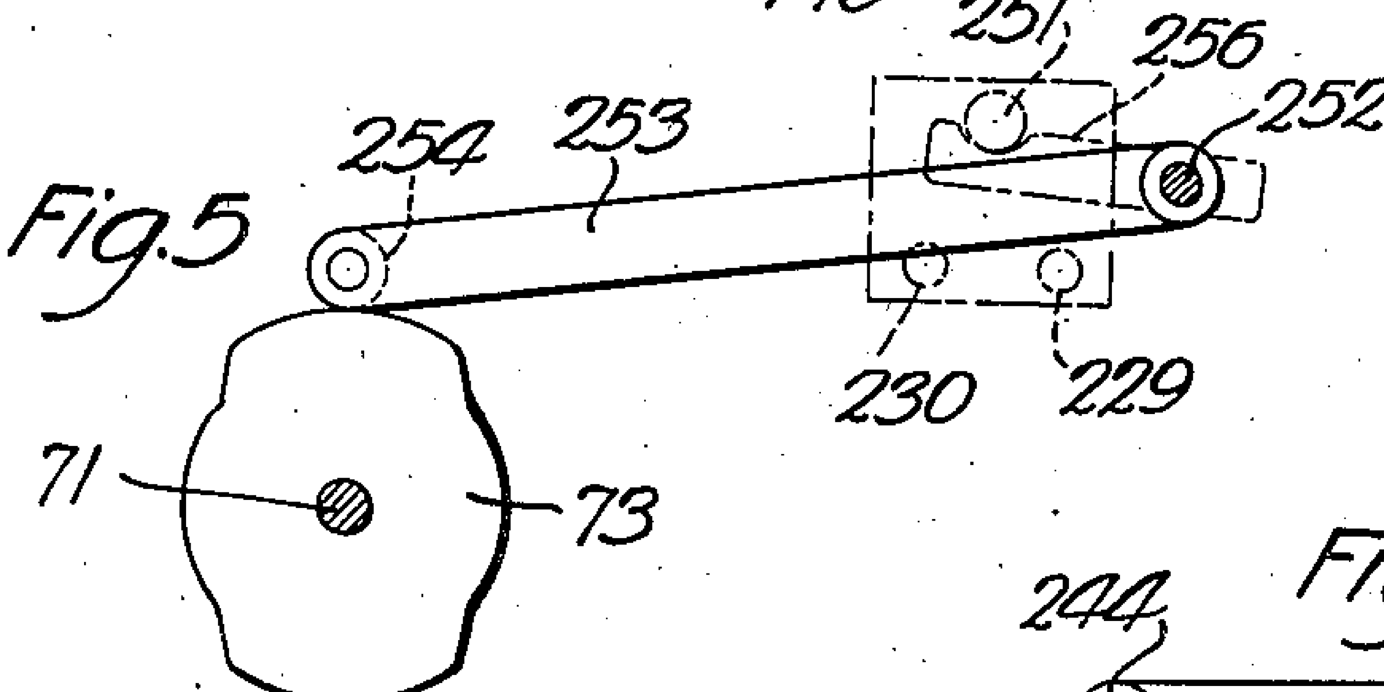
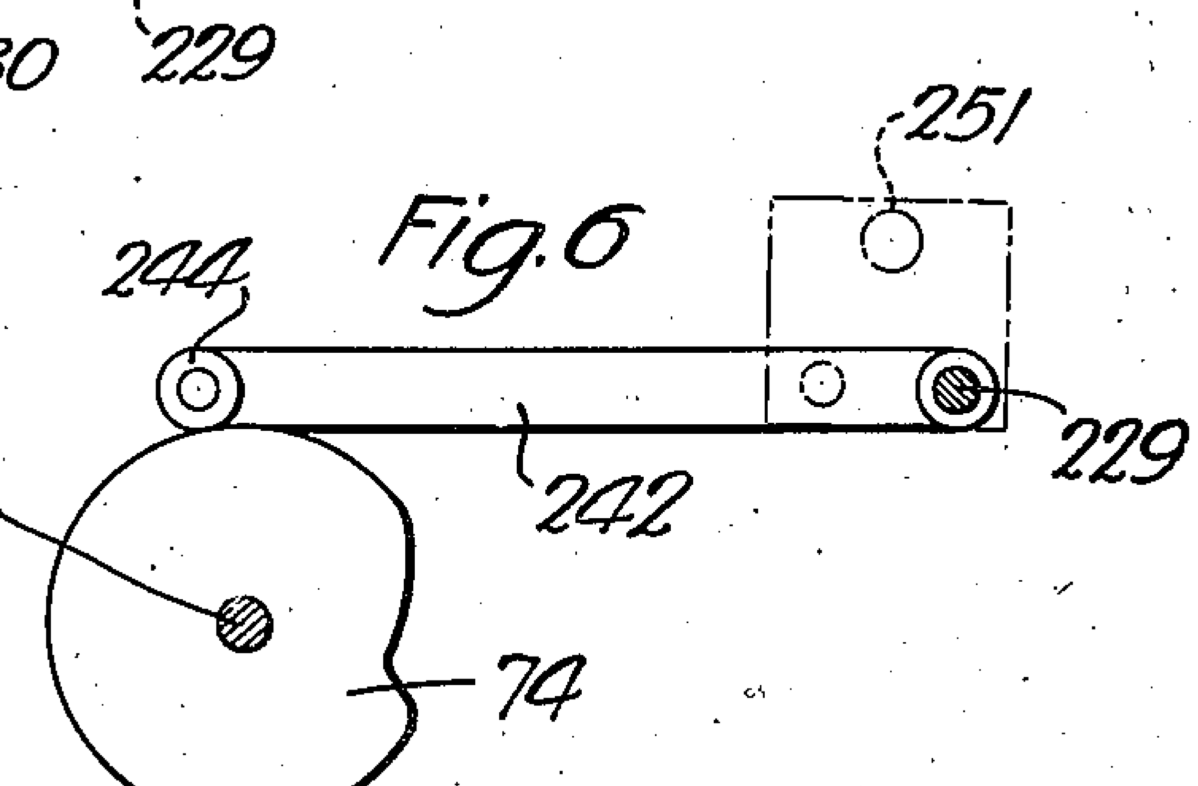


