Feb. 9, 1965 F. S. WEISS 3,168,885

METHOD AND APPARATUS FOR THE MANUFACTURE OF CAPACITORS

Filed March 13, 1959 4 Sheets-Sheet 1

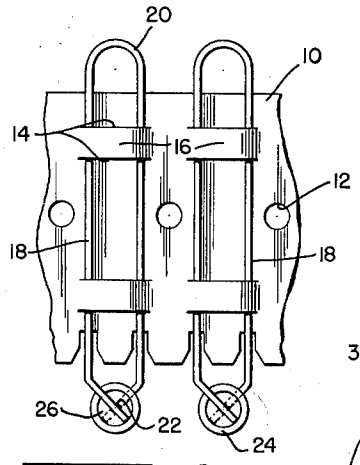


Fig. 1

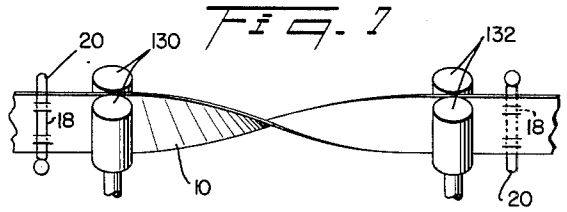


Fig. 1

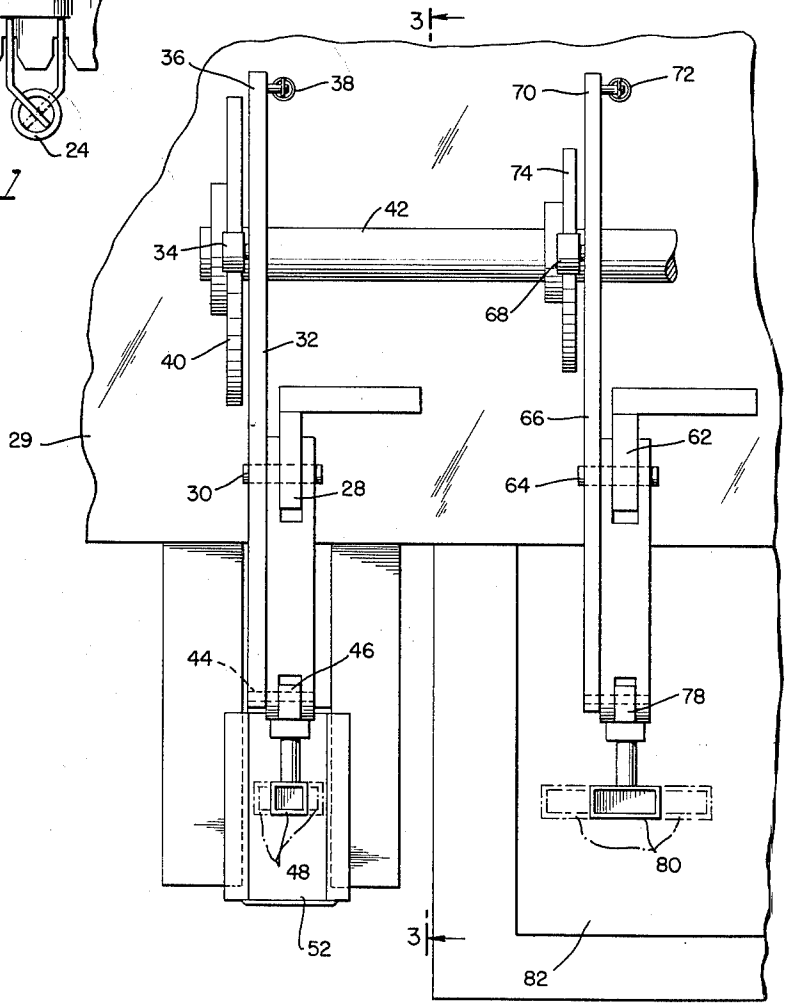


Fig. 2

INVENTOR.

