

[54] TRANSPORT ASSEMBLY

[75] Inventors: Howard J. Squires, Rochester;
Donald C. Rimlinger, Holcomb,
both of N.Y.

[73] Assignee: Stromberg-Carlson Corporation,
Rochester, N.Y.

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[52] U.S. Cl. 29/203 P

[51] Int. Cl. H01r 43/00

[58] Field of Search 29/203 P, 203 R, 203 J,
29/203 D

[56] **References Cited**

UNITED STATES PATENTS

2,755,760 7/1956 Fermanian et al. 29/203 J

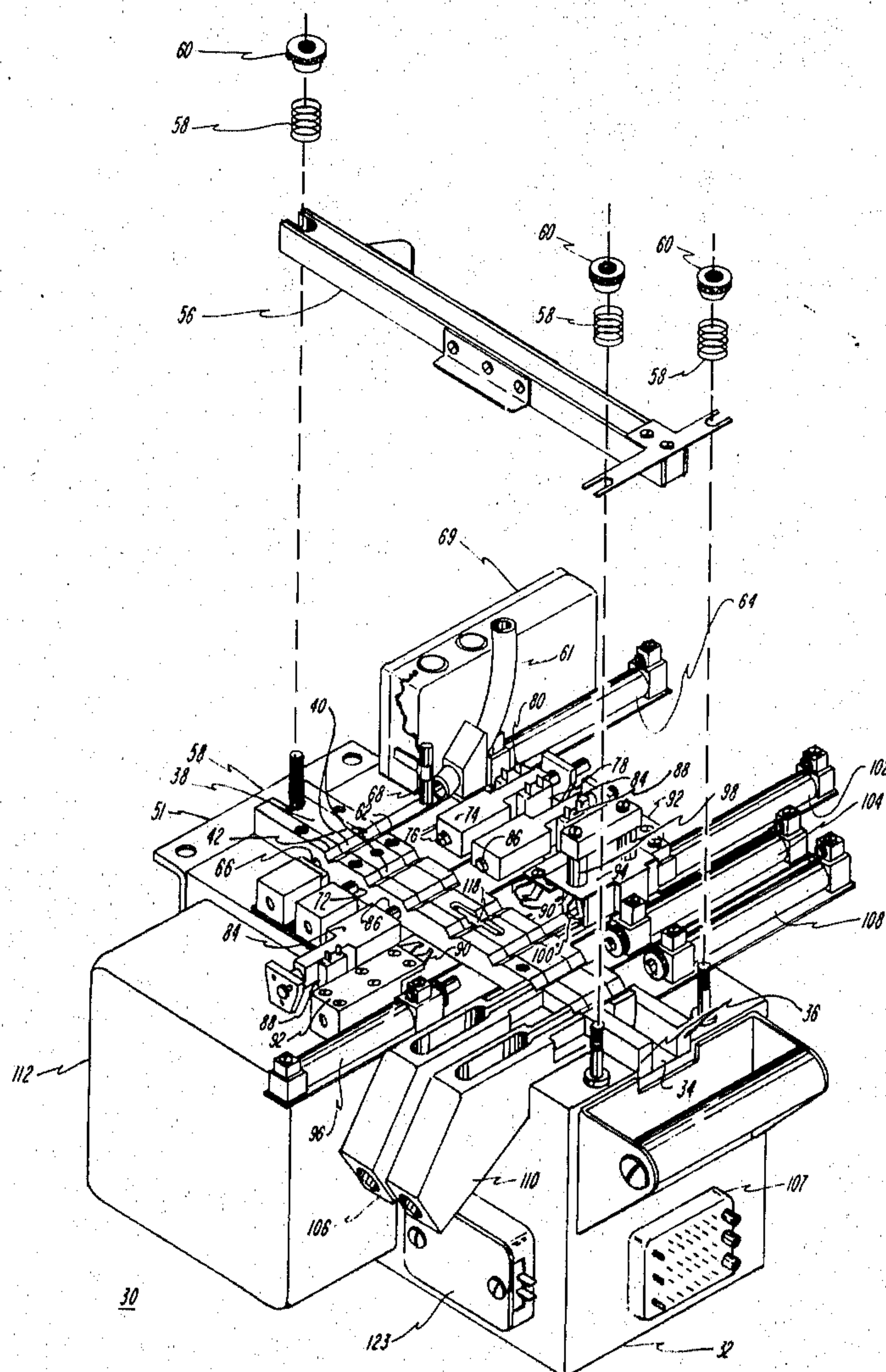
3,626,571 12/1971 Marlin et al. 29/203 P

Primary Examiner—Thomas H. Eager
Attorney, Agent, or Firm—William F. Porter, Jr.

[57] **ABSTRACT**

A reed switch analyzer for testing the mechanical and electrical characteristics of reed switches employs a unique transport assembly in a test head for advancing the reed switches through various test stations and timer means for synchronizing the operation of the test head with the reed switch manufacturing machine so that the test head is compact and is easily and conveniently added to or removed from the manufacturing machine without interfering with its operation. The test head provides test result signals for separating good switches from the bad ones and for providing feedback information to the machine operator for quality control purposes as the switches are automatically received from the manufacturing machine.

6 Claims, 14 Drawing Figures



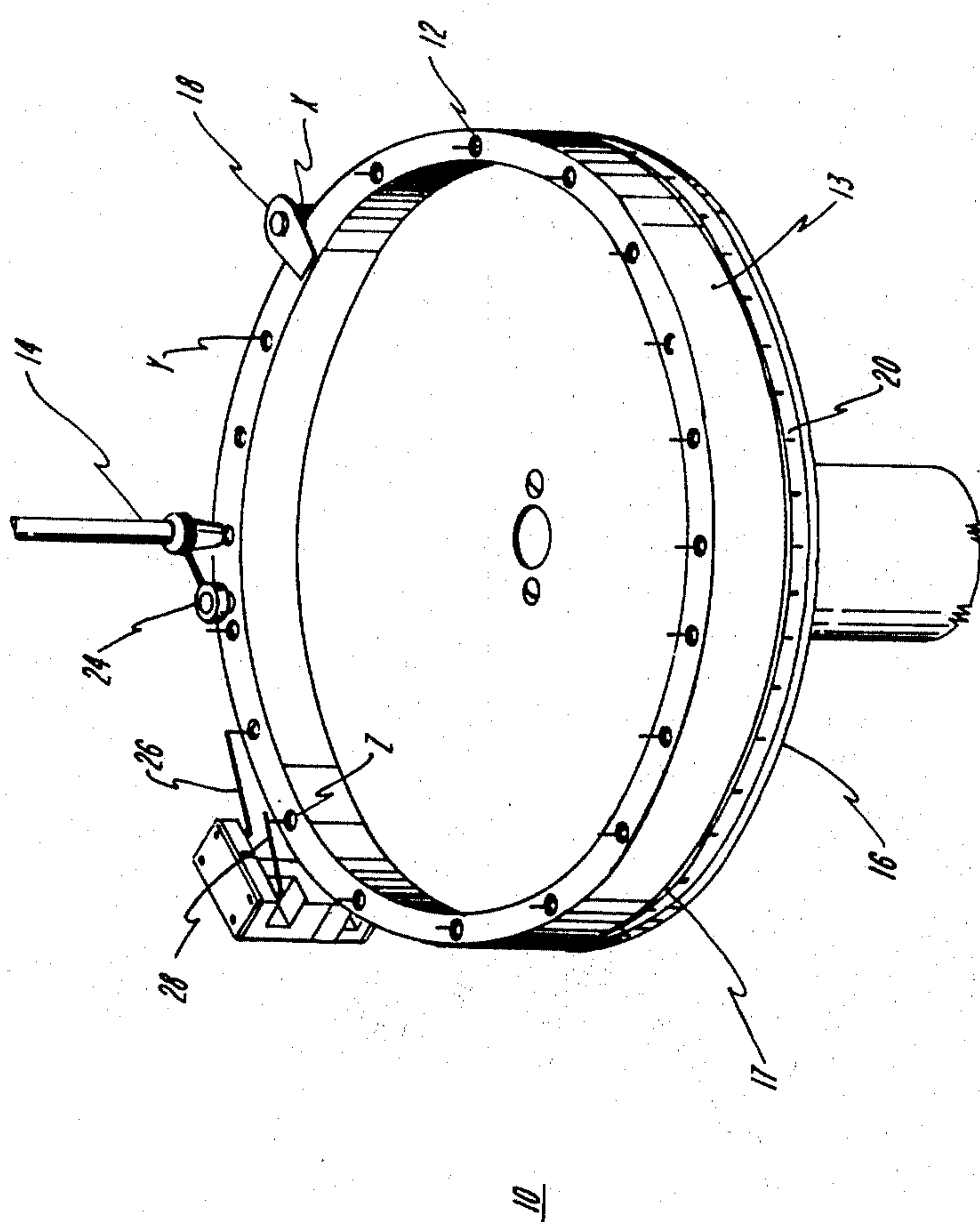
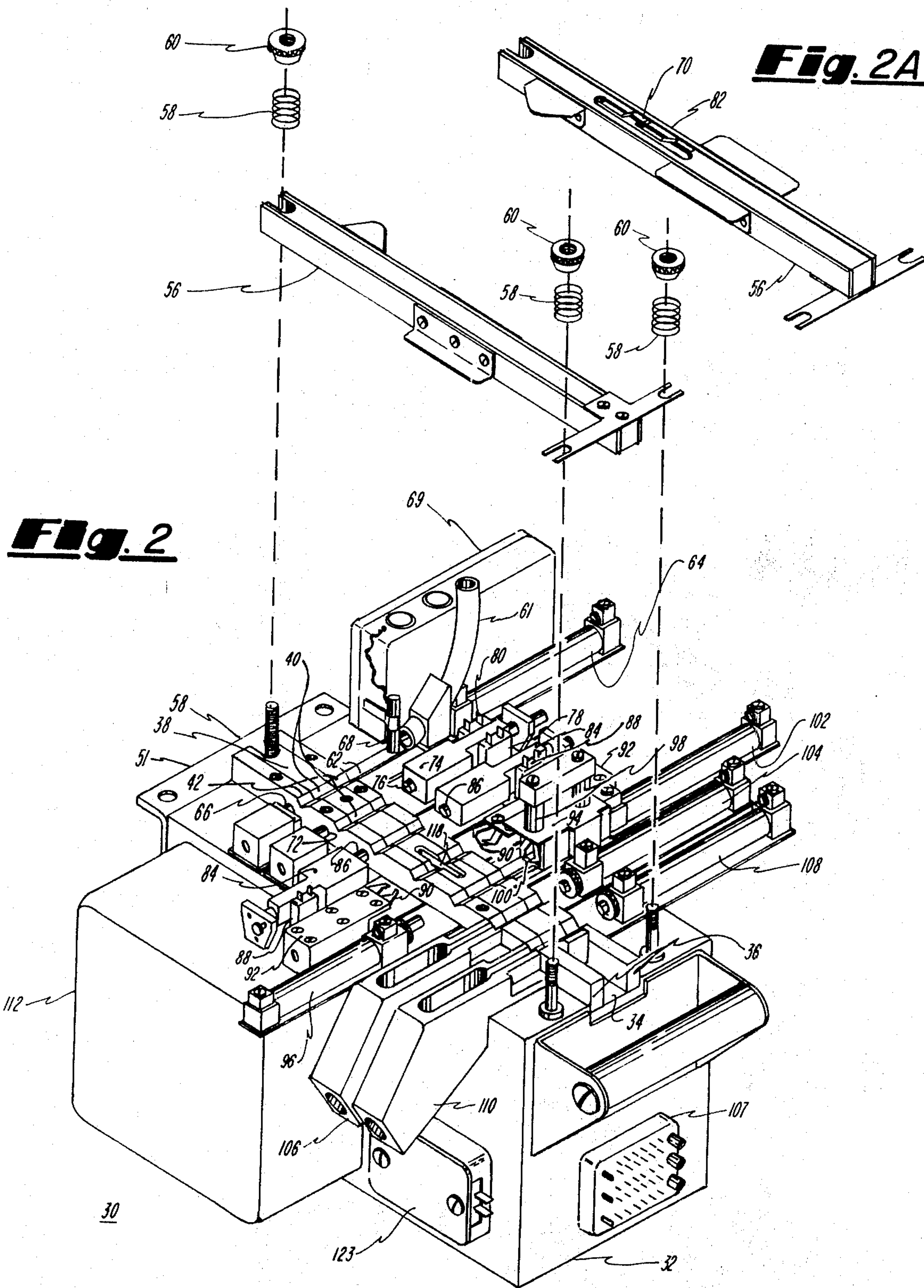


