

April 15, 1969

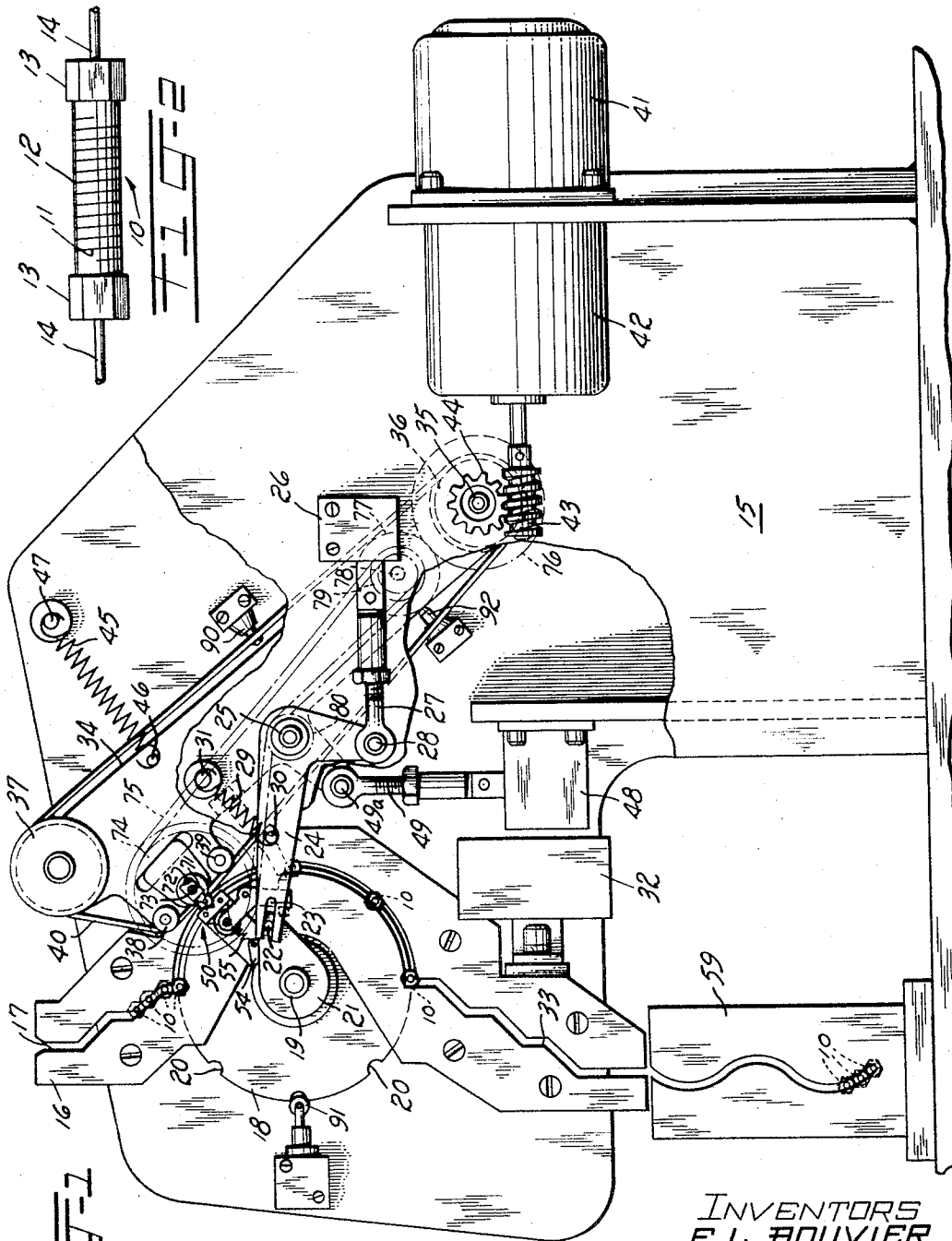
F. L. BOUVIER ET AL

3,438,155

APPARATUS FOR ABRADING-TO-VALUE ELECTRICAL COMPONENTS

Filed July 9, 1965

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INVENTORS
F. L. BOUVIER
R. C. CARLSON JR.
C. W. HIGGINS
J. J. KELLEY
N. F. SMITH