Fig.5

Fig.6



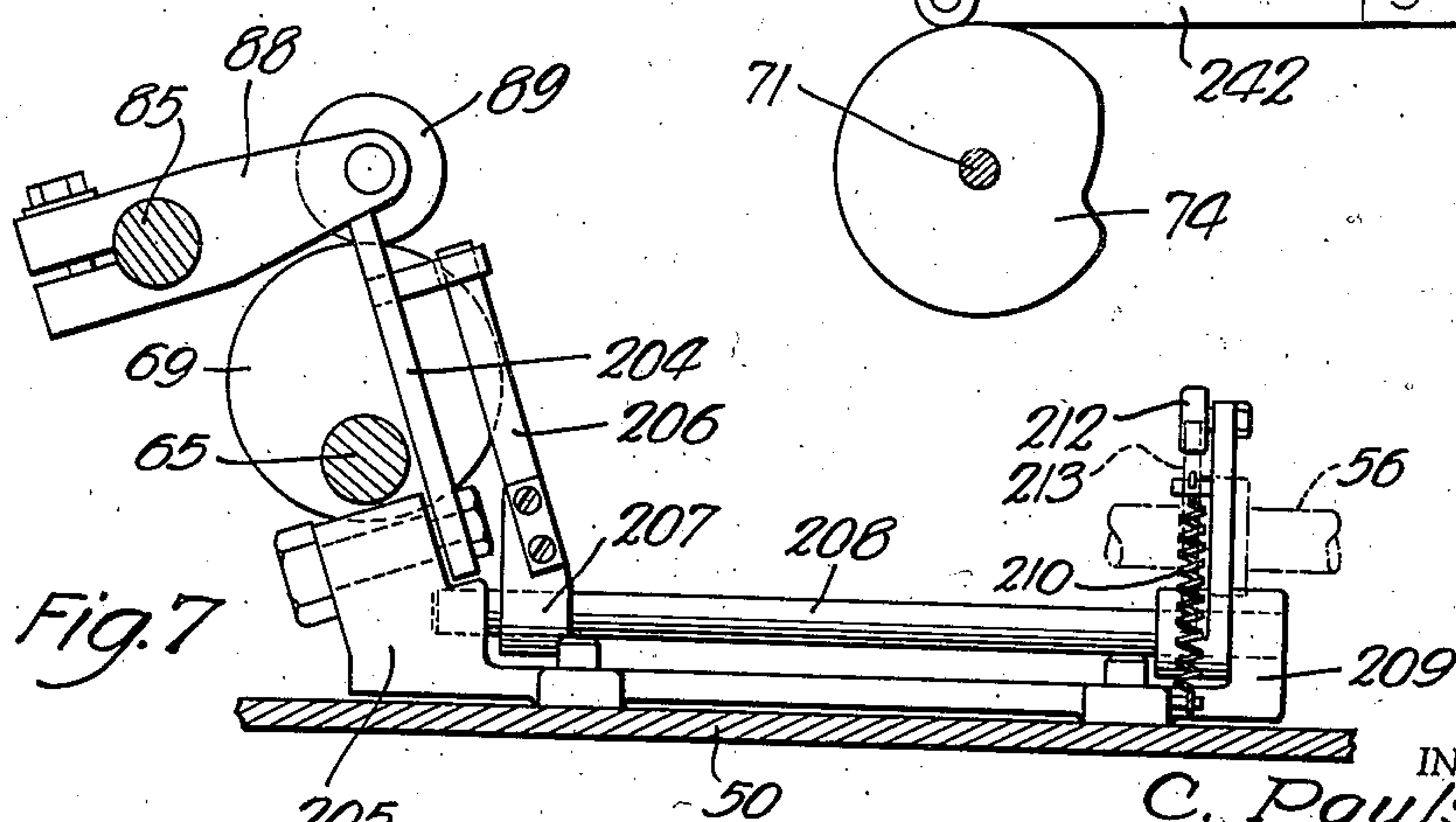


Fig.7

INVENTOR.
C. Paulson

BY
Emery Robinson
ATTORNEY.

Dec. 23, 1941. C. PAULSON 2,267,129

TESTING APPARATUS

Filed July 10, 1940 7 Sheets-Sheet 4

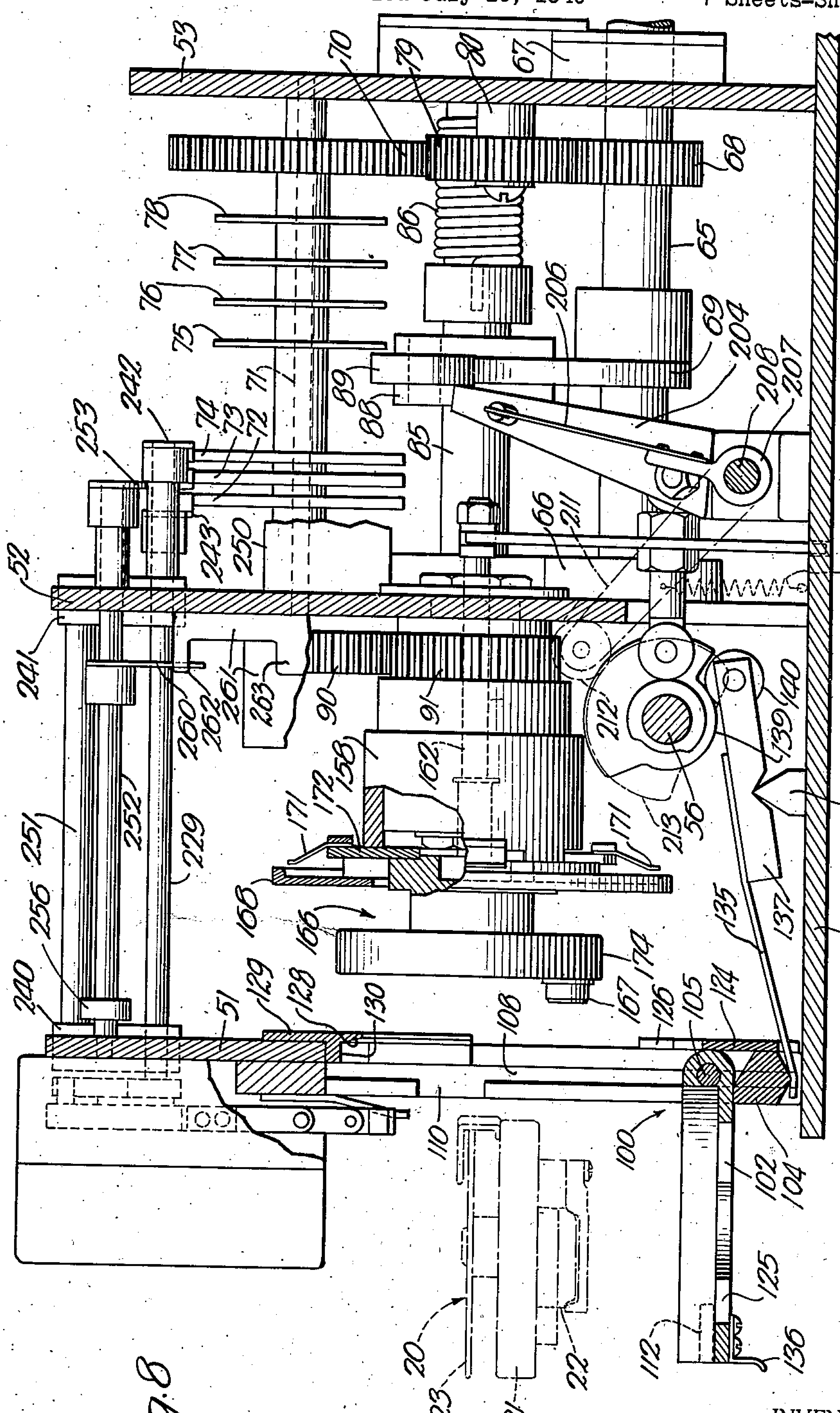
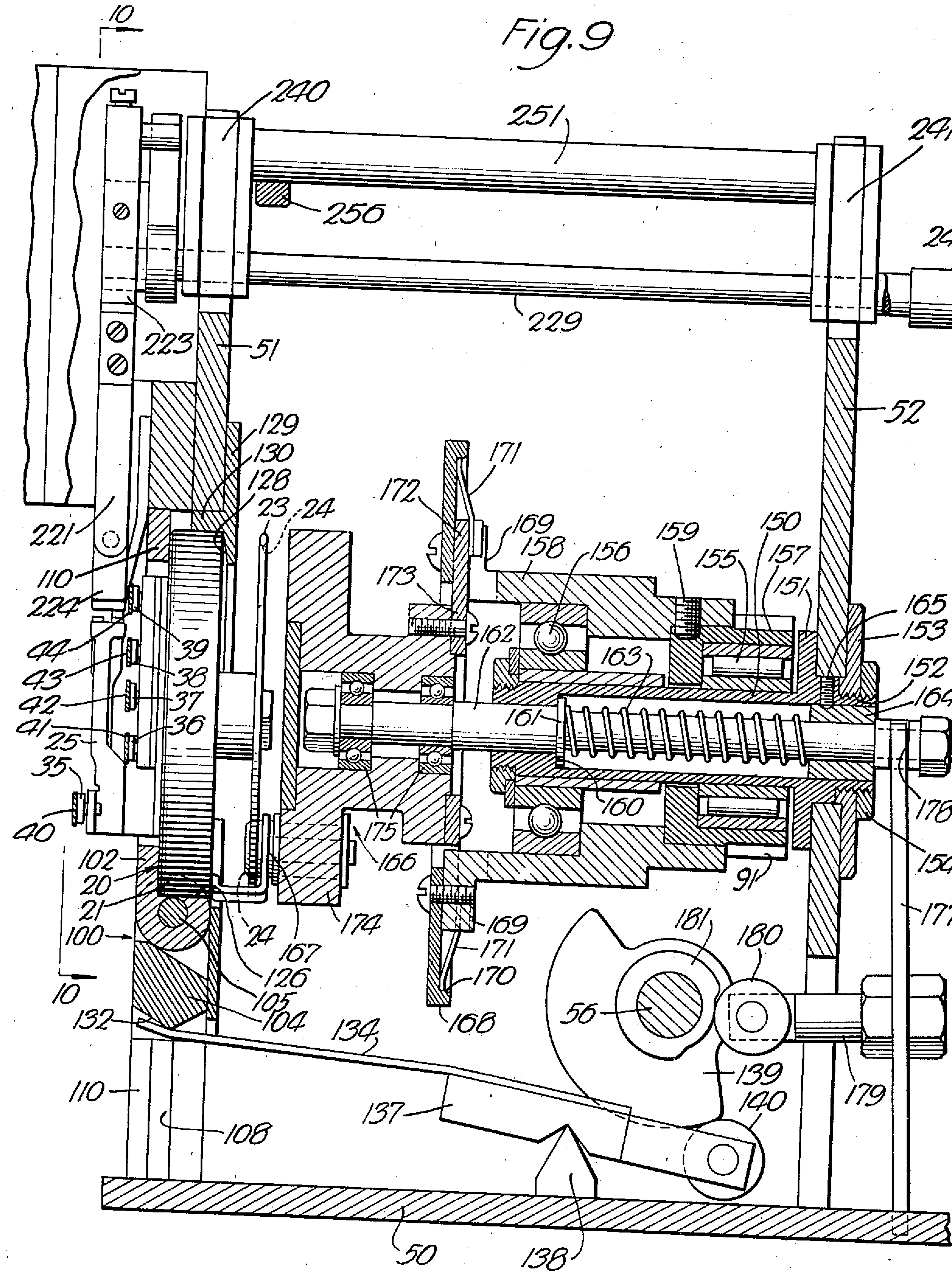


Fig. 8

INVENTOR.
C. Paulson

BY Emery Robinson
ATTORNEY.