Fig. 1



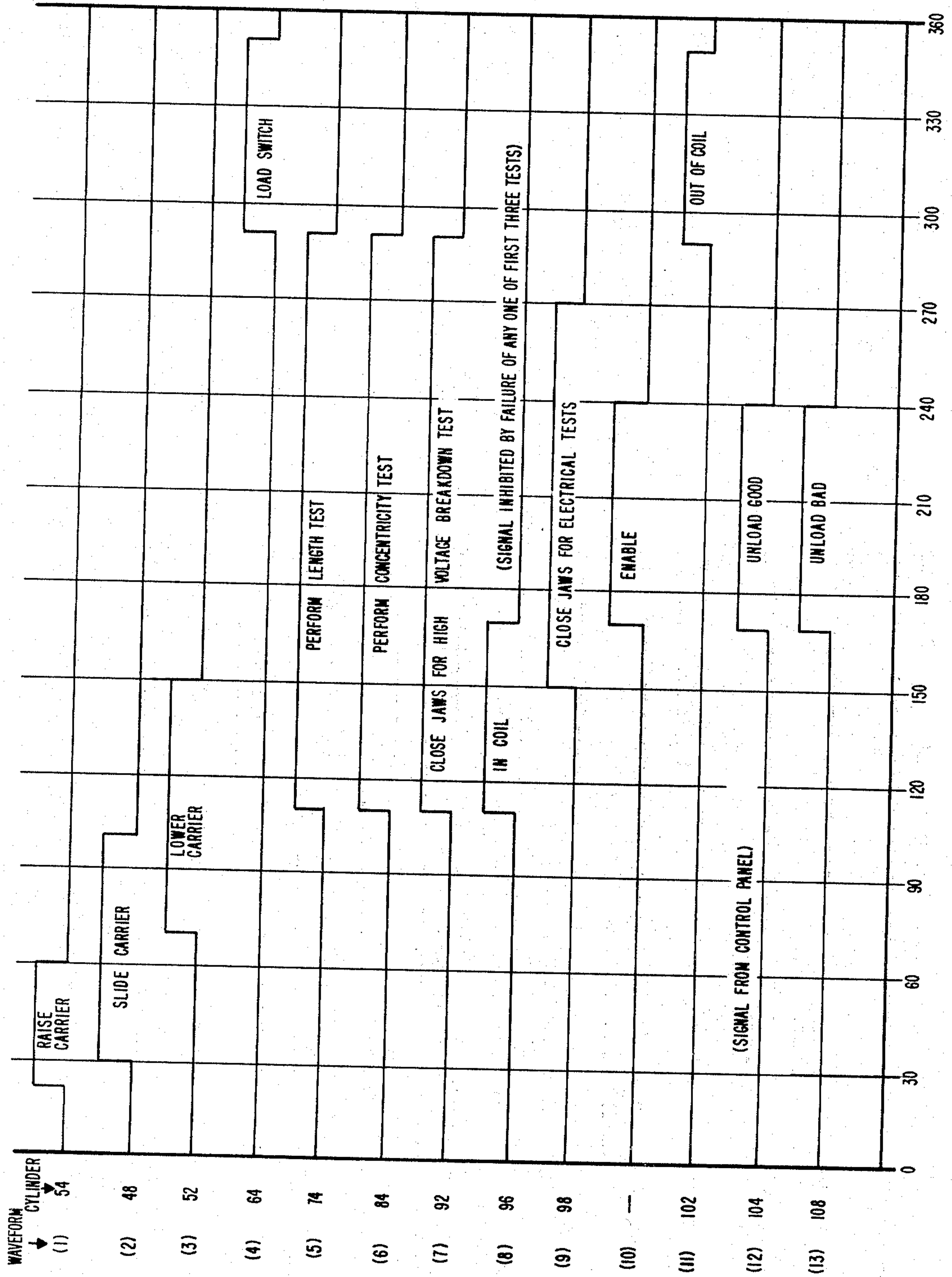


Fig. 3

Fig. 4a

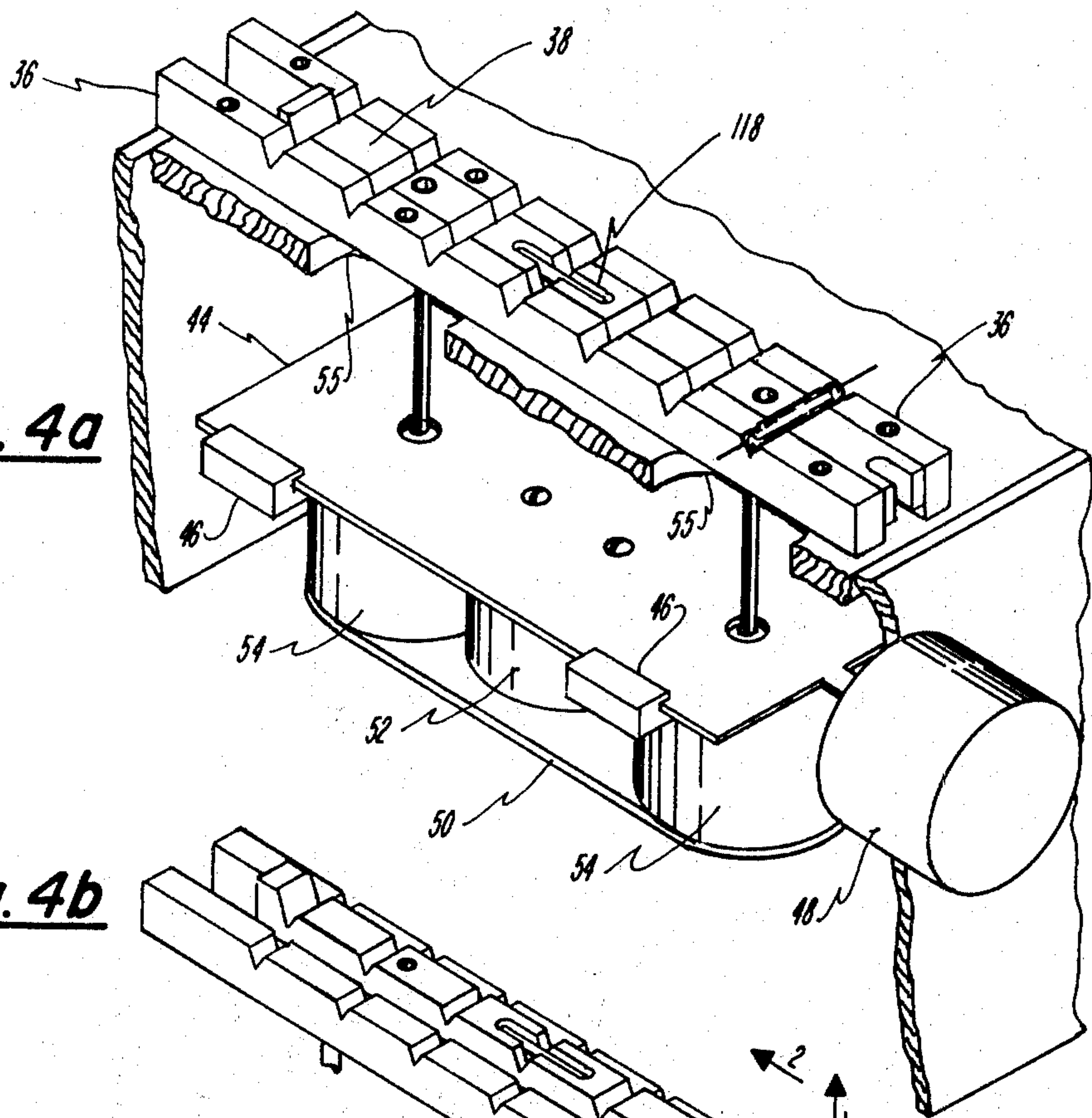


Fig. 4b

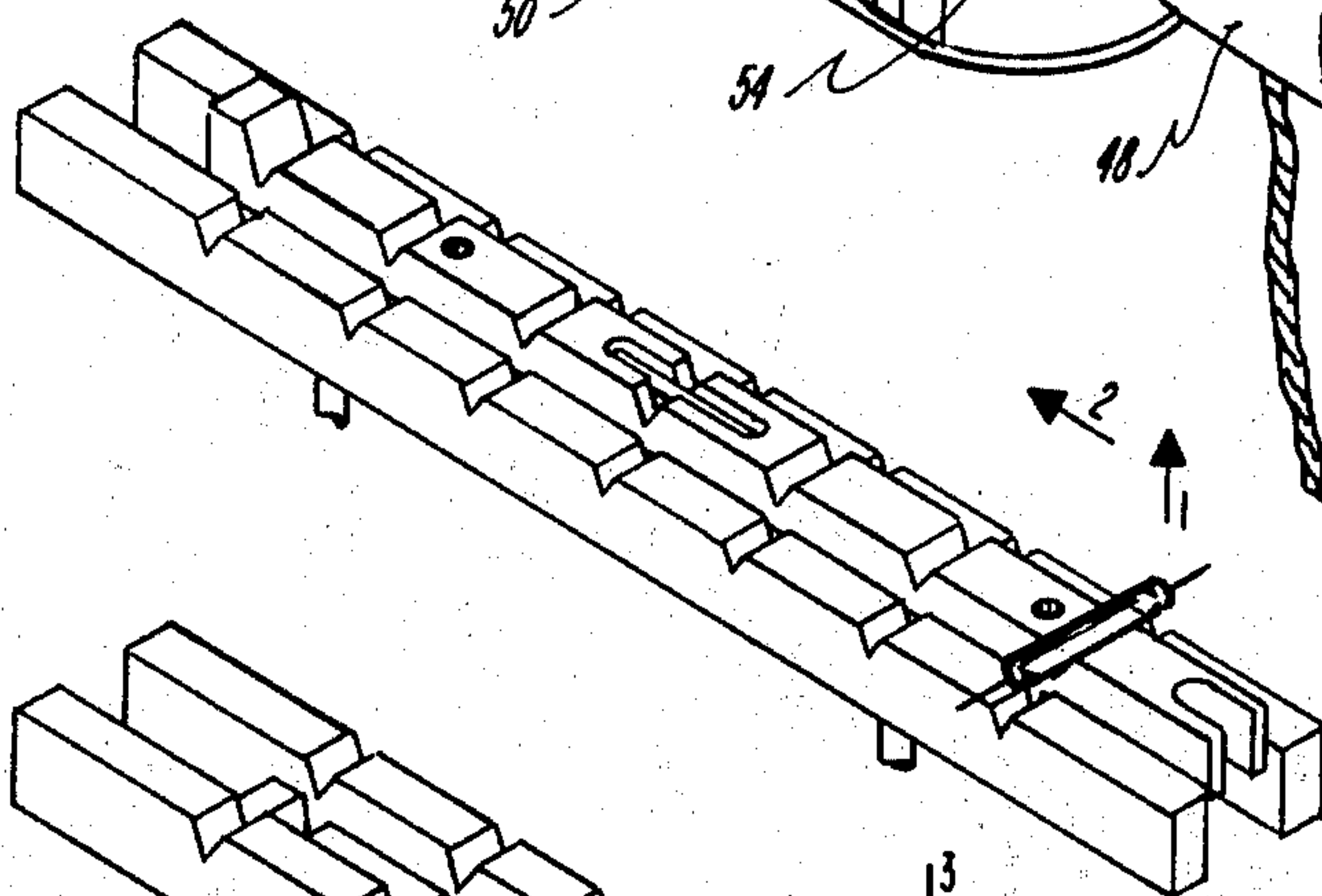


Fig. 4c

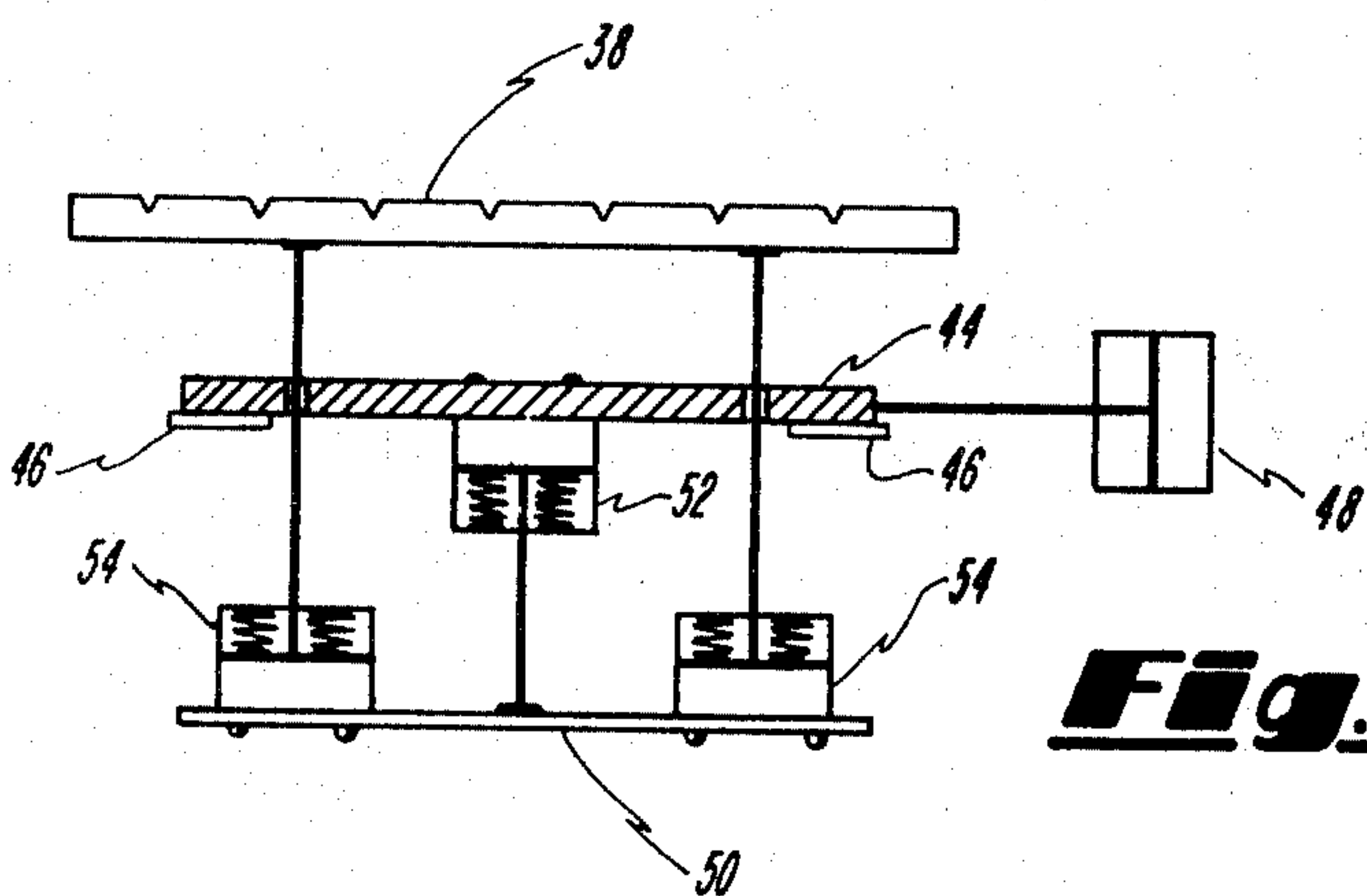
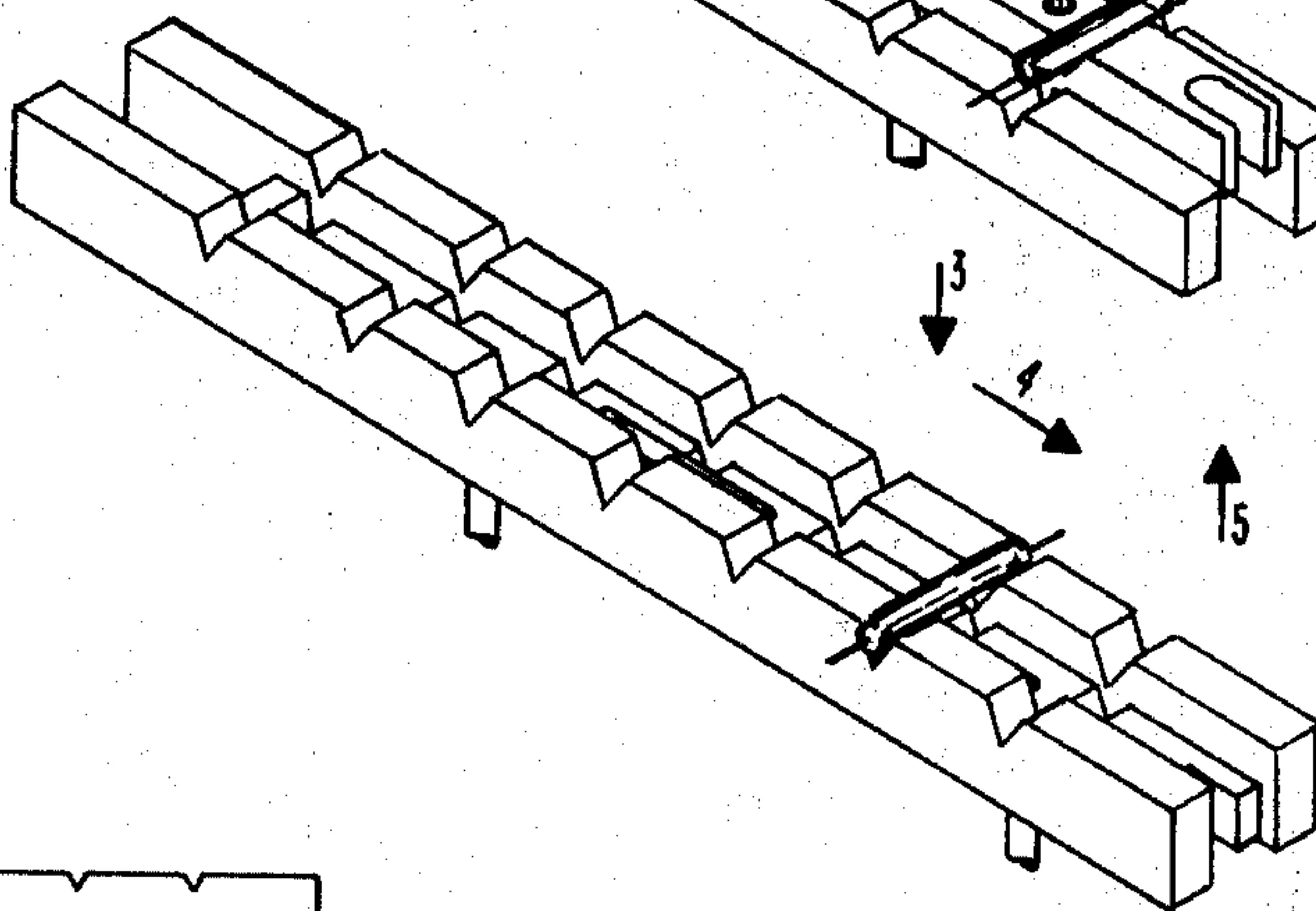