FELIX S. WEISS

BY

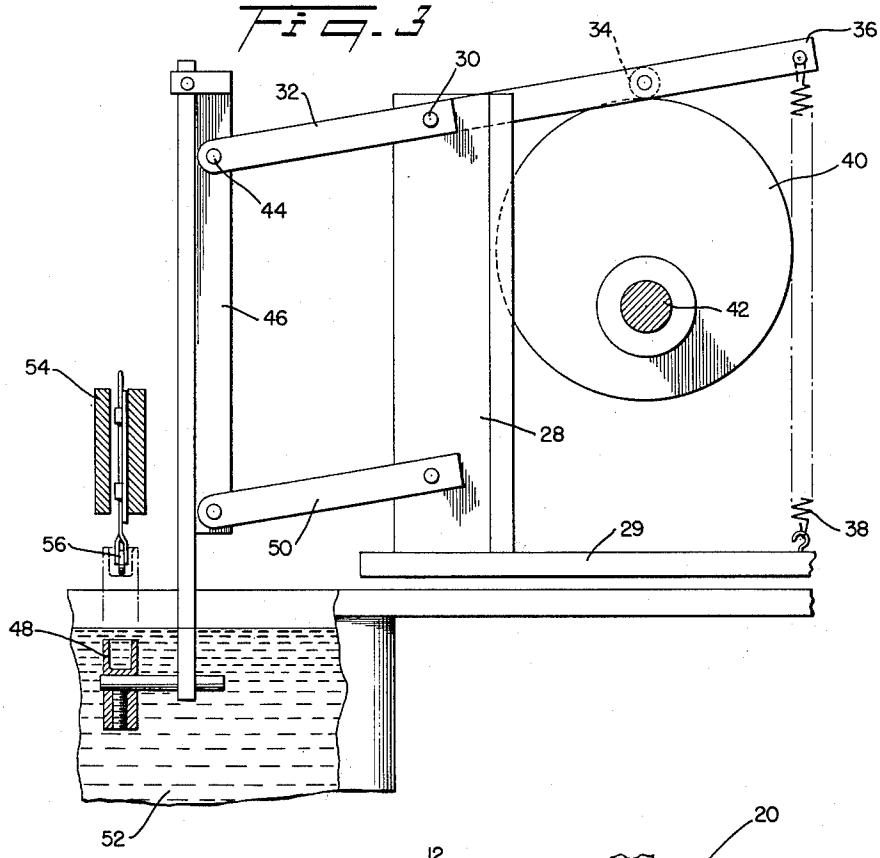
Robert E. Isner

ATTORNEY

METHOD AND APPARATUS FOR THE MANUFACTURE OF CAPACITORS

Filed March 13, 1959 4 Sheets-Sheet 2

Fig. 3



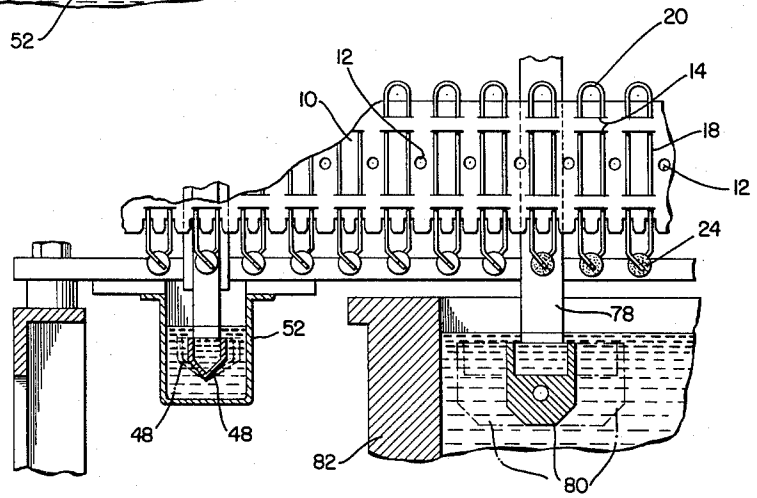


Fig. 4

INVENTOR.
FELIX S. WEISS

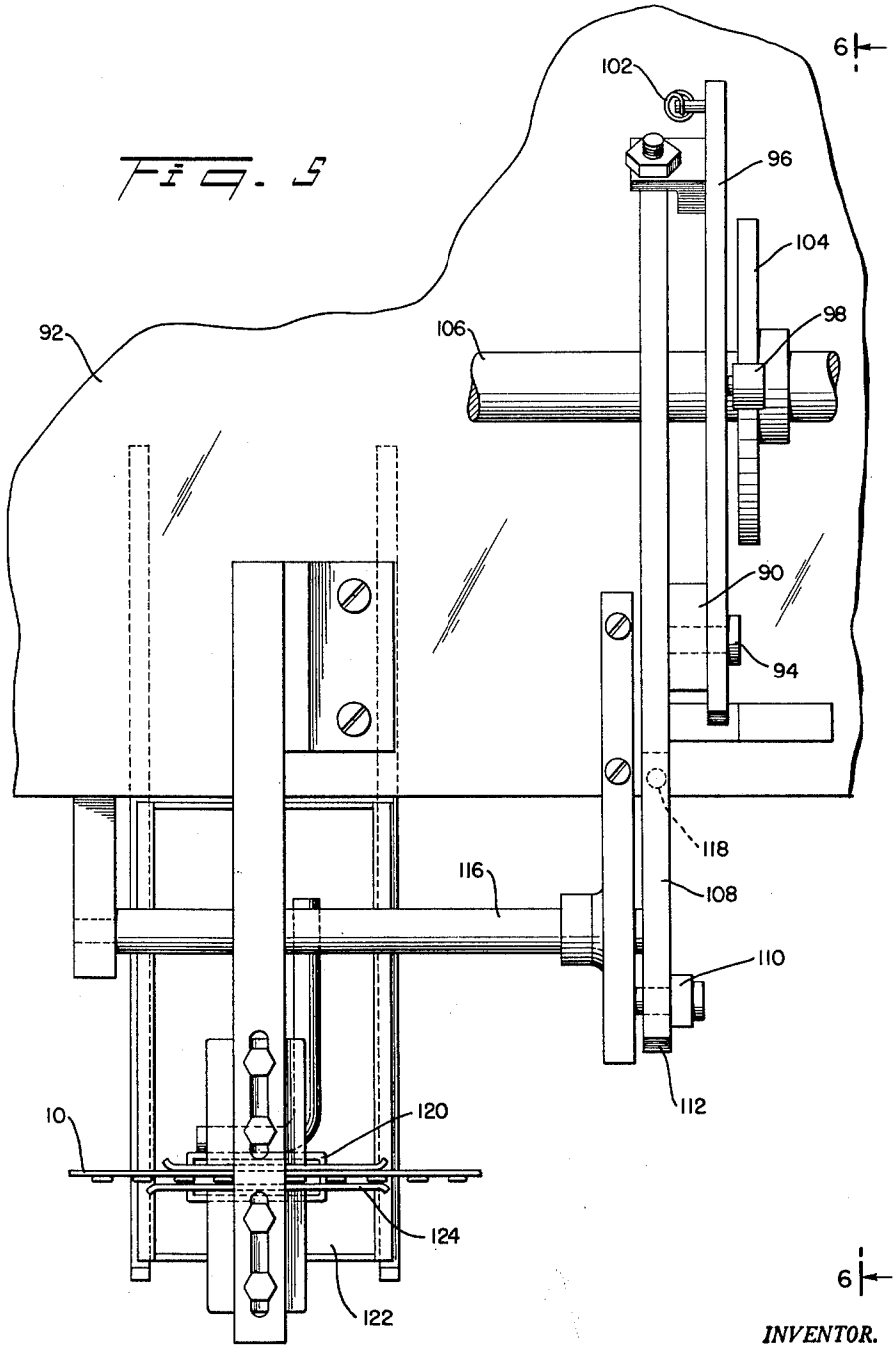
BY
Robert E. Sauer
ATTORNEY

Feb. 9, 1965 F. S. WEISS 3,168,885

METHOD AND APPARATUS FOR THE MANUFACTURE OF CAPACITORS

Filed March 13, 1959 4 Sheets-Sheet 3

Fig. 5



INVENTOR.
FELIX S. WEISS

BY Robert E. Jones

ATTORNEY

Feb. 9, 1965 F. S. WEISS 3,168,885

METHOD AND APPARATUS FOR THE MANUFACTURE OF CAPACITORS