Fig. 9



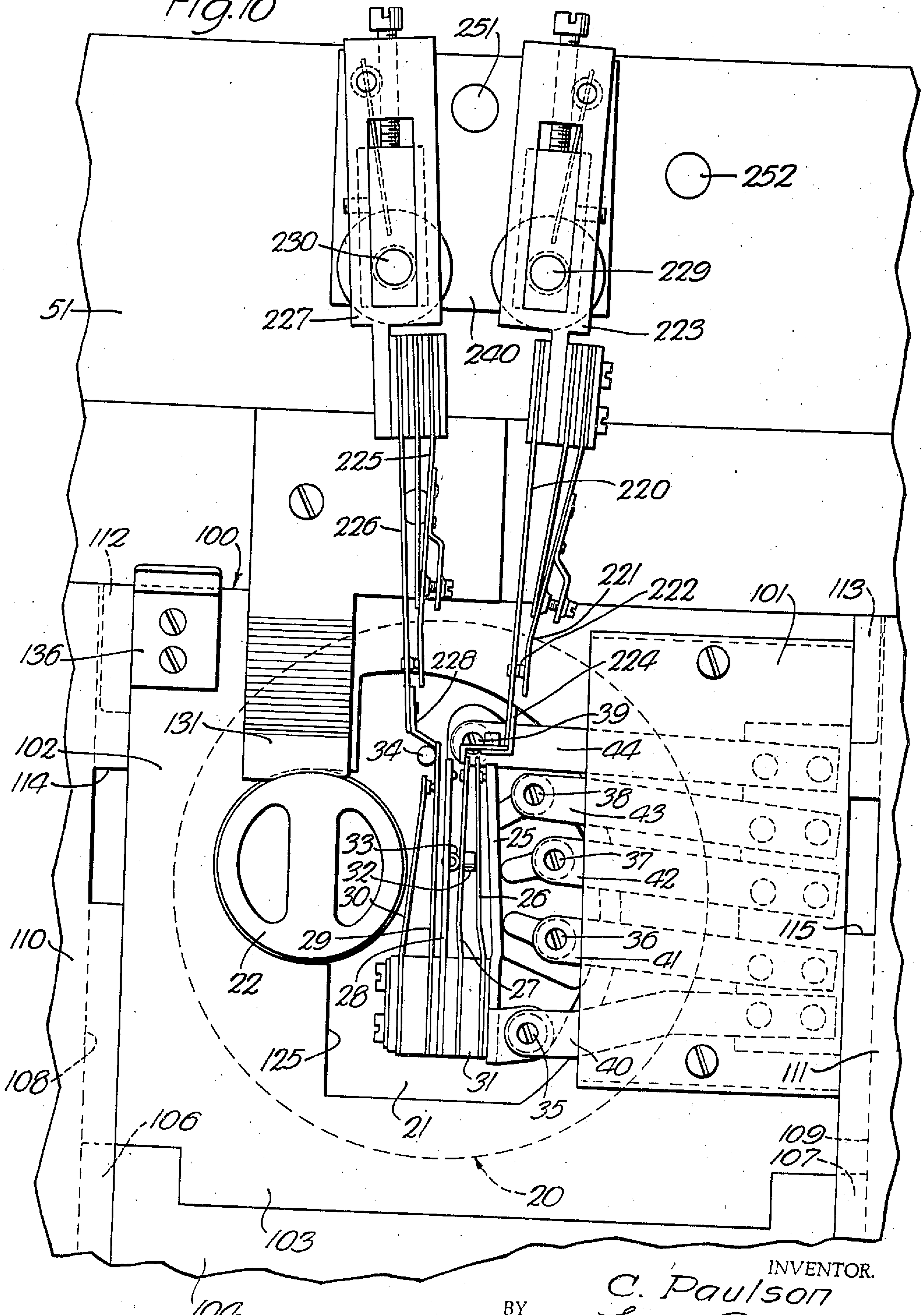
INVENTOR.
C. Paulson
BY Emery Robinson
ATTORNEY.

Dec. 23, 1941. C. PAULSON 2,267,129

TESTING APPARATUS

Filed July 10, 1940 7 Sheets-Sheet 6

Fig. 10



INVENTOR.
C. Paulson
BY Emery Robinson
ATTORNEY.

Dec. 23, 1941.

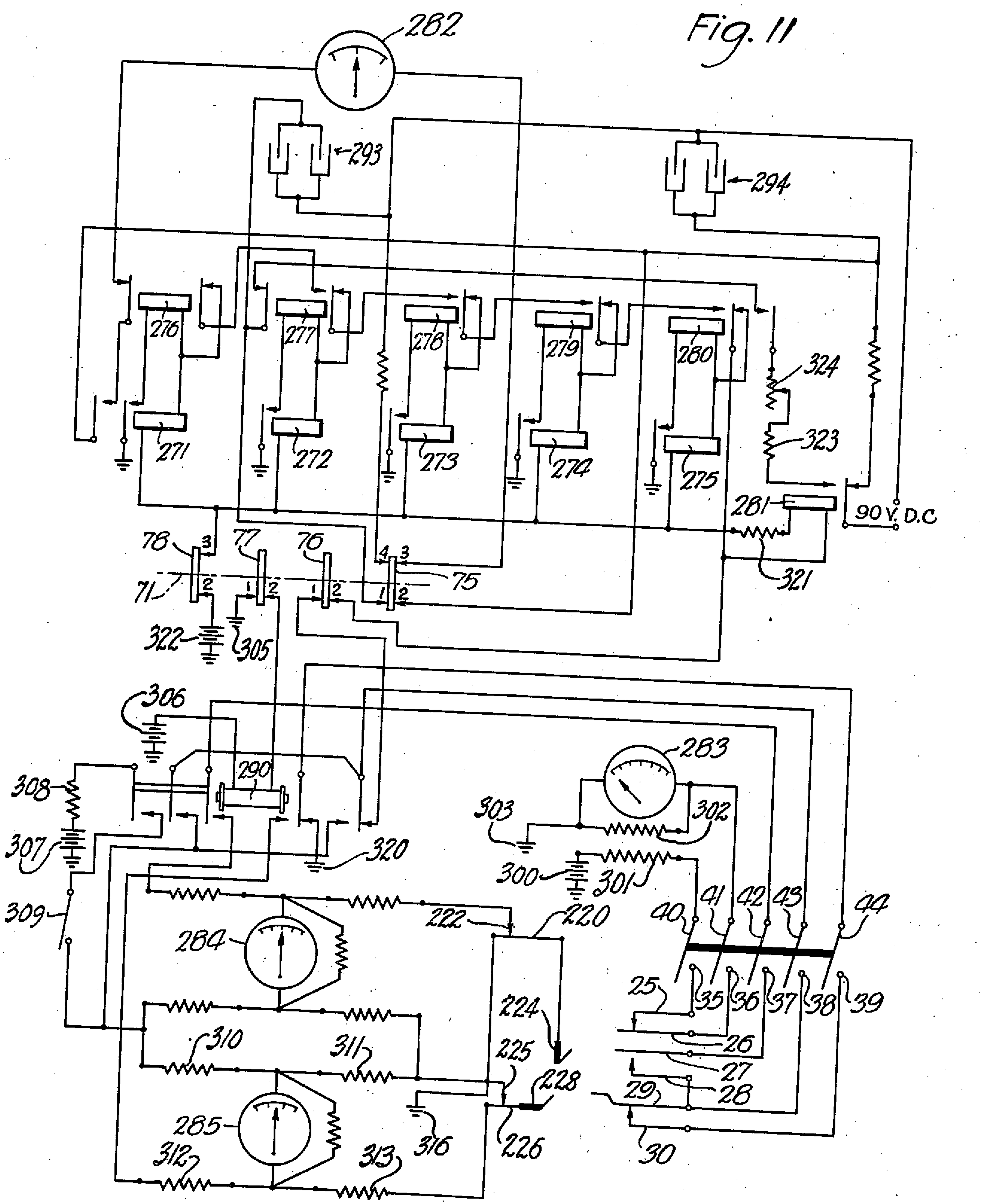
C. PAULSON

2,267,129

TESTING APPARATUS

Filed July 10, 1940

7 Sheets-Sheet 7



INVENTOR.
C. Paulson
BY Emery Robinson
ATTORNEY.

Patented Dec. 23, 1941

2,267,129

UNITED STATES PATENT OFFICE

2,267,129

TESTING APPARATUS

Christian Paulson, Elmhurst, Ill., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Application July 10, 1940, Serial No. 344,672

9 Claims. (Cl. 179—175.2)

This invention relates to testing apparatus and more particularly to apparatus for repeatedly applying tests to telephone calling dials during the adjustment thereof.

In the manufacture of calling dials for automatic telephone systems, the contact springs in the dial, which control the pulses transmitted in calling a subscriber or which short-circuit the telephone transmitter during the transmission of selecting impulses, must be adjusted to engage their cooperating springs at predetermined pressures. Similarly, the contact springs which open the talking circuit through the telephone receiver must be adjusted so that they break their circuit after the finger wheel of the dial has moved a predetermined amount from its normal position and before it has moved a slightly greater predetermined amount. The contacts which control the pulses transmitted in calling a subscriber must be adjusted so that they will, on the return of the finger wheel to normal to transmit impulses, be closed a predetermined amount of the time in proportion to the time they are open. The adjustment of these contact springs to give them the desired operating characteristics necessitates bending the springs manually after they are assembled and, in bending one of the springs to give it the desired operating characteristic, another spring may be affected so that it will be out of proper adjustment due to the fact that some of the springs have to be adjusted for more than one characteristic.

In the past, the adjustment of the springs of dials has entailed a great amount of tedious manual work, since the method followed was to make an adjustment in a spring, then operate the dial manually to see if the springs operated in the proper sequence, and then manually test them to see that they operated properly. If necessary, another adjustment was made and the process repeated.

It is an object of the present invention to provide a unitary device for repeatedly making a series of tests of the various characteristics of electrical apparatus during the adjustment of parts of the apparatus.

In accordance with one embodiment of the invention, a fixture is provided for receiving a telephone dial with the springs of the dial extending outwardly from the fixture whereby they may be adjusted. The fixture for receiving the dial is tiltable and slidable and when the apparatus is in its normal or inoperative position, the tiltable fixture is tilted outwardly to a position where it may receive a dial, suitable abutments being provided to properly position the dial in the fixture. After a dial has been placed in the fixture, the fixture may be tilted to substantially vertical position, whereupon the main actuating lever of the apparatus may be operated manually. The manual operation of this lever causes the dial receiving fixture to be slid into position to have a series of tests applied to it. The handle which actuates the fixture to move the dial therein to its testing position also causes the driven member of a clutch to move a finger carried by it into one of the holes in the dial and just shortly after the finger engages the finger hole in the dial, continued movement of the manual lever will cause the driving clutch member to engage the driven clutch member and prepare the dial for repeated operation.

In the embodiment of the invention being described herein, the number "4" is dialed repeatedly and the finger on the driven clutch member will float when the driven clutch member is disengaged from the driving clutch member so that the dial will not be moved out of its normal position during the engagement of the finger wheel thereof by the finger mounted on the driven clutch member. The single manually operable lever provided in the present device also serves to unlock a cam driven gear segment which drives the driving clutch member, suitable interlocking mechanism being provided to insure that the driven clutch member will always start at the same position. Just prior to the time when the manually operable lever releases the gear segment for operation, it releases two groups of gauges to permit them to move downwardly into position to engage springs in the dial which are to be tested. As soon as the interlock mentioned hereinbefore unlocks at its proper cyclic interval, the gear segment will drive the finger wheel and a series of cams operating in timed relation to the gear segment will cause the gauges to apply force to the springs in the dial to determine if some of them, which are to be tested for tension, have the proper tension. The present apparatus is provided with a number of electrical timing cams which control the testing circuits to apply the tests in a definite cyclic order. These cams are continuously driven, as are the cams which drive the gages, and which actuate the gear segment so that the time of initiation of each test is accurately controlled. When the apparatus is in its normal, inoperative position, the electrical timing cams and the gage and gear segment actuating cams operate repeatedly to no effect. However, when the manually operable lever is moved to a position to start testing operations, the interlock will cause the sequence of tests to start at a definite time in the cycle of the apparatus.

A better understanding of the invention may be had by reference to the following detailed description when considered in conjunction with the accompanying drawings, wherein

Fig. 1 is a plan view of a testing apparatus embodying the present invention with the top cover of the apparatus removed to show the various parts inside the apparatus, parts being broken away to permit showing the apparatus on a larger scale;

Fig. 2 is a front elevational view of the apparatus, part being broken away to conserve space, and showing the gaging instruments which the operator of the device scans during the adjustments of a dial;

Fig. 3 is a vertical sectional view taken substantially along the line **3—3** of Fig. 1 in the direction of the arrows and showing some of the details of construction of the clutch mechanism, parts being broken away to more clearly illustrate those parts of the apparatus which are a short distance in back of the line on which the view is taken;

Fig. 4 is a vertical sectional view taken along the line **4—4** of Fig. 1 in the direction of the arrows showing the main driving cam which drives the clutch element and the cam shaft actuated by the manually operable lever for controlling the operation of the various parts of the apparatus in the proper sequence;

Fig. 5 is a detail sectional view showing the cam which, twice in each cycle of the machine, drops the gages down into position to engage the springs of the dial;

Fig. 6 is a detail sectional view showing one of the cams for moving a gage spring through an arcuate path to apply tension to one of the springs in the dial after the gages have been dropped to that position by the cam shown in Fig. 5;

Fig. 7 is a vertical sectional view taken substantially along the line **7—7** of Fig. 1 showing details of the interlocking mechanism which insures that the clutch driving gear segment will start only at a definite time in the cycle of tests made by the apparatus;

Fig. 8 is an irregular vertical sectional view taken substantially along the line **8—8** of Fig. 1 in the direction of the arrows showing details of the dial holding fixture, the clutch mechanism and the various driving cams;

Fig. 9 is an enlarged fragmentary sectional view taken substantially along the line **9—9** of Fig. 2 in the direction of the arrows and showing some of the details of construction of the clutch mechanism, and a dial holding fixture, as well as the relative position of the gage springs which engage the springs on the dial to test them;

Fig. 10 is an enlarged fragmentary front elevational view of the gage springs engaging the contact springs of the dial and is taken substantially along the line **10—10** of Fig. 9 in the direction of the arrows, and

Fig. 11 is a circuit schematic showing the electrical connections made by the electrical timing cams or discs in applying the various tests to the dial springs.

Referring to the drawings, wherein like reference characters designate the same parts throughout the several views, particular reference being had at this time to Figs. 8, 9 and 10, wherein a dial is shown somewhat diagrammatically in solid lines in Figs. 9 and 10 and in dot and dash lines in Fig. 8.

The dial to be tested

The dial **20** comprises a casing or housing **21** on which there is mounted a governor **22** which controls the speed of the dial in returning to its normal position under spring propulsion, at which time the number dialed by a telephone user is transmitted over the telephone circuits to select the called telephone subscriber. A finger wheel **23**, having ten finger holes **24** therein, is mounted in spaced relation to the casing **21** for manipulation by a subscriber in calling another subscriber of the telephone system. Mounted upon the back of the casing **21** are a series of springs or contact members **25, 26, 27, 28, 29** and **30**. The contact member **25** and spring **26** are normally in engagement to complete a circuit through them which comprises a part of the talking circuit of the telephone system. The contact member **25** and spring **26** are, therefore, insulated one from another at their lower end, as viewed in Fig. 10, a suitable mounting bracket **31** also insulated from the springs and contact members being provided for supporting them on the casing. The contact spring **26** and contact spring **27** are interconnected by an insulator **32** so that they move together when they are released from engagement with a camming member **33** actuated by the finger wheel of the dial, the springs **26** and **27** being normally biased to move the spring **26** out of engagement with the contact member **25** and to move the spring **27** into engagement with the contact member **28**. Engagement of the contact member **28** by the contact spring **27** short-circuits the transmitter unit of the telephone during dialing operations. The spring **29** and contact member **30** comprise the impulsing contacts which are made and broken to transmit impulses in the calling of one subscriber by another. These springs are biased so that they are normally closed and will be intermittently broken by a camming member **34** operated under control of the finger wheel of the dial. The camming member **34**, it will be understood, in the operation of this device and in the ordinary operation of the telephone dial, is ineffective to break the contact between the contact member **30** and spring **29** during the windup of the finger wheel **23** of the dial, but intermittently breaks this circuit on the return of the finger wheel to normal. The various contact members and springs **25** to **30**, inclusive, are connected in any suitable manner to terminal posts **35, 36, 37, 38** and **39** mounted on the casing **21** in the manner as illustrated in the circuit schematic (Fig. 11) and may be interconnected with the various parts of the testing apparatus through resilient terminal members **40, 41, 42, 43** and **44**, respectively.