Fig. 5

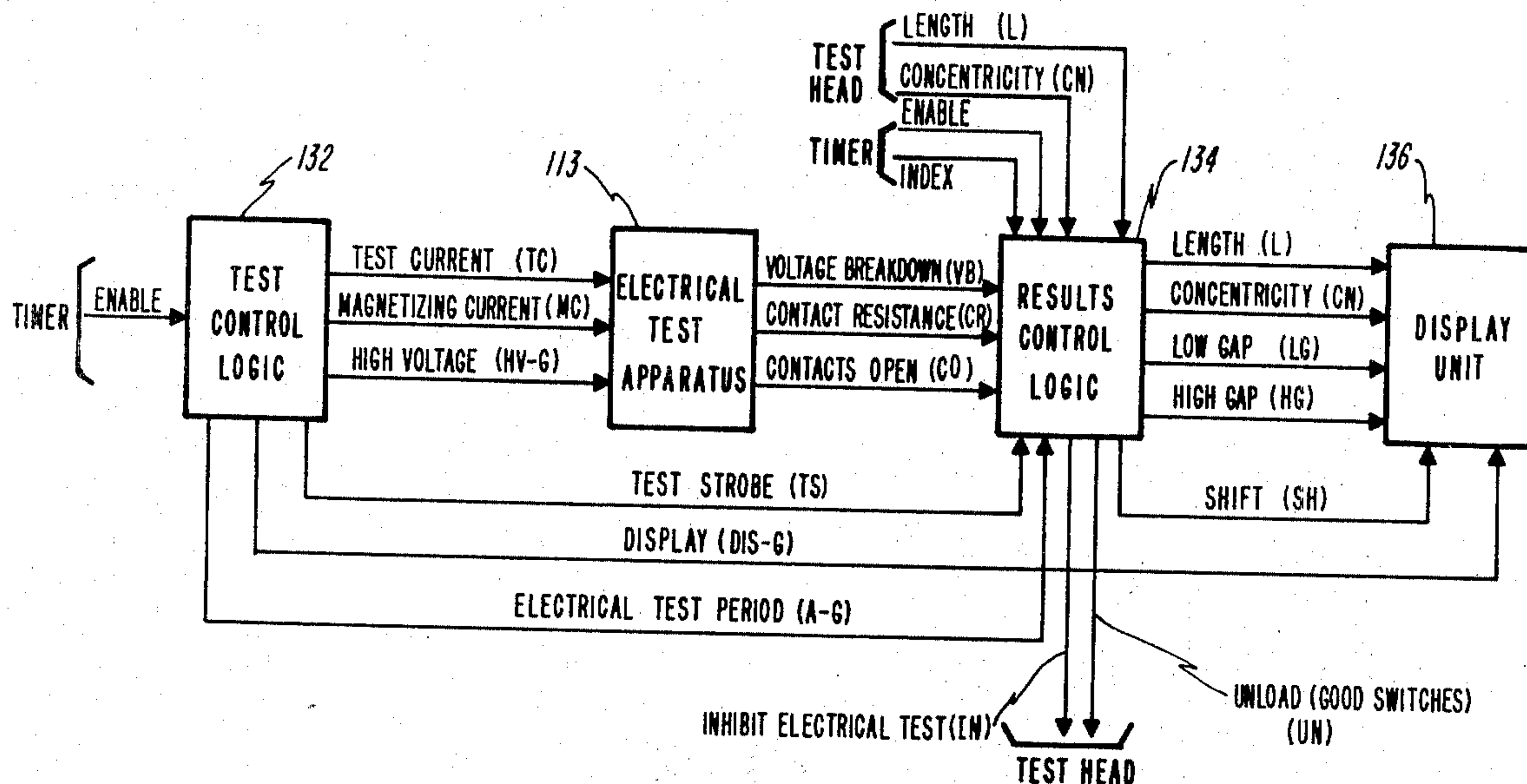


Fig. 7

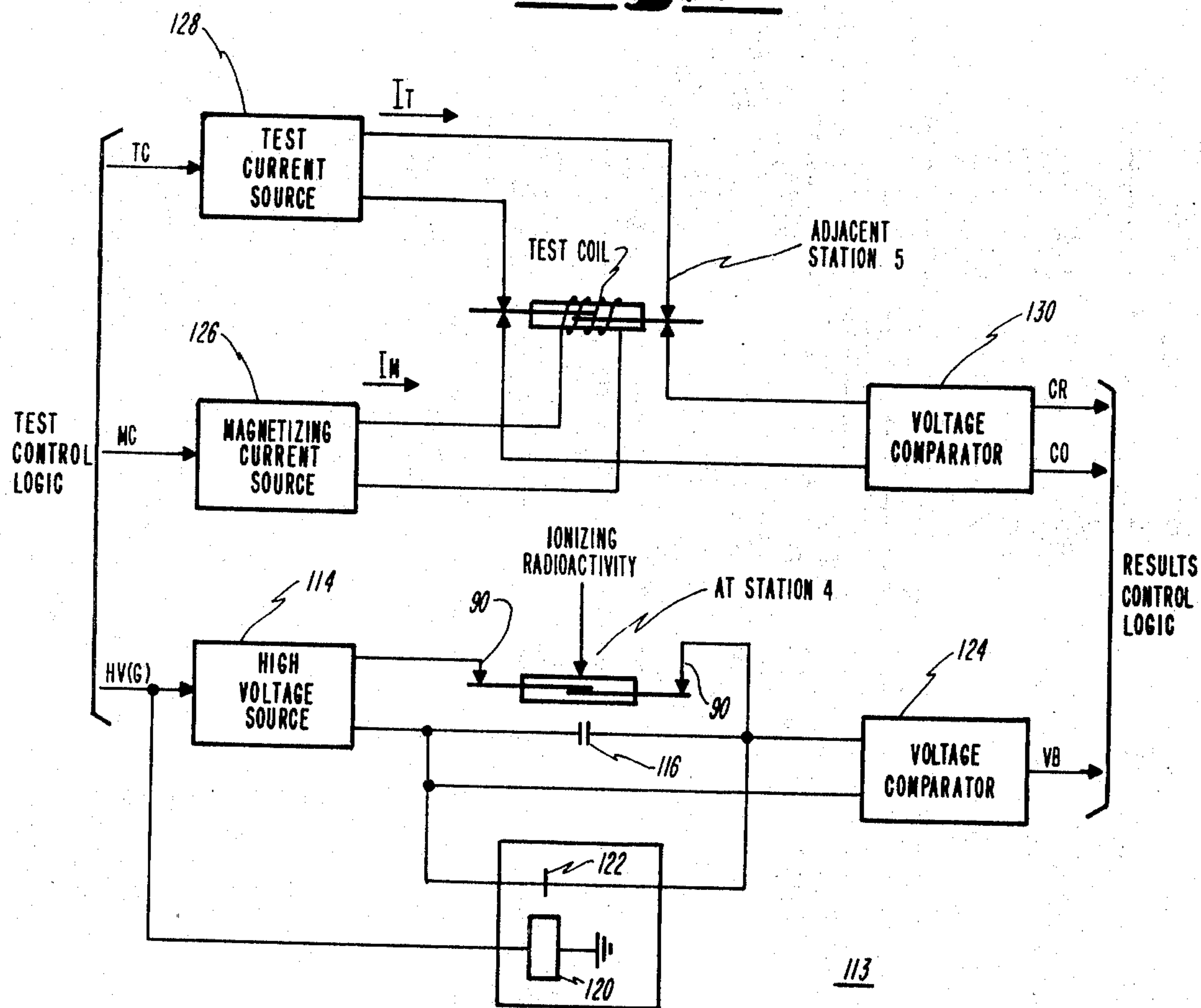


Fig. 6

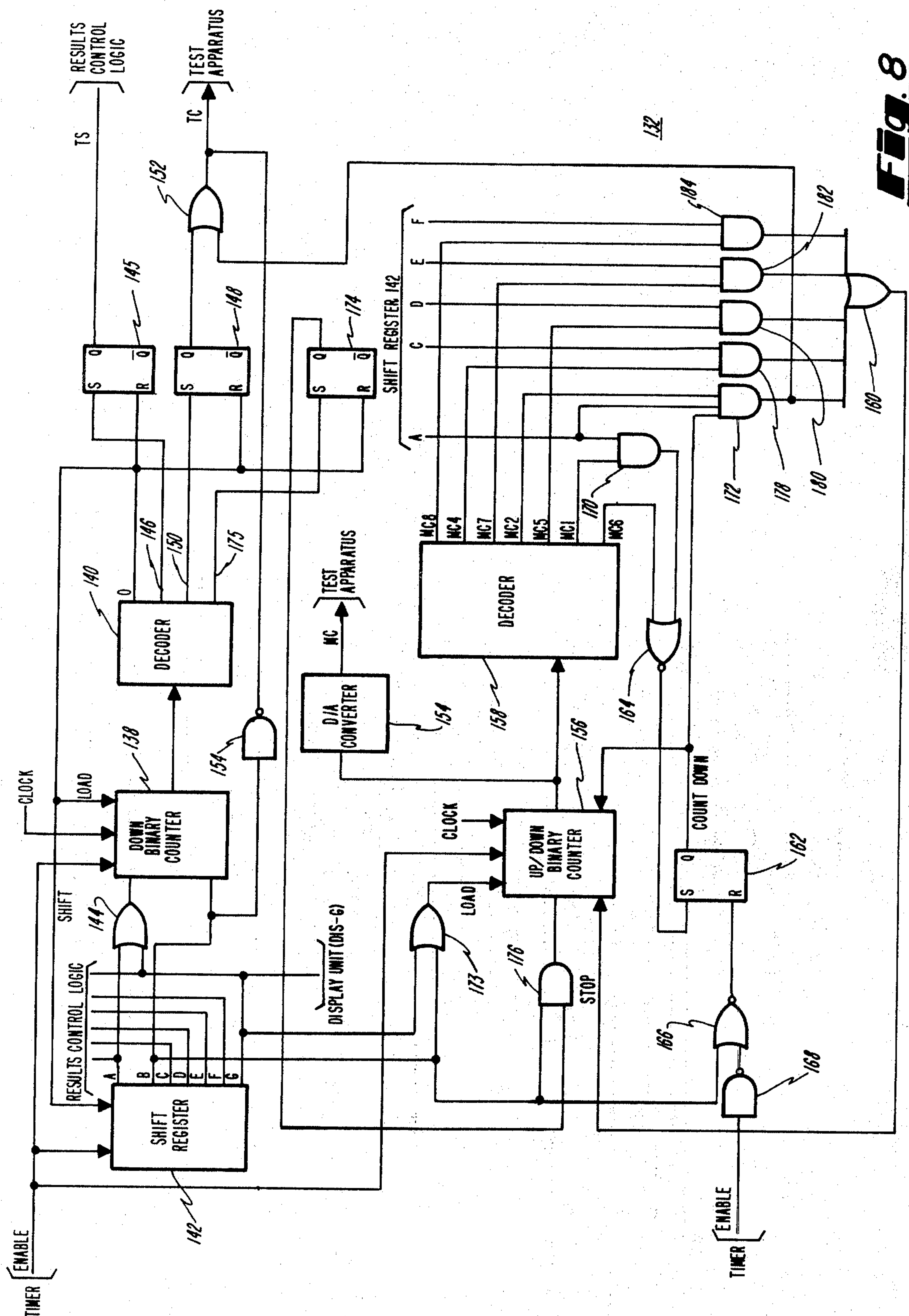


Fig. 8

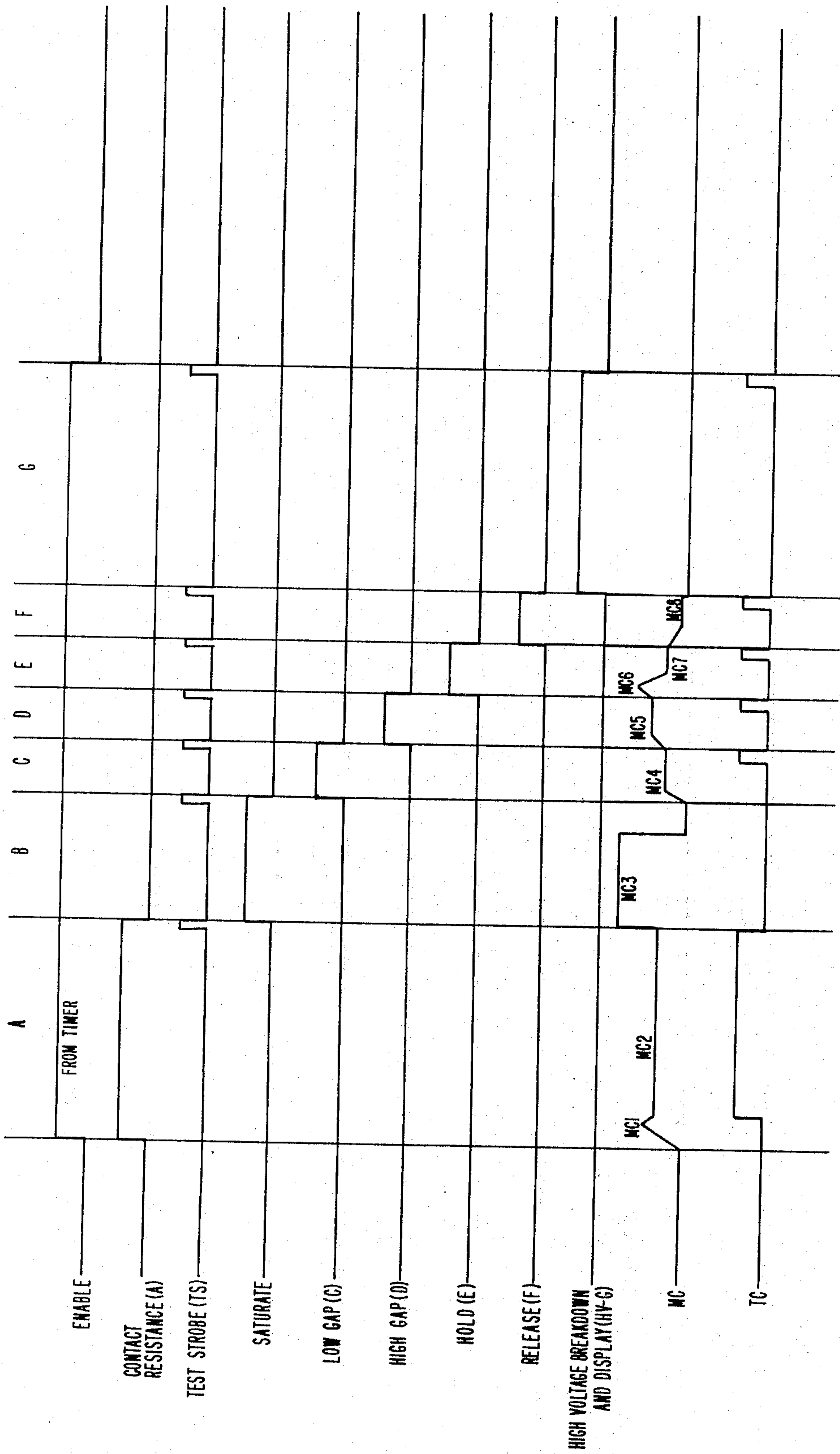


Fig. 9

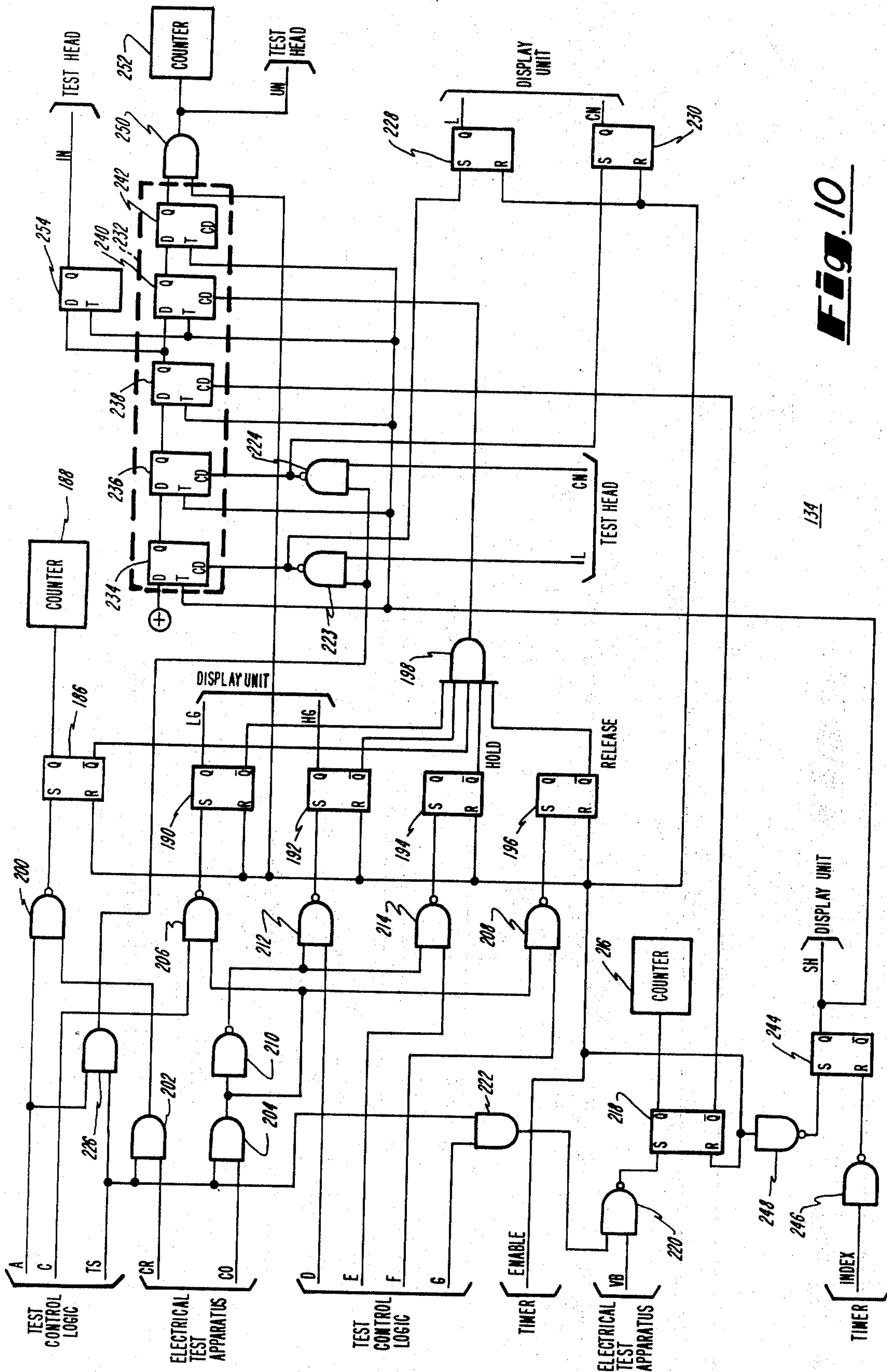
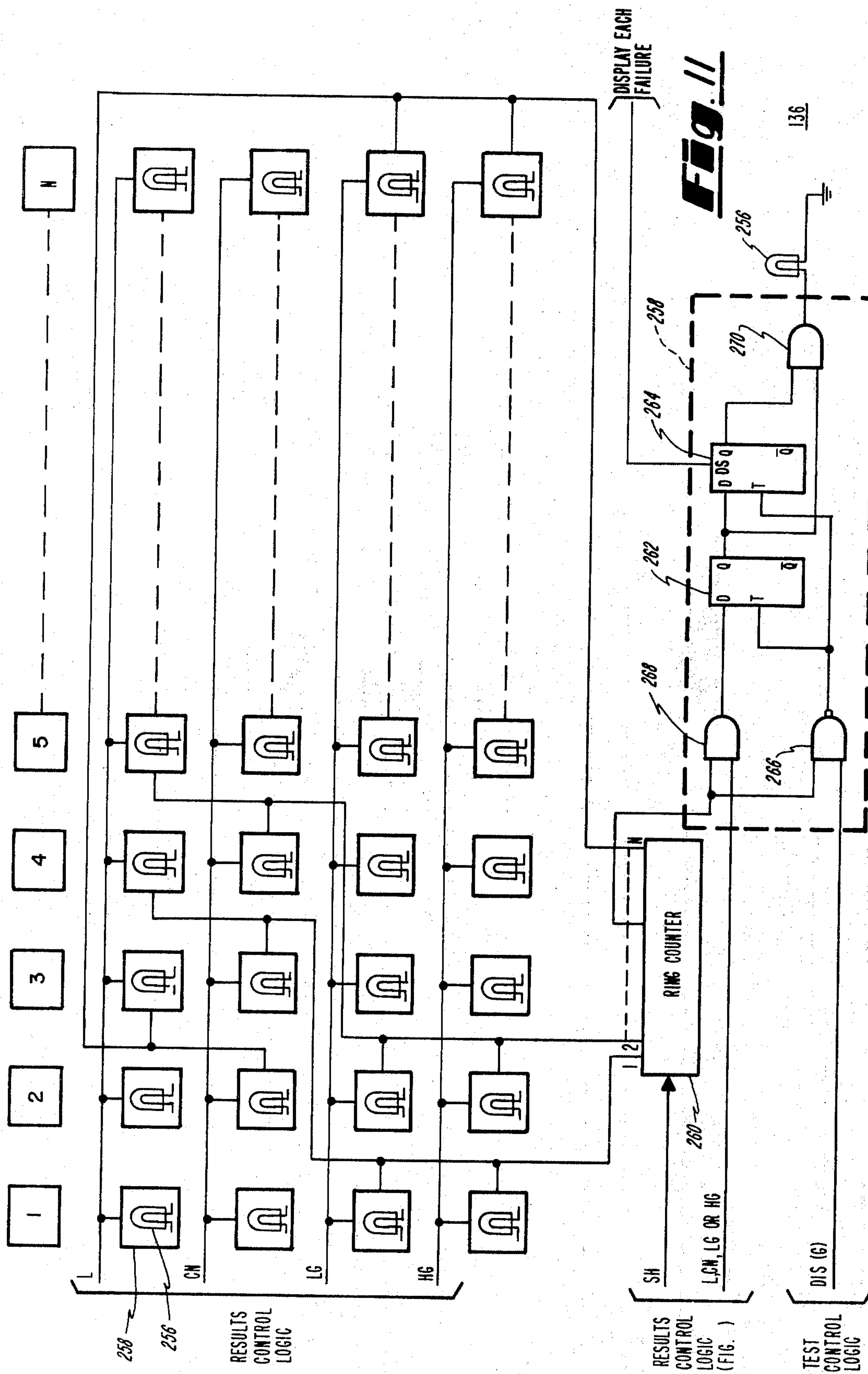