Filed March 13, 1959 4 Sheets-Sheet 4

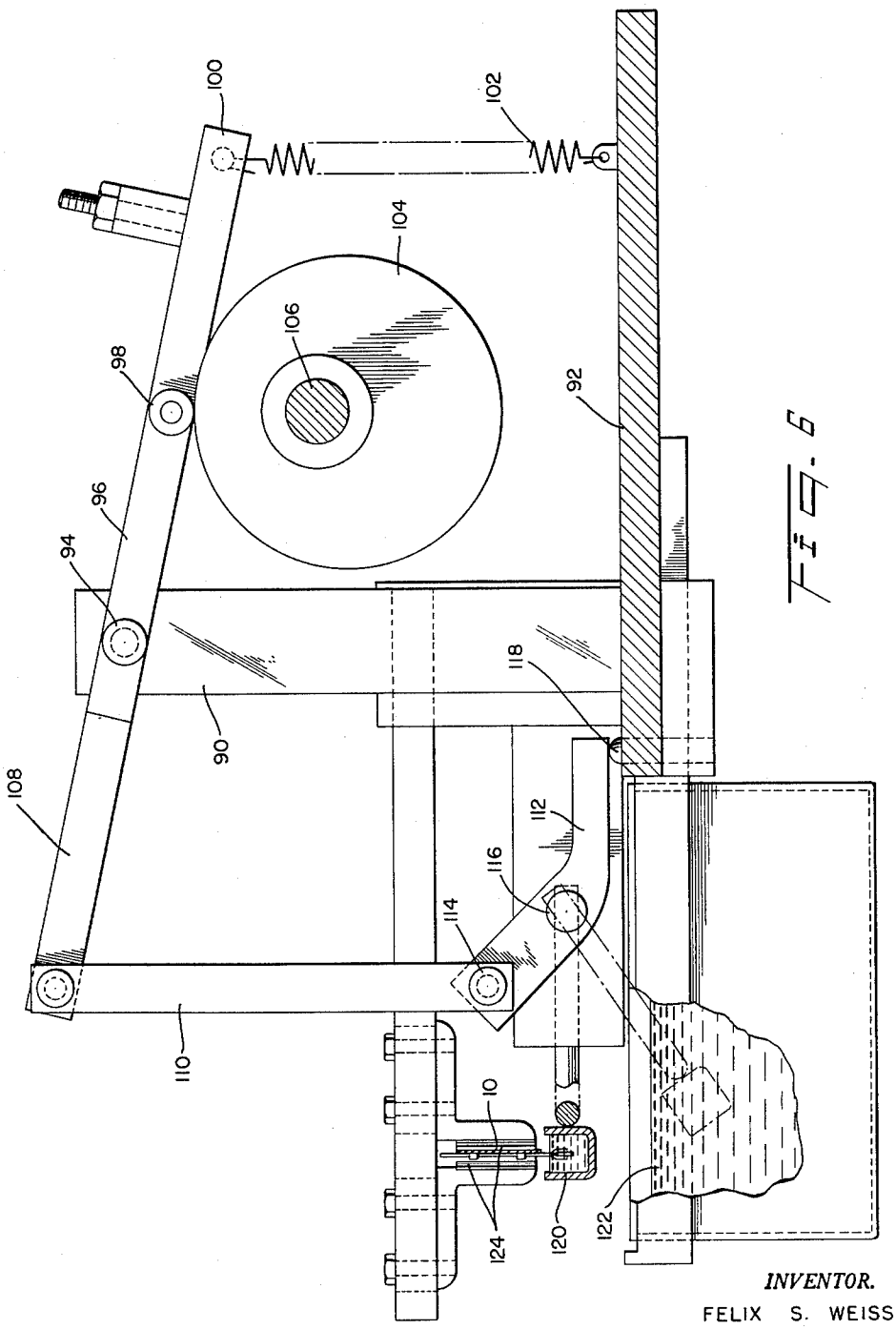


FIG. 6

INVENTOR.
FELIX S. WEISS

BY
Robert E. Isner
ATTORNEY

United States Patent Office 3,168,885 Patented Feb. 9, 1965

3,168,885

METHOD AND APPARATUS FOR THE MANUFACTURE OF CAPACITORS

Felix S. Weiss, Chestnut Hill, Mass., assignor to Cornell-Dubilier Electric Corporation, South Plainfield, N.J., a corporation of Delaware

Filed Mar. 13, 1959, Ser. No. 799,373
14 Claims. (Cl. 113—126)

This invention relates to certain improvements in machines for manufacturing capacitors, and similar relatively small electrical instrumentalities incorporating a plurality of extending terminal wires, by production line methods in which an effectively endless conveying medium, such as, in the preferred form here shown, a dispensable strip of flexible paperlike material, advances the material from which the capacitor or other electrical instrumentality is to be assembled and finally the capacitor or other instrumentality itself to various operating stations at which sequential steps of assembly and eventually final processing, and if desirable, testings of the completed units are performed.