General framework of the apparatus

The general framework of the apparatus comprises a base plate **50** (Figs. 1, 4, 7, 8 and 9) having extending upwardly from it a face plate **51**, an intermediate plate **52** and a back plate **53**, which serve to support the majority of the moving parts of the apparatus. Also extending upwardly from the base plate **50** are a pair of side plates **54** and **55** (Fig. 1), in which there is journalled a main control shaft **56** adapted to be actuated by a manually operable handle **57** to initiate testing operations in the machine.

Extending downwardly from the base plate 50, adjacent its front end, are a pair of legs 58—58 (Fig. 2), which, when the apparatus is in use, tend to tilt it so that the angle at which the apparatus is positioned is such that when a dial 20 has been placed in the position to be tested, it will be at a slight slant from the vertical. However, in all of the views of the drawings, the apparatus has been shown in its flat position and where the face, intermediate and back plates 51, 52 and 53 are in a vertical plane and the base plate 50 is in a horizontal plane.

Driving mechanism

Power is supplied to the apparatus from any suitable driving motor (not shown) which drives a main power shaft 65 continuously. The shaft 65 (Figs. 1 and 8) is journalled in suitable bearings 66 and 67 mounted on the intermediate plate 52 and back plate 53 and carries intermediate its ends a gear 68 and a main driving cam 69. The gear 68 meshes with an idler gear 79 mounted on a stud shaft 80 and the idler 79 meshes with a gear 70 fixed to a shaft 71, which is, in turn, journalled in the intermediate plate 52 and back plate 53. The shaft 71 carries on it a set of three cams 72, 73 and 74 for actuating the gages of the apparatus, as will be described more in detail hereinafter, and four electrical cams or commutator discs 75, 76, 77 and 78 (Figs. 8 and 11). There is also journalled in the intermediate plate 52 and end plate 53 a rock shaft 85, which is normally urged into the position shown in Figs. 1, 4 and 8 by a coiled spring 86 which surrounds the shaft and is fixed to it and to the back plate 53 at 87. The rock shaft 85 carries an adjustable cam arm 88 (Figs. 1 and 8) having a cam roller 89 mounted on the free end for cooperation with the cam 69 on the main power shaft 65. The extending end of the rock shaft 85, which extends forward of the intermediate plate 52, has fixed to it a gear segment 90 (Figs. 1, 4 and 8), which is in mesh with a clutch driving gear 91.

Dial receiving fixture

As previously pointed out, a dial receiving fixture is provided. This fixture has been designated generally by the numeral 100 and comprises, in addition to the terminal members 40, 41, 42, 43 and 44, a block 101 of insulating material in which the terminal members are mounted. This block 101 (Fig. 10) is mounted upon a gate 102 having a hinge portion 103 extending downwardly into a cooperating hinge plate 104 being pivotally held therein by a pin 105. The hinge plate 104 is provided with extending portions 106 and 107, which extend into slots 108 and 109, respectively (Figs. 2, 8 and 9) formed by shouldered member 110 and 111 mounted on the face of the face plate 51 and cooperating with the face plate 51 to form the slots 108 and 109. The gate 102 is provided with a pair of lugs 112 and 113, which, when the gate is moved to its vertical position, pass through notched-out portions 114 and 115 in the plates 110 and 111 and into the grooves 108 and 109 so that when the dial receiving fixture is moved bodily upward, as will be described, the gate 102 will be locked in position with the lugs 112 and 113 in back of the shoulder on the shouldered members 110 and 111. The gate 102 is provided with an irregularly shaped aperture 125 (Figs. 2, 8 and 10) for receiving the dial governor 22 and springs and contact members 25 to 30, inclusive. The hinge plate 104 has fixed to it a holding plate 124 provided with a pair of rounded shoulders 126 and 127, against which the face of the casing 21 of the dial will rest when the dial is placed between the gate 102 and holding plate 124. It will thus be apparent that with the gate 102 in the position shown in Fig. 8, a dial to be tested may be placed in the gate, where it will be loosely held and after the gate has been moved to the position shown in Fig. 2, the dial receiving fixture may be moved upwardly to the position shown in Figs. 9 and 10, where the upper end of the casing 21 will engage a sloping surface 128 of a plate 129 fixed on the rear of the face plate 51 to guide the dial accurately into the position shown in Figs. 9 and 10, where the casing 21 will be engaged by a rounded abutment 130 and the governor 22 will be tightly engaged against a second rounded abutment 131 fixed to the face plate 51.

The bottom edge of the hinge plate 104 (Fig. 2) has a pair of notches 132 and 133 formed in it for receiving relatively stiff resilient members 134 and 135, respectively, which serve as levers to move the dial receiving fixture upwardly to its gaging position, as shown in Figs. 9 and 10. The gate 102 is provided with a handle 136, whereby it may be rocked about the pin 105 when it is in its lowermost position, as shown in Figs. 2 and 8. The levers 134 and 135 are mounted on a pivot block 137, pivotally mounted on a bar 137 and adapted to be actuated by a cam 139 (Fig. 9) fixed to the main control shaft 56 and engaging a cam roller 140 mounted in the above-mentioned block 137. It is believed to be apparent that, as the handle 57 is moved from the position shown in Fig. 1 in a forward direction toward the front of the apparatus, the shaft 56 will be rocked in a counter-clockwise direction (Figs. 8 and 9) and will move the members 134 and 135 upwardly to lift the dial receiving fixture 100 to the position shown in Fig. 9.

Clutch mechanism

Fixed to the intermediate plate 52, as most clearly shown in Fig. 9, is an irregularly shaped bearing sleeve 150 having a shoulder 151 bearing against the left face (Fig. 9) of the intermediate plate 52 and having a threaded portion 152 which extends outwardly to the right (Fig. 9) of the intermediate plate 52. A threaded member 153 is threaded onto the portion 152 and cooperates with the shoulder 151 to fix the bearing sleeve 150 to the intermediate plate 52, a lock nut 154 being provided to lock the threaded member 153 in place on the portion 152 of the sleeve 150. Positioned on the outer periphery of the sleeve 150 are two sets of bearings 155 and 156, of conventional construction, which serve to rotatably support a gear 91 and a clutch sleeve 158. The clutch sleeve 158 extends out over a portion of the gear hub and is fixed thereto by means of a set screw 159. From the foregoing, it will be apparent that the gear 91 and clutch sleeve 158 are freely rotatable as a unit about the outer surface of the bearing sleeve 150. The bearing sleeve 150 has an inwardly extending shoulder 160, against which a collar 161, formed integrally with a push rod 162, bears. The collar 161 is urged against the shoulder 162 by a compression spring 163 interposed between it and a bushing 164 held in the right end (Fig. 9) of the bearing sleeve 150 by means of a set screw 165. The shoulder 160 and the bushing 164 serve to slidably support the push rod 162, which is urged to the left (Fig. 9) by the spring 163, to carry a driven clutch member, designated generally by the numeral 166, into the position shown in Fig. 9. When the driven clutch member is in the position shown in Fig. 9, a finger 167, extending outwardly from the lefthand surface (Fig. 9) of the driven clutch member, will enter a finger hole 24 of the telephone dial 20 and the driven clutch member will be interconnected with and driven by a driving clutch member 168, which is mounted on a series of radially extending arms 169—169, formed integrally with the clutch sleeve 158. The driving clutch member 168 is annular in configuration and has an annular shoulder 170 formed thereon adapted for coopera-tion with a series of resilient members 171—171, which are mounted on a series of radially extending arms 172 formed integrally with an annular plate 173, which is, in turn, fixed to a member 174. The member 174 carries the finger 167, and is rotatably mounted, by means of bearings 175—175, on a reduced portion of the push rod 162. The radially extending arms 169 and 172 are disposed alternately in substantially the same vertical plane and a series of light tension springs 176 tend normally to hold the radially extending arms 169 and 172 equally spaced one from another. However, these springs 176 are light enough to permit partial rotation of the member 174 about the push rod 162 without moving the finger wheel 23 of the telephone dial 20 out of its normal position when the finger 167 is moving into the finger hole 24 in the dial. It should be noted that the end of the finger 167 is tapered slightly so that, if the push rod 162 moves to the left (Fig. 9) and the finger 167 is not in exact registration with the finger hole 23, the member 174 will be rotated slightly about the push rod 162 until the resilient members 171, which are rounded on their outer ends to conform to the configuration of the shoulder 170, engage with and grip the shoulder 170.