Fig. 10



TRANSPORT ASSEMBLY

BACKGROUND OF THE INVENTION

This application is a Division of application Ser. No. 366,938, filed on June 4, 1973.

The subject invention pretains generally to the manufacture of reed switches and specifically to a compact testing machine which may be easily and conveniently added to the manufacturing machine for analyzing and displaying the characteristics of the switches with regard to predetermined standards.

Reed switches are common electrical switching devices consisting of two metal paddles separated by a narrow gap in a glass encapsulated vacuum with the leads brought out for connection in the electrical path which is to be controlled. The switches are normally manufactured on a multihead machine with each head carrying a single switch through various processing stations, each station providing a different step in the overall manufacturing cycle. Such a machine is disclosed in a U.S. Pat. No. 3,626,571, entitled, "Apparatus For Assembling Sealed Contact Switches" which was issued to Glenn Ardrian Marlin, et al., on Dec. 14, 1971. The switch is housed in an electrical coil which is then energized to establish a magnetic field for closing the switch and de-energized thereafter for removing the magnetic field to open the switch. Because the switch is small and simple in structure its mechanical and electrical characteristics are particularly critical to its proper operation. Regarding its mechanical characteristics its overall length (from the end of one lead to the other) should be within a small tolerance while the leads should be concentric with another so that they are perfectly aligned. Regarding the electrical operating characteristics the gap should not be too narrow, lest the switch operates (close) or releases prematurely in the presence of a magnetic field nor should the gap be too large lest the switches not close or remain closed when required. Furthermore, the gap should not break down and become conductive when high voltage spurious signals are inadvertently applied to its leads.

It is important that the foregoing characteristics be tested for two reasons: one to separate the defective switches (those which do not meet the predetermined standards) from the good ones and two to provide feedback information to the machine operator about specific characteristics which are controllable so that he may make the appropriate adjustments on those machine heads which are shown to be producing defective switches for quality control purposes to maximize output. Because of the complexity of the test apparatus and the importance of maintaining volume production of the reed switches which are used in great numbers, at present the test apparatus which is available is physically separated from the manufacturing machine so that it need not encumber nor in the case of failure impede manufacturing production. This detracts from overall efficiency however since the reed switches must be first moved manually from the manufacturing area after being unloaded from the manufacturing machine to a testing area to be loaded into the testing machine. Furthermore at present automatic test procedures are limited to the electrical characteristics only with the mechanical tests for length and concentricity being performed by hand through the use of gauges.

With the foregoing in mind it is a primary object of the present invention to provide a reed switch analyzer which is compact and so designed that it may be easily mounted on or adjacent to a reed switch manufacturing machine for testing the characteristics of the reed switches as they are received from the machine and which may be easily removed thereafter without interfering with manufacturing production.

It is a further object of the present invention to provide such a reed switch analyzer which not only monitors the electrical characteristics of the reed switches but also the mechanical characteristics.

It is still a further object of the present invention to provide a reed switch analyzer which not only separates the good switches from the bad after testing but which also affords immediate feedback information to the machine operator indicating which controllable characteristics the reed switches are failing to meet in accordance with the machine heads on which they were produced.

These objects as well as others will be more readily apparent from the detailed description of the invention hereinbelow considered in view of the nine attached drawings.

BRIEF DESCRIPTION OF THE INVENTION

The reed switch analyzer of the invention employs a compact test head which can easily be mounted on or adjacent to the manufacturing machine for testing the mechanical and electrical characteristics of the reed switches as they are received from the machine. The compactness of the test head is due in great part to the transport assembly used for simultaneously moving the reed switches through various test stations in synchronism with the manufacturing machine. The reed switches rest in pairs of support notches, each pair defining a station along a channel in which a carrier bar is free to move horizontally and vertically. The carrier bar has notches along its length which align with the support notches when stationary. To advance the switches to the next stations the bar is raised sufficiently to lift the switches out of the support notches, then moved horizontally so that the switches are above the next support notches, then lowered sufficiently so that the switches are deposited in the support notches with the carrier bar being capable of clearing their undersides after which the bar is returned horizontally and then vertically to its original position. This motion is repeated continuously to advance the switches from station to station each time the manufacturing machine indexes. In the preferred embodiment all mechanical movements in the test head for performing the tests as well as for transporting the switches from station to station are provided by air cylinders controlled from solenoid valves which are responsive to electric signals. The electric signals are generated by microswitches in a timer assembly which includes a cam shaft driven from the manufacturing machine. Since there are no direct mechanical links between the test head and the manufacturing machine, the machine need not be stopped in order to add or remove the test head therefrom.

Electric signals are applied to and received from the test head through a connector cable so that to disengage the test head it is only necessary to disconnect the connector cable which does not affect manufacturing output. The cable also carries all the digital signals to

and from a separate control panel which houses the logic circuits for controlling the electrical tests and for processing and displaying the results of all the tests both mechanical and electrical. The electrical test apparatus is preferably mounted on the test head to minimize the attenuation and distortion of the analyzer test signals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of the cooling table which is used in conjunction with the reed switch analyzer.

FIG. 2 is an isometric view of the test head used in the analyzer for performing and reporting the results of the various tests; FIG. 2a shows the underside of the restraining bar used in the test head.

FIG. 3 is a mechanical timing chart which depicts the various signals for controlling mechanical movements in the test head of FIG. 2.

FIGS. 4a-4c show the transport assembly carrier bar in various positions for advancing the reed switches from station to station.

FIG. 5 is a schematic view of the transport assembly which is helpful in explaining the transport motion.

FIG. 6 is a schematic diagram of the test apparatus mounted on the test head for performing the electrical tests and generating signal indications of the results thereof.

FIG. 7 is a block diagram showing the basic components of the control panel and the various signal paths for controlling the tests and for processing and displaying the results thereof.

FIG. 8 is a schematic diagram of the test control logic in the control panel which controls the electrical tests as well as the processing and displaying of the test results.

FIG. 9 shows the various control signals generated by the test control logic of FIG. 8.

FIG. 10 is a schematic diagram of the results control logic in the control panel used for storing and processing the test results.

FIG. 11 is a schematic diagram of the display unit in the control panel.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a circular cooling table 10 which may be moved around its vertical axis in synchronism with a multihead reed switch manufacturing machine by any common driving mechanism (not shown) linking the two. Each time the machine indexes, viz. moves its manufacturing heads from one position to the next, the cooling table 10 is partially rotated (counterclockwise as depicted in FIG. 1) so that a different one of a plurality of holes 12 located around its periphery in a rim 13 is placed underneath a loading chute 14 to receive a single reed switch from the machine. The cooling table 10 permits the switches, which are still hot when received from the machine, to cool sufficiently before reaching an unloading station at point X so as to stabilize their characteristics before the tests are begun. At point X the switches are permitted to drop by gravity through a hole (not visible) in a stationary plate 16 located below the base 17 of the cooling table 10 into a test head where the tests are actually performed. As a safety precaution, should a switch become jammed as it is fed into the test head, a photoelectric eye mounted thereon detects the condition and energizes an electromagnet 18 which prevents subsequent switches from

being unloaded at point X. Each switch is then transported to point Y where it is allowed to drop through another hole in the plate 16 into a hooper placed thereunder for that purpose.

Once deposited in a hole 12, the reed switch is supported by its lower lead standing on the plate 16, the lower lead being visible in FIG. 1 because of the narrow separation 20 between the base 17 of the cooling table 10 and the plate 16. Since the overall length of the reed switch (distance between lead ends) cannot vary greatly by the manufacturing process, the height of the switch relative to the plate 16 while standing in a hole 12 is essentially fixed. Since each hole 12 is only large enough to accommodate a single free standing switch, should a second switch inadvertently drop into an occupied hole 12, it will extend above the normally anticipated height. This is an undesirable situation since it is important that only one switch be fed to the test head at a time. A permanent magnet 24 is so positioned to pick off these unwanted occupants. Should the magnet 24 fail to pick off a second switch in a hole 12, a feeler 26 set slightly above the normally anticipated height is activated by the reed switch to close a circuit for providing an audible alarm to warn the machine operator who is always in the general vicinity. There is sufficient time between the signalling of the alarm and the time that it takes the table 10 to move the hole 12 having two switches therein to point X for the operator to walk over to the table 10 to remove the second switch.

Although not probable, it is possible that the manufacturing machine will produce a reed switch having only one lead or even no leads. These switches are detected at point Z to also provide an alarm to the operator so that he may remove them to avoid feeding them into the test head where they might otherwise create problems during testing. A feeler 28 set just below the anticipated height must be activated by the upper lead of the switch together with another feeler which cannot be seen, but extends into the separation 20 at point Z to be activated by the lower lead to prevent the alarm from sounding. The lower feeler enables the alarm to be sounded only when a switch is in fact located in the hole 12, while the upper feeler 28 is activated only if the switch has leads on both ends.

The test head which is represented generally by reference numeral 30 in FIG. 2 has a housing 32 on which is mounted a transport assembly for moving the reed switches from station to station and the test apparatus for performing different tests at the various stations. Because of the type transport assembly employed, the test head 30 is compact and therefore easily mounted on or adjacent to the manufacturing machine itself. The mechanical movements required for transporting and testing the reed switches are all imparted by the piston rods or plungers of air cylinders under the control of solenoid valves which are responsive to electrical signals from a timer assembly. The timer assembly consists of microswitches which are closed to apply the electrical signals to the solenoid valves by various cams on a shaft connected to the manufacturing machine so that the mechanical movements in the test head are all synchronized to the machine movement. Preferably short piston strokes are controlled by a three way valve which opens the inlet port and closes the outlet port to allow air into the cylinder chamber for moving the piston when energized and closes the inlet port and opens the outlet port to evacuate the air when de-energized

to permit the piston to return under spring pressure. Preferably long piston strokes are provided by a four way valve which functions with a cylinder having inlet and outlet ports on top and bottom of the cylinder chamber. The piston rod is extended by energizing the valve which closes the bottom inlet port and top outlet port and opens the bottom outlet port and the top inlet port, thereby permitting air to fill the cylinder chamber above the piston head while air is evacuated below it. To return the piston, the valve is de-energized which closes the top inlet port and bottom outlet port and opens the bottom inlet port and top outlet port to permit air to enter the cylinder chamber below the piston head while air is evacuated above it. Since the cylinder-valve and timer assemblies are well known no further elaboration is required. For the sake of clarity none of the ports have been shown in the drawings. The valves are not visible in FIG. 2 because they are located physically behind the test head 30 in that view. A mechanical timing chart has been provided in FIG. 3 to relate the timing signals to the cam shaft rotation to facilitate the reader's understanding of the invention. Each waveform with the exception of waveform 10 corresponds to a different valve and its associated air cylinder, the upper level of the waveform representing the period during which the valve is energized and the air cylinder is operated so that its piston rod or plunger is extended.

Looking again to FIG. 2, it is seen that the housing 32 is provided with an open channel formed in part by a rectangular groove 34 cut into the horizontal surface thereof and a pair of parallel walls 36 disposed on either side of the groove 34. The groove 34 is only partly visible because of a carrier bar 38 which is located between the walls 36 above the groove 34 and which is free to move vertically (up or down) and horizontally (forward to the right and back) with respect to the channel. The carrier bar 38 may be said to be in a normal level position when situated as shown in FIG. 2, normal referring to the horizontal positioning while level refers to the vertical positioning. It will be noted that in the normal level position each V notch 40 formed in the bar 38 aligns with a pair of oppositely placed V notches 42 formed in the walls 36. It will be further noted that the horizontal distance between any pair of successive V notches 40 is the same. The bar 38 can be moved forward (to the right) horizontally by an amount equal to this distance where in this forward position each V notch 40 can be aligned with the pair of V notches 42 directly forward (to the right) of the pair of V notches 42 it normally aligns with when the bar 38 is the normal level position. Each pair of V notches 42 defines a station in which a different reed switch resets. Different characteristic tests can be performed at different stations simultaneously while the reed switches straddle the V notches 42 with the bar 38 in the normal level position.

The transport assembly for moving the reed switches from station to station is shown in detail in FIGS. 4a-4c and schematically in FIG. 5. In FIG. 4a the housing 32 is cut away to reveal the portion of the transport assembly located inside. This consists of a slider 44 which can only move horizontally to the left and back (for convenience these views are rotated 180° from how they would appear in FIG. 2) on fixed bearings 46 when moved by the piston rod of an air cylinder 48, a plate 50 affixed to the piston rod of an air cylinder 52 which

is itself mounted to the slider 44 and a pair of air cylinders 54 mounted to the plate 50 with their piston rods each being affixed to the carrier bar 38. Cylinders 52 and 54 are controlled by three-way valves while cylinder 48 is controlled by a four-way valve.

Although in actual operation there would be a reed switch in each of the first six stations, for simplicity of explaining the transport motion, only one reed switch is shown in the first station which is to be moved to the second station located immediately to the left of the first station. As shown in FIG. 4a, the carrier bar 38 is in its normal level position, the valves for the cylinders 48, 52 and 54 are de-energized so that their piston rods are not extended. First, the cylinders 54 are operated to extend their cylinder rods upward, thereby raising the carrier bar 38 above its level (normal) position to a sufficient height to lift the reed switch out of the V notches 42 so that its underside can clear the notches. FIG. 4b shows the carrier bar in its normal upper position. Second, cylinder 48 is operated to extend its piston rod to the left thereby moving the carrier bar to the forward (upper) position via the slider 44 (it may be readily appreciated that the carrier bar 38 must follow the motion of the slider 44 because of the forces produced by the structural arrangement of the transport assembly). Third, the air is released from the cylinders 54 to allow the carrier bar 38 to return to its level (forward) position thereby depositing the reed switch in the second station and then cylinder 52 is operated to extend its piston rod downward. This lowers the plate 50 together with the cylinders 54, their piston rods as well as the carrier bar 38. The carrier bar 38 is thus lowered below its level (forward) position sufficiently so that the top of the bar 38 clears the underside of the reed switch. Fourth, the piston rod of cylinder 48 is returned to the right by putting air into the cylinder chamber below the piston head thereby returning the carrier bar 38 to its normal (lower) position as depicted in FIG. 4c. Fifth and last, the air is evacuated from cylinder 52 permitting the carrier bar 38 to be raised to its level (normal) position. This completes the transport cycle, each reed switch having been moved to the next forward station. The transport cycle is represented by the first three waveforms in FIG. 3. It should be noted that the point at which the carrier bar 38 is first raised (waveform 1) to begin the transport cycle coincides with the machine index point.

It should be realized that what is important here is the type of motion imparted to the carrier bar 38 for advancing each reed switch from station to station rather than the specific structure provided for that purpose, since this may easily take different forms. For instance rather than provide the side walls 36, the V notches 42 (or any other suitable shape notch for that matter) could be formed in the horizontal surface of the housing 32, if desired, with the top of the carrier bar 38 being level with this surface. Another alternative is to raise the height of the side walls 36 sufficiently so that the carrier bar 38 can be lowered for clearance upon its return stroke without the need for entering the groove 34 in the horizontal surface. Rectangular apertures 55 are provided in the housing 30 for permitting the piston rods of air cylinders 54 to be moved horizontally during the transport cycle.

Returning to FIG. 2 again, it is seen that a restraining bar 56 is provided for mounting over the carrier bar 38 which is held in place by springs 58 and clamping nuts

60. This spring loaded mounting permits the restraining bar 56 to move up with the carrier bar 38 to exert a slight pressure on the reed switches located in the V notches 40 of the raised carrier bar 38 to maintain the switches in place during transit.

As already mentioned, the test head 30 has seven stations, with the first station to the extreme left in FIG. 2 being a loading station. Each time a reed switch falls through a chute 61 which is located under the hole in plate 16 (FIG. 1) at point X onto a V track 62 aligned with the first station, an air cylinder 64 is operated (waveform 4 of FIG. 3) to extend its plunger (not visible) against the lead of the reed switch to push the switch into place in the first station. The switch is slid into place and stopped by a fixed stop 66 which contacts the other lead of the switch. This movement as well as all those that follow take place while the carrier bar 38 is in the normal level position. A light source 68 is placed above the track 62 to divert the flow of switches from the cooling table 10, as already mentioned, should a switch become jammed thereby covering the photoelectric cell which lies in the track 62. This would then cause an energizing potential to be applied to the electromagnet 18 of FIG. 1. The photoelectric control circuitry is located in the box marked 69.

Once the reed switch is in place in the first station it is moved to the second station (immediately to the right of station one) during the next transport cycle as previously described (as the switch in the second station is moved to the third station and so on). A length test is performed at the second station to determine if the distance between the ends of the switch leads is within a prescribed tolerance. The switch is held down in place for precise measurement by a spring clip 70 mounted on the underside of the restraining bar 56 as shown in FIG. 2a. As one lead is held against a fixed stop 72, an air cylinder 74 is operated (waveform 5 of FIG. 3) to move the face of its plunger 76 against the other lead. The plunger 76 must travel a minimum distance to operate a first microswitch 78 and less than some maximum distance to avoid operating a second microswitch 80. The distances are arranged so that the longest tolerable reed in station two stops the plunger 76 after it has traveled the minimum distance to activate microswitch 78 and the shortest tolerable reed permits the plunger 76 to travel just slightly less than the maximum distance to avoid operating microswitch 80. If microswitch 78 does not operate (switch too long) or microswitch 80 does operate (switch too short) a signal L is generated indicating that the switch failed the length test.

As a length test is performed on a reed switch in station two, a concentricity test is performed on another reed switch in station three to test whether or not the two leads of the switch are in exact alignment with one another. Because of the precise measurement required, another spring clip 82 is mounted on the underside of the restraining bar 56 to hold the reed switch down while in this station. Two air cylinders 84 located opposite one another on either side of the channel are operated (waveform 6) to extend their plungers 86 toward one another and the leads of the reed switch. Each plunger 86 has a small cavity in its face which aligns exactly with that of the other and engages a lead of the switch when fully extended to close a microswitch 88. If a lead does not align with the cavity of its respective

plunger 86, then it impedes the plunger travel so that the associated microswitch 88 will not operate. If either one or both microswitches 86 do not operate a signal CN is generated to indicate that the reed switch failed the concentricity test.

A high voltage breakdown test is performed on each reed switch in station four by applying a high voltage potential across its leads through two pairs of jaws 90 which are closed across the leads by the operation of air cylinders 92 (waveform 7). The high voltage breakdown test will be fully explained later.

The fifth station is adjacent a housing 94 which has a test coil (not visible) into which a reed switch is inserted for testing its various electrical operating characteristics. With the reed switch in station five an air cylinder 96 is operated (waveform 8) to slide the reed switch to the right into the test coil so long as the switch passed the first three tests (length, concentricity and breakdown). If the switch fails any one of the first three tests an inhibit signal IN is generated which prevents air cylinder 96 from operating by opening the signal path between the microswitch and its solenoid valve. Once inside the coil, air cylinders 98 are operated (waveform 9) to close two pairs of jaws 100 (only one pair visible) on the switch leads. One jaw of each pair 100 carries the test current for performing the electrical tests while the other jaw carries the current for measuring the results, with the jaws being insulated from each other to obtain more accurate measurements. An enable signal (waveform 10) is generated by the timer assembly which allows the electrical tests to take place and all of the test results to be processed and displayed as will be fully explained hereinafter. Although this signal does not operate any air cylinder it is supplied from the timer assembly and is included in the mechanical timing chart of FIG. 3 so that the reader can easily relate this period to the others in the overall test cycle (complete rotation of the cam shaft through 360°). Following the completion of the electrical tests the reed is pushed out of the test coil back into station five by the operation of air cylinder 102 (waveform 11).

A switch is deemed good if it meets all of the prescribed standards for all or the tests, in which case an air cylinder 104 adjacent to the sixth station is operated (waveform 12) to push the switch into an unloading chute 106 where it drops by gravity into a hopper below for receiving the good switches. The unload signal UN corresponding to waveform 12 is the only one in FIG. 3 which is not supplied from the timer assembly. This signal is supplied from the control panel which houses all the electrical circuitry for controlling the electrical and high voltage breakdown tests and for processing and displaying the test results. Since the control panel is fairly large, unlike the test head 30 which is compact, it cannot be easily mounted on or immediately adjacent to the reed switch manufacturing machine. Therefore it is located physically apart from the test head 30 and a cable having the requisite number of leads carries the various signals between the test head 30 and the control panel. The cable plugs into a connector block 107 mounted on the side of the test head 30, the connector block providing leads for passing control panel signals to and from the test head 30 as well as the timing signals from the timer assembly which is also physically isolated from the test head 30. If a switch fails any one of the tests the signal UN is not generated in the control panel and the air cylinder 104

therefore is not operated for that switch so that the switch is transported to the seventh station where an air cylinder 108 is operated (waveform 13) to push the bad switch into an unloading chute 110 where it drops into a different hopper below for receiving the bad switches.

The electrical test apparatus for performing the electrical and high voltage breakdown tests and for measuring the results thereof comprises any suitable solid state circuitry, preferably located in a box 112 mounted on the test head 30 itself to minimize noise and attenuation of the analogue test and measurement signals. The test apparatus which is shown schematically in FIG. 6 by general reference numeral 113 is controlled by digital signals generated in a test control logic circuit located in the aforementioned control panel. The high voltage breakdown test circuitry comprises a high voltage source 114 which generates a high voltage potential at its output in response to a signal HV(G) applied to its input from the test control logic circuit. This potential is applied across the leads of a reed switch while located in station four via the jaws 90 and a capacitor 116. A radioactive ionizing source 118 is located in the carrier bar 38 at station four to ionize the air gap of the reed switch from below to enable it to pass current under breakdown even though the switch is open. Because a relay 120 or other equivalent device is operated by the signal HV(G) at this time, its normally closed contacts 122 shunting the capacitor 116 are open so that capacitor 116 is free to charge up as current passes through it via the switch if breakdown should occur. A voltage comparator 124 is connected across the capacitor 116 to compare the developed voltage over a predetermined period with some minimum voltage which would indicate the flow of current and the occurrence of breakdown. When the minimum voltage is exceeded the voltage comparator 124 generates a signal VB (voltage breakdown) which is applied to a results control logic circuit in the control panel indicating that the reed switch failed the voltage breakdown test. Upon completion of this test the signal HV(G) is removed, thereby de-energizing the relay 120 which permits the contacts 122 to close and the capacitor 116 to discharge therethrough. Power for operating the high voltage and current sources is applied through a connector 123 on the test head 30 as shown in FIG. 2.

Five electrical tests are performed on a reed switch while in the test coil adjacent station five, these being:

1. Contact resistance — to ensure that the resistance of the switch when closed does not exceed some maximum allowable value.
2. Low gap — to ensure that the air gap is not so small that the switch operates (closes) before it is supposed to, e.g., at some predetermined value of magnetic flux produced by the test coil.
3. High gap — to ensure that the air gap is not so large that the switch cannot operate when it is supposed to, e.g., at a second predetermined value of magnetic flux produced by the test coil which is higher than the first value.
4. Hold — to ensure that the switch remains operated when it is supposed to, e.g., at a predetermined value of magnetic flux greater than the first value but less than the second value.