This application is a continuation-in-part of my application Serial No. 579,679, filed April 20, 1956, now abandoned, and is particularly concerned, as will hereinafter more fully be described, with improved structures and methods for the processing stations at which dipping operations, such as flux or solder dipping, or application of an insulating coating by a dip type operation, are performed.

The invention may be briefly described as an improved method and apparatus for effecting immersion coating or treatment of capacitors and similar relatively small electrical instrumentalities incorporating a plurality of extending terminal wires and includes, in its broader aspects, means for positioning the article to be coated above a reservoir of coating material and displaceable means for removing a predetermined quantity of coating material from said reservoir and disposing the same in surrounding relation with the portion of said article to be coated.

The improvements and methods which are the subject of this invention are particularly adaptable to the above described general method of assembly and production for the principles, purpose and object of increasing efficiency of production and the quality and uniformity of the articles so produced. While its principles may be advantageously used in the production of capacitors and other similar electrical instrumentalities such as resistors and rectifiers in various sizes and shapes and which incorporate a plurality of extending terminal wires and may be applied whether the conveying strip be made of one flexible material or another, or in fact whether a conveying strip be employed at all, the present invention is particularly useful in the production of ceramic disc capacitors which include a relatively small ceramic dielectric disc with a layer of conducting material disposed on each of the opposite faces thereof and serving as the electrode elements for the capacitor units. In the assembling of such units, suitable terminal or lead wires are secured to the conducting layers on the ceramic disc and the disc and adjacent portions of the terminal wires secured thereto are covered with a coating of suitable insulating material.

The success of the use of continuous assembly methods of the general type described in the manufacture of these ceramic disc type capacitors depends not only upon the rapidity and continuous flow of operations at the various assembly and processing stations, but also upon the accuracy and reproducibility of those operations at each station, all to the end that each capacitor, as it comes to a point of completion, is as much like the preceding and following capacitors as possible, and that all of such capacitors meet the particular requirements for a given order as, for example, a secure soldered connection a uniform and predetermined thickness of coating and a uniform and predetermined longitudinal extent of coating. These objectives are materially aided by the provision of the herein described structures and methods for effecting dip type coating operations.

Conventional dip type coating apparatus and methods usually involve the displacement of the articles to be soldered or otherwise coated or treated into a reservoir of liquid material or the effecting of article immersion by displacement of the reservoir relative to a fixedly positioned article with the attendant disadvantages of control of the displacing mechanism in accordance with the level of the liquid in the reservoir. In addition thereto such conventional practices are almost always subject to the presence of surface impurities and contaminants on the liquid in the reservoir and through which the articles must necessarily pass prior to effecting the desired immersion of the article within the body of liquid. Practice of the herein disclosed invention overcomes most, if not all, of the disadvantages attendant present day practice.

Among the advantages flowing from utilization of the herein disclosed invention are the permitted convenient and accurate positioning of the articles to be treated, accurate control of the immersion time, depth and rate of immersion of the articles to be soldered independent of the depth of liquid in a reservoir, the permitted continued utilization of clean and fresh liquid material free of deleterious surface impurities and contaminants and the continual agitation of the liquid material within the reservoir.

The object of this invention is the provision of an improved method and apparatus for effecting dip coatings of capacitors and similar relatively small electrical instrumentalities incorporating a plurality of extending terminal wires.

Another object of this invention is the provision of an improved method and apparatus for effecting dip type treatment operations of relatively small sized articles such as capacitors and similar relatively small electrical instrumentalities incorporating a plurality of extending terminal lead wires.

A further object of this invention is the provision of an improved method and apparatus for effecting dip type treatment operations of capacitors and similar electrical instrumentalities incorporating a plurality of extending terminal wires in the fabrication thereof by production line methods.

Other objects and advantages of the invention herein described will be pointed out in the following disclosure and claims and will be illustrated in the accompanying drawings which disclose, by way of illustrative example, the principles underlying the invention and the presently preferred embodiments incorporating those principles, and by which said principles may be usefully employed in the production of finished ceramic disc capacitors and other similar relatively small electrical instrumentalities incorporating a