The clutch mechanism is shown in its operative position in Fig. 9 and in its inoperative position in Fig. 8. It will be understood that the spring 163 (Fig. 9) normally urges the clutch mechanism to its operative position and the normal tension of the spring is overcome by a bifurcated lever 177 engaging in a notch 178 in the push rod 162. The lever 177 is pivotally mounted in the base plate 50 and carries an adjustable cam rod 179, which, in turn, carries a cam roller 180 for cooperation with a cam 181 mounted on the shaft 56.

The details of construction of the clutch mechanism are described more fully and claimed in my co-pending application, Serial No. 344,673, filed July 10, 1940.

Interlocking mechanism

The shaft 85, which carries the gear segment 90, is normally urged to rotate in a clockwise direction (Figs. 4 and 7) by the coil spring 86 (Figs. 1 and 8) and when the handle 57 is in the inoperative position, the gear segment 90 is held in its uppermost position, as shown in Fig. 4, by a cam 200. The cam 200 is mounted on the main control shaft 56 and engages a cam roller 201, mounted on the end of a cam arm 202 which is, in turn, fixed to the shaft 85. When the handle 57 is moved to operative position, the cam 200 will rotate and move out of the path of cam roller 201, thereby tending to permit the spring 86 to drive the shaft 85 if the cam 69 on shaft 65 is not engaging the cam roller 89. In order to prevent the gear segment 90 from snapping downwardly too rapidly, a lever 204, pivoted on a bracket 205, is normally urged into position under the cam lever 88, as shown in Fig. 7, by a leaf spring 206. The leaf spring 206 is mounted on a collar 207 fixed to a shaft 208. The shaft 208 has one end journalled in the bracket 205 and has the other end journalled in a casting 209, which is formed integrally with the bracket 205. The shaft 208 is normally urged to rotate in a counter-clockwise direction (Fig. 8) by a contractile spring 210, which is fixed to a portion of the casting 209 and to a cam lever 211, having one end fixed to the shaft 208 and carrying at its other end a cam roller 212. The cam roller 212 bears on a cam 213 (Figs. 7 and 8) mounted on the main control shaft 56. When the main control shaft 56 is rocked in a counter-clockwise direction (Fig. 8), the shaft 208 will, upon engagement of the cam roller 212 with the low part of cam 213, rock in a counter-clockwise direction. However, the lever 204 will only be moved out from under the adjustable cam lever 88 by the spring 206 when the cam 69, in its highest part, raises the cam roller 89 slightly from the position shown in Fig. 7, at which time the spring 206 will snap the lever 204 out from under the cam lever 88, thereby to permit the cam roller 89 to follow the contour of the cam 69 and thereby impart oscillation to the gear segment 90.

Gaging mechanism

The gaging mechanism, as most clearly shown in Figs. 9 and 10, comprises two sets of tension springs, movable as a unit, in a vertical plane and oscillatable individually to apply tension to the springs in the dial, the tension of which is to be tested. The set of gages which measure the tension under which the spring 27 engages its associated contact 28 comprises a contact spring 220, which is in engagement with an adjustable spring 221 and presses against the spring 221 to close a contact at 222 under the same tension that the spring 27 should exert against its contact member 28. The springs 220 and 221 are mounted upon and insulated from a gage support 223 and the lower end of the spring 220 has a substantially Z-shaped insulating member 224 fixed to it for engagement with the spring 27 when the gages are moved downwardly as a unit and when the gage support 223 is rocked or oscillated individually. In a similar manner, a pair of contact springs 225 and 226 are mounted upon a gage support 227 and insulated therefrom, the spring 225 being adjustable so that the tension with which it makes contact with the spring 226 may be varied. Fixed to the lower end of the spring 226 is an insulating member 228 adapted to engage the extending end of the contact spring 29 of the dial so that upon oscillation of the gage support 227, pressure will be applied to the spring 29, tending to break its contact with the contact member 30. The gage supports 223 and 227 are mounted on the ends of rods 229 and 230, respectively (Figs. 1, 8, 9 and 10). The rods 229 and 230 are journalled in a pair of blocks 240 and 241 somewhat loosely mounted in the face plate 51 and intermediate plate 52, respectively. The rods 229 and 230 have fixed to them, at their rear ends (right end Fig. 8), cam levers 242 and 243, respectively, which carry cam rollers 244 and 245 (Fig. 1), respectively, which are held by means of springs 246 and 247 against the peripheries of the cams 72 and 74, respectively. The springs

246 and 247 are fixed to a bracket 250 mounted on the intermediate plate 52. The rods 229 and 230 are oscillatable in the bearings 240 and 241 (Figs. 8 and 9), which are rigidly interconnected by a stay bar 251. Journalled in the face plate 51 and the intermediate plate 52 is a rock shaft 252 (Figs. 1, 4, 5 and 8), which carries at its rear end a cam lever 253, having a cam roller 254 urged into engagement with the cam 73 by a spring 255. The rock shaft 252 has fixed to it, adjacent its forward end, a lever 256 (Fig. 1), which engages the stay bar 251 (Fig. 5), and upon rotation of the cam 73, the lever 256 will be oscillated to move the block 240 downwardly to carry the gage springs into position, where they may engage the springs in the dial.

The shaft 252 also has fixed to it a stop lever 260 (Figs. 4 and 8), which extends into the path of a latch 262 formed integrally with a slidable plate 263, which, in turn, abuts a bearing plate 261 and is positioned to slide between the bearing plate 261 and a cam 264, a portion of the slidable plate 263 being cut out, as shown at 268, to slidably engage the shaft 56 and the intermediate plate 52. A cam roller 265, fixed to the slidable plate 263, serves to move the plate 263 upwardly when engaged by the high part of the cam 264 to carry the latch 262 out of the path of the stop lever 260. A spring 269, fixed to a pin 267, extending outwardly from the slidable plate 263 and to a pin 266 fixed to the bearing plate 261, normally tends to hold the slidable plate 263 in its downward position. When the shaft 56 is rotated to initiate a testing operation, the cam 264, which is mounted on the shaft 56, will move the latch 262 out of the path of the stop lever 260 and the spring 255 (Fig. 1) will then be able to move the lever 253 and thereby rock the shaft 252 to permit the gages to drop down into association with the contact springs to be gaged. However, when the shaft 56 is in its inoperative position, as shown in Fig. 8, the continuous operation of the cam 73 will be ineffective to drop the gates and will become effective only when the handle 57 has been operated to initiate a testing operation.

Testing circuit and operation

The apparatus shown diagrammatically in the circuit schematic (Fig. 11) makes a series of tests on a dial each revolution of the shaft 71 and the electrical cams 75, 76, 77 and 78 control the sequence of the tests. In measuring the tension of the contact springs of the dial, two testing circuits of the type described in detail and claimed in the co-pending patent application of Christian Paulson, Serial No. 298,409, filed October 7, 1939, are utilized, together with circuits for testing the proportion of time that the pulsing contacts are open and closed when the finger wheel of the dial is operated and circuits for measuring the length of time the contact springs which open the telephone talking circuit remain closed after the dial starts to move from its normal position.

Since the circuits for performing these functions are relatively simple, they will now be described in conjunction with the description of operation of the apparatus.

In the bridge circuit for testing the tension of the contact springs, there are provided a pair of milliammeters 284 and 285, which operate in exactly the same manner as the milliammeter shown in the Paulson application hereinbefore identified. A milliammeter 283 is used in the circuit for measuring the length of time the contact springs in the talking circuit remain closed after the dial starts to move, and in the circuit for measuring the proportion of make and break of the impulse transmitting contacts, a microammeter 282 is utilized in connection with two banks of condensers 293 and 294, which are progressively charged during the closed and open periods, respectively, of the impulsing contacts on the return of the dial to normal. In the circuit for measuring the proportion of make and break of the impulsing contacts, a series of chain relays 271 to 280 are utilized, in conjunction with a control relay 281, to control the flow of current from a 90 volt direct current source to the banks of condensers 293 and 294 through suitable resistances.