5. Release — to ensure that the switch releases when it is supposed to, e.g., at a fourth predetermined value of magnetic flux less than the first value.

The different currents necessary to provide the different values of magnetic flux in the test coil are provided by a magnetizing current source 126 whose current output I_M is a function of the magnitude of a signal MC (magnetizing current) applied to its input from the test control logic.

The test results are determined by applying a fixed current I_T to the leads of the switch from a test current source 128 in response to a signal TC (test current) from the test control logic. Since the current I_T is fixed, the voltage across the switch is directly proportional to its resistance when closed. A voltage comparator 130 whose input is connected across the switch compares the voltage across the switch with a first reference voltage which corresponds to the maximum resistance acceptable. If the measured voltage exceeds this reference voltage the comparator 130 generates a signal CR (contact resistance) indicating the switch resistance is excessive. The switch is considered to be open when the switch is in fact open or the switch resistance greatly exceeds the maximum acceptable resistance. The voltage comparator 130 provides a second reference voltage equal to the fixed current I_T multiplied by the greater value of resistance. Any time the measured voltage across the switch exceeds the second reference voltage, the comparator generates a signal CO (contacts open) rather than the signal CR.

Before going into the details of the logic circuitry in the control panel which controls the electrical test apparatus and the processing and displaying of test results it may be advantageous to consider the block diagram of FIG. 7 which shows the basic components of the control panel and traces the various signal paths. The test control logic 132 initiates all activity in the control panel in response to the enable signal (waveform 10 of FIG. 2) from the timer assembly. It generates the aforementioned three signals TC, MC and HV(G) which are applied to the electrical test apparatus 113 for controlling its operation. The results control logic 134 serves the very important function of monitoring the test results including relating the results of the switch tested to separate the good switches from the bad. Thus the failure signals VB, CR and CO from the electrical test apparatus 113 are fed into the results control logic 134, as well as the failure signals L and CN from the test head 30. To properly relate the test results to each of the switches, the timer assembly applies the enable and index signals to the results control logic 134 while the test control logic 132 applies various electrical test period (A-G) signals over individual leads. The test results are strobed by a signal TS from the test control logic 132 to minimize errors introduced by noise and spurious signals. The results control logic 134 applies the feedback control signals IN and UN to the test head 30 to respectively inhibit a reed switch from being inserted into the test coil if necessary and to unload the good switches at station six as explained earlier.

To immediately provide the operator with important feedback information for quality control the control panel displays the results of four tests of those reed switch characteristics which are controllable and may be altered by the operator by making appropriate adjustments on the manufacturing heads. These tests are for length, concentricity, low gap and high gap so that

the respective failure signals L, CN, LG and HG are fed from the results control logic 134 to a display unit 136 in the control panel. The display unit 136 provides a visual display of these failures for each switch in accordance with the manufacturing head on which the switch was produced so that the operator is directed to the appropriate head requiring adjustment. To relate the failures to the proper manufacturing head the display unit 136 receives a shift signal SH from the results control logic 134 and a display signal (DIS-G) from the test control logic 132.

As already mentioned the electrical and high voltage breakdown tests and all the test results (including those for length and concentricity) are processed and displayed during the enable period (waveform 10) of FIG. 3. The test control logic 132 which is shown in detail in FIG. 8 provides the signals MC and TC for controlling respectively the magnetizing and test currents applied by the electrical test apparatus for the electrical operating characteristics and in addition breaks the enable period into seven discrete periods A-G, five of which are used for the five electrical tests, and one for the high voltage breakdown test as shown by the signal waveforms in FIG. 9, the upper level of the waveforms representing the activating signal. Looking at FIG. 9, it is seen that the first period A within the enable period is devoted to the contact resistance test. During this period the magnetizing current I_M to the test coil is increased by the control signal MC from a value of zero to a high enough value MC1 to operate the reed switch inserted therein after which the current I_M is reduced to a constant level MC2 sufficient to hold the switch operated. With the switch operated at the constant level of current MC2, the test current I_T is applied to the switch leads to compare its contact resistance with that of the acceptable maximum. The period B is provided to first magnetically saturate the switch with a magnetizing current MC3 before reducing the magnetizing current to zero preparatory to performing the electrical operating tests. During period C the current I_M is increased from zero to a constant value MC4 which is not great enough to operate a reed switch having a gap equal to or greater than the minimum acceptable. Toward the end of the period the test current I_T is applied to the switch leads to determine whether or not the switch is operated, the generation of the signal CO by the voltage comparator 130 (FIG. 6) indicating that the switch did not operate. Operation of the switch during period C of course means that the switch failed the low gap test.

During period D the magnetizing current I_M is increased to a higher constant value MC5 which is sufficient to operate a reed switch having a gap equal to or less than the maximum gap acceptable. Toward the end of the period the current I_T is again applied to the switch leads. Operation of the switch during period D means that the switch passed the high gap test. During period E the magnetizing current I_M is increased to a peak value, MC6 to ensure the operation of the switch, then reduced to a constant value MC7 in between MC4 and MC5 to test the holding characteristic of the switch. At this constant value of magnetizing current MC7 the switch should remain operated. During period F the magnetizing current is reduced to a constant value MC8 which is less than MC4 and is not sufficient to maintain a normal switch operated and therefore, the switch should release.

Following the completion of the electrical operating tests the high voltage breakdown test is performed during period G. Since this test is performed at a different station than the foregoing tests it could be done simultaneously with those tests, but it is not to avoid introducing spurious signals, caused by the high voltage during the breakdown test, into the sensitive electrical operating test measurements which might otherwise produce inaccurate results. To further minimize the possible adverse effect of spurious signals and noise the test results are registered in the results control logic 134 only during the brief time slot at the end of each test period provided by the test strobe signal TS generated in the test control logic 132. To minimize the complexity of the circuitry in the test control logic 132 the periods A-G are formed with three different time periods, one for periods A and G, one for B and one for periods C-F.

The test control logic 132 of FIG. 8 comprises a binary counter 138 which counts down from any one of three different counts, each count corresponding to a different one of the three time periods just referred to. The output of the counter 138 is connected to a first decoder 140 which produces negative pulses on its output leads indicative of the count in said binary counter. The zero output of decoder 140 is fed back to the binary counter 138 to provide a load signal which enables the count to be entered and to a shift register 142 to provide a shift signal for shifting the positive output signal of the register 142 from lead to lead. The output leads of shift register 142 provides the seven periods A-G as well as the information for entering the counts in binary counter 138. Whenever the output signal of register 142 is applied to leads A or G in the presence of the load signal, an OR gate 144 enters a count in binary counter 138 corresponding to the time period for periods A and G meaning that the time it takes for the counter 138 to count down to zero is equivalent to said time period. Whenever the output signal of register 142 is applied to lead B in the presence of the load signal it is also applied to the binary counter 138 to load a corresponding count therein. The binary counter 138 is programmed so that if no signal is applied thereto in the presence of a load signal it automatically selects a count equivalent to the third time period for periods C-F.

When the enable signal is applied by the timer to the shift register 142 and binary counter 138 (the decoder 140 output is on zero at this time), the shift register output is applied to its A lead loading a corresponding count in the counter 138 which then begins counting down to zero in response to the clock pulses. When zero is reached the negative pulse on the zero output of decoder 140 causes the output of register 142 to shift to its B lead while a corresponding count is loaded into the counter 138. Once again the counter 138 counts down to zero after which the output of register 142 shifts to its C lead loading a corresponding count in the counter 138. The process is repeated until all seven periods A-G have been generated at which time the enable signal is removed inhibiting the shift register 142 and binary counter 138.

The test strobe signal TS is obtained from the Q output of a flip-flop 145 whose reset input R is connected to the zero output of decoder 140 and whose set input S is connected to another output 146 of decoder 140 corresponding to any suitable count for providing the

desired strobe period. Toward the end of each of the seven periods A-G, as the counter 138 counts down the count reaches a point whereby output 146 generates a negative pulse setting flip-flop 145 to initiate the test strobe pulse TS. When the count of zero is reached the negative pulse on the zero output of decoder 140 resets flip-flop 145 terminating the test strobe period.

By a similar technique the test current signal TC is generated for enabling the flow of current I_T during the strobe period for performing the measurements to obtain the results for the electrical operating characteristics. A flip-flop 148 has its reset output R connected to the zero output of decoder 140 while its set input S is connected to an output 150 which corresponds to a slightly higher count than output 146 so that the test current I_T is already present when the test strobe signal TS is generated. The signal TC is obtained from the Q output of flip-flop 148 through an OR gate 152 for the periods C-F. During period B when no test current is required the signal is inhibited by connecting the output of OR gate 152 to the B output of shift register 142 through an inverter 154. The longer period of test current I_T required during period A for the contact resistance test is provided by enabling OR gate 152 from a second input which will be explained shortly.

The signal MC for controlling the magnitude of magnetizing current I_M is provided through a digital-/analogue converter 154 whose output at any time is of course a function of the magnitude of the input digital signal and whose rate of change is a function of the speed of the counter driving it, the change being in the same direction in which the counter is counting (up or down). This affords a simple and convenient control for providing the various ramp and constant current levels which constitute the magnetizing current I_M . The input to the D/A converter 154 is derived from an up/down binary counter 156 whose output is also connected to a decoder 158 which has a number of output leads each of which corresponds to a different count in the counter 156 for generating positive pulses to provide the different current levels for the magnetizing current I_M . When the enable signal from the timer is applied to the counter 156 it immediately starts counting up from zero in response to the clock pulses applied thereto. The count may be stopped at any point in response to a stop signal from an OR gate 160 having five input leads for enabling the gate, each during a different one of the seven periods A-G, with the exception of periods B and G. The count may also be reversed from up to down by a count-down signal generated by the Q output of a flip-flop 162 when set in response to the output of a NOR gate 164 having two inputs. At the end of each enable period the flip-flop 162 is automatically reset via a NOR gate 166 having one of its inputs connected to receive the enable signal through an inverter 168. Thus at the beginning of the next enable period flip-flop 162 is reset and the count down signal is not generated so that the binary counter 156 begins its operation by counting up.

During period A when the counter 156 reaches a count corresponding to MC1, the MC1 output of decoder 158 together with the A output of register 142 enables an AND gate 170 to generate a signal which is applied to one of the inputs of NOR gate 164 to enable it to pass a signal for setting flip-flop 162. The binary counter now begins immediately counting down until it reaches a count corresponding to MC2, at which time

the MC2 output of decoder 158 together with the A output of register 142 and the high output of flip-flop 162 (now in the set state) fully enables an AND gate 172 to generate a signal which causes OR gate 160 to generate the stop signal. The counter 156 is thus stopped at the MC2 count and remains at this count for the duration of period A. The output of AND gate 172 is also fed back to the second input of OR gate 152, as previously alluded to, for providing the TC signal and thus the test current I_T also for the duration of period A.

At the termination of period A, the shift register 142 output appears on lead B thereby partially disabling AND gate 172 removing the stop signal applied to the counter 156. The B output of register 142 is applied continuously as a load signal via one input of an OR gate 173 to counter 156 which is programmed in the absence of any other loading inputs to jump to a count corresponding to MC3. A flip-flop 174 is provided for changing the magnetizing current I_M to zero at the appropriate time during period B. The Q output of flip-flop 174 when set, together with the B output of register 142 fully enables an AND gate 176 to enter a count of zero in counter 156. The flip-flop 174 has its set input S connected to an output 175 of the decoder 140 corresponding to the time at which I_M is to go from MC3 to zero, with its reset input R connected to the zero output of decoder 140.

The B output of register 142 is also connected to the second input of NOR gate 166 to reset flip-flop 162 at the beginning of the B period. Consequently, when period C begins the counter 156 begins counting up from zero (the load signal provided by B is also removed at this time). At a count corresponding to MC4, the MC4 output of decoder 158, together with the C output of register 142 enables an AND gate 178 to once again cause OR gate 160 to generate the stop signal freezing the count of counter 156 at that level for the duration of period C. During period D the counter 156 continues to increase its count until that corresponding to MC5 whereupon the MC5 output of decoder 158 together with the D output of register 142 enables an AND gate 180 to once again stop the count for the duration of period D.

In period E the counter begins counting again until a count corresponding to that of MC6 whereupon the MC6 output of decoder 158 which is connected to the second input of NOR gate 164 enables gate 164 to set flip-flop 162, changing the count to the down direction. At a count corresponding to MC7, and AND gate 182 is fully enabled (by outputs E and MC7) to stop the count for the duration of period E.

During period F the count progresses downward until that corresponding to MC8 where it remains for the duration of the period as a result of enabling an AND gate 184. During period G the count of counter 156 is maintained at zero by generating the load signal once again from the output of OR gate 173 through a second input connected to the G output of register 142 (recalling that the counter 156 is programmed to load a count of zero in the absence of any information to the contrary). The G output of register 142 is applied to the display unit 136 for control purposes to be explained below. All of the outputs A-G of register 142 are applied to the results control logic 134 for control purposes which will now be explained.

The results control logic 134 of FIG. 10 includes five flip-flops, each one being provided for storing the information for the results of a different one of the five electrical tests of the reed switch. Any time that a flip-flop is set it indicates that the particular reed switch failed the electrical test associated therewith. For instance, a flip-flop 186, which monitors contact resistance has its Q output connected to a counter 188 to count each time flip-flop 186 is set, or in other words the number of reed switches failing the contact resistance test. This information is not displayed for the immediate feedback benefit of the operator since he has no control over the manufacturing machine with regard to this characteristic. Flip-flops 190 and 192, which monitor the low gap and high gap tests respectively have their Q outputs connected to the display unit 136 for immediate feedback control purposes. Like the contact resistance characteristic, the hold and release characteristics are not under the control of the operator so that the outputs of flip-flops 194 and 196, which monitor these two tests respectively, are not connected to the display unit 136. The Q outputs of all five flip-flops 186-196 are connected to an AND gate 198 whose output provides a signal anytime that a reed switch fails at least one of the electrical tests. The reset inputs R of these flip-flops are all connected to receive the enable signal so that those flip-flops set during the enable period are reset at the end of the period preparatory to the testing of the next switch.

The output A of register 142 is connected to a NAND gate 200 to partially enable said gate during period A to set flip-flop 186. The gate 200 is fully enabled by a signal on its second input which is derived from an AND gate 202 during the application of the test strobe signal TS to one of its inputs while the signal CR is applied to its other input. The CR signal is, of course, generated by the voltage comparator 130 in the electrical test apparatus 113 only if the reed switch failed the control resistance test.

The flip-flops 190-196 are all controlled during their respective periods C-F by the signal CO which indicates that the reed switch under test is operated (closed). Flip-flops 190 and 196 are set to indicate failure of the respective tests, low gap and release, if the signal CO is present (switch closed) while flip-flops 192 and 194 are set to indicate failure of their respective tests, high gap and hold if the signal CO is not present (switch open). An AND gate 204 is fully enabled by the signals TS and CO applied to its inputs. The output of AND gate 204 is connected to the S inputs of flip-flops 190 and 196 via NAND gates 206 and 208 respectively. Consequently when AND gate 204 is fully enabled during period C, (low gap test) the output C of register 142 applied to the second input of gate 206 fully enables said gate to set flip-flop 190. Similarly fully enabling AND gate 204 during period F (release test) sets flip-flop 196.

The output of AND gate 204 is passed through an inverter 210 and then applied to the S inputs of flip-flops 192 and 194 via NAND gates 212 and 214 respectively. Consequently when AND gate 204 is disabled during period D, NAND gate 212 is fully enabled by the output of gate 204 and the D output of register 142 to set flip-flop 192. Similarly NAND gate 214 is fully enabled during period E to set flip-flop 194 when AND gate 204 is disabled.

Because the operator also has no control over the high voltage breakdown characteristic, the results of this test are not displayed but merely monitored by a counter 216 which counts the number of failures via Q output of a flip-flop 218 which stores the information. Flip-flop 218 is set in response to the signal VB indicating a failure which is applied to an input of a NAND gate 220 that is fully enabled during the G period in the presence of the test strobe via an AND gate 222. Flip-flop 218 is reset each time at the end of the enable period.

The signals L and CN from the test head indicating length and concentricity failures are applied to two NAND gates 223 and 224 respectively which are partially enabled during period A in the presence of the test strobe via an AND gate 226. Their outputs are connected to the S inputs of two flip-flops 228 and 230 respectively for setting these when fully enabled. The Q outputs of flip-flops 228 and 230 are connected to the display unit 136 for displaying the results of the length and concentricity tests to provide immediate feedback information to the operator.

A shift register 232, comprising five flip-flops, is used to determine if a switch is good or bad by simultaneously receiving the test results for the switches in test stations two through five of the test head 30 and shifting the information from flip-flop to flip-flop in synchronism with the movement of the switches. For instance, the first flip-flop 234 has its CD (clear direct) input connected to the output of NAND gate 223 so that a negative pulse indicating a length failure for the switch in station two resets flip-flop 234 causing a low signal to appear at its Q output. Similarly a flip-flop 236, which has its CD input connected to the output of NAND gate 224, is reset by a negative pulse indicating a concentricity failure for the switch in station three. A flip-flop 238 has its CD input connected to the $\bar{Q}$ output of flip-flop 218 to receive a reset signal therefrom for failure of the high voltage breakdown test by a switch in station four. A flip-flop 240 has its CD input connected to the output of AND gate 198 to receive a reset signal therefrom for failure of any one or more of the electrical tests by a switch while in the test coil adjacent station five. A flip-flop 242 provides a signal at its Q output indicating whether the switch in station six is good or bad, a high signal indicating good and a low signal indicating bad.

Each flip-flop of register 232 has its Q output lead connected to the D input lead of the next flip-flop (to the right) so that when toggled by a negative going pulse on its T input its Q output is transferred to the following D input. The toggle signal is supplied from the Q output of a flip-flop 244 which is reset each time the machine indexes by applying to its reset input R through an inverter 246, the raise carrier signal (waveform 1 of FIG. 3) and is set at the beginning of the enable period by applying the enable signal to its set input through an inverter 248. Thus as a switch moves from one station to the next the information for it is passed from one flip-flop to the next. As soon as a switch fails a test the flip-flop of register 232 associated with that test is reset and the low signal of the Q output is thereafter shifted from flip-flop to flip-flop as the switch moves from station to station until it arrives at station six. If the switch passed all of the tests then the high Q output of flip-flop 242, indicating a good switch, together with the enable signal fully enables an AND gate

250 to generate the unload signal Un applied to air cylinder 104 to enable it to push the switch in the good switch hopper. A low Q output of flip-flop 242, indicating a bad switch, disables AND gate 250 inhibiting the signal UN so that air cylinder 104 is not operated, thereby permitting the switch to be transported to station seven where it is unloaded in the bad switch hopper. A counter 252 is connected to the output of AND gate 250 of monitor the number of good switches tested by registering the number of high signal pulses received.

A flip-flop 254 has its D input connected to the Q output of flip-flop 238 to provide the inhibit signal IN which is applied to the test head 30 to inhibit air cylinder 96 from pushing a switch located in station five into the test coil if it failed any one of the first three tests (length, concentricity or high voltage breakdown). As such a switch is moved from station four to station five the low Q output of flip-flop 238 is transferred to the Q output of flip-flop 254 upon toggling so that the signal IN will be present when the switch arrives in station five. Although air cylinder 96 is actually controlled from the timer assembly for timing purposes the path for the signal may be easily opened in one of many different ways, such as by a relay which is responsive to the signal IN.

The display unit 136 in the control panel for displaying the reed switch test results comprises a matrix array of lamps 256, each having its own associated logic circuitry 258 for energizing the light as shown in FIG. 11. Each column consists of four lamps for each one of the N plurality of machine manufacturing heads (the machine head being identified by numbers at the top of each column) while each row corresponds to one of the four tests selected for display, namely length (L), concentricity (CN), low gap (LG) and high gap (HG). Each lamp is operated when a switch manufactured on the head corresponding to its column fails the test corresponding to its row. Each of the four failure signal leads from the results control logic is connected to all of the logic circuits 258 associated with that particular row of lamps. The display unit 136 further comprises a ring counter 260 having N output leads with each lead being connected to four logic circuits 258, one in each row in such a manner so as to control the lighting of the proper lamp for the proper switch and test. Bearing in mind that the results of the length test for a switch in station two, the concentricity test for a switch in station three and the low gap and high gap tests for a switch adjacent station four are received simultaneously and the reed switches are received in the test head from the machine head in increasing numerical sequence, it may be appreciated that the proper lamps will always be lighted by connecting each output lead of counter 260 to a logic circuit 258 in a given column in the first row (L), the logic circuit 258 in the first column preceding said given column in the second row (C) and the logic circuits 258 in the third column preceding said given column in the third (LC) and fourth (HG) rows. The control signal of counter 260 is shifted from one output lead to the next by a shift signal SH received from the Q output of flip-flop 244 in the results control logic 134 when set at the beginning of each enable period.

Each logic circuit 258 is seen to contain two flip-flops 262 and 264, a NAND gate 266 for providing a toggle signal, an AND gate 268 for passing the test informa-

tion and an AND gate 270 for energizing the lamp 256 when fully enabled by both its inputs to indicate a test failure. For the moment assume that flip-flop 264 is maintained in a set state by the application of a display each failure signal to its DS input so that its Q output is high and AND gate 270 is partially enabled and that furthermore flip-flop 262 is in a reset state. The AND gate 270 is then fully enabled when flip-flop 262 is set (Q output high) which will occur upon toggling if AND gate 268 is fully enabled when the control signal from counter 260 is applied to its input in the presence of a failure signal on its other input, the failure signal corresponding to the row for that particular logic circuit. The toggle signal is supplied each time during period G by the G output of register 142 in the test control logic 132 in the presence of the control signal from counter 260. Once lit the lamp 256 remains lit until AND gate 270 is disabled which will occur only when flip-flop 262 is reset during some subsequent toggle period by a low output from AND gate 268, which is disabled by the absence of a failure signal for some later tested switch. In other words once a lamp 256 for a particular machine head operates to indicate a particular test failure it remains operated until some following switch produced on that same machine head passes that particular test. By looking at the lamps for each machine head, the operator knows at a glance which of the four controlled characteristics for each machine head needs adjustment.

To aid the operator in deciding whether or not to make adjustments it may be desirable to convey such a need by operating a lamp 256 only if two successive switches from the corresponding manufacturing head fail the same test rather than each time a switch fails that test. It will be readily seen that such will be the case when the display each failure signal is removed from flip-flop 264 by the operator pushing a button on the display panel. The test failure of the first switch sets flip-flop 262 while the test failure of the next switch sets flip-flop 264 to fully enable AND gate 270.

It may now be readily appreciated that the unique transport assembly used for transporting the reed switches from station to station together with the mechanical test movements employed in the reed switch analyzer result in a test head which is compact and so designed that it may be added to or removed from the manufacturing machine quite easily and conveniently without interfering with production output. This is so because no direct mechanical linkage interconnect the test head with the manufacturing machine so that the latter need not be stopped to permit adding or removing the former. Synchronism between the two is provided by the timer assembly which is mechanically linked to the manufacturing machine but is electrically linked to the test head so that to disengage the test head it is only necessary to remove the connector cable without stopping the machine. The connector cable also carries the control and display digital signals to and from the control panel so that the equipment therein need not encumber the manufacturing machine. Thus the reed switch analyzer of this invention is able to separate good switches from the bad as they are received from the manufacturing machine without any human intervention while at the same time providing immediate feedback information to the machine operator for quality control purposes. The specific embodiment described herein is intended to be merely illustrative and

not restrictive of the invention since various modifications thereto may be readily apparent to those familiar with the art without departing from the scope and spirit of the invention as set forth in the claims hereinbelow.

What is claimed is:

1. A transport assembly for moving reed switches or the like from station to station comprising:
 - a housing having an open channel formed in a horizontal surface thereof with support notches located opposite one another on either side of the channel spaced along the channel, each pair of oppositely placed notches defining a station in which a reed switch is to be received;
 - a carrier bar positioned within the channel which is free to move vertically or horizontally relative thereto, said carrier bar having notches along its length which align with said pairs of support notches while said bar is in a level position relative to the channel surface and in a normal position relative to the channel length;
 - a transport member for moving said bar, including raise means which is activated to raise said bar from the level position so that the undersides of any reed switches received in the notches thereof clear the top of said support notches, lower means which is activated to lower said bar below the level position so that the top surface of the bar clears the undersides of the reed switches received in said support notches and sliding means which is activated to advance said bar horizontally so that each of said bar notches are advanced to the next pair of support notches and is deactivated to return said bar

to the normal position, and timing means for controlling said transport assembly in the following cyclical sequence: 1) activate said raise means, 2) activate said sliding means, 3) deactivate said raise means and activate said lower means, 4) deactivate said sliding means and 5) deactivate said lower means.

2. The transport assembly of claim 1 wherein each of the transport assembly means includes a pneumatic device which is responsive to electrical signals from said timing means.

3. The transport assembly of claim 2 wherein the generation of electrical signals by said timing means is mechanically controlled by a cam shaft adapted to be synchronized to and driven by a machine used for producing the reed switches.

4. The transport assembly of claim 2 wherein said pneumatic devices are air cylinders controlled by solenoid valves.

5. The transport assembly of claim 4 wherein said sliding means includes a slider connected to the piston rod of an air cylinder and a horizontal guide for restricting the slide to horizontal movement.

6. The transport assembly of claim 5 wherein said transport member includes a horizontal plate situated below said slider and the air cylinder of said lower means is affixed to said slider while its piston rod is affixed to said plate for lowering said plate when activated and said raise means comprises two air cylinders affixed to said plate while their piston rods are affixed to said carrier bar for raising same when activated.

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