FL

J. J. Lipari
ATTORNEY

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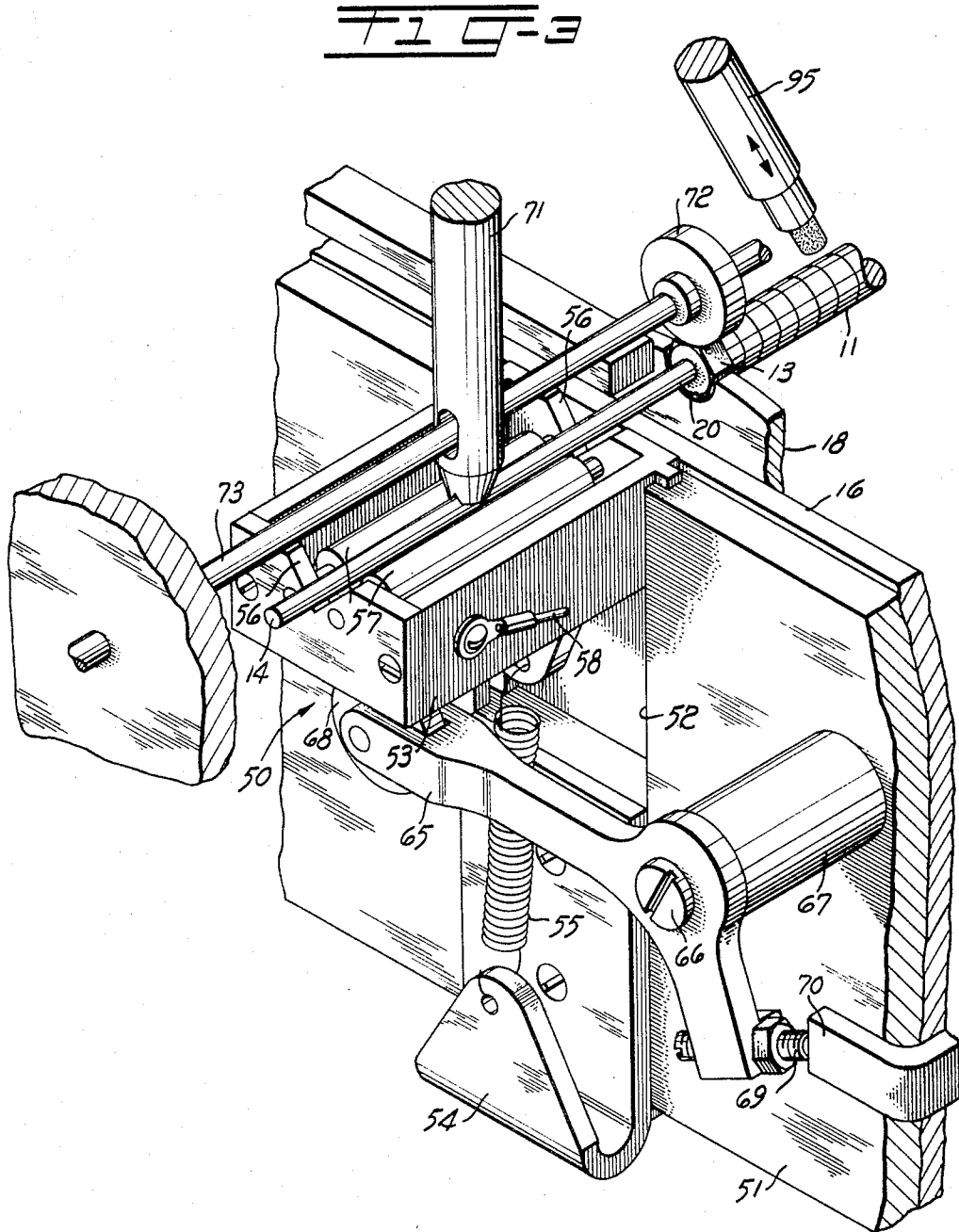
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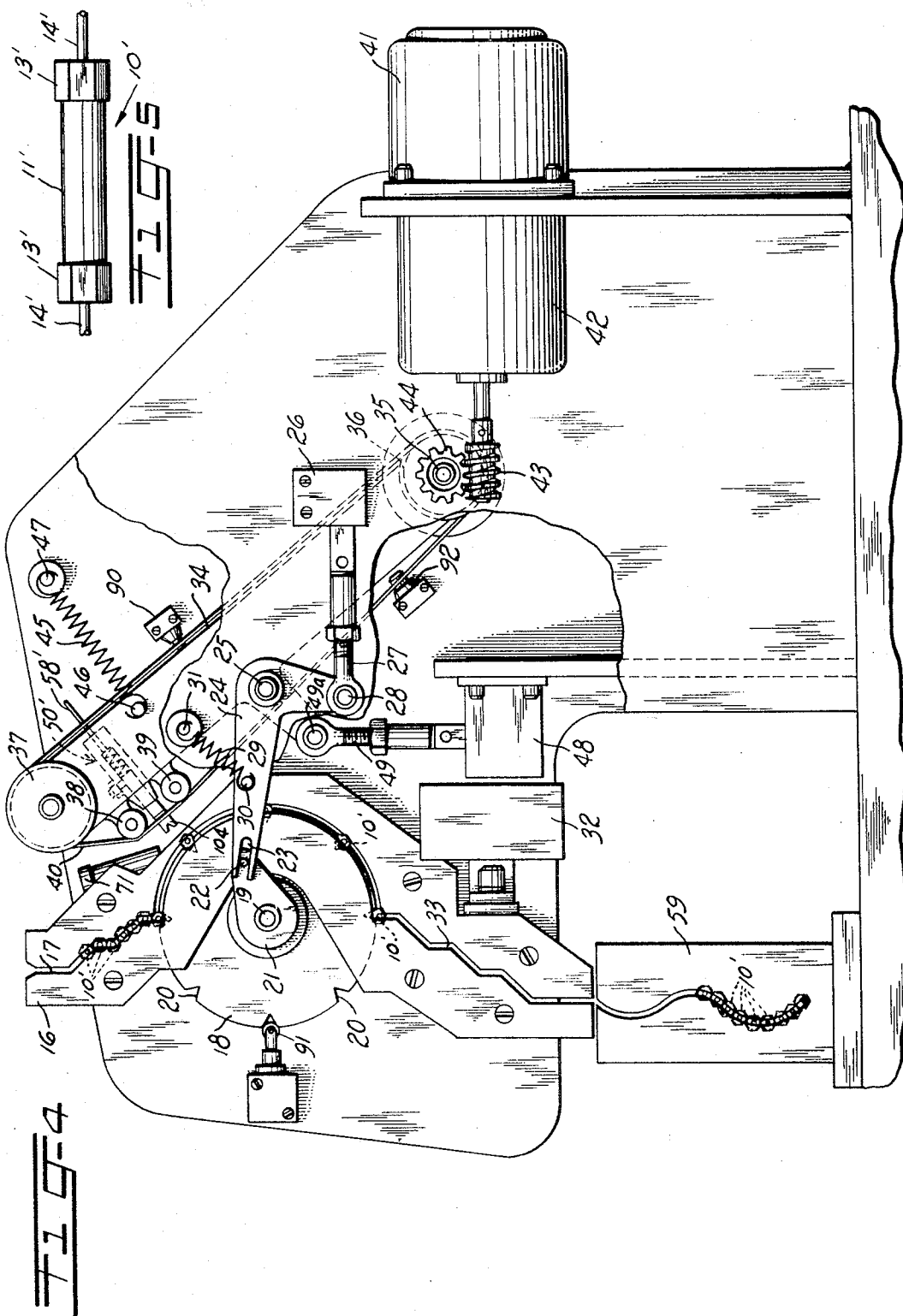
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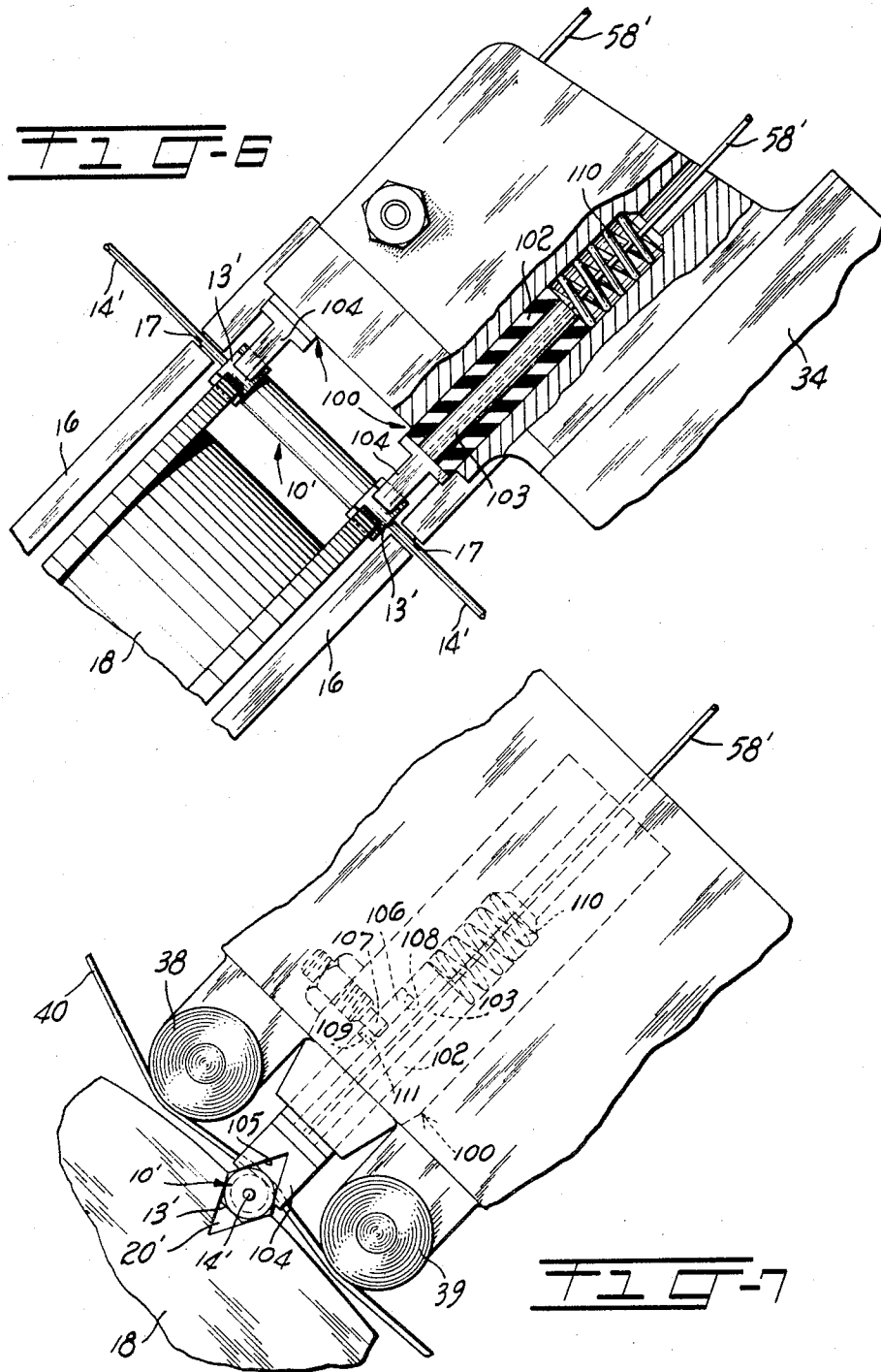
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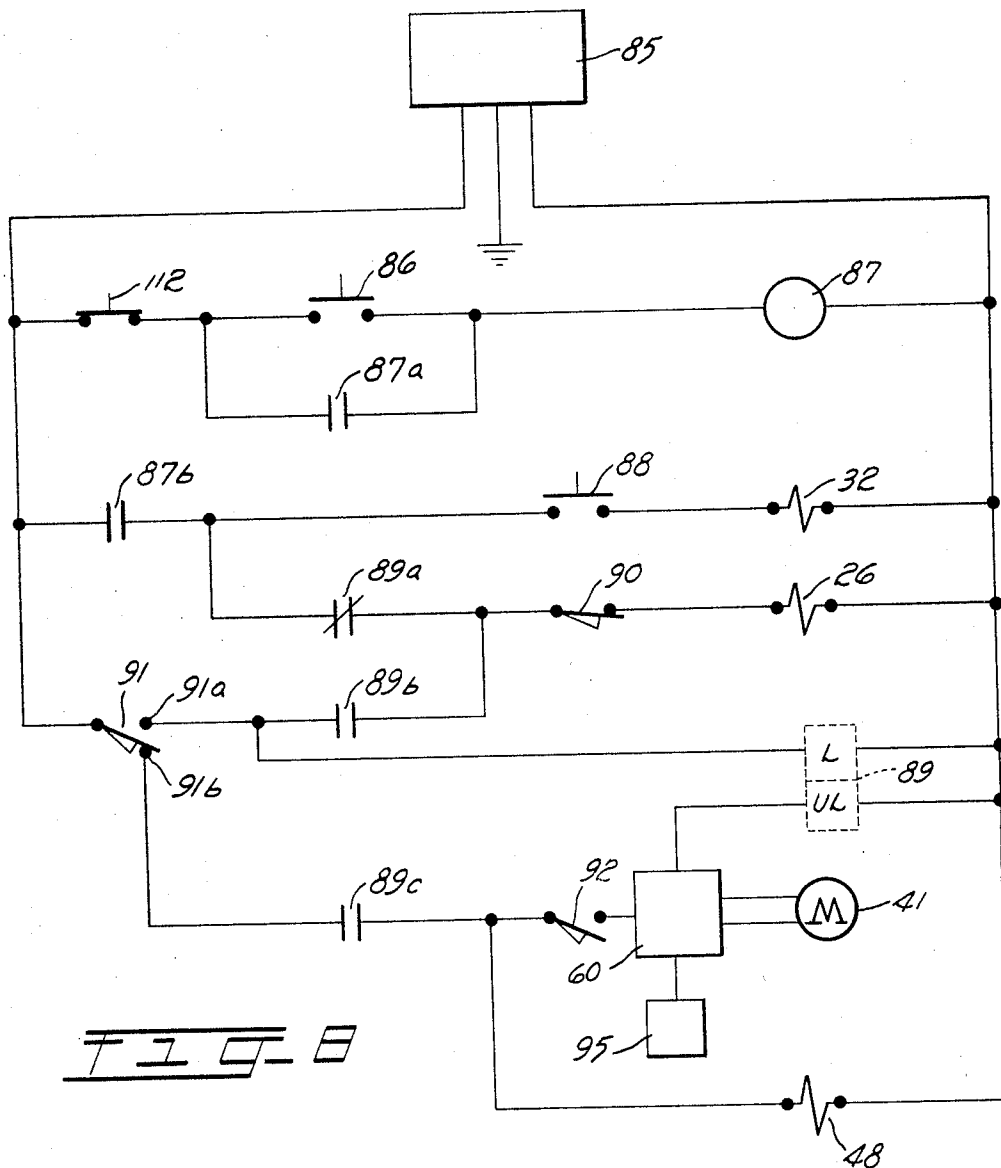
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APPARATUS FOR ABRADING-TO-VALUE ELECTRICAL COMPONENTS

Francis L. Bouvier, Haverhill, Roy C. Carlson, Jr., Box-
ford, Charles W. Higgins, Methuen, John J. Kelley, 5
Lawrence, and Norman F. Smith, Methuen, Mass., as-
signors to Western Electric Company, Incorporated,
New York, N.Y., a corporation of New York
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Int. Cl. B24b 49/02, 21/00, 47/00
U.S. Cl. 51—165 15 Claims 10

ABSTRACT OF THE DISCLOSURE

The disclosure concerns automatic control means for 15
altering the resistance value of a resistor by removal of
a surface layer of its resistive material by means of an
endless abrasive belt. The belt engages the resistor in
tangential contact as it rubs the surface of the resistor
unit. A control circuit is programmed to measure the 20
resistor unit prior to and during abrading operation. If
the measurement indicates a need for a resistance in-
crease, the circuit initiates the abrasive operation and
continues same until the measured resistance value equals
the preset value, whereupon the circuit disengages the 25
abrasive belt from the resistor and indexes the next re-
sistor into position for measurement and abrading.

This invention relates to apparatus for altering a pa-
rameter of an electrical component and particularly to
apparatus for abrading automatically a deposited film of
a resistor until a predetermined resistance value is at-
tained.

Resistors requiring a highly accurate resistance value
are often used in high frequency circuit applications, for
example, in the field of communications. Resistors utilized
in these applications are often manufactured by forming
a thin resistive film on a cylindrical, dielectric core. For 40
example, in the manufacture of carbon-deposited resistors
a thin film of carbon is deposited on a ceramic core. The
methods and apparatus used presently in the deposition
of the thin resistive film on the dielectric core cannot
be controlled adequately to produce resistors with both
uniform and accurate values of resistance. Complicating
the problems encountered in manufacturing carbon-
deposited resistors, for example, is the fact that one type
has a helical groove cut into the resistive film in order
to increase its resistance value. In carrying out the helix-
ing operation, difficulty has been encountered in con-
trolling accurately the final resistance value of the re-
sistor.

Heretofore, in order to achieve a high degree of ac-
curacy in the resistance value of helixed, as well as un-
helixed resistors, it was necessary to rub each resistor
individually by hand with an abrasive sheet to remove the
resistive material from the resistor until the desired re-
sistance value was obtained. Obviously, such a method
is expensive, tedious and time consuming.

An object of this invention, therefore, is to provide ap-
paratus which facilitates the manufacture of precision
resistors at an improved rate and reduced cost.

Another object of the invention is to provide an appa-
ratus for automatically controlling the removal of resis-
tive material from resistors in order to attain uniform
and precise resistance values.

Broadly, an apparatus is provided according to these
and other objects for altering a parameter of an elec-
trical component having a film thereon to a predeter-
mined value. The apparatus includes a control measur-
ing unit, means for electrically connecting the compo-

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nent to the control measuring unit for ascertaining the
parameter value of the component, and an abrading unit.
Means are provided responsive to the control measuring
unit for operating the abrading unit to remove a portion
of the component film until the parameter value of the
component is equal to the predetermined value.

The apparatus, in an embodiment used for helixed
resistors, includes a transport wheel for advancing
individual resistors beneath an abrasive belt located on
a movable support arm. A pair of roller units are actu-
ated to engage and lift the respective leads of a resistor
into secure electrical contact with a measuring control
unit. The measuring control unit ascertains the resistance
value of the resistor and, if it is less than the desired
predetermined resistance value, the measuring control
unit causes the abrasive belt on the support arm
to operate and remove the resistive material from the
resistor body until the desired predetermined resistance
value is attained. During the abrading or rubbing opera-
tion, rotational movement is imparted to the resistor to
assure a uniform removal of the resistive film from the
body of the helixed resistor.

In another embodiment, for unhelixed resistors, the
apparatus includes a pair of spring-loaded electrical
contact heads on the support arm, in lieu of the roller
units of the said one embodiment, for firmly holding
metallic end caps of the resistor in the transport wheel.
Similarly, as with the apparatus for the helixed resistor,
the measuring control unit measures the resistance of
the resistor and controls the operation of the abrasive
belt to remove resistive material from the resistor body
until the resistor attains the desired resistance value.

In both embodiments, when a resistor has a resistance
value in excess of the predetermined resistance value,
the abrasive belt will not operate. Instead, means are
operated to actuate a marking unit for marking the
resistor.

Other objects, features and advantages will become
more apparent from the following detailed description
when considered in conjunction with the accompanying
drawings, wherein:

FIG. 1 is a cutaway side view of an apparatus em-
bodiment for lifting and rotating a helixed resistor for
a rub-to-value operation therein;

FIG. 2 is a view of a helixed resistor;

FIG. 3 is a cutaway isometric view of one side of the
apparatus of FIG. 1 depicting the lifting and rotating
mechanism thereof;

FIG. 4 is a cutaway side view of another embodiment
of the apparatus for rubbing-to-value unhelixed resistors
held in a fixed position;

FIG. 5 is a view of an unhelixed resistor;

FIG. 6 is a sectional plan view of a holding finger
mechanism of the embodiment of FIG. 4 for holding the
unhelixed resistors in a fixed position;

FIG. 7 is a sectional side view of the holding finger
mechanism shown in FIG. 6; and

FIG. 8 is a schematic diagram of the control circuit
for both embodiments of the apparatus.

Referring now to the drawings, and particularly to
FIG. 1 thereof, an apparatus is illustrated for abrading-
to-value a carbon deposit type of resistor, such as the
resistor 10 shown in FIG. 2, which requires a uniform
removal of resistive material therefrom. The resistor 10
is of the helix type and includes a resistive body portion
11 having a film of resistive material thereon with a
helical groove 12 formed therein, end caps 13—13 con-
nected to the body portion, and leads 14—14 axially ex-
tending from the end caps.

The apparatus includes a frame 15 which is provided
with a raceway 16 having an upper slot 17 for receiving

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and feeding resistors 10 of varying resistance values to a transport wheel 18. The transport wheel is mounted on a shaft 19 and is provided with a plurality of U-shaped grooves 20 spaced equidistantly about the periphery thereof for receiving individual resistors from the raceway upper slot 17.

A drive arm 21 is rigidly connected to the transport wheel 18 and is provided with a pin 22 slidably linked within a slot 23 of a bell crank 24 which is pivotally mounted on a pin 25. An indexing solenoid 26 is operable to actuate the bell crank 24 through an adjustable shaft 27 pivotally connected to the bell crank by a pin 28. Operating in conjunction with the bell crank 24 is a spring 29 which is fastened at one end to the bell crank by a pin 30 and at the other end to a pin 31. A vibrator 32 is connected to the raceway 16 for vibrating and thereby assuring gravity feed of the resistors 10 through the upper slot 17 and subsequently through a lower slot 33 which communicates with a receptacle 59 for receiving resistors from the transport wheel 18.

A support arm 34 is pivotally connected to a drive shaft 35 journaled within the frame 15. The support arm 34 is provided with a drive pulley 36 keyed to shaft 35, a take-up pulley 37, and upper and lower idler pulleys 38 and 39, respectively. An endless belt 40, having a finely distributed abrasive particle surface, is driven about the pulleys 36, 37, 38 and 39 by a motor 41 through a suitable conventional clutch-brake unit 42 connected to a worm gear 43 in mesh with a drive pulley 44 connected to drive shaft 35. A belt lifting spring 45 is connected at one end to a pin 46 on the belt support arm 34 and at its opposite end to a pin 47 on the frame 15 for urging the pivotal support arm in an upward direction. A belt solenoid 48 operates an adjustable shaft 49 pivotally connected to the belt support arm 34 by a pin 49a for pivotally moving the belt support arm about shaft 35.

A lifting and rotating mechanism, generally referred to as 50 and best seen in FIG. 3 for rotating the resistor 10 during the rub-to-value operation, consists of two identical units each connected to the outer surface of the raceway 16 for imparting rotational movement to resistor 10 through the axially extending resistor leads 14-14. To facilitate a description of the lifting and rotating mechanism 50, only one unit, as shown in detail in FIG. 3, will be described, it being understood that another identical unit is located on the other side of the raceway 16.

As depicted, the lifting and rotating mechanism 50 includes a plate 51 attached to the raceway 16. The plate 51 is provided with a channel 52 through which a roller housing 53 is slidably movable, the roller housing being connected to a fixed bracket 54 by a spring 55 urging a downward force on the roller housing. The roller housing 53 is of a conductive material, such as brass, and has a pair of V-shaped grooves 56-56 therein for receiving a resistor during the belt abrading or rubbing operation. extends within the roller housing 53 between the grooves 56-56 for permitting the associated resistor lead 14 to be in rolling contact therewith. A conductor 58 interconnects the roller housing with a suitable, conventional electrical measuring control unit 60 (FIG. 8), the function thereof to be described hereinafter.

A lifting lever 65 is rotatable about a shaft 66 which is secured to a protruding, cylindrical collar 67 formed on or otherwise affixed to the plate 51. The lifting lever 65 is provided at one end with a cam roller 68 in contact with the bottom portion of the roller housing 53 and at the other end with an adjustable, actuating element 69 adaptable to be actuated, when in its upper position, by an actuator 70 extending from the belt support arm 34. The actuator 70 is operable to strike and move the actuating element 69 when the belt support arm 34 is being lowered to bring the rubbing belt 40 into contact with a resistor body 11. In turn, the force of the actuator 70 on the lifting lever 65 causes the latter to pivot clock-

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wise, the cam roller 68 on the lever rotating as it vertically lifts the roller housing 53 upwardly against the force exerted by the spring 55. As the roller housing moves upwardly, the V-shaped grooves 56-56 guide the lead 14 therein and between rollers 57-57 into contact with a spring-loaded plunger 71 which holds the lead against the rollers and V-shaped grooves with sufficient force to assure good electrical contact with the roller housing, yet enabling a subsequent rotation of the resistor during the abrading operation. Also, the resistor end cap 13 is in engagement with a drive roller 72, previously engaged during the index of the transport wheel 18, to rotate the resistor during the belt abrading or rubbing operation.

As best seen in FIGS. 1 and 3, motion is applied to the drive roller 72 through a shaft 73 connected to a sprocket 74 driven by a continuous chain 75. The chain 75 is driven by a first gear 76 which is fixedly mounted on the shaft 35 which also is connected to the belt drive pulley 36, as previously described. A second gear 77 meshes with the first drive gear 76 to rotate a shaft 78 keyed thereto and journaled in the belt support arm 34. In turn, shaft 78 drives a sprocket 79 for moving the continuous chain 75 about sprocket 74 and idler sprocket 80 connected to the belt support arm 34 for maintaining proper tension on the chain 75.

As seen in FIG. 8, a circuit is provided for controlling the operation of the apparatus. The circuit is connected to a power source 85 and is actuated by closing a start switch 86 which energizes a relay 87 to close its normally open contact 87a which permits the switch to be released without reopening the circuit. A normally open contact 87b also is closed by the energization of relay 87, thereby permitting the vibrator 32 (FIG. 1) to vibrate the raceway 16, if desired, by manually closing a switch 88 to facilitate the gravity feed of the resistors.

Current is passed through a normally closed contact 89a of a latch relay 89 to energize the index solenoid 26 through a belt-up microswitch 90 (FIG. 1) which is held closed since the belt support arm 34 is spring retracted in its upward non-contact position with a resistor to be rubbed. The index solenoid 26 operates bell crank 24 to intermittently advance the transport wheel 18 to index a resistor 10 beneath the rubbing belt 40. During an index of the transport wheel, a microswitch 91 (FIG. 1) is actuated to close its contact 91a which energizes latch relay 89, causing the opening of its normally closed contact 89a and simultaneous closing of its normally open contacts 89b and 89c. The index solenoid 26 continues to remain energized through the closed contact 89b. When the transport wheel has moved the angular distance between two contiguous grooves 20-20, index microswitch 91 is urged into a succeeding, adjacently disposed groove 20 of the transport wheel thereby resulting in the opening of its contact 91a, which de-energizes index solenoid 26, and a closing of its contact 91b.

The closing of contact 91b energizes belt solenoid 48 causing the belt support arm 34 to pivotally move downwardly into the rubbing position so that the rubbing belt 40 and resistor 10 are in contacting relationship, the belt support arm opening microswitch 90 and striking and closing belt-down microswitch 92 during its travel. Closing of the microswitch 92 causes the measuring control unit 60 to quickly measure the resistance of a resistor lifted from the transport wheel 18 by the roller housing 53, during the lowering of the support arm, as previously described.

In the event the value of the resistor is less than the prescribed desired resistance value, thereby requiring some removal of the resistive coating from the resistor body 11, the measuring control unit 60 energizes motor 41. In turn, shaft 35 is rotated causing pulley 36 to drive rubbing belt 40 and gear 79 to drive roller 72 to rotate the resistor, thereby resulting in the resistor body 11 being uniformly rubbed by the belt. When the measuring control unit 60 ascertains that the resistor is rubbed to the prescribed

desired resistance value, it causes latch relay 89 to unlatch thereby resulting in contact 89a closing and contacts 89b and 89c opening to release the belt solenoid 48. Accordingly, spring 45 is free to compress thereby causing the pivotal return of the belt support arm 34 to its upward position. When support arm 34 reaches its upward position, it strikes and closes belt-up microswitch 90 which energizes index solenoid 26 to index the transport wheel 18 and thereby ready the apparatus for another cycle.

In the event the resistance value of the resistor, presented to the rubbing belt 40, was in excess of the prescribed desired resistance, the measuring control unit 60 energizes a suitable conventional-type marking unit 95 for marking the resistor body 11 to indicate it could not be rubbed to the desired resistance. After marking, the latch relay 89, in response to the operation of the marking unit 95, unlatches as previously described when a resistor had been rubbed, to index the transport wheel 18 for another cycle.

An alternative embodiment of the apparatus is shown in FIG. 4, for rubbing-to-value resistors of the type which are not required to be rotated during the rubbing operation. For example, a resistor, such as an unhelixed carbon deposited resistor 10', as seen in FIG. 5, which includes a carbon coated body 11', end caps 13'—13', and leads 14'—14' axially extending from the end caps, is not required to be rotated since removal of carbon in any one particular area would not cause an excessive current density thereat and perhaps produce an open circuit. The alternative embodiment, to be described, is precisely the same in structure and function as the preferred embodiment except that a holding finger mechanism 50', as seen in FIG. 4 and shown in detail in FIGS. 6 and 7, is substituted for the lifting and rotating mechanism 50. The holding finger mechanism 50' consists of two units 100—100, each unit mounted on the belt support arm 34 and functioning to engage the end caps 13'—13' of the resistor 10' at the rubbing area to firmly hold the resistor in the transport wheel 18 and to effectuate an electrical connection with the measuring control unit 60. To facilitate a description of the holding finger mechanism 50', only one unit 100 will be described, it being understood that the other unit 100 is identical in structure, function and result.

As depicted in FIGS. 4, 6 and 7, the holding finger member unit 100 includes a body 102 and an opening 103 extending therethrough. An electrically conducting contact head 104 having an inverted V-shaped groove 105 formed therein is connected to one end of the body 102 and normally extends a slight distance beyond the belt 40 when the belt support arm 34 is in the raised position (FIG. 4). A conductor 58' is connected to the contact head 104 and extends through the body opening 103 to the measuring control unit 60. A slot 106 is provided in the body 102 for receiving a set screw 107 therein, the slot forming two stops 108 and 109. A spring 110 is located at the other end of the body 102 for urging a resilient force thereon.

In operation, after a resistor 10' is indexed into the rubbing area, the belt support arm 34 is pivotally moved downwardly in a counterclockwise direction. The contact head 104 engages the resistor end cap 13' and locks it in the V-shaped groove 20' of the transport wheel 18 as seen in FIG. 6, thereby providing good electrical contact with the measuring control unit for measuring the resistance and operating the apparatus, as previously described. Further movement of the belt-support arm 34 to its lowered position, as seen in FIG. 7, causes the rubbing belt 40 to engage the resistor body 11' with sufficient force for the rubbing operation, and the set screw 107 to be positioned at a point just prior to stop 109, as indicated by gap 111.

As previously described in the first embodiment, the resistance value of the resistor 10' is then ascertained, the index solenoid 26 operating the transport wheel 18 to index another resistor 10', after a marking of resis-

tor 10' by marking unit 95, in the event its resistance is in excess of the desired resistance. However, in the event the resistance value of the resistor is within the predetermined resistance, measuring control unit 60 causes motor 41 to energize to operate the rubbing belt 40 which removes a portion of the resistive coating from the resistor body 11' until the predetermined desired resistance is obtained.

In the event there is a faulty condition with the apparatus, such as the belt support arm not returning to its upward position when the desired predetermined resistance is obtained, the abrading action will continue only until the gap 111 is closed, i.e., when set screw 107 engages stop 109. Accordingly, there will be no further contact of the rubbing belt with the resistor body 11' thus precluding any excessive build-up of heat within the resistor and thereby preventing any injury to the apparatus. The apparatus may be stopped at any time by manually opening stop switch 112.

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

What is claimed is:

1. Apparatus for altering a parameter of an electrical component having a film thereon to a predetermined value, which comprises:

a control measuring unit,
means for electrically connecting the component to the control measuring unit for ascertaining the parameter value of the component,
an abrading unit for removing a surface layer of film material from said component upon tangential rubbing contact with said surface,
means for operating the abrading unit, and
means responsive to the control measuring unit for actuating the operating means to cause the abrading unit to remove a portion of the component film until the parameter value of the component is equal to the predetermined value.

2. Apparatus for altering a parameter of an electrical component having a film thereon to a predetermined value, which comprises:

means for indexing a component to a prescribed area,
a control measuring unit,
means for electrically connecting the component to the control measuring unit at the prescribed area for ascertaining the parameter value of the component,
an abrading unit for removing a surface layer of film material from said component upon tangential rubbing contact with said surface,
means for operating the abrading unit, and
means responsive to the control measuring unit for actuating the operating means to cause the abrading unit to remove a portion of the component film until the parameter value of the component is equal to the predetermined value.

3. Apparatus, according to claim 2, wherein the electrical connecting means includes a clamping mechanism operable in response to the indexing means, said clamping mechanism including a pair of resilient elements having contact head portions for securely contacting and holding the component during the operation of the abrading unit.

4. Apparatus, according to claim 3 wherein each of the resilient elements is provided with a slot therein defining at least one stopping surface, and a projecting element is located within the slot for engaging said one stopping surface during the operation of the abrading unit for preventing any excessive abrading action by said unit on the component.

5. Apparatus for adjusting the resistance value of a resistor to a predetermined resistance value, said resistor

having a body portion with a resistive coating thereon, conductive caps located at each end of the body portion, and conducting leads axially extending from the end caps, said apparatus comprising:

a control measuring unit,
a rotatable wheel having a plurality of notches spaced equidistantly about the periphery thereof for receiving the respective end caps of the resistor therein, means for intermittently indexing the wheel to present a resistor to a prescribed area,

means for electrically connecting the resistor at the prescribed area to the control measuring unit for ascertaining the resistance value thereof, said means including a clamping mechanism having a pair of resilient elements provided with contact head portions for contacting the resistor end caps and securely holding the resistor in a fixed position,

an abrading unit having an endless abrasive belt, means for moving the endless belt into contact with the resistive coating of the resistor,

means responsive to the control measuring unit for actuating the abrading unit, if the resistance value of the resistor is less than the predetermined resistance value to cause the abrading unit to remove at least a portion of the resistive coating of the resistor until the resistance value of the resistor is equal to the predetermined value,

a marking unit, and

means responsive to the control measuring unit for actuating the marking unit, if the resistance value of the resistor is in excess of the predetermined resistance value, to cause a marking to be applied onto the resistor to indicate a resistance value in excess of said predetermined value.

6. Apparatus for adjusting the resistance value of a resistor to a predetermined resistance value which comprises:

a control measuring unit,
means responsive to the control measuring unit for indexing a resistor to a prescribed area,

means for electrically connecting the resistor to the control measuring unit at the prescribed area for ascertaining the resistance value thereof,

an abrading unit,

means for operating the abrading unit,

means responsive to the control measuring unit for actuating the operating means, in the event the resistance value of the resistor is less than the predetermined resistance value, to cause the abrading unit to abrade at least a portion of the resistor until the resistance value of the resistor is equal to the predetermined resistance value,

a marking unit, and

means responsive to the control measuring unit for actuating the marking unit, in the event the resistance value of the resistor is in excess of the predetermined resistance value, to cause a marking to be applied onto to resistor to indicate a resistance value in excess of said predetermined value.

7. Apparatus for adjusting the resistance value of a resistor to a predetermined resistance value, which comprises:

a control measuring unit,

means for indexing a resistor to a prescribed area, an abrading unit for removing a surface layer of resistive material from said resistor upon tangential rubbing contact with said surface,

means for operating the abrading unit,

lifting means for electrically connecting said resistor with the control measuring unit to ascertain the resistance value of the resistor,

means for providing relative movement between the lifting means and abrading unit, and

means responsive to the control measuring unit for actuating the operating means to cause the abrading

unit to abrade at least a portion of the resistor until the resistance value of the resistor is equal to the predetermined value.

8. Apparatus, according to claim 7, including means for rotating the resistor, and

means responsive to said control measuring unit for operating the rotating means to rotate the resistor during the abrading thereof by the abrading unit.

9. Apparatus, according to claim 7, wherein the resistor includes a body portion having a resistive coating thereon and the abrading unit includes an endless belt having a surface of finely distributed abrasive particles thereon for uniformly removing a portion of the resistive coating of the resistor.

10. Apparatus, according to claim 7, wherein the resistor is provided with a body portion having a resistive coating thereon, a pair of metallic caps connected to opposite ends of the body portion and conducting leads axially extending from the metallic caps, and said indexing means includes:

a rotatable wheel having a plurality of pairs of grooves each spaced equidistantly thereabout, the respective pairs of grooves being adaptable for holding the respective metallic caps of a resistor during indexing and the abrading action by the abrading unit.

11. Apparatus for adjusting the resistance value of a resistor to a predetermined value, wherein the resistor has a body portion with a resistive coating thereon, a pair of metallic caps on the opposite ends of the body portion and conductive leads extending axially from the end caps, the combination comprising:

a control measuring unit,

an abrading unit,

means for operating said abrading unit,

means for indexing the resistor to a prescribed area and including a rotatable wheel having a plurality of pairs of grooves each spaced equidistantly about the wheel, the respective pairs of said grooves are designed to hold respective metallic caps of a resistor during indexing and abrading action by said abrading unit,

lifting means for electrically connecting said resistor with the control measuring unit to ascertain the resistance value of the resistor,

means for providing relative movement between the lifting means and abrading unit,

means responsive to the control measuring unit for actuating the operating means to cause the abrading unit to abrade at least a portion of the resistor until the resistance value of the resistor is equal to the predetermined value,

said lifting means including:

a movable member having a pair of opposing notches therein,

a pair of rollers extending between said opposing notches, and

means for moving said movable member so that the opposing notches guide the axially extending leads of the resistor between the rollers of the roller pair and into contacting relationship with said electrical connecting means.

12. Apparatus for adjusting the resistance value of a resistor to a predetermined value, wherein the resistor has a body portion with a resistive coating thereon, a pair of metallic caps on the opposite ends of the body portion and conductive leads extending axially from the end caps, the combination comprising:

a control measuring unit,

an abrading unit,

means for operating said abrading unit,

means for indexing the resistor to a prescribed area and including a rotatable wheel having a plurality of pairs of grooves each spaced equidistantly about the wheel, the respective pairs of said grooves are designed to hold respective metallic caps of a resistor

during indexing and abrading action by said abrading unit,
 lifting means for electrically connecting said resistor with the control measuring unit to ascertain the resistance value of the resistor,
 means for providing relative movement between the lifting means and abrading unit,
 means responsive to the control measuring unit for actuating the operating means to cause the abrading unit to abrade at least a portion of the resistor until the resistance value of the resistor is equal to the predetermined value, and
 roller means responsive to said control measuring unit for rotating the resistor end caps within the wheel grooves during the abrading of the resistive coating of the resistor by the abrading unit.

13. Apparatus for adjusting the resistance value of a resistor to a predetermined resistance value, said resistor having a body portion with a resistive coating thereon, conductive caps located at each end of the body portion, and conducting leads axially extending from the end caps, said apparatus comprising:

- a control measuring unit,
- a rotatable wheel having a plurality of pairs of grooves each spaced equidistantly thereabout for receiving the respective end caps of a resistor therein,
- means for intermittently indexing the rotatable wheel to position a resistor at a prescribed area,
- an abrading unit including an endless belt having a surface of finely distributed abrasive particles thereon,
- means for operating the abrading unit,
- means for electrically connecting the resistor at the prescribed area to the control measuring unit for ascertaining the resistance value of the resistor,
- means for lifting the axially extending leads of the resistor into contact with the electrically connecting means, said lifting means including a movable member having a pair of opposing notches therein, a pair of rollers extending between said opposing notches, and means for moving said movable member so that the opposing notches guide the axially extending leads of the resistor therein and between the rollers of said roller pair,
- means for providing relative movement between the lifting means and the abrading unit so that said resistor is in contact with the electrical connecting means and abrading unit,
- means responsive to the control measuring unit for actuating the abrading unit operating means, in the event the resistance value of the resistor is less than the predetermined resistance value, to cause the endless belt to remove at least a portion of the resistive coating of the resistor until the resistance value of the resistor is equal to the predetermined value,
- means responsive to the control measuring unit for rotating the resistor within its respective pair of

grooves on the wheel during the actuation of the abrading unit, and
 a marking unit, and
 means responsive to the control measuring unit for actuating the marking unit, in the event the resistance value of the resistor is in excess of the predetermined resistance value, to cause a marking to be applied onto the resistor to indicate a resistance value in excess of said predetermined value.

14. Apparatus for adjusting the resistance value of a resistor having a surface of resistive material to a predetermined value comprising:

- means for indexing a resistor to a prescribed area,
- control measuring means for measuring the value of said resistor and comparing said value to the predetermined value,
- means for electrically connecting the resistor at the prescribed area to said control measuring means for ascertaining the resistance value of said resistor,
- an abrading unit for removing a surface layer of resistive material from said resistor upon tangential rubbing contact with the surface thereof, said abrading unit having an "on-off" operating status and is in rubbing contact with said resistor during its "on" status,
- means for operating said abrading unit, and
- means responsive to the control measuring means for actuating the operating means if the measured resistance is less than the predetermined value to cause the abrading unit to remove a portion of the resistive surface until the resistance measured by the control measuring means equals the predetermined value whereupon said operating means is deactuated and abrasion of the resistor ceases.

15. Apparatus as defined in claim 14 wherein the electrical connecting means includes:

- means for clamping across the opposite resistor ends when the indexing means locates the resistor at the prescribed area and to permit the control measuring means to measure the resistance value of said resistor prior to and during abrasion of said resistor.

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LESTER M. SWINGLE, *Primary Examiner.*

U.S. Cl. X.R.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,438,155 Dated April 15, 1969
Inventor(s) Francis L. Bouvier; Roy C. Carolson, Jr.; Charles W. Higgins; John J. Kelley; and Norman F. Smith

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 56, cancel "during the belt abrading or rubbing operation" and insert --lead 14. A pair of rollers 57-57 is mounted and--.

SIGNED AND
SEALED
MAR 10 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents