United States Patent

Atchley et al.

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[45] **Aug. 15, 1972**

[54] **COATING APPARATUS**

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[21] Appl. No.: **32,141**

[52] **U.S. Cl.** .....**118/50,** 118/230, 118/261, 214/1 BS, 279/3

[51] **Int. Cl.** **B05c 1/00,** B25h 5/08

[58] **Field of Search**.....118/50, 50.1, 219, 230; 214/1 BH, 1 BV

[56] **References Cited**

UNITED STATES PATENTS

3,498,258	3/1970	Swaisgood	118/50
2,821,158	1/1958	Brown et al.	118/2
2,289,862	7/1942	Bailey	118/223 C
R11,997	5/1902	Thomson et al.	118/223 X
2,419,484	4/1947	Danziger	118/230 X
2,004,492	6/1935	McNamara et al.	214/1 BS X
3,414,959	12/1968	Konazewski et al.	269/21 X
2,860,761	11/1958	Kocan et al.	214/1 BS X
2,359,432	10/1944	McNamara	214/1 BS
2,479,663	8/1949	Andrew et al.	118/DIG. 3
2,770,214	11/1956	Ryckman	118/230 X

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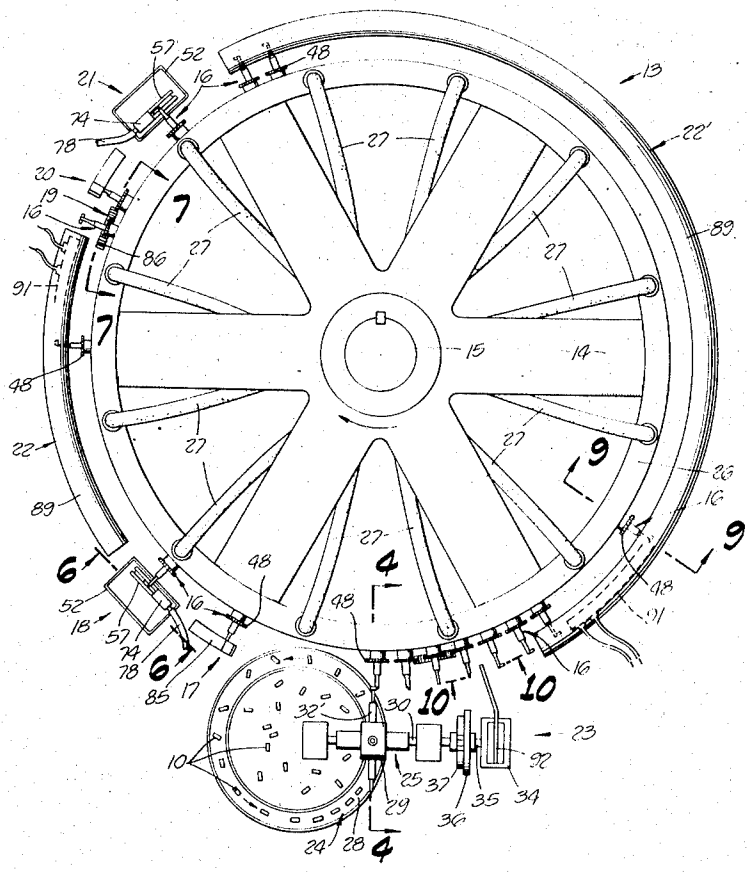
[57] **ABSTRACT**

Capacitors are transferred one at a time by a vacuum feed chuck to one of a plurality of vacuum mounting heads which are moving along a definite path. As the capacitors are conveyed along the path, and exposed portion thereof to be coated is submerged to a prescribed depth in a liquid coating material. Next the vacuum mounting head is rotated to expose a further portion of the item to be coated in operating orientation, after which this portion then receives a coating as before. The freshly coated part is then passed through a lehr where the coating material is heat hardened. Finally, the capacitor is contacted by an arm as the vacuum head carrying it moves along the path, thereby disengaging it from the head and allowing it to drop into a receptacle.

5 Claims, 11 Drawing Figures



PATENTED AUG 15 1972

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FIG. 1.

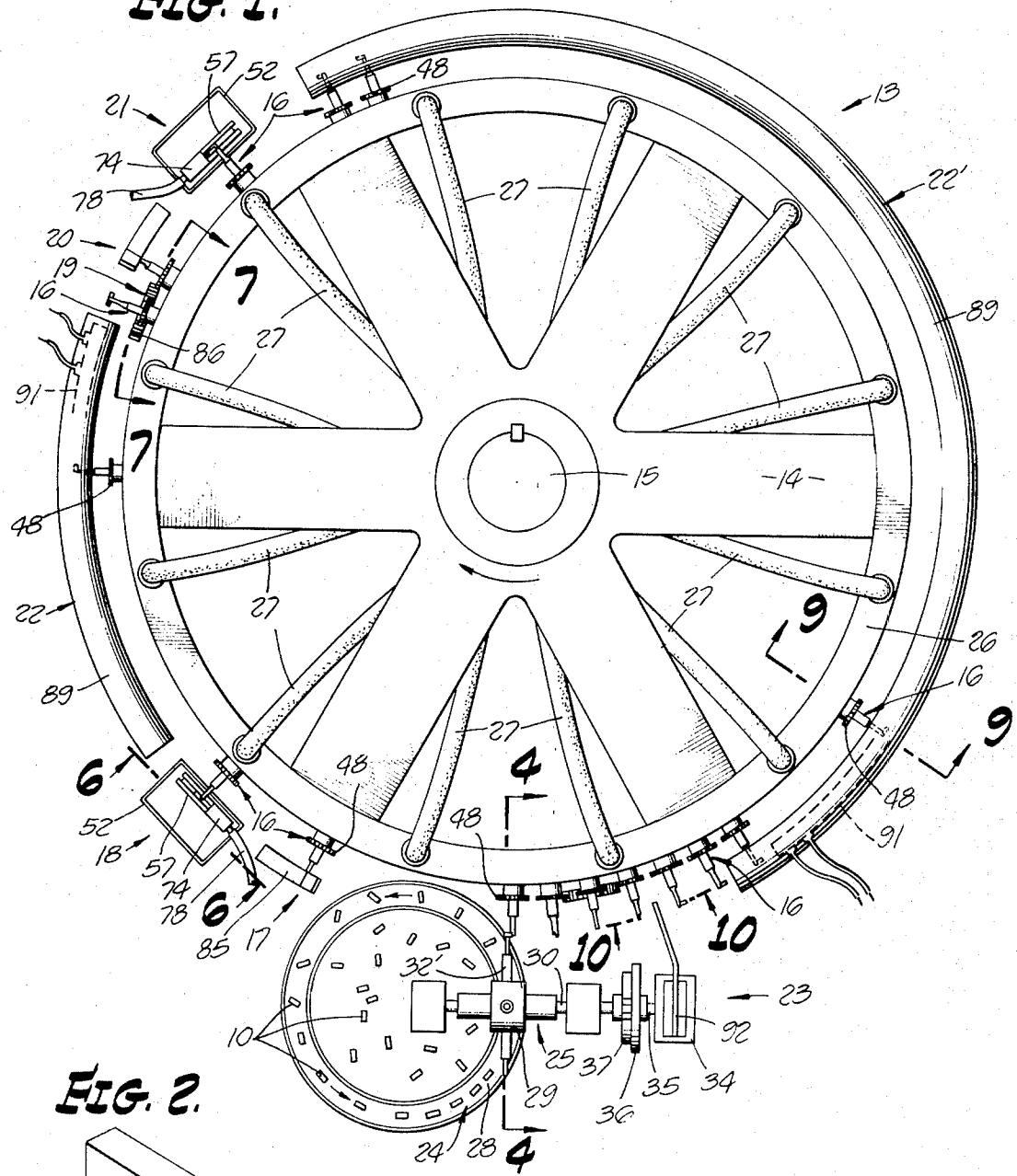
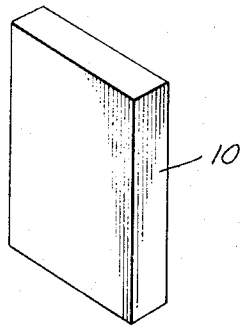


FIG. 2.



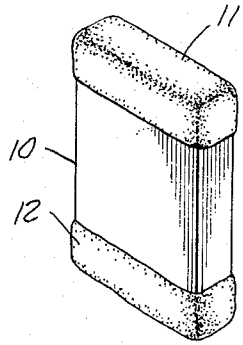


FIG. 3.

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FIG. 4.

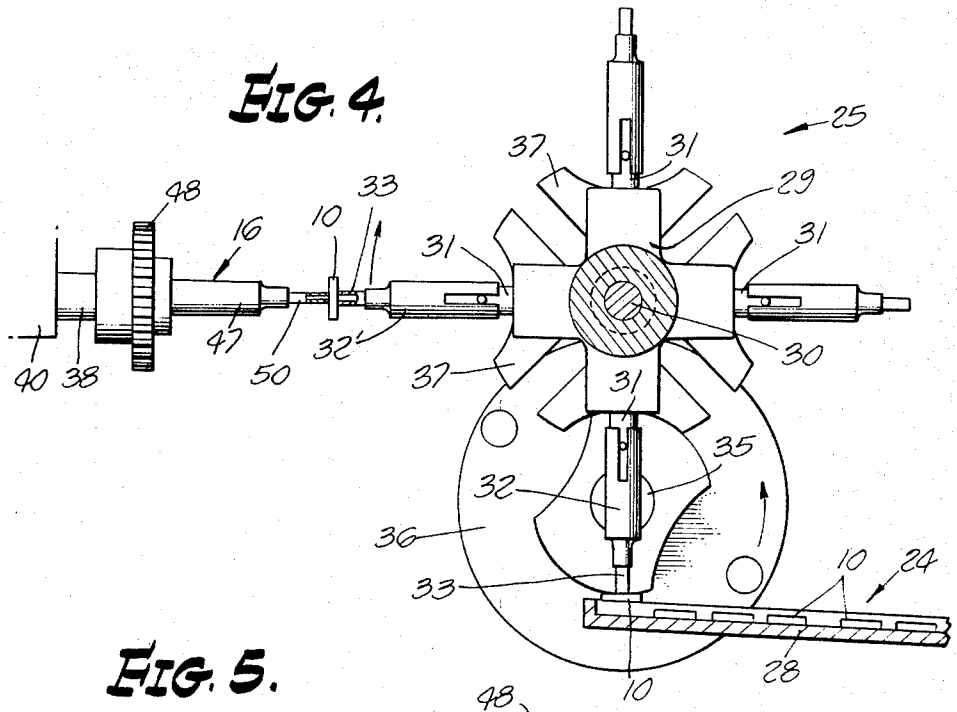


FIG. 5.

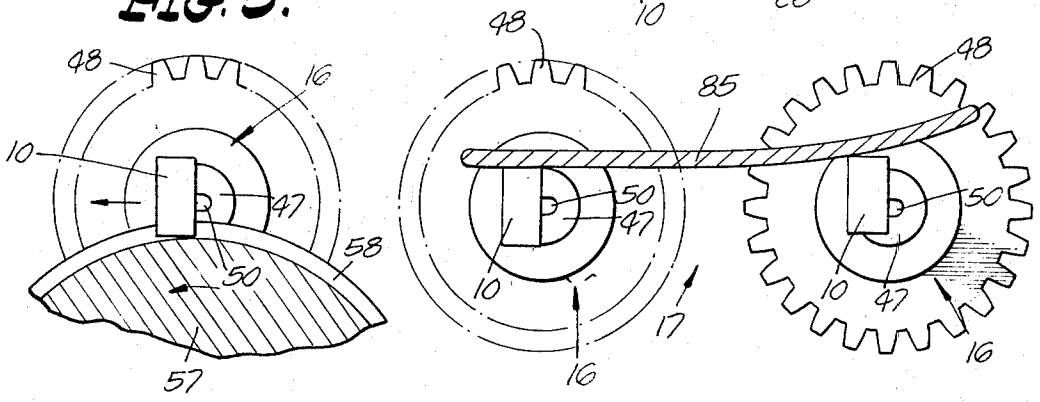


FIG. 9.

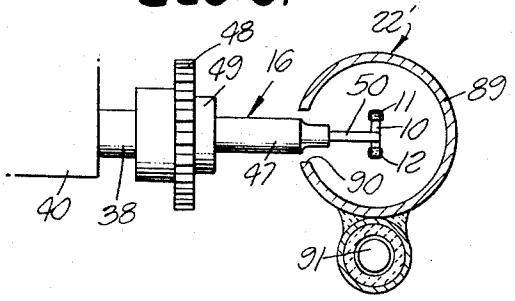
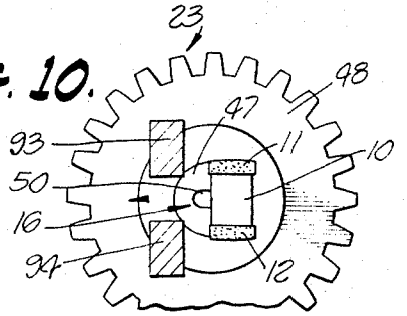


FIG. 10.



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SHEET 3 OF 3

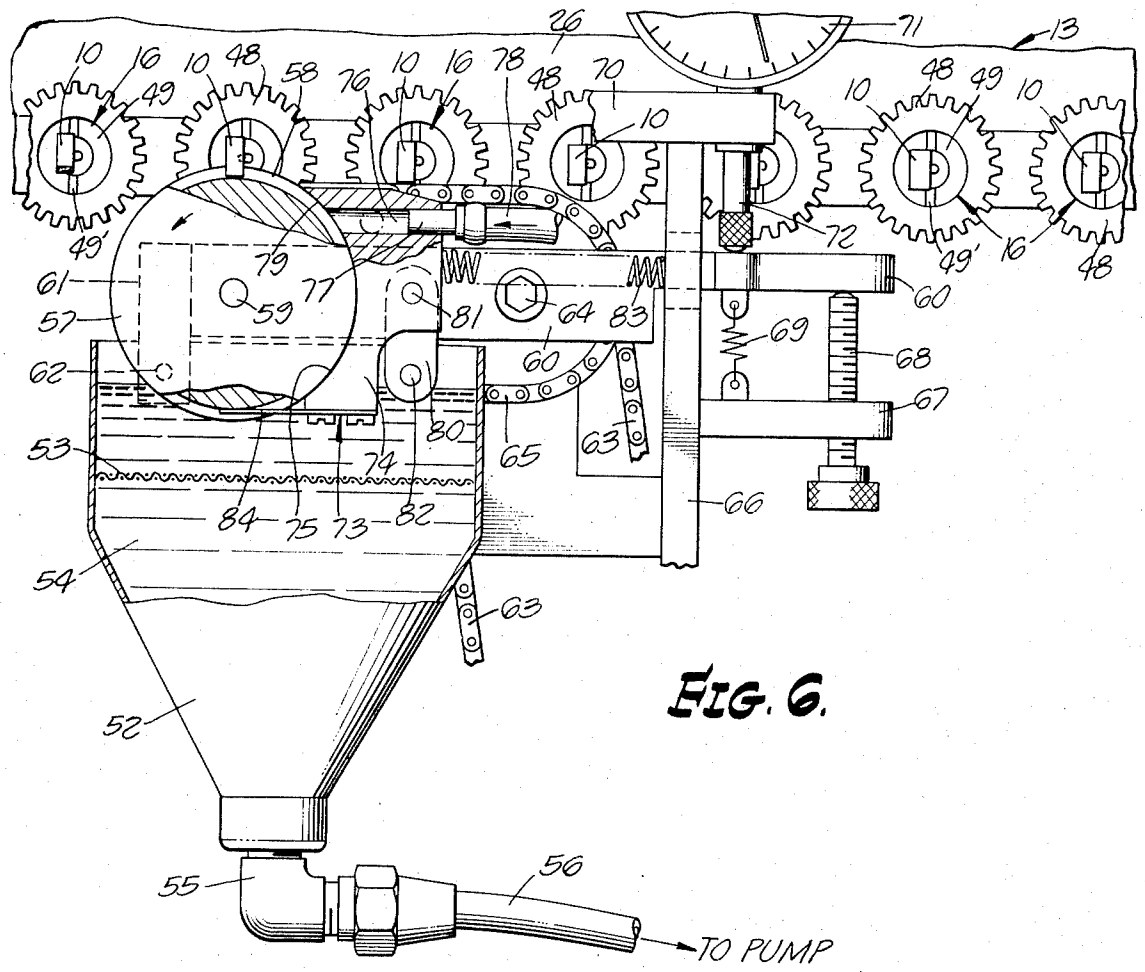

FIG. 6.

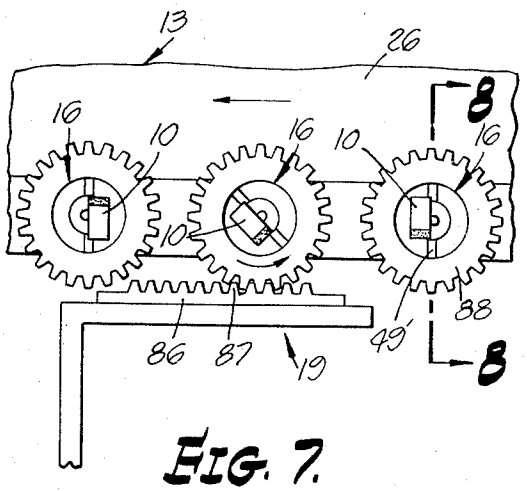

FIG. 7.

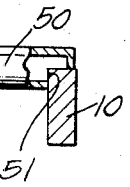

FIG. 11.

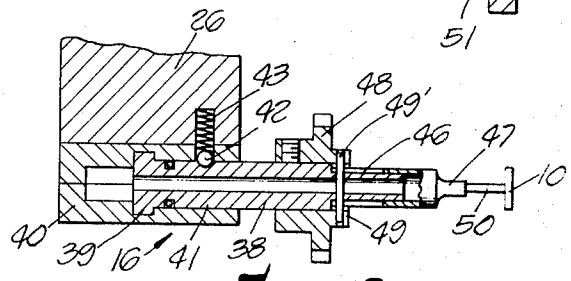

FIG. 8.

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COATING APPARATUS

The present invention relates generally to electrically conductive coatings, and, more particularly, to the provision of such coatings on electrical and electronic devices to serve as connective electrodes.

Along with the ever increasing tendency towards reduction in size of electronic circuits and circuit components, a concomitant problem has been the provision of conductive electrodes on such circuits or components by which they may be connected to other circuits or apparatus. That is, although the individual items to which the electrodes are applied are relatively small, requiring the electrodes to be commensurately small, such electrodes still must be of sufficient size and rugged enough to permit adherence thereto of, say, a wire or other lead element. In addition to being strong enough to support final connection in a circuit with other apparatus, it is conventional to subject the circuit or component to one or more testing operations which require disturbing the electrode with a temporary connection for each such test.

In the past, for example in the fabrication of small sized capacitors, final connecting electrodes have conventionally been applied by hand dipping or hand painting of a conductive liquid onto prescribed areas of the capacitor which, after drying and heat curing, sets up to provide a finished electrode. Hand dipping or hand application of electrodic coatings have not been completely satisfactory for a number of reasons. First of all, hand coatings are very difficult to apply uniformly over precisely defined small areas. Also, it is highly advisable that the thickness of such coatings be maintained uniform in order not to induce a spurious electrical resistance factor and this is difficult to obtain in a hand operation. Still further, coating materials have not infrequently been accidentally applied to other regions of the capacitor during hand painting, which might give occasion for an electrical short. Lastly, and perhaps most important, hand application of electrodes adds a considerable labor cost to the overall manufacturing expense.

SUMMARY OF THE INVENTION

In the practice of the present invention, a plurality of capacitors to be provided with coated electrodes are arranged seriatim by a vibrator feeder and with uniform orientation. The capacitors are transferred one at a time by a vacuum feed chuck to one of a plurality of vacuum mounting heads forming a conveyor which moves along a definite path. As the capacitors are conveyed along the path, an exposed portion thereof to be coated is submerged to a prescribed depth in a liquid coating material. Next the vacuum mounting head is rotated to expose a further portion of the item to be coated in operating orientation, after which this portion then receives coating as before. The freshly coated part is then passed through a lehr where the coating material is heat hardened. Finally, the capacitor is contacted by an arm as the vacuum head carrying it moves along the path, thereby disengaging it from the head and allowing it to drop into a receptacle. The capacitors may be subjected to a conventional firing at an elevated temperature to fully cure the coatings.

As a further aspect of the invention, it is contemplated that there may be cases in which it is desirable to provide conductive electrodes on a capacitor of a greater thickness than would normally be accomplished by a single dip and cure process. To achieve this, there are an odd number of vacuum mounting heads on the conveyor and the capacitors are loaded onto every other vacuum mounting head. Each capacitor makes two passes through the coating and drying equipment, and after the first loaded capacitor is double-coated, synchronized removal of every other capacitor beginning with the first is instituted. As in the case of a single dip, the coated capacitors are later fired at an elevated temperature to fully cure the coatings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a preferred form of apparatus for providing coated electrode terminals in accordance with the process of this invention.

FIG. **2** is a perspective view of a typical capacitor illustrated before coated terminals are applied.

FIG. **3** is a perspective view of the capacitor of FIG. **2** depicted with coated terminals.

FIG. **4** is a plan, partially sectional, view of a vacuum chuck for transferring uncoated capacitors from a supply receptacle to the coating conveyor taken along the line **4—4** of FIG. **1**.

FIG. **5** is an enlarged, elevational view of capacitors mounted on the coating conveyor showing precision locating of the capacitors immediately prior to coating.

FIG. **6** is an elevational, partially sectional view of the coating apparatus taken along line **6—6** of FIG. **1**.

FIG. **7** is an elevational view of means for changing the capacitor orientation after coating of one terminal and prior to coating another terminal, taken along the line **7—7** of FIG. **1**.

FIG. **8** is a sectional view taken along the line **8—8** of FIG. **7**.

FIG. **9** is a sectional view depicting a freshly coated capacitor within a curing lehr.

FIG. **10** is a sectional, elevational view of a coated capacitor immediately prior to removal from the coating apparatus.

FIG. **11** is an enlarged fragmentary view of a vacuum retention means.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference now particularly to FIGS. **2** and **3**, a typical capacitor to which electrode terminals are to be applied is shown at **10** and includes a generally rectangular parallelepiped body form of an insulative material containing the capacitor electrodes within. As shown best in FIG. **3**, in the practice of this invention coated terminals **11** and **12** are formed on the margins of two opposite sides. Each terminal consists of a continuous cap of conductive material enclosing the respective side and margin of the capacitor and in electrical contact with portions of the capacitor electrodes or plates (not shown) which extend outwardly of the insulative body. The coatings **11** and **12** are of uniform thickness and extend inwardly of the capacitor edge a precise predetermined amount.

As seen from above in FIG. **1**, the apparatus of the invention, enumerated generally as **13**, includes wheel shaped conveyor **14** powered to rotate about a central axis **15**. A plurality of vacuum mounting heads **16** rotatably secured to the periphery of the conveyor in-

dividually carry the capacitors **10** successively through a first capacitor alignment station **17**, first coating apparatus **18**, capacitor edge orientation station **19**, second capacitor alignment station **20**, second coating apparatus **21**, a pair of drying lehrs **22** and **22'** and a discharge station **23**.

In a way that will be more particularly described later herein, a plurality of uncoated capacitors **10** uniformly arranged in a line as at **24** by a conventional vibrator feeder are picked up one at a time and transferred to a vacuum mounting head **15** by a vacuum loading chuck **25** for processing as described above.

More particularly, the conveyor **14** includes a peripheral circular member **26** which includes a plurality of separate internal vacuum manifolds connected with a suitable air pump (not shown) by conduits **27**.

For the following description of the vacuum loading chuck **25** construction, reference is made particularly to FIG. **4**. An upper tray portion **28** of the vibratory feeder with the line of commonly oriented capacitors **24** is located below and outwardly of the vacuum mounting heads **16**. As the capacitors are transferred to the conveyor, the vibratory feeder moves the capacitor line in the direction of the arrow to continuously maintain a capacitor in the leftmost or loading position.

The vacuum chuck **25** includes a cross-shaped body portion **29** affixed to an axially located shaft **30** for rotation therewith. At the outer end of each of the body portion arms, which arms are at **90**-degree separation, there is provided an axially aligned hollow tube **31** onto which is removably received a sleevelike transfer head **32**. The head **32** terminates in a hollow open-ended tube **33**, the bore of which communicates through the bore of the head **32**, tube **31** and passageway within the body portion **29** to a source of supply of low-pressure air (not shown). By means of a rotative power source **34** (FIG. **1**) acting through the shaft **35**, cam **36** and cam follower **37**, the body portion **29** is successively indexed in 90 degree increments. The special cam and cam follower **36**, **37** arrangement is what is conventionally referred to as a Geneva mechanism and details of operation are well known to those skilled in the art.

When a transfer head **32** is indexed into the lowermost position with the open end of tube **33** disposed opposite the first capacitor **10** in the line **24**, a synchronized switch means (not shown) connects the bore of the tube **33** with a conventional vacuum pump (not shown). In this manner the capacitor is held to the end of the tube **33**.

Next, the body portion **29** is indexed a further 90 degrees, bringing the uncoated capacitor just picked up from the line **24** to a position of engagement with the outermost end of a vacuum mounting head **16** as it moves therepast. Shortly after the capacitor engages a head **16**, the synchronizing means disconnects the vacuum pump from the transfer head **32'** holding the same capacitor, thereby transferring the capacitor to the conveyor mounting head **16**, the specific retaining means being described below.

Turning now particularly to FIG. **8**, each vacuum mounting head **15** includes a cylindrical shaft **38** with an inner flanged end **39** rotatably received in a suitably shaped opening of an outer wall **40** of the conveyor peripheral member **26**. The outer surface of the shaft **38** within the wall **40** includes a pair of diametrically opposed recesses **41**, which are so arranged as to receive a ball detent **42** carried within an opening in the wall **40**. A coil spring **43** urges the detent against the shaft **38** and in that way two fixed rotational positions or stops exist at those points where the ball detent engages the recesses **41**.

The outer end of the shaft **38** includes a reduced diameter portion **46** onto which is received a hollow, sleevelike capacitor retaining member **47**. A spur gear **48** fits on the outer end of the larger diameter portion of the shaft **38** and includes a slotted hub **49** via which a pin **49'** secures the gear, retaining member **47** and shaft **38** together as a unit. The retaining member **47** has a flattened tubular end **50** with a notch or recess **51**. When a source of lowered air pressure is connected to the manifold associated with the respective mounting head, a capacitor is retained within the recess **51** by the air pressure force operating on both the facing surface and edge of the capacitor received in the recess. It is to be particularly noted that the relative dimensions of the capacitor and recess **51** are such that the bore opening within the recess is completely covered when the capacitor is retained therein.

As seen best by comparing FIGS. **7** and **8**, the stop recesses **41** are so located as to orient the side of the capacitor retained within **51** in a vertical position. That is, when the ball detent **42** resides within one of the recesses **41**, a first end of the capacitor is, say, pointed downwardly, whereas rotating the gear **48** and shaft **38** to engage the ball **42** within the other recess **41** brings that same capacitor end to an upwardly directed position.

The detailed construction of the coating apparatus **18** and **21** is seen best in FIG. **6**. As open-ended tank **52** is fixedly mounted adjacent the conveyor **14** with its open end located under the capacitor path of movement. A mesh screen **53** for straining the liquid coating material **54** is anchored to the tank wall at a point substantially spaced from the open end. A fitting **55** in the bottom of the tank connects the coating material via a hose **56** to a circulating pump (not shown) for removing the coating material from the tank.

A coating wheel **57** with a peripheral groove **58** of uniform and predetermined depth is mounted on a horizontally disposed axle **59** for rotation therewith, which axle, in turn, is rotatably journaled in an elongated swivel plate **60**. An L-shaped extension arm **61** integral with the plate **60** is pivotally affixed to the tank wall **52** as at **62**, affording precise vertical positioning of the coating wheel upon vertical adjustment of other end of the plate **60**. Rotative drive for the wheel **57** is provided from a power source (not shown) via a first sprocket chain **63**, a first sprocket (not shown) affixed to a shaft **63** passing through plate **60**, a second sprocket pinned to the shaft **63**, a second sprocket chain **64**, and a further sprocket (not shown) affixed to the axle **59** and located behind the coating wheel as depicted in FIG. **6**.

A support **66** fixedly mounted with respect to the tank **52** includes an extension arm **67** having a threaded stop **68** for engaging the outer margin of the plate **60**. A coil spring **69** interconnects the plate **60** and arm **67** urging them toward one another. Adjustment of the threaded stop **68** raises or lowers the end of plate **60**, as the case may be, to position the coating wheel **57** ac-

cordingly. The upper end of the base **66** includes a table **70** for supporting a surface gage **71**, the actuating or measuring arm **72** of which extends downwardly of the table to engage the upper surface of the plate **60** and measure the vertical position of the plate from a threshold plane in a conventional manner.

Means for applying coating material liquid or slurry to the wheel groove **58** and for removing the same is identified generally by the reference numeral **73**. This means comprises a body member **74** having a curved concave portion **75** closely fitting about a corresponding part of the coating wheel circumferential periphery. A passageway **76** extending completely through the body **74** has its inner opening emptying into the wheel groove in the upper reaches of the wheel and its outer opening connected via a tubular fitting **77** and hose **78** to receive coating liquid or slurry from the pump. That is, coating slurry strained by the mesh **53** is removed from the tank **52** via fitting **55** and hose **56** and then pumped back through hose **78**, fitting **77** and passageway **76** to fill the groove **58**. The curved beveled wall surface **79** contacts the wheel periphery and serves to smooth the coating slurry upper surface in the groove and thereby insure continuous uniform depth during application to the capacitor, as will be described.

An elongated member **80** has its two ends pivotally secured to the body member **74** and tank wall **52** at **81** and **82**, respectively, thereby affording the means **73** movement following corresponding movement of the wheel **57**. A compression coil spring **83** engaging the outer end of body member **74** and the support base **66** resiliently urges the means **73** against the wheel **57**.

On a lower surface of the member **74** is affixed a thin springlike metal blade **84** having an outer end of such dimensions and so located as to ride in the bottom of groove **58** at the lowermost wheel position. As the wheel rotates in the direction of the arrow, the blade strips out the coating material, preventing a buildup which could impair capacitor coating. The stripped off coating slurry falls into the tank and is strained and recirculated as already described.

In the event that relatively short capacitors are to be dipped by the described technique, it is important that the capacitor edge to be coated be specially aligned. The first alignment station **17** is located immediately adjacent and prior to the first coating apparatus **18**. More particularly, as is shown in FIG. **5**, the alignment apparatus includes an elongate, slightly downwardly curving plate **85**, located above the centerline of the mounting heads **16** to engage the upper edges of the capacitors as they move therepast and urge them downwardly. That is, the plate **85** positions the short capacitors low enough so that the lower capacitor edges will all contact the bottom wall of the wheel groove **58** and in this manner insure that the lower edge of each capacitor is coated to an extent equal to the groove depth. If the capacitor is sufficiently long, alignment by the apparatus at **17** and **20** may be eliminated since the capacitor lower edge will automatically bottom in the groove **58**.

After a capacitor has one margin coated as described, it is conveyed through the lehr **22** to the capacitor orientation station **19** and rotated to dispose another margin to be coated in the lowermost position.

Turning to FIG. **7**, the capacitor orientation station **19** is seen to include a horizontal rack **86** fixedly mounted adjacent the conveyor **14** and presenting a set of upwardly directed rack teeth **87** for engaging and rotating the gears **48** as they move therepast. The number of teeth **87** in the rack are such that an incoming gear **88**, carrying a capacitor with its lower edge coated, will be rotated **180** degrees on passing through the station locating the coated edge in the uppermost position and aligning a capacitor edge in the lowermost position for subsequent coating. It will be recalled on reference to FIG. **8** that both coating positions are accurately defined by the detent ball **42** engaging the respective recesses **41**.

After orienting the capacitor in **19**, it is optionally aligned in the second alignment station **20**, which is identical to the station already described and depicted in FIG. **5**. The capacitor then has its newly positioned lower edge coated in the second coating apparatus **21**, the latter being identical to the apparatus **18** previously described.

The capacitor with two opposite sides coated is next conveyed through a heating lehr **22** where the coating material sets up into hardened terminals. As seen on comparing FIGS. **1** and **9**, the lehr comprises a hollow elongated cylindrical tube **89** which is curved to accommodate the curvature of the circular member **26**. The tube **89**, as shown best in FIG. **9**, is fixedly mounted adjacent the path of travel of the capacitors carried by mounting head **16** and includes a slotted opening **90** in the inwardly directed wall extending throughout its length through which the vacuum mounting heads **16** extend. An electrical resistance heater **91** is integrally affixed to the lower wall of the tube **89** for heating the tube bore in a conventional manner. In practice, a coated capacitor **10** is conveyed along the central portion of the tube bore and is heated to such a temperature and for an extent of time sufficient to set up the coating material.

Reference is now made to FIGS. **1** and **10** and the details of the discharge station **23**. Essentially, the station **23** includes a fixedly mounted arm **92**, the end portion of which is slotted and located to engage a conveyed capacitor as it moves along the definite path. More particularly, the slotted end elements **93** and **94** are so spaced vertically that the head **16** passes through the slotted wall while the members **93** and **94** engage a capacitor carried thereby and remove it from retention by the head **16**. A removed, fully coated capacitor is permitted to fall by gravity into a suitable receptacle.

Although the capacitors are now provided with hardened terminal coatings, they are not sufficiently formed to permit adhering an electrical lead by soldering or other means. Depending on the particular coating material used, the usual final step is to fire the capacitors at an elevated temperature for a prescribed period of time to fully cure the coatings. For example, in an actual construction using a coating slurry including powdered ceramic and metal, the capacitors are fired to a temperature of approximately 1,500 degrees F.

The total number of heads **16** on the conveyor has been purposely made odd in order to permit ready use of the aforedescribed apparatus for double-dipping a capacitor. To achieve this, the capacitors are loaded

onto every other head **16** and make two complete passes through the equipment. As the first loaded capacitor finishes its second pass, and thus has both its terminals **11** and **12** double-dipped, the removal apparatus **23** is synchronized (by apparatus not shown) to remove every other capacitor beginning with the first one loaded. In this way, the same apparatus can be optionally utilized to provide single- or double-dipping runs.

What is claimed is:

1. Apparatus for coating the ends of elongated articles, comprising:

a conveyor turret including a plurality of vacuum chucks for indexing said articles through a loading station, at least one coating station, at least one heat treating station and an unloading station;

each of said chucks including a notched face conforming to the configuration of an elongate section of the article received thereat;

means feeding said articles to a transfer turret having a plurality of vacuum chucks;

said turrets being disposed and synchronized in movement whereby opposed chucks are paired in cooperative association to effect transfer of said articles from the transfer turret chuck to the notched face on the conveyor turret chuck;

means effecting said transfer of articles including valve means which at the time of common contact of an article with a pair of opposed chucks is adapted to connect the conveyor chuck to a vacuum source while simultaneously removing such vacuum from the transfer chuck;

a non-planar guide plate overlying the path of conveyor chuck travel and contacting an end face of the article conveyed whereby to slide said article along the notched portion of the conveyor chuck to effect a predetermined alignment of the other end of said article with respect to the coating means at said coating station; and

a coating means including a circumferentially grooved roller partially immersed in a pool of coating material and positioned to receive said other article end in said groove.

2. Apparatus as in claim **1** including means disposed subsequent to the heating station and adapted to rotate each conveyor chuck thereby inverting the article carried.

3. Apparatus as in claim **2** including additional coating and heating stations disposed subsequent to the means to rotate and operatively associated with the conveyor turret whereby each end of said article is coated.

4. Apparatus as in claim **1**, in which said grooved roller is axially rotated during article coating in such direction that the portions of the roller immediately adjacent the article are moving in the same general direction as the article indexing movement.

5. Apparatus as in claim **1**, in which the unloading station includes a fixedly mounted arm which engages a coated article as it is indexed through said unloading station and removes it from the associated conveyor turret vacuum chuck.

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