If it be assumed that the circuit shown in Fig. 11 is connected to the 90 volt direct current source through any suitable switching mechanism and that the driving motor (not shown) is operating, the apparatus is prepared to apply the tests to a telephone dial 20, the shaft 65 being continually in rotation, and, through the idler gear 79, will drive the shaft 71 at one-half the speed of the shaft 65. With the apparatus in this condition, a dial may be placed in the gate 102 while the gate is in the position shown in Fig. 8. After a dial has been placed in the gate 102, the gate may be closed and the handle 57 rocked to move the main control shaft 56 in a counter-clockwise direction (Figs. 8 and 9). As the shaft 56 is rocked in a counterclockwise direction, the dial will be clamped rigidly in place and the tests thereon will be initiated, it being understood that the shaft 71, in rotating continuously, will actuate the parts associated with it continuously. However, when no dial is in place in the apparatus, the gear segment 90 will not be rocked due to the fact that the lever 204 will extend under the adjustable cam lever 88 and prevent the cam roller 89 from following the contour of the cam 69 until the handle 57 has been moved to its ultimate position to rock the main control shaft 56 in a counter-clockwise direction, as was explained in detail in connection with the detailed description of the interlocking mechanism. As the shaft 56 rocks in a counter-clockwise direction from the position shown in Fig. 8 to the position shown in Fig. 9, the cam 139 will cause left ends of the members 134 and 135 to be moved upwardly, thereby to raise the gate 102 to the position shown in Fig. 9. As the gate 102 approaches the position shown in Fig. 9, the cam roller 80 will ride onto the low part of cam 181 and permit the spring 163 to move the push rod 162 to the left, thereby to carry the finger 167 into the hole 24 in the finger wheel 23 for the digit 4 on the dial mechanism. Shortly after the finger 167 enters the finger hole 24 in the dial 23, the resilient members 171 will engage the annular shoulder 170 to lock the driving and driven clutch parts together. Just as soon as the clutch engages, the cam 200 will move out of the path of the cam roller 201 (Fig. 4) and the next time the cam 69 (Fig. 7) raises the lever 88, the lever 204 will be snapped out of the path of the lever 88 and the cam roller 89 will follow the cam 69 to oscillate the dial back and forth until the handle 57 is again moved to inoperative position.

In moving from the position shown in Fig. 8 to the position shown in Fig. 9, the shaft 56 will rotate the cam 264 (Fig. 4) to move the cam roller 265 and thereby lift the latch 262 out of the path of the stop lever 269 so that the cams 72, 73 and 74 may operate the gage supports 223 and 227. Since the lever 204 will be snapped out of the path of the lever 208 at the same time in any cycle when the spring 206 has been flexed due to the movement of the handle 57 to operative position, the movement of the dial by the driven clutch member will always be synchronized with the operation of the gages under control of the cams 72, 73 and 74 and with the electrical circuits which operate under control of the electrical cams or commutator discs 75, 76, 77 and 78 and therefore the tests performed by the electrical circuits will be made in synchronization with the oscillation of the dial finger wheel 23. In the operation of the testing apparatus, a dial 20, having been placed in the gate 102 and moved to testing position and the tests initiated by the various mechanical interlocking mechanisms, the gage supports 223 and 227 will be dropped twice into position, where the gages carried by them can engage the contact springs to apply pressure to them in each cycle of the rotation of the shaft 71 due to the shape of the cam 73 (Fig. 5). Since the shaft 71 makes one revolution while the shaft 65 is making two revolutions, the cam 73 will move the gage supports 223 and 227 downwardly twice in each revolution of the shaft 71, i. e., once for each revolution of shaft 65, and the cams 72 and 74 will actuate their associated gage supports 227 and 223, respectively, on alternate revolutions of the shaft 65.

The tension tests of the contact springs in the dial are made during the windup of the dial and, of course, the amount of travel of the dial before contact between the member 25 and spring 26 breaks, is also measured at the beginning of the windup of the dial. Referring to Fig. 11, it will be seen that as soon as a dial is in place to be tested, the terminal posts 35, 36, 37, 38 and 39 will be connected to the terminal members 40, 41, 42, 43 and 44, respectively. As soon as these connections are made, grounded battery at 300 will be connected through resistance 301, closed spring 26 and member 25, the milliammeter 283 to ground 303 and across shunt resistance 302 to ground 303. This circuit is designed to utilize the inherent time delay characteristic of the milliammeter to measure the length of time the member 25 and spring 26 are in contact and, accordingly, the value of the battery 300, resistances 301 and 302 and milliammeter are chosen so that when the number 25 and spring 26 stay in engagement, the needle of the milliammeter will just move to full scale deflection. Therefore, the length of time that the contact member 25 and contact spring 26 are in engagement will be indicated by the amount of deflection of the needle of the milliammeter 283 once for each oscillation of the wheel and while the dial finger wheel is being oscillated, the spring 26 may be adjusted.

Each time the cam 73 starts to lower the gate supports to make a tension test, brush 2 of electrical cam 77 makes contact with a conducting portion of the cam 77 and since the brush 1 associated with the cam 77 is always in contact with a conducting portion thereof and is connected to ground at 305, the relay 290 will be energized over a circuit from ground at 305, through brushes 1 and 2, and winding of relay 290 to grounded battery 306. Thus, relay 290 will be energized throughout the entire time that a tension test is being made. When the relay 290 is energized, it connects grounded battery at 307 through a suitable resistance 308 and a manually operated switch 309, which is closed all during testing operations to tension testing bridge circuits associated with the milliammeters 284 and 285. During the first half revolution of the shaft 71, cam 74 will be effective to oscillate gage support 227 and, therefore, the tension of spring 29 will be tested during this interval.

The bridge circuit associated with the milliammeter 285 comprises four equal resistances 310, 311, 312 and 313 of any suitable value so long as they are equal and they and the power source at grounded battery 307 may be chosen to suit the particular milliammeter selected for use. A milliammeter should be chosen which takes approximately the same length of time to go from zero to full scale deflection under influence of the battery 307 and the resistances as it takes the gage spring 226 to oscillate through one cycle. When the relay 290 is energized, the contact spring 29 will be connected through the right hand make contact of the relay to the resistance 310 and through the switch 309 and left hand make contact of the relay 290 to grounded battery at 307. Similarly, contact member 30 will be connected through one of the right hand make contacts of relay 290 to resistances 312. Resistance 311 is connected to ground at 316 and when contact spring 226 is in engagement with contact member 225, ground at 316 will also be connected to the resistance 313. In the operation of this tension testing circuit, the insulating member 228 will engage the spring 29 to open the circuit between contact spring 29 and contact member 30 and contact springs 225 and 226. If, in the oscillation of the gauge support 227, the contacts just mentioned open at the same time, thereby indicating that the tension in the spring 226 is equal to the tension in the spring 29, no current will flow through the milliammeter 285 and, therefore, its pointer will remain stationary. However, should the spring 29 under test be weaker or stronger than the spring 226, the pairs of contacts will not open at the same instant, thus permitting current to flow through the meter in one direction or the other, depending upon which pair of springs break contact first. Since the time interval between the breaking of contact is proportional to the difference in tension between the spring 226 and the spring 29 under test, the deflection of the meter pointer will be proportional to the difference in tension of the two springs and the direction of movement of the needle will indicate which of the two springs is stronger. Thus, an operator watching the milliammeter 285 may adjust the tension in the contact spring 29 until the meter pointer remains substantially stationary under repeated tests.

During the second half cycle of the shaft 71, the relay 290 will be reenergized and held energized all the time the gage supports are in their lower position. Since no tension will be applied to the spring 29, the milliammeter 285 will not be unbalanced. However, the spring 27 will be in engagement with the contact member 28 and will be urged away from it by the insulating member 224 when the gage support 223 is oscillated. The energization of relay 290 will connect the contact spring 27 and contact member 28 to opposite sides of the bridge circuit associated with the milliammeter 284, which is supplied with suitable resistances in exactly the same manner as the milliammeter 285, and while the gage supports are in their lowermost positions during the second half of the cycle of the shaft 71, the milliammeter 284 will indicate the difference in tension between the spring 27 under test and the spring 220 mounted on the gage support.

Brush 3, associated with electrical cam 78, brush 2 associated with electrical cam 76 and brush 1 associated with electrical cam 75 are always in engagement with conducting portions of their respective electrical cams. Brush 1 associated with cam 76 makes contact with a conducting portion of the cam 76 in the second half of each cycle of the shaft 65 and, therefore, ground at 320 will be connected over the left hand break contact of relay 290 to contact member 30 and when the contact spring 29 is in engagement with contact 30, the circuit will be completed through the right hand break contact of relay 290, brushes 1 and 2 of cam 76 to one side of the winding of relay 281, the other side of the winding of which is connected through a suitable resistance 321 to brush 3 associated with electrical cam 78, which makes in the normal position of shaft 65 and breaks for a short interval near the end of each half cycle of the shaft 65. It will be understood that the shaft 65 is the shaft which supplies power to drive the dial finger wheel in both directions and that the proportion of make time to break time of the contact 29 is measured in the second half cycle or while the dial is dialing numbers. Since the brush 76—1 makes contact with its associated cam on the return of the finger wheel of the dial to normal, ground at 320 will be connected through the contact of relay 390, through the contact member 30 and spring 29, which are normally in engagement, through right hand break contact of relay 290, brushes 1 and 2 associated with cam 76, through winding of relay 281 to grounded battery 322 at brush 2 of cam 78 to energize relay 281 and connect the 90 volt direct current source through a resistance 323, and variable resistance 324 to right hand make contact of relay 280, which is not energized at this time. Relay 275, however, will be energized over the ground lead from brush 2 on cam 76, break contact of relay 280, winding of relay 275, brushes 3 and 2 of cam 78 to grounded battery at 322. The relay 281 will be held energized all the time contact is made between spring 29 and contact member 30 in their normal position. However, as soon as the dial finger wheel starts to return to normal, the relay 281 will be deenergized and the 90 volt direct current source will be connected through contact of relay 281 across the bank of condensers 294 to charge these condensers. Also, as soon as the contact between spring 29 and contact member 30 breaks, ground at 320 will be removed from one side of the winding of relay 275. However, relay 275, when it was energized, connected ground at its make contact through the winding of relay 280, winding of relay 275, through brushes 3 and 2 of cam 78, to grounded battery at 322. When the ground connection at 320 is broken by the disengagement of contact spring 29 with contact member 30, relay 280 will pull up over a path from ground at the make contact of relay 275 through the winding of relays 280 and 275 in series to grounded battery at 322. When relay 280 pulls up, it will also connect the lead from the make contact of relay 281 through a break contact of relay 277 to prepare a circuit path to one side of the bank of condensers 293. This circuit path will become effective the next time spring 29 engages member 30, but is uneffective since the circuit is broken at relay 281.

The bank of condensers 294 will be charged all the time the contact between the spring 29 and the contact member 30 is open as the finger wheel moves a portion of one digit space in its return to normal since the bank of condensers 294 is connected at this time to the 90 volt direct current source. As soon as the contact between the spring 29 and contact member 30 again closes, relay 281 will be reenergized and the charging of the bank of condensers 293 will begin. Also, relay 274 will pull up over make contact of relay 280 and break contact of relay 279. When the contact between the spring 29 and contact member 30 again breaks, another charge will be sent to the bank of condensers 294. Thus, the bank of condensers 294 and the bank of condensers 293 will receive charges proportional to the length of time the contact between the springs 29 and contact member 30 are open and closed, respectively, during the return of the dial finger wheel to normal and the chain relays will pull up in succession from right to left until the dial finger wheel returns to its normal position. When chain relay 277 pulls up on the break of the last pulse, its left hand break contact will disconnect the bank of condensers 293 from the 90 volt direct current source and will energize relay 271. Energization of relay 271 will connect one side of the microammeter 288 to one side of the bank of condensers 294 and to brush 2 associated with cam 75. At this time, brush 2, associated with cam 75, is not engaging a conducting portion of the cam 75 so that this portion of the circuit is ineffective. However, as the shaft 65 completes one cycle of rotation, brush 3 at cam 75 will engage a conducting portion of cam 75 to connect one side of the bank of condensers 293 through brush 1 of cam 75 to one side of the microammeter 282. Now, since one side of the bank of condensers 294 is connected to one side of the microammeter 292 and one side of the bank of condensers 293 is connected to the other side of the microammeter 282, the relay 281 is reenergized, the charges in the banks of condensers 293 and 294 will be opposed, and, therefore, the needle of the microammeter 282 will be displaced from normal in one direction or the other, depending upon the charges in the banks of condensers and this will indicate whether the proportion between the make and break time of spring 29 and contact member 30 is correct and the spring 29 or contact member 30 may be adjusted to have the desired characteristics, as indicated by the microammeter 282 in staying in a predetermined position.

Shortly after the shaft 65 moves out of normal position, and after brush 3 of cam 75 has broken contact, brushes 2 and 4 of cam 75 will make contact for a short time to discharge the banks of condensers 293 and 294 over a circuit from brushes 2 and 4 through banks of condensers 293 and 294 to brush 1 of cam 75, thus restoring the mechanism that makes the percentage of make and break test to normal.

Although a specific embodiment of the invention has been described hereinbefore, it will be understood that the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. In an apparatus for repeatedly testing telephone dials during their adjustment, a continuously rotating shaft, a series of testing circuits repeatedly prepared for operation each time said

shaft rotates, a second shaft operating in timed relation with said first-mentioned shaft, a set of gages operable under control of said first-mentioned shaft, an actuator operable by the second-mentioned shaft, and a control means for synchronizing the initiation of operations by the shafts in a predetermined cyclic order.

2. In a testing apparatus for testing telephone dials during the adjustment thereof, a pair of vertically reciprocatable gages, means for reciprocating said gages to move them into operative relation with a piece of apparatus to be tested, means for oscillating the gages separately to test separate parts of the apparatus being tested, means for positioning the apparatus in a predetermined position, and means operable under control of said last mentioned means for rendering the means for reciprocating the gages operable.

3. In a testing device for telephone dials, means for moving the dial into position to be tested, a pair of gages for applying tension tests to contact springs in the dial, a bridge circuit associated with each of the gages for measuring the tension of the contact springs, means for repeatedly operating the dial, and means for rendering the tension testing circuits operable during the wind-up of the dial.

4. In an apparatus for repeatedly applying tests to the contact springs of telephone dials during the adjustment thereof, means for repeatedly operating the dial, an electrical circuit connected to a pair of contacts of the dial for measuring the relative length of time after the dial starts to operate until said contacts break, circuits for measuring the tension of contact springs in the dial during the windup part of the operation of the dial, circuits for measuring the proportion of make time to break time of a pair of contacts in the dial during the return of the dial to normal, and means for synchronizing the operation of the circuits with the means for repeatedly operating the dial.

5. In an apparatus for repeatedly applying tests to the contact springs of a telephone dial during the adjustment thereof, means for repeatedly operating the dial, a plurality of circuits for applying the various tests to the contact springs of the dial, a control means for controlling the duration and sequence of the tests applied to the dial, and means operable in synchronism with said last mentioned means for initiating the operation of the dial operating mechanism at a predetermined time in the cycle of operation of the testing circuits, said means for synchronizing the operation of the dial operating mechanism with the testing circuits comprising a stop member for holding the dial operating mechanism inoperative, a spring for urging said stop member out of the path of the dial operating mechanism, and a cam associated with the dial operating mechanism for driving it, said cam being so shaped as to move the dial operating mechanism away from said stop lever at one point in the cycle of rotation thereof.

6. In a testing apparatus for dials, means for receiving and holding a telephone dial, a continuously driven shaft, a means for oscillating the dial finger wheel, means for interconnecting the oscillating means with the driven shaft, and means for controlling the sequence of tests in timed relation to the oscillation of the finger wheel.

7. In a testing apparatus for telephone calling dials, a continuously driven shaft, means driven by said shaft for completing circuits to control the sequence of tests made on the dial, means for repeatedly operating the dial, and means for connecting said operating means to be driven by the shaft.

8. In an apparatus for applying repeated tests to the contact springs in telephone dials during their adjustment, a set of reciprocatable and oscillatable gages for applying tension to contact springs in the dials, means for repeatedly operating the dial, a fixture for receiving the dial, and a unitary control means for moving the dial to position to be tested, for rendering the tension gages operable, and for initiating operation of the means for repeatedly operating the dial.

9. In an apparatus for applying repeated tests to the contact springs in telephone dials during their adjustment, a set of reciprocatable and oscillatable gages for applying tension to contact springs in the dials, means for repeatedly operating the dial, a fixture for receiving the dial, and a unitary control means for moving the dial to position to be tested, for rendering the tension gages operable, and for initiating operation of the means for repeatedly operating the dial, said unitary control device being provided with interlocking mechanism for initiating the operation of the dial operating mechanism at a predetermined point in the cycle of operation of the means for repeatedly operating the dial.

CHRISTIAN PAULSON.