

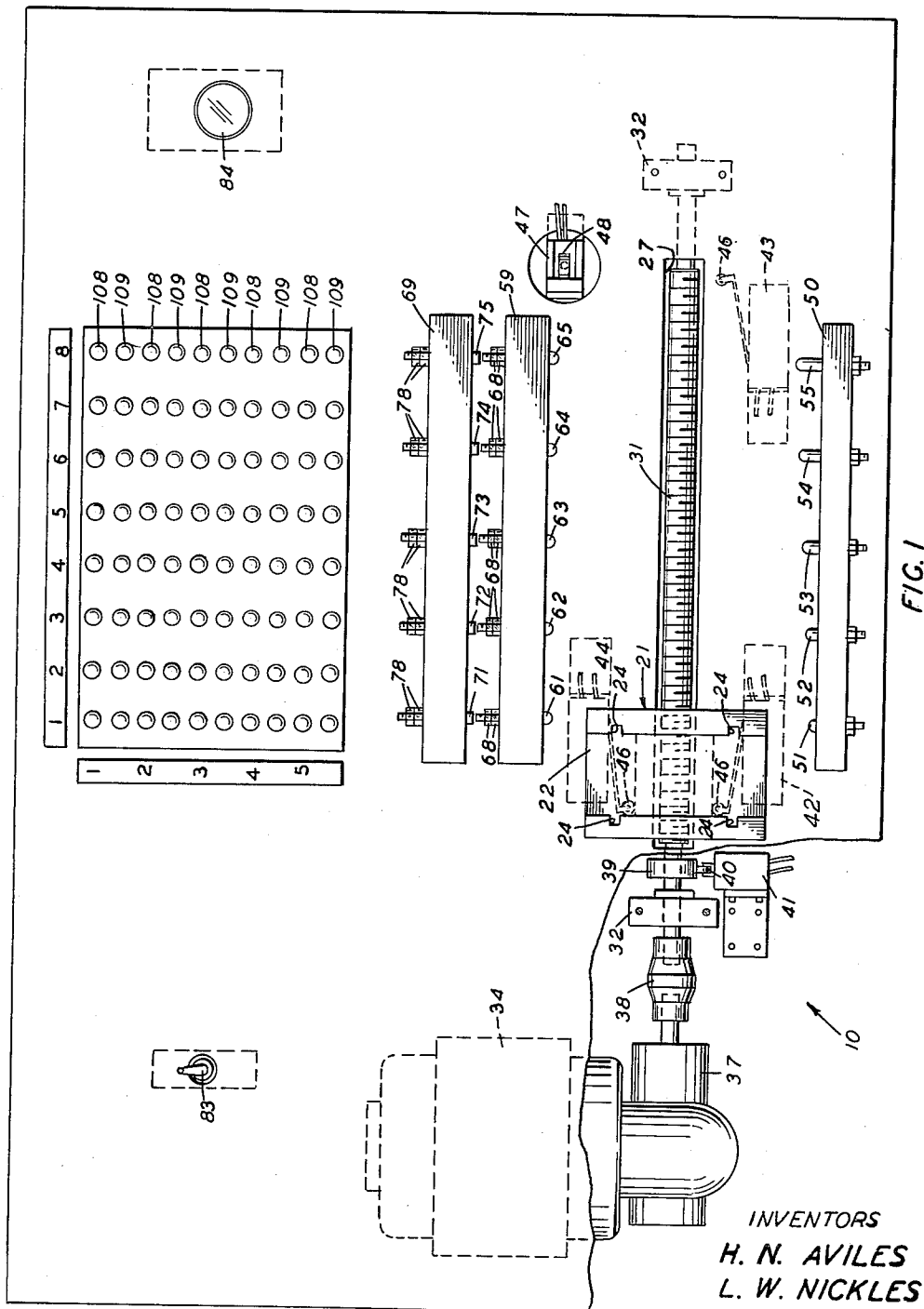
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H. N. AVILES ET AL
GAUGING APPARATUS

3,061,937

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3 Sheets-Sheet 1



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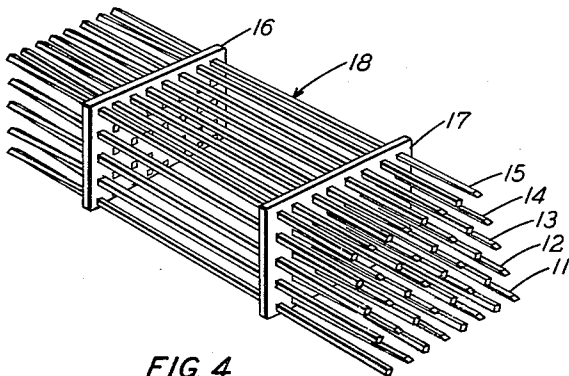
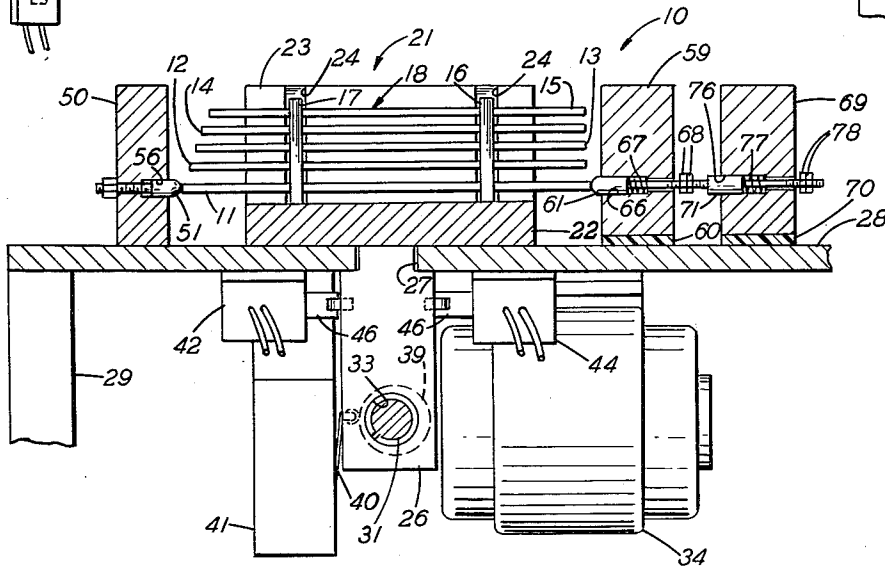
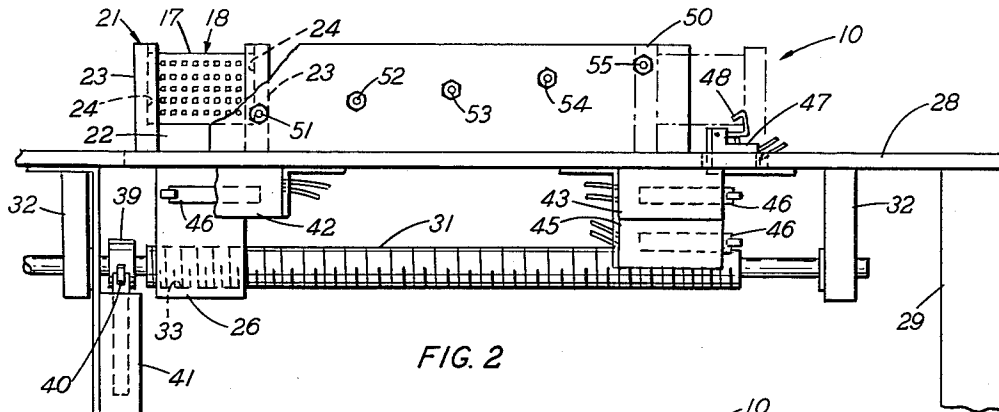
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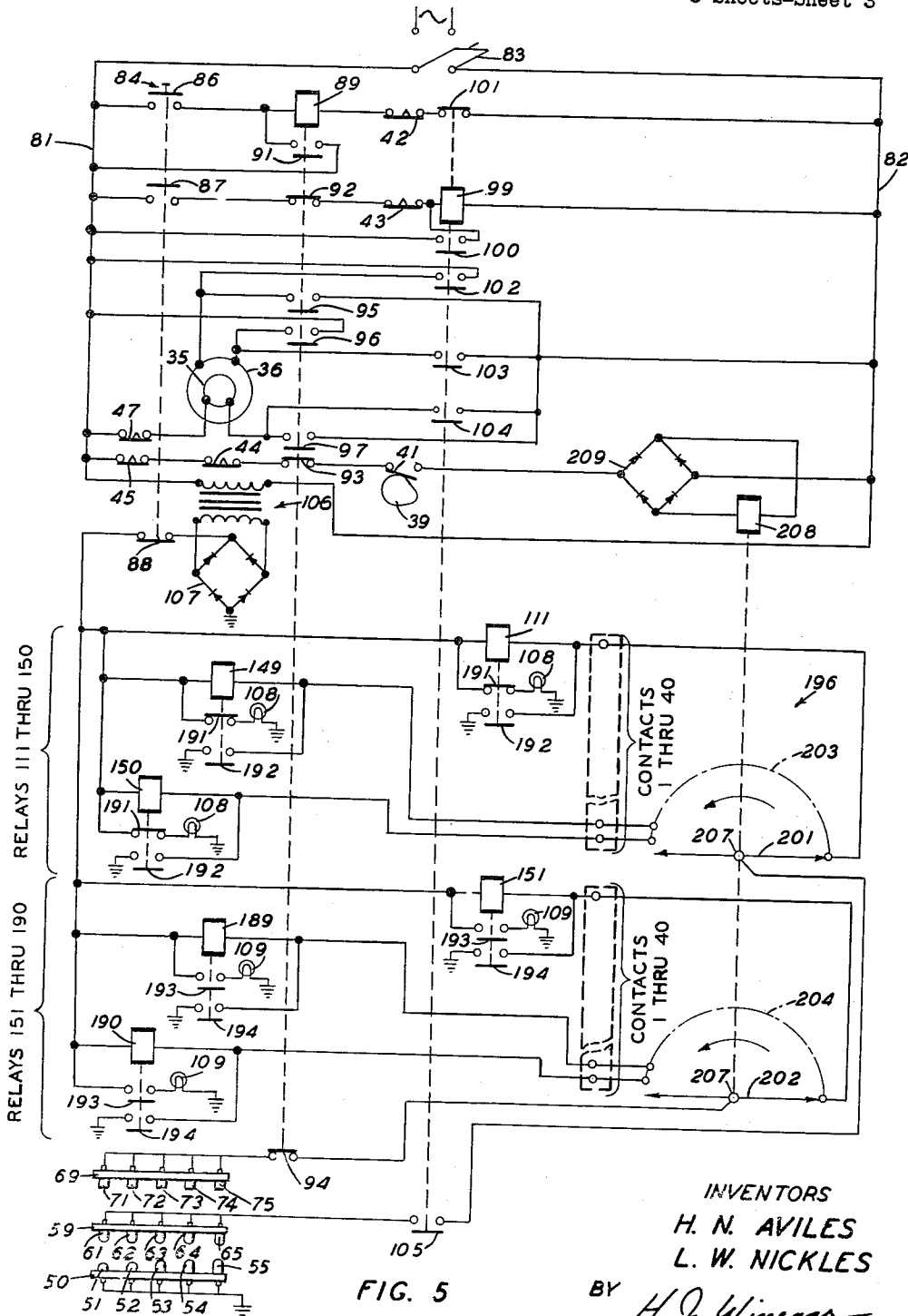
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3 Sheets-Sheet 3



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3,061,937

GAUGING APPARATUS

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8 Claims. (Cl. 33-174)

This invention relates to gauging apparatus and more particularly to apparatus for gauging the lengths of elongated rods, such as metal terminals of a terminal strip subassembly, and for indicating whether the gauged lengths correspond to specified standards.

Certain types of terminal strips used in telephone equipment are formed by imbedding a plurality of elongated metal terminals in a block of plastic insulating material. In accordance with one method of manufacturing terminal strips, axially pretwisted wire terminals having rectangular cross sections are inserted through complementary apertures in a pair of spaced, plastic, insulating end plates to form a terminal strip subassembly. The portions of the terminals between the end plates of the terminal strip subassembly are then imbedded in a block of plastic insulating material to form a terminal strip. A terminal strip subassembly of this type is disclosed in U.S. Patent 2,855,651, issued on May 5, 1959, to L. V. Moeller.

The terminal strip subassembly described in the above-identified patent contains several rows of axially pretwisted terminals, the individual rows containing terminals of substantially the same length. Methods of and apparatus for making terminal strip subassemblies having several rows of terminals, the individual rows of which have terminals of substantially the same length, but of lengths different from the lengths of terminals in the other rows, are disclosed in copending application, Serial No. 753,724, filed on August 7, 1958, in the name of L. J. Moeller.

During the assembly of terminals with end plates by the above-mentioned methods and apparatus, the pretwisted terminals of various lengths are threaded through a plurality of rows of aligned apertures in a pair of juxtaposed end plates. The end plates are then separated by keeping one plate stationary and moving the other plate axially of the terminals so that the pretwisted terminals and the end plates are locked together to form a self-contained unit. During the assembly, the ends of the terminals adjacent to one end plate abut a stepped terminal stop. The stop holds the terminals during the movement of one of the end plates axially thereof, so that the ends of rows of the terminals form a stepped configuration, wherein individual rows form individual steps complementary to the steps of the terminal stop. The steps of the terminal stop and lengths of the terminals in the various rows are so selected that the opposite ends of the terminals adjacent to the other end plate lie substantially in a common plane.

To provide for certain factors, such as a normal wear or misalignment of terminal strip subassembly manufacturing apparatus, for example, of a terminal shearing mechanism, the lengths of the terminals are provided with maximum and minimum tolerances. Because of these tolerances, the lengths of terminals in any one row of a terminal strip subassembly and, therefore, the extent to which opposite ends of terminals protrude from the respective end plates, may vary within the tolerance limits without rendering the terminal strip subassembly unacceptable.

After the assembly of such terminal strip subassemblies it is desirable to check the lengths of the terminals to eliminate the possibility of production of terminal

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strip subassemblies, which might have some, or even all, terminals, having lengths exceeding the predetermined tolerance limit conditions. It is also desirable to check to determine whether the terminals, even though of proper length, are displaced longitudinally relative to the end plates sufficiently to produce terminal strip subassemblies opposite ends of terminals of which are so displaced as to correspond to the ends of the terminals having lengths exceeding the tolerance limit conditions. It is, therefore, desirable to provide apparatus for gauging the lengths of each individual terminal in each row of each representative terminal strip subassembly being checked from time to time during the manufacture thereof and for indicating whether individual terminals meet with the specified standards.

It is an object of this invention to provide new and improved gauging apparatus.

It is another object of this invention to provide new and improved apparatus for gauging the lengths of individual terminals in a row of terminals and for indicating whether the gauged lengths of the individual terminals comply with specified standards.

An apparatus illustrating certain features of the invention may include a pair of electrically conductive, axially aligned probes, one of the probes being mounted for axial movement relative to the other probe. Resilient means are provided for normally urging the movable probe to a position wherein one end of the movable probe is spaced from the adjacent end of the other probe a predetermined distance equal to a desired minimum dimension of an electrically conductive article to be gauged. An electrically conductive contact member is axially aligned with the probes and spaced a second predetermined distance from the opposite end of the movable probe, the second predetermined distance being infinitesimally greater than an allowable tolerance in the dimension to be gauged. Also provided are a source of E.M.F. and first indicating circuit means connected to the probes and arranged to be completed and electrically energized from the source of E.M.F. when an electrically conductive article having at least the desired minimum dimension is properly positioned between and in axial alignment with the probes and with one end of the article in contact with the other probe. Energization of the first indicating circuit means gives an indication that the dimension of the article is equal to at least the desired minimum. Second indicating circuit means, connected to the probes and the contact member, are arranged to be completed and electrically energized from the source of E.M.F. when the dimension of the article being gauged exceeds the desired predetermined minimum by an amount infinitesimally greater than the allowable tolerance and the movable probe is caused to engage the contact. Energization of the second indicating circuit means gives an indication that the dimension of the article exceeds the desired minimum by more than the allowable tolerance.

Other objects and advantages of the invention will be apparent from the following detailed description of a specific embodiment thereof, when read in conjunction with appended drawings in which:

FIG. 1 is a top plan view of gauging apparatus embodying certain features of the present invention with parts thereof broken away for clarity;

FIG. 2 is a fragmentary, front elevation of the gauging apparatus of FIG. 1 with parts thereof broken away for clarity;

FIG. 3 is an enlarged, vertical section of the gauging apparatus of FIG. 2 looking from the right side of the apparatus to the left, with parts broken away for

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clarity and illustrating parts thereof in an operative gauging position;

FIG. 4 is a perspective view of a terminal strip subassembly with portions of terminals broken away for clarity, and

FIG. 5 shows a schematic diagram of an electrical circuit forming a part of the gauging apparatus.

Referring now to the drawings, and particularly to FIG. 1 thereof, there is shown gauging apparatus, designated generally by the numeral 10. The gauging apparatus 10 is designed for gauging the lengths of individual, electrically conductive, noncircular, pretwisted metal wire terminals 11—11 to 15—15, inclusive, positioned in a predetermined array in noncircular apertures in a pair of plastic end plates 16 and 17 of a terminal strip subassembly, designated generally by the numeral 18 (FIGS. 2, 3 and 4). The gauging apparatus 10 is also designed to indicate whether the gauged lengths of individual metal terminals 11—11 to 15—15, inclusive, satisfy predetermined tolerance conditions, i.e. whether the lengths of the gauged terminals correspond to predetermined standard lengths. The terminals 11—11 to 15—15, inclusive, which are of predetermined graduated lengths, are supported in the end plates 16 and 17 in five rows, each row comprising eight terminals spaced uniformly in parallel relationship to each other and locked against axial movement relative to the end plates. As is shown in FIGS. 3 and 4, the terminals 11—11 to 15—15, inclusive, in each discrete row are aligned vertically with the corresponding terminals in any other row of the terminal strip subassembly. The terminals 11—11 to 15—15, inclusive, in any discrete row are of substantially equal lengths, but of different lengths than the terminals in the next row. For example, the terminals 11—11 are the longest, and the terminals 15—15 are the shortest, with terminals 12—12, 13—13 and 14—14 of intermediate, uniformly decreasing lengths spaced therebetween.

It is desirable that the ends of all of the terminals 11—11 to 15—15, inclusive, adjacent to the end plate 16 normally protrude substantially equal distances beyond the outer face of the latter, while the ends of the terminals in individual rows thereof adjacent to the end plate 17 normally protrude respective substantially equal distances beyond the outer face of the end plate 17 to form a stepped configuration as best illustrated in FIG. 4.

The gauging apparatus 10 includes a carriage, designated generally by the numeral 21, having a base 22 and a pair of upstanding sides 23—23. The sides 23—23 are provided each with a pair of spaced grooves 24—24 which extend in a direction perpendicular to the base 22. The grooves 24—24 are designated to receive therein side portions of the end plates 16 and 17 of a terminal strip subassembly 18 to be gauged to properly position each terminal strip subassembly relative to the carriage 21. The grooves 24—24 are of sufficient width to allow limited movement of the end plates 16 and 17 laterally thereof, and, therefore, of the terminal strip subassembly 18 laterally of the carriage 21 in the event that the terminal strip subassembly will have some or all of the terminals 11—11 to 15—15, inclusive, displaced longitudinally thereof relative to the end plates 16 and 17. The width of the grooves 24—24 is such, that the terminal strip subassembly 18 may move laterally of the carriage 21 a distance equal to twice the difference between the maximum and the minimum acceptable lengths of any of the terminals 11—11 to 15—15, inclusive.

A terminal strip subassembly 18 to be gauged is inserted in the carriage 21 in a position such that the shortest terminals 15—15 are at the top, that is, farthest from the base 22. The carriage 21 is provided with a dependent portion 26 (FIGS. 2 and 3) which extends through an elongated slot 27 formed in a top plate 28, supported by supports 29—29. An elongated, threaded shaft 31 is mounted rotatably by a pair of brackets 32—32

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underneath the top plate 28, parallel to the slot 27 and extends at least the entire length thereof. The dependent portion 26 of the carriage 21 is provided with a threaded aperture 33, which threadedly receives the shaft 31 so that rotation of the shaft 31 is transformed into a linear movement of the carriage 21 longitudinally of the slot 27.

A split-phase, reversible motor 34, having windings 35 and 36 (FIG. 5), and an associated gear reduction unit 37, is connected by means of a coupling 38 to the threaded shaft 31. When the windings 35 and 36 of the motor 34 are energized, the motor causes rotation of the threaded shaft 31 in one or the other direction, depending on the direction of electric current in the winding 36. Accordingly, depending on the direction of rotation of the threaded shaft 31, the carriage 21 is moved from its original loading position, shown in solid lines in FIGS. 1 and 2, to an unloading position shown in phantom lines in FIG. 2, or vice versa. The pitch of the thread on the threaded shaft 31 is so selected that, when the threaded shaft makes one complete revolution, the carriage 21 moves a distance equal to one space between two adjacent terminals in any row of a terminal strip subassembly 18 being gauged.

A cam 39 is mounted fixedly on the threaded shaft 31. Once during each complete revolution of the threaded shaft 31, the cam 39 actuates an actuating arm 40 of a normally open limit switch 41. Mounted adjacent to the path of travel of the carriage 21 are normally closed limit switches 42 to 45, inclusive, provided with actuator arms 46—46, and a limit switch 47 provided with an actuator arm 48. The dependent portion 26 of the carriage 21 strikes the actuator arms 46—46 of the switches 42 and 44 when the carriage 21 approaches its loading position and strikes the actuator arms 46—46 of the switches 43 and 45 when the carriage 21 approaches its unloading position, to close the respective switches. Opening of either of the switches 42 and 43 causes deenergization of the windings 35 and 36 of the motor 34 to stop the carriage 21. Either of the switches 44 and 45, when opened, interrupts the circuit of the switch 41 so as to render the actuation of the switch 41 by the cam 39 ineffective.

The switch 47 is secured to the top plate 28 in such relationship to the carriage 21 that, when the last of the terminals 11—11 to 15—15, inclusive, has been gauged and the carriage is in the unloading position, the first of the terminals 11—11 of the terminal strip subassembly 18 carried by carriage 21 will depress the actuating arm 48 of the switch 47. When the actuating arm 48 is depressed the switch 47 is opened to interrupt the circuit including the winding 35 of the motor 34, so as to prevent reverse movement of the carriage 21 until the gauged terminal strip subassembly 18 is removed from the carriage. The operation and electrical relationship of the switches 41 to 45, inclusive, and 47 is described hereinafter in connection with the electrical circuit and for the operation of the apparatus.

Positioned parallel to and on one side of the path of travel of the carriage 21 is a probe-mounting member 50 made of suitable material, such as steel. The probe-mounting member 50, which is secured fixedly to the top plate 28, in parallel, spaced relation to the slot 27, is provided with five electrically conductive probes 51 to 55, inclusive. Each of the probes 51 to 55, inclusive, which is in the form of a stepped, cylindrical pin having a rounded nose and a reduced, threaded portion at opposite ends thereof, is positioned adjustably, by means of threads, in stepped bores 56—56. The individual probes 51 to 55, inclusive are mounted along the probe-mounting member 50 at different heights above the top plate 28. The respective probes 51 to 55, inclusive, are mounted relative to the top plate 28 in a manner such that the heights of different probes correspond to the heights of the respective rows of terminals 11—11 to 15—15, inclusive, of the terminal strip subassembly 18 positioned in the carriage 21. The probes 51 to 55, inclusive, are

so positioned vertically relative to the top plate 28 and are so adjusted axially relative to the slot 27, that the probes protrude various predetermined, graduated distances from the probe-mounting member 50 toward the slot 27 so as to form a stepped configuration, substantially complementary to the stepped configuration of the rows of terminals 11—11 to 15—15, inclusive.

Further, the probes 51 to 55, inclusive, are uniformly spaced horizontally of the probe-mounting member 50 so that the horizontal distances between the longitudinal axes of any two consecutive probes are equal to eight spaces between longitudinal axes of any two consecutive terminals. Accordingly, when the first terminal of any one row of terminals 12—12 to 15—15, inclusive, is axially aligned with the associated one of the probes 52 to 55, inclusive, respectively, the last terminal of that row will be removed from a preceding one of the probes 51 to 54, inclusive, respectively, a distance equal to the distance between the longitudinal axes of any two consecutive terminals. The various positions and lengths of the probes 51 to 55, inclusive, are such that, when the terminal strip subassembly 18 is moved by the carriage 21 along the probe-mounting member 50, the consecutive terminals 11—11 to 15—15, inclusive, of each consecutive row successively become axially aligned with the consecutive probes 51 to 55, inclusive, respectively, at uniformly spaced intervals.

A second probe-mounting member 59, made of suitable material such as steel, is mounted fixedly on a plastic insulating spacer 60 secured by suitable means on the top plate 28. The probe-mounting member 59 is positioned in parallel relationship to the probe-mounting member 50 and on the opposite side of the path of travel of the carriage 21. The probe-mounting member 59 is provided with five electrically conductive probes 61 to 65, inclusive, spaced along the probe-mounting member 59 at distances and heights corresponding to and axially aligned with corresponding ones of the probes 51 to 55, inclusive.

Each of the probes 61 to 65, inclusive, is in the form of a stepped, cylindrical pin having a rounded nose and a reduced threaded portion at the opposite ends thereof. The probes 61 to 65, inclusive, are positioned slidably in stepped bores 66—66 in the probe-mounting 59 so that the rounded noses thereof face toward the slot 27 and, therefore, toward their mating probes 51 to 55, inclusive. Compression springs 67—67, fitting one about the reduced portion of each of the probes 61 to 65, inclusive, normally urge each of the probes 61 to 65, outwardly of the probe-mounting member 59 toward the corresponding probes 51 to 55, inclusive. The probes 61 to 65, inclusive, are adjusted axially by means of threaded members 68—68 so that the ends of the rounded noses of these probes extend the same distance from the adjacent face of the probe-mounting member 59.

A contact-mounting member 69, made of suitable material, such as steel, is mounted fixedly on a plastic insulating spacer 70 which is secured by suitable means to the top plate 28. The contact-mounting member 69 is positioned adjacent to and parallel with the probe-mounting member 59. A plurality of electrically conductive contacts 71 to 75, inclusive, in the form of stepped, cylindrical pins are positioned slidably in stepped bores 76—76 in the contact-mounting member 69 in alignment with associated probes 61 to 65, inclusive, respectively. Compression springs 77—77, fitting one about a reduced portion of each of the contacts 71 to 75, inclusive, normally urge these contacts outwardly of the contact-mounting member 69 toward the probes 61 to 65, inclusive, respectively. The contacts 71 to 75, inclusive, are adjustable axially with respect to the probes 61 to 65, inclusive, respectively, by means of threaded members 78—78.

The probes 51 to 55, inclusive, and 61 to 65, inclusive,

respectively, are so adjusted relative to each other, that the mating pairs of probes are normally spaced apart predetermined distances equal to the respective minimum acceptable lengths of the terminals 11—11 to 15—15, inclusive. The contacts 71 to 75, inclusive, are normally spaced from the associated probes 61 to 65, inclusive, a distance infinitesimally greater than the distance between the maximum and minimum acceptable lengths of the terminals 11—11 to 15—15, inclusive, so that when a terminal having a length infinitesimally greater than the maximum acceptable length thereof is in contact with both of the mating pairs of probes 51 to 55, inclusive, and 61 to 65, inclusive, respectively, the associated one of the probes 61 to 65, inclusive, will be in contact with the associated one of the contacts 71 to 75, inclusive.

The probes 51 to 55, inclusive, are further arranged at predetermined fixed distances with respect to the vertical plane passing through the center lines of the mating pair of grooves 24—24 closest to the probes 51 to 55, inclusive. The latter distances are such that when the end plates 16 and 17 are positioned in the pairs of grooves 24—24 in contact with the walls thereof adjacent to the probes 51 to 55, inclusive, the end portions of the terminals 11—11 to 15—15, inclusive, protruding from the end plate 17 must extend a minimum acceptable distance therefrom to just engage the associated one of the probes 51 to 55, inclusive. The width of the grooves 24—24 is such as to allow the end plates 16 and 17 to move therein distances equal to twice the difference between the maximum and minimum acceptable lengths of the terminals 11—11 to 15—15, inclusive, i.e. to twice the allowable tolerance in the length thereof. Accordingly, the distances, which the end portions of the terminals 11—11 to 15—15, inclusive, protrude from the end plate 17, may vary within the limits equal to twice the allowable tolerance between the maximum and minimum acceptable lengths of the terminals and still be acceptable. Thus, it may be seen that the width of the grooves 24—24 and the respective positions of the probes 51 to 55, inclusive, 61 to 65, inclusive, and contacts 71 to 75, inclusive, respectively, allow simultaneous measurement of the lengths of the terminals 11—11 to 15—15, inclusive, and also the positions of the end portions of these terminals relative to the end plate 17.

Referring now to FIG. 5, there is shown an electrical circuit forming a part of the gauging apparatus 10 which includes a pair of bus bars 81 and 82 arranged to be connected through a double-pole toggle switch 83 to a source of electrical energy, such as a 110-volt A.C. source. It will be understood that the contacts of all relays of the electrical circuit illustrated in FIG. 5 are moved upwardly by the relays when energized. A push-button start switch, designated generally by the numeral 84, having normally open contacts 86 and 87 and a normally closed contact 88, is provided for initiating the gauging operation. A relay 89 is provided with normally open contacts 91, 95, 96 and 97 and with normally closed contacts 92, 93 and 94. A relay 99 is provided with normally open contacts 100 and 102 to 105, inclusive, and normally closed contact 101. One terminal of an operating coil of the relay 89 is arranged to be connected through the contact 86 of the start switch 84 to the bus bar 81. An operating coil of the relay 99 is connected to the bus bars 81 and 82 through the normally open contact 87 of the start switch 84, the normally closed contact 92 of the relay 89 and the normally closed limit switch 43. The other terminal of the operating coil of the relay 89 is connected to the bus bar 82 through the normally closed limit switch 42 and the normally closed contact 101 of the relay 99.

One terminal of the winding 35 of the reversible motor 34 is arranged to be connected to the bus bar 81 through the normally closed limit switch 47 and the other terminal is arranged to be connected to the bus bar 82

through the normally open contact 97 of the relay 89 and, alternatively, through the normally open contact 104 of the relay 99. One terminal of the winding 36 of the motor 34 is connected to the bus bar 81 through the normally open contact 102 of the relay 99 and, alternatively, to the bus bar 82 through the normally open contact 95 of the relay 89. The other terminal of the winding 36 is connected to the bus bar 81 through the normally open contact 96 of the relay 89 and, alternatively, to the bus bar 82 through the normally open contact 103 of the relay 99. The latter arrangement allows reversal of the direction of rotation of the motor 34, and, accordingly, reversal of the rotation of the threaded shaft 31, and, therefore, reversal of the direction of movement of the carriage 21.

It may be seen that when the contacts 102, 103 and 104 of the relay 99 close, the carriage 21 is caused to move from left to right as viewed in FIGS. 1 and 2, i.e. from its loading position shown in FIGS. 1 and 2 in solid lines, past the probes 51 to 55, inclusive and the probes 61 to 65, inclusive, respectively, into its unloading position shown in phantom lines in FIG. 2. Similarly, when the contacts 95, 96 and 97 of the relay 89 close, the carriage 21 is caused to move from right to left, as viewed in FIGS. 1 and 2, so as to return the carriage from the unloading position back to its original, loading position.

A transformer, designated generally by the numeral 106, a primary coil of which is connected to the bus bars 81 and 82, and a secondary coil to a rectifier 107, is provided to supply a reduced input voltage to the rectifier. One terminal of the D.C. output of the rectifier 107 is grounded, while the other terminal thereof is connected through the normally closed contact 88 of the start switch 84 to supply a low voltage D.C. current to forty green indicating lights 108—108, arranged in five rows of eight lights each, and forty associated relays 111 to 150, inclusive; and forty red indicating lights 109—109, arranged also in five rows of eight lights each, and forty associated relays 151 to 190, inclusive. The green lights 108—108 and the red lights 109—109 are spaced in alternating rows. One green light 108 in any horizontal row and one red light 109 in the same vertical row but in the next horizontal row are associated with one terminal of the group of terminals 11—11 to 15—15, inclusive, in the terminal strip subassembly during the gauging thereof.

The relays 111 to 150, inclusive, are each provided with a normally closed contact 191 connected between the ground and a coil of the associated one of the relays 111 to 150, inclusive, and with a normally open contact 192. The green indicating lights 108—108 associated with the relays 111 to 150, inclusive, are connected individually between ground and the positive output terminal of the rectifier 107 through the normally closed contacts 191—191 of the associated relays 111 to 150, inclusive.

The relays 151 to 190, inclusive, are each provided with a normally open contact 193 connected between ground and a coil of the associated one of the relays 151 to 190, inclusive, and with a normally open contact 194. The red indicating lights 109—109, associated with the relays 151 to 190, inclusive, are connected individually between ground and the positive output terminal of the rectifier 107 through the normally open contacts 194—194 of the associated relays 151 to 190, inclusive.

A conventional stepping switch, designated generally by the numeral 196, is provided to connect successively individual ones of the relays 111 to 150, inclusive, through the normally open contact 105 of the relay 99 to the probes 61 to 65, inclusive; and, simultaneously, to connect successively individual ones of the relays 151 to 190, inclusive, respectively, through the normally closed contact 94 of the relay 89 to the contacts 71 to 75, inclusive. The stepping switch 196 is provided with two double-ended rotary wipers 201 and 202, inclusive, mounted on a single shaft, and two contact banks 203 and 204, inclusive. Each of the contact banks 203 and 204 is provided with forty contacts arranged in an arcuate path. The arrangement of the contact banks 203 and 204 with respect

to the wipers 201 and 202, respectively, mounted on a shaft 207 for rotation therewith, is such that at any time only one end of the wipers is in contact with the respective contact banks.

The shaft 207 is rotated by a ratchet and pawl (not shown) operated by a solenoid 208. The solenoid 208 is connected to the output terminals of a rectifier 209. The input terminals of the rectifier 209 are connected to the bus bars 81 and 82 through the normally closed limit switches 44 and 45, the normally closed contact 93 of the relay 89, and the normally open limit switch 41. Closing and opening of the limit switch 41 by the cam 39 during the rotation of the threaded shaft 31 results in energization and deenergization of the solenoid 208, which causes the shaft 207 to rotate sufficiently to step the wipers 201 and 202, inclusive. The position of the cam 39 on the threaded shaft 31 is so adjusted that the cam will actuate the actuating arm 40 (FIGS. 1, 2 and 3) of the switch 41 to close and open the latter during an interval when neither of any two consecutive terminals 11—11 to 15—15, inclusive, one gauged and the other to be gauged, is aligned axially with respective ones of the probes 51 to 55, inclusive, and 61 to 65, inclusive, respectively.

When the carriage 21 is to the left of an instantaneous gauging position thereof, whereat the first of the terminals 11—11 is aligned axially with the probes 51 and 61, the actuating arm 46 (FIGS. 1, 2 and 3) of the normally closed limit switch 44 is depressed by the dependent portion 26 of the carriage so that the switch 44 is open. Similarly, when the carriage 21 moves to the right of the instantaneous position thereof, whereat the last of the terminals 15—15 is aligned axially with the probes 55 and 65, the actuating arm 46 (FIGS. 1, 2 and 3) of the normally closed switch 45 is depressed by the dependent portion 26 of the carriage so that the switch 45 is open. The opening of either of the switches 44 or 45 causes interruption of the circuit of the switch 41 so as to render the actuation of the latter by the cam 39 ineffective.

The normally closed contact 93 of the relay 89 is provided to interrupt the circuit of the rectifier 209 when the relay 89 is energized. Interruption of the circuit of the rectifier 209 by the contact 93 renders the switch 41 ineffective during the return of the carriage 21 from the unloading into the loading position thereof so that the stepping switch 196 is not stepped during this time.

The wiper 201 is connected through the normally open contact 105 of the relay 99 to the electrically interconnected probes 61 to 65, inclusive. The forty contacts of the contact bank 203 are connected individually and consecutively to the coils of one of the relays 111 to 150, inclusive, respectively. During the gauging operation, when the contact 105 of the relay 99 is closed and one of the terminals 11—11 to 15—15, inclusive, is in contact with a corresponding one of the probes 51 to 55, inclusive, respectively, connected to ground, and with the respective one of the probes 61 to 65, inclusive, an electrical circuit of the coils of the respective one of the relays 111 to 151, inclusive, is completed, resulting in energization of the coil of the associated relay. Upon energization of the coil of the respective one of the relays 111 to 151, inclusive, the normally open contact 192 thereof, connected between ground and the energized coil of the relay, is closed so that the coil of the latter is self-locked and stays energized until the contact 88 of the start switch 84 is opened. Energization of the coil of the respective one of the relays 111 to 151, inclusive, also results in opening of the normally closed contact 191 thereof so that the lighted associated green indicating light 108 is extinguished, indicating that the terminal being gauged is either of right size or oversize.

The wiper 202 is connected through the normally closed contact 94 of the relay 89 to the electrically interconnected contacts 71 to 75, inclusive. The forty contacts of the contact bank 204 are connected individually and con-

secutively to one coil of each of the relays 151 to 190, inclusive, respectively. During the gauging operation, when one of the terminals 11—11 to 15—15, inclusive, is oversize, this terminal will not only be in contact with the corresponding one of the probes 51 to 55, inclusive, and with the associated one of the probes 61 to 65, inclusive, respectively, but also will force the respective one of the latter toward and in contact with the associated one of the contacts 71 to 75, inclusive, respectively. This will result not only in completion of an electrical circuit of the coil of the respective one of the relays 111 to 151, inclusive, and extinguishment of the green indicating light 108 associated with that relay, but also in completion of an electrical circuit of the coil of the respective one of the relays 151 to 190, inclusive.

Upon completion of the electrical circuit of the coil of the corresponding one of the relays 151 to 190, inclusive, the coil thereof is energized, the normally open contact 194 thereof, connected between ground and the coil of the relay, is closed so that the coil of the latter is locked, and the normally open contact 193 of the relay is closed. The closing of the normally open contact 193 results in lighting of the red indicating light 109 associated with the relay, indicating that the gauged terminal is oversize. The lighted indicating lights 109—109 remain lit and the coils of the associated relays 151 to 190, inclusive, remain energized until the normally closed contact 88 of the start switch 84 is opened, causing de-energization of the coils of the relays and opening of the normally open contacts 193 and 194 thereof.

Operation

At the beginning of the operation it is assumed that the carriage 21 is in its loading position, as shown in solid lines in FIGS. 1 and 2. In this position the dependent portion 26 of the carriage 21 maintains the normally closed limit switches 42 and 44 open. It is also assumed that the toggle switch 83 is open and the wipers 201 and 202 of the stepping switch 196 are in contact with the first contacts of the contact banks 203 and 204, respectively. Closing of the toggle switch 83 by an operator results in completion of the circuits of the green indicating lights 108—108 associated with the relays 111 to 150, inclusive, so that the green indicating lights 108—108 will be lighted and remain lit until extinguished by opening the associated ones of the normally closed contacts 191—191 of the respective ones of the relays 111 to 150, inclusive.

The operator then inserts a terminal strip subassembly 18 into the carriage 21 so that the end plates 16 and 17 slide down the grooves 24—24 in the sides 23—23 of the carriage 21 until the end plates rest on the base 22 of the carriage. The grooves 24—24 are of sufficient width to allow a limited play of a terminal strip subassembly 18, being gauged, longitudinally of the carriage 21 for reasons previously explained. The terminal strip subassembly 18 is placed into the carriage 21 in such a manner that the row of the longest terminals 11—11 is at the bottom, next to the base 22 of the carriage 21.

The operator then momentarily actuates the start switch 84 to initiate the gauging operation of the lengths of the terminals 11—11 to 15—15, inclusive, of the terminal strip subassembly 18 positioned in the carriage 21. Actuation of the start switch 84 results in momentarily closing of the contacts 86 and 87 thereof in the circuit of the coil of the relays 89 and 99, respectively, and opening of the contact 88. However, because the normally closed limit switch 42 is maintained open by the dependent portion 26 of the carriage 21, the coil of the relay 89 will not be energized and, therefore, the contacts 91 to 97, inclusive, thereof maintain their normal positions.

The normally open contact 87 completes the circuit of the coil of the relay 99 through the still closed, normally closed, contact 92 of the relay 89 and the still closed,

normally closed, limit switch 43. The coil of the relay 99 then locks itself through the normally open contact 100, opens the normally closed contact 101 and closes the normally open contacts 102 to 105, inclusive. The opening of contact 101 of the relay 99 eliminates any possibility of the relay 89 being energized at any time when the relay 99 is energized, i.e. during the advancement of the carriage 21 from left to right from its loading to its unloading positions. The closed contact 105 interconnects the probes 61 to 65, inclusive, with the wiper 201.

Closing of the contacts 102 to 104 of relay 99 results, since the limit switch 47 at the right end of the slot 27, as viewed in FIG. 1, is closed, in completion of the circuit of the windings 35 and 36 of the motor 34. The motor 34 causes the rotary movement of the threaded shaft 31, transformed into the linear movement of the carriage 21 along the slot 27, so that the first of the terminals 11—11 moves into the space between the probes 51 and 61 and occupies instantaneously a position, shown in FIG. 3, axially aligned with the probes 51 and 61.

It is assumed that the first of the terminals 11—11 being gauged is of a length greater than the maximum acceptable length thereof, and that the end of this terminal adjacent to the end plate 17 corresponds to an end of a terminal of a nominal length, as is shown in FIG. 3. The terminal 11 contacts both probes 51 and 61 so that the end plates 16 and 17 are substantially centrally positioned in the grooves 24—24, and moves the probe 61 axially toward and in contact with the contact 71. The terminal 11 is then interconnecting electrically the probes 51 and 61 and completes the circuit of the coil of the relay 111 associated with the first contact of the contact bank 203. The circuit of the coil of the relay 111 is then completed from ground through the probe 51, the terminal 11, the probe 61, the normally open, but now closed contact 105 of the relay 99, the wiper 201, the first contact of the contact bank 203, through the normally closed contact 88 of the start switch 84 and the rectifier 107 to ground.

The energized coil of the relay 111 opens the normally closed contact 191 and closes the normally open contact 192. Opening of the normally closed contact 191 of the relay 111 results in the associated one of the green indicating lights 108—108, which is the first green light 108 in the first horizontal row thereof, being extinguished to indicate to the operator that the terminal 11 is either of proper length or too long, i.e. that the terminal 11 satisfies a predetermined minimum acceptable length. Closing of the normally open contact 192 of the relay 111 results in locking in of the coil thereof, so that the associated green indicating light 108 remains extinguished until the end of the gauging operation when the locked-in coils of the relays 111 to 150, inclusive, are deenergized by opening the normally closed contact 88 of the start switch 84.

The probe 61, interconnected electrically to the probe 51 by the terminal 11 is also in contact with the contact 71 to complete the circuit through the coil of the relay 151 associated with the first contact of the contact bank 204. In his case, the coil of the relay 151 is connected from ground through the probe 51, the terminal 11, the probe 61, the contact 71, the normally closed contact 94 of the relay 89, the wiper 202, the first contact of the contact bank 204, the contact 88 and the rectifier 107 to ground.

The energized coil of the relay 151 closes the normally open contacts 193 and 194 of the relay 151 to complete the circuit of the associated one of the red indicating lights 109—109, which is the first light in the first horizontal row thereof, to light that red indicating light to indicate to the operator that the gauged terminal 11 is too long. Closing of the normally open contact 194 of the relay 151 results in locking-in of the coil thereof so that the relay 151 maintains the contact 193

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closed and the red indicating light lit until the end of the gauging operation when any of the locked-in coils of the relays 151 to 190, inclusive, are deenergized along with any locked-in coils of the relays 111 to 150, inclusive, by opening the normally closed contact 88 of the start switch 84.

The gauging of the first of the terminals 11—11 occurred almost instantaneously while the carriage 21 continued to move the terminal 11 past the probes 51 and 61 and when the terminal 11 occupied an instantaneous position axially aligned with the probes 51 and 61. The motor 34 then continues to rotate the threaded shaft 31, which continues to move the carriage 21 therealong, so as to move the first of the terminals 11—11 out of axial alignment with the probes 51 and 61 and to carry the second of the terminals 11—11 towards its instantaneous position in axial alignment with these probes.

While the first of the terminals 11—11 was in axial alignment with the probes 51 and 61, the position of the dependent portion 26 of the carriage 21 along the threaded shaft 31 was such with respect to the actuating arm 46 of the limit switch 44, that the latter is now closed so as to render actuation of the switch 41 by the cam 39 effective. During an interval when the first of the terminals 11—11 moves out of the axial alignment and out of possible contact with the probes 51 and 61 but before the second of the terminals 11—11 moves in alignment with the probes 51 and 61, the cam 39 operates the actuating arm 40 of the switch 41 to close the latter and then to let the switch 41 reopen. Closing and opening of the switch 41, now that both switches 44 and 45 and the contact 93 of the relay 89 are closed, results in stepping of the wipers 201 and 202 to the next position thereof in contact with second contacts of the contact banks 203 and 204, respectively.

If it is assumed that the length of the second of the terminals 11—11 is equal to the minimum acceptable length, this terminal then contacts the probes 51 and 61 and completes the circuit of the relay 112 in a way similar to that of the first of the terminals 11—11 but through the second of the contacts of the contact bank 203. As a result, the second green light 108 in the first horizontal row thereof associated with the relay 112 is extinguished. Since the contact 71 is not contacted by the probe 61, the relay 152 remains deenergized and the second red light 109 in the first horizontal row thereof associated therewith remains extinguished. The operator observing the respective lights 108—108 and 109—109 will note that the length of the second of the terminals 11—11 falls within the minimum and maximum tolerance limits thereof, and that this terminal is acceptable.

If the third of the terminals 11—11, rather than being oversize or of the acceptable size, is too short, i.e. "undersize," this terminal contacts only one of the mating probes 51 and 61 so that the circuit of the relay 113 connected through the third contact of the contact bank 203 remains uncompleted and the green light 108 associated therewith remains lighted. After the third of the terminals 11—11 has passed beyond the probes 51 and 61, or at the end of the gauging operation, the operator, by observing the third lighted green light 108 in the first horizontal row thereof, will know that the third of the terminals is undersize.

In the event that a fourth terminal 11 is of proper length, but is displaced longitudinally thereof relative to the plates 16 and 17 so as to contact only one of the probes 51 or 61, for example the probe 61, the probe 61 will tend to shift the terminal strip subassembly 18 from right to left, as viewed in FIG. 3, so that the end plates 16 and 17 come into engagement with the walls of the grooves 24—24 in position closest to the probe 51. However, if the end of the fourth terminal 11, protruding from the end plate 17, is shorter than a similar end of a properly positioned terminal of a minimum acceptable length, the circuit between these probes remains uncom-

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pleted in a manner similar to that for a short terminal, so that the operator, by observing the fourth of the lights 108—108 in the first row thereof, associated with the relay 114 connected through the fourth contact of the contact bank 203 to the probe 61, receives an indication that the terminal strip subassembly is unacceptable.

While the carriage 21 continues to move on, carrying the terminal strip subassembly 18 past the probes 51 and 61, the cam 39 intermittently closes the switch 41, so that the wipers 201 and 202 step from contact to contact of the contact banks 203 and 204 respectively, in timed relationship with the movement of the consecutive of the terminals 11—11 past the probes 51 and 61. After all of the terminals 11—11 move past the probes 51 and 61, the first of the terminals 12—12 will move in axial alignment with the probes 52 and 62. At this time, the wipers 201 and 202 will be in contact with the ninth contact of the contact banks 203 and 204, respectively. After all of the terminals 12—12 move past the probes 52 and 62, the first of the terminals 13—13 will be in alignment with the probes 53 and 63 while the wipers 201 and 202 will be in contact with the seventeenth contact of the contact banks 203 and 204, respectively.

The carriage 21 then continues to move on carrying the successive terminals 13—13, 14—14 and 15—15 in the successive rows thereof in alignment with the probes 53 and 63, 54 and 64, and 55 and 65, respectively. When the first of the terminals 14—14 and 15—15 move in alignment with the respective pairs of probes 54 and 64, and 55 and 65, the wipers 201 and 202 move in contact with the twenty-sixth and thirty-third contacts, respectively, of the contact banks 203 and 204, respectively.

After the last of the terminals 15—15 moves out of alignment with the probes 55 and 65 and moves a distance therefrom equal to the distance between longitudinal axes of any two consecutive terminals 11—11 to 15—15, inclusive, in any horizontal row thereof, the lowermost row of terminals 11—11 engages an actuating arm 48 of the switch 47 to open the latter, so as to stop the motor 34. The switch 47 prevents operation of the motor and movement of the carriage 21 in any direction any time before the gauged terminal subassembly 18 is removed from the carriage.

Simultaneously, with the opening of the switch 47, the dependent portion 26 of the carriage 21 actuates actuating arms 46—46 of the respective switches 43 and 45 to open both of the latter. Opening of the switch 43 causes deenergization of the coil of the relay 99, which results in opening of the contact 100, closing of the normally closed contact 101 in the circuit of the relay 89, opening of the normally open contacts 102, 103 and 104 in the circuit of the windings 36 and 35, respectively, of the motor 34, and opening of the normally open contact 105 in the circuit connecting the probes 61 to 65, inclusive, with the wiper 201. Opening of the switch 45 results in rendering actuation of the switch 41 by the cam 39 ineffective during any possible further movement of the carriage 21 toward the right, as viewed in FIGS. 1 and 2.

While the carriage 21 moves the last of the terminals 15—15 out of alignment with the probes 55 and 65, and before the switch 45 is opened, the cam 39 actuates the switch 41 once more causing one end of the wipers 201 and 202 to step one more step off the fortieth contact and the other end of the wipers in contact with the first contact of the contact banks 203 and 204, respectively. Opening of the limit switch 45 a moment thereafter, before the cam 39 actuates the switch 41 once more, interrupts the circuit of the rectifier 209, and, therefore, of the solenoid 208, so that the wipers 201 and 202 remain in contact with the first contact of the contact banks 203 and 204, respectively.

At this time, or after the operator takes the gauged terminal strip subassembly 18 out of the carriage 21, the operator may inspect the lights 108—108 and 109—109 to see whether the lengths of the terminals 11—11 to

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15—15, inclusive, correspond to a predetermined standard to determine whether the whole terminal strip subassembly 18 is acceptable. If some, or all, of the green lights 108—108 remain lighted, or if all of the green lights 108—108 are extinguished but some or all of the red lights 109—109 are lighted, the operator has an indication that terminal strip subassembly manufacturing machines, particularly a terminal shearing mechanism, may need adjustment and direction of such adjustment.

After the operator takes the gauged terminal strip subassembly 18 out of the carriage 21, which results in reclosing of the switch 47 in the circuit of the winding 35 of the motor 34, the operator may initiate return of the carriage 21 into its loading position, as viewed in FIGS. 1 and 2, by momentarily closing the push button start switch 84 so as to close its normally open contacts 86 and 87 and to open its normally closed contact 88. The momentarily open contact 88 of the start switch 84 causes interruption in the circuit of any of the energized coils of the relays 111 to 150, inclusive, and 151 to 190, inclusive, so as to reset the associated contacts 191 and 192, and 193 and 194, respectively, back to their normal positions, and to relight any of the extinguished green lights 108—108 and to extinguish any of the lit red lights 109—109.

Closing of the contact 86 effects energization of the coil of the relay 89, which closes the normally open contacts 91, 95, 96 and 97 and opens the normally closed contacts 92, 93 and 94. The closed contact 91 of the relay 89 completes the circuit of the coil of the relay 89 so as to lock the coil and to keep it energized, even though the contact 86 was closed momentarily only, until its circuit is interrupted by the opening of the switch 42 by the dependent portion 26 of the carriage 21 at its loading position. Opening of the contact 92 results in the circuit of the coil of the relay 99 being interrupted during the time when the relay 89 is energized, i.e. during the return of the carriage 21 back to its loading position, so as to render the reclosing of the switch 43, in the circuit of the relay 99, ineffective.

Opening of the contact 93 causes interruption of the circuit of the rectifier 209 so as to render the switch 41 ineffective during the return of the carriage back to the loading position. Opening of the contact 94 interrupts the circuit between the contacts 71 to 75, inclusive, and the wiper 202. Closing of the contacts 95, 96 and 97 completes the circuit of the windings 35 and 36 of the motor 34 to reverse the direction of rotation thereof. The motor 34 then causes rotation of the threaded shaft 31 in the opposite direction so as to move the carriage 21 from right to left, as viewed in FIGS. 1 and 2, back into its loading position.

When the carriage 21 comes again to its loading position, shown in solid lines in FIGS. 1 and 2, the dependent portion 26 of the carriage causes the actuating arms 46—46 to open the switches 42 and 44. Opening of the switch 42 results in deenergization of the coil of the relay 89 and reopening of the contacts 91, 95, 96 and 97 and reclosing of the contacts 92, 93 and 94. Opening of the contacts 95, 96 and 97 of the relay 89 results in deenergization of the windings 35 and 36 of the motor 34 and stoppage of the motor and, therefore, stoppage of the carriage 21 in its loading position. Opening of the switch 44 renders any actuation of the switch 41 by the cam 39 ineffective.

At this time the elements of the gauging apparatus 10 are again in the same positions as at the beginning of the above-described operation. By inserting a new terminal strip subassembly 18 into the carriage 21 and pressing the start switch 84, the operator then can start the gauging of the new terminal strip subassembly in a manner similar to that described above.

The apparatus 10 may also be used, with slight modifications, to gauge the lengths of terminals of a terminal strip subassembly on the return trip of the carriage 21,

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during the movement of the carriage 21 from right to left, as viewed in FIGS. 1 and 2. These modifications may include elimination of the contact 93 and of the limit switch 47, and provision of a normally closed contact of the relay 99 in the circuit between the probes 61 to 65, inclusive, and the wiper 201 and of a normally open contact of the relay 89 in the circuit between the contacts 71 to 75, inclusive, and the wiper 202. Also, a plurality of sets of contacts, axially aligned with the probes 61 to 65, inclusive, and contacts 71 to 75, inclusive, and similar to the contacts 71 to 75, inclusive, may be spaced relative to the latter and to each other and connected to various sets of relays, similar to the relays 151 to 190, inclusive, to divide a predetermined tolerance range into a whole number of smaller ranges so as to enable gauging of a whole number of grades of the lengths of terminals.

It will be understood that it may be necessary to provide a weight (not shown) made of electrical insulating material, which is placed on the terminal strip subassembly 18 when the latter is inserted in the carriage 21. The weight is provided to eliminate any possibility of the terminal strip subassembly being moved upwardly of the carriage when the ends of the terminals strike the ends of the probes 51 to 55, inclusive, and 61 to 65, inclusive.

It is manifest that this invention is not limited to the specific details described in connection with the above embodiment of the invention, but that various modifications thereof may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for gauging the lengths of a series of elongated, electrically conductive terminals of a terminal strip subassembly supported in coplanar, uniformly spaced, parallel, electrically insulated relationship with one another in insulating retaining means and for indicating whether the gauged lengths of properly positioned terminals correspond to a desired predetermined standard length, which apparatus comprises a pair of electrically conductive, axially aligned probes, adjacent ends of said probes being spaced normally a predetermined distance apart, equal to a desired minimum terminal length, at least one of said probes being mounted resiliently for limited axial movement with respect to the other, a movable carriage for supporting such a terminal strip subassembly in a manner such that the longitudinal axes of said terminals are maintained in parallel coplanar relationship with the common longitudinal axes of said probes, means for moving said carriage relative to the probes so that consecutive ones of the terminals move between the probes and become aligned axially instantaneously therewith, opposite ends of such aligned terminals instantaneously engaging the adjacent ends of said probes to make an electrical connection therebetween provided that a terminal positioned therebetween is of at least the desired minimum length and is not shifted axially of itself in the retainer by an amount sufficient to preclude contact with both of the probes, a plurality of electrical indicating circuit means energizable when said probes are electrically connected together for indicating that the length of an individual terminal is at least of said desired minimum length, and switching means actuated in timed relationship with the movement of the carriage and the consecutive terminals between said probes for connecting said probes electrically to consecutive individual ones of said indicating circuit means as corresponding consecutive terminals become aligned axially instantaneously with said probes so that the respective indicating circuit means indicate whether corresponding ones of individual terminals meet with desired standard conditions with respect to length and position.

2. Apparatus for gauging the lengths of a series of elongated, electrically conductive terminals of a terminal strip subassembly supported in coplanar, uniformly spaced, parallel, electrically insulated relationship with one another in insulating retaining means and for indicating whether

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the gauged lengths of properly positioned terminals correspond to a desired predetermined standard length, which apparatus comprises a pair of electrically conductive, axially aligned probes, adjacent ends of said probes being spaced apart normally a predetermined distance equal to a desired minimum terminal length, at least one of said probes being mounted resiliently for limited axial movement with respect to the other, a movable carriage for supporting such a terminal strip subassembly in a manner such that the longitudinal axes of said terminals are maintained in parallel coplanar relationship with the common longitudinal axes of said probes, a rotatably driven shaft for moving said carriage relative to the probes so that consecutive ones of the terminals move between the probes and become aligned axially instantaneously therewith, opposite ends of such aligned terminals instantaneously engaging the adjacent ends of said probes to make an electrical connection therebetween provided that a terminal positioned therebetween is of at least the desired minimum length and is not shifted axially of itself in the retainer by an amount sufficient to preclude contact with both of the probes, a plurality of electrical indicating circuit means energizable when said probes are electrically connected together for indicating that the length of an individual terminal is at least of said desired minimum length, switching means actuatable for connecting said probes electrically to consecutive individual ones of said indicating circuit means, and cam means positioned on said shaft for rotation therewith for actuating said switching means in timed relationship with the movement of the carriage and the consecutive terminals between said probes so that as the consecutive terminals become instantaneously aligned axially with the probes said switching means connect said probes of the respective indicating circuit means to indicate whether corresponding ones of individual terminals meet with desired standard conditions with respect to length and position.

3. Apparatus for gauging the lengths of a series of elongated, electrically conductive terminals of a terminal strip subassembly supported in coplanar, uniformly spaced, parallel, electrically insulated relationship with one another in an insulating retaining means with the ends of the terminals normally projecting predetermined distances beyond opposite sides of the insulating retaining means, and for indicating whether the gauged lengths of properly positioned terminals correspond to a desired predetermined standard length, which apparatus comprises a pair of electrically conductive, axially aligned probes, adjacent ends of said probes being spaced normally a predetermined distance apart equal to a desired minimum terminal length, at least one of said probes being mounted resiliently for limited axial movement with respect to the other probe, a movable carriage for supporting such a terminal strip subassembly in a manner such that the longitudinal axes of said terminals are maintained in parallel coplanar relationship with the common longitudinal axis of said probes, the terminal strip subassembly being supported on the carriage for limited movement transversely of the path of travel of the carriage with respect to the carriage, the amount of permissible transverse movement of the terminal strip subassembly being substantially equal to at least an allowable tolerance in the length of the terminals, means for moving said carriage relative to the probes so that consecutive ones of the terminals move between the probes and become aligned axially instantaneously therewith, opposite ends of such aligned terminals instantaneously engaging the adjacent ends of said probes to make an electrical connection therebetween provided that a terminal positioned therebetween is of at least the desired minimum length and is not shifted axially of itself in the retainer by an amount sufficient to preclude contact with both of the probes even after the terminal strip subassembly moved transversely of the carriage said permissible amount of transverse movement, a plurality of electrical indicating circuit

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means energizable when said probes are electrically connected together for indicating that the length of an individual terminal is at least of said desired minimum length, and switching means actuated in timed relationship with the movement of the carriage and the consecutive terminals between said probes for connecting said probes electrically to consecutive individual ones of said indicating circuit means as corresponding consecutive terminals become aligned axially instantaneously with said probes so that the respective indicating circuit means indicate whether corresponding ones of individual terminals meet with desired standard conditions with respect to length and position.

4. Apparatus for gauging the lengths of a series of elongated, electrically conductive terminals of a terminal strip subassembly supported in coplanar, uniformly spaced, parallel, electrically insulated relationship with one another in an insulating retainer and for indicating whether the gauged lengths of properly positioned terminals correspond to a desired predetermined standard length, which apparatus comprises a pair of electrically conductive, axially aligned probes, adjacent ends of said probes being spaced normally a first predetermined distance apart, equal to a desired minimum terminal length, at least one of said probes being mounted resiliently for limited axial movement with respect to the other, an electrically conductive contact member aligned axially with said probes and spaced a second predetermined distance from the opposite end of the movable probe, said second predetermined distance being infinitesimally greater than an allowable tolerance in the dimension to be gauged, a movable carriage for supporting such a terminal subassembly in a manner such that the longitudinal axes of said terminals are maintained in parallel coplanar relationship with the common longitudinal axes of said probes, means for moving said carriage relative to the probes so that consecutive ones of the terminals move between the probes and become aligned axially instantaneously therewith, opposite ends of such aligned terminals instantaneously engaging the adjacent ends of said probes to make an electrical connection therebetween provided that a terminal positioned therebetween is of at least the desired minimum length and is not shifted axially of itself in the retainer by an amount sufficient to preclude contact with both of the probes, a plurality of primary electrical indicating circuit means energizable when said probes are electrically connected together for indicating that the length of an individual terminal is at least of said desired minimum length, a plurality of secondary electrical indicating circuit means energizable when the contact member is electrically connected to the probes for indicating that the length of individual terminals exceeds the desired minimum by at least an amount infinitesimally greater than the allowable tolerance, and switching means actuated in timed relationship with the movement of the carriage and the consecutive terminals between said probes for connecting said probes electrically to consecutive individual ones of said primary indicating circuit means and for connecting simultaneously said contact member electrically to consecutive individual ones of said secondary indicating circuit means as corresponding consecutive terminals become aligned axially instantaneously with said probes so that the respective primary indicating circuit means indicate whether corresponding ones of individual terminals meet the desired standard conditions with respect to length and position, and the respective secondary indicating means indicate whether the length of corresponding ones of properly positioned individual terminals exceeds the desired minimum by more than the allowable tolerance.

5. Apparatus for gauging the lengths of individual terminals of a terminal strip subassembly, which comprises a carriage for receiving and advancing a terminal strip subassembly having a plurality of rows of terminals which extend through the subassembly and project from

opposite sides thereof and are held insulatedly in spaced relationship with each other by plastic retainers, the terminals in each discrete row being of substantially equal lengths and the axes thereof being contained in a single plane but the terminals in different rows being of different lengths and the axes thereof being contained in different parallel planes, a plurality of electrical probes mounted at different heights adjacent to one side of the path of travel of the subassembly with the carriage, the axis of each probe being contained in the plane containing the associated terminals to be gauged thereby, electrically conductive means positioned adjacent to the other side of the path of travel of the subassembly with the carriage, the spacing along the axes of the probes between the electrically conductive means on one side of the path of travel of the subassembly and the associated probe on the other side of the path of travel of the subassembly being normally equal to the minimum desired length of the associated terminal, means for mounting the probes resiliently for axial movement with respect to the electrically conductive means transversely of the path of travel of the subassembly, means for advancing the carriage and the subassembly past the plurality of spaced probes of different heights so that properly positioned terminals of the desired minimum lengths engage instantaneously both the electrically conductive means and the associated probes to complete circuits therebetween and properly positioned terminals of length in excess of the desired minimum length cause relative axial movement of the probes with respect to the electrically conductive means, the carriage moving the terminals in each discrete row past the associated probes successively and the successive rows of terminals past the associated probes in succession, electrical means for detecting relative axial movements between the probes and the electrically conductive means of at least a predetermined minimum amount infinitesimally greater than an allowable tolerance in the desired length of the terminals, a multibank stepping switch stepped in timed relationship with the advancement of the carriage, separate banks of said stepping switch being connected respectively to the electrical detecting means and to the circuits containing the electrical conductive means and the probes, said last-mentioned circuits being closed by the terminals being measured engaging both the associated probes and electrically conductive means, and an electrical circuit associated with each of said terminals and connected to banks of the stepping switch to indicate which of the individual terminals are undersize, are of the desired size and are oversize.

6. Apparatus for gauging the lengths of terminals of an electrical unit, which comprises a carriage for receiving and advancing an electrical unit having a plurality of electrically conductive terminals held insulatedly in spaced relationship with each other and projecting from opposite sides of the unit in a plurality of rows in which the terminals in each discrete row are of substantially equal length but the terminals of different rows are of different lengths, a plurality of pairs of electrical probes mounted at different heights adjacent to opposite sides of the path of travel of the unit with the carriage, the spacing between the pairs of electrical probes on opposite sides of the path of travel of the unit being normally equal to the minimum desired length of the associated terminals, means for mounting at least one of the probes of each pair resiliently for limited axial movement with respect to the other probe transversely of the path of travel of the unit, means for advancing the carriage and the unit past the plurality of spaced probes of different heights so that successive terminals of each row of terminals are moved successively instantaneously into axial alignment with the associated pair of probes, properly aligned terminals of the desired minimum lengths engaging instantaneously both of the probes of the associated pairs of probes to complete circuits therebetween and properly aligned terminals of length in excess of the desired minimum length causing

relative axial movement of the associated pairs of probes, the carriage moving the terminals in each discrete row between the associated probes successively and the successive rows of terminals between the spaced probes associated therewith in succession, electrical indicating means responsive to the associated terminals contacting both of the associated probes simultaneously, also electrical indicating means responsive to the associated terminals contacting both of the associated probes simultaneously and causing an axial relative movement between the associated probes of at least a predetermined minimum amount infinitesimally greater than an allowable tolerance in the desired length of the terminals, and switching means actuated in timed relationship with the advancement of the carriage for connecting the associated electrical indicating means to the selectively associated probes and terminals for indicating which of the individual terminals are undersize, are of the desired size and are oversize.

7. Apparatus for gauging the lengths of terminals of an electrical unit, which comprises a carriage for receiving and advancing an electrical unit having a plurality of electrically conductive terminals held insulatedly in spaced relationship with each other and projecting from opposite sides of the unit in a plurality of rows in which the terminals in each discrete row are of substantially equal length but the terminals of different rows are of different lengths, a plurality of pairs of electrical probes mounted at different heights adjacent to opposite sides of the path of travel of the unit with the carriage, the spacing between the pairs of electrical probes on opposite sides of the path of travel of the unit being normally equal to the minimum desired length of the associated terminals, means for mounting at least one of the probes of each pair resiliently for limited axial movement with respect to the other probe transversely of the path of travel of the unit, a plurality of electrically conductive contact members aligned axially with individual ones of said movable probes and spaced a predetermined distance from the opposite ends thereof, said distance being infinitesimally greater than an allowable tolerance in the length to be gauged, means for advancing the carriage and the unit past the plurality of spaced probes of different heights so that successive terminals of each row of terminals are moved successively instantaneously into axial alignment with the associated pairs of probes, properly aligned terminals of the desired minimum lengths engaging instantaneously both of the probes of the associated pairs of probes to complete circuits therebetween and properly aligned terminals of length in excess of the desired minimum length causing relative axial movement of the associated pairs of probes, the carriage moving the terminals in each discrete row between the associated probes successively and the successive rows of terminals between the spaced probes associated therewith in succession, primary electrical indicating means responsive to the associated terminals contacting both of the associated probes simultaneously, secondary electrical indicating means responsive to the associated terminals contacting both of the associated probes simultaneously and causing a relative movement of the associated ones of the movable probes into engagement with the associated one of the contact members, and switching means actuated in timed relationship with the advancement of the carriage for connecting said probes electrically to consecutive individual ones of said primary indicating means and simultaneously for connecting said contact members electrically to consecutive individual ones of said secondary indicating means as corresponding consecutive terminals become aligned axially instantaneously with said probes so that the respective primary indicating means indicate whether corresponding ones of individual terminals meet with desired standard conditions with respect to length and position and the respective secondary indicating means indicate whether the length of corresponding ones of properly positioned individual terminals ex-

ceeds the desired minimum by more than the allowable tolerance.

8. Apparatus for gauging the lengths of elongated, electrically conductive terminals of a terminal strip assembly held insulatedly in spaced relationship with each other and projecting from the opposite sides of the assembly in a plurality of rows in which terminals in each discrete row are of substantially equal length but the terminals of different rows are of different lengths, which comprises a carriage for receiving and advancing a terminal strip assembly having a plurality of electrically conductive terminals held insulatedly in spaced relationship with each other and projecting from opposite sides of the assembly in a plurality of rows in which the terminals in each discrete row are of substantially equal length but the terminals of different rows are of different lengths, said assembly being supported on the carriage for limited movement transversely of the path of travel of the carriage, the amount of permissible transverse movement of said assembly with respect to the carriage being equal to at least an allowable tolerance in the lengths to be gauged, a plurality of pairs of electrical probes mounted at different heights adjacent to opposite sides of the path of travel of the assembly with the carriage, the spacing between adjacent ends of each of the pairs of electrical probes being normally equal to the minimum desired length of the associated terminals to be gauged thereby, means for mounting at least one of the probes of each pair resiliently for limited axial movement with respect to the other probe transversely of the path of travel of the assembly, a plurality of electrically conductive contact members aligned axially with individual ones of said movable probes and spaced a predetermined distance from the opposite ends thereof, said distance being infinitesimally greater than said allowable tolerance, means for advancing the carriage and the assembly past the plurality of spaced probes of different heights so that successive terminals of each row of terminals are moved successively into instantaneous axial alignment with the associated pairs of probes, opposite ends of such aligned terminals instantaneously engaging the adjacent ends of the respective ones of the probes to make an electrical connection therebetween provided that such aligned terminals are of at least the desired minimum lengths and are not displaced axially in the assembly by an amount sufficient to preclude the engagement with both of the associated probes even after said

assembly is moved transversely of the carriage said permissible amount of transverse movement, the terminals of lengths in excess of the desired minimum lengths and in engagement with said adjacent ends of said other probes causing relative axial movement of the associated pairs of probes, the carriage moving the terminals in each discrete row successively between the pair of probes corresponding to that particular row and the successive rows of terminals in succession between the spaced probes corresponding thereto, a plurality of first electrical indicating means, a plurality of second electrical indicating means, a stepping switch, a first electrical circuit connecting the stepping switch to the movable probes and to individual ones of the first indicating means, second electrical circuit connecting the stepping switch to the contact means and the individual ones of the second indicating means, said first circuit being arranged to be completed when a terminal having at least a desired minimum length engages both of the associated probes simultaneously, said second circuit being arranged to be completed when a terminal having a length which exceeds the desired minimum by an amount infinitesimally greater than said allowable tolerance engages both of the associated probes and the movable probe is caused to engage the contact member, and means for stepping said stepping switch in timed relationship with the movement of the carriage and the consecutive terminals between the pairs of probes so that as corresponding consecutive terminals become aligned axially instantaneously with the associated pairs of probes the respective ones of the first indicating means indicate whether corresponding ones of the individual terminals meet the desired standard conditions with respect to length and position and the respective one of the second indicating means indicate whether the length of corresponding ones of properly positioned individual terminals exceeds the desired minimum by more than the allowable tolerance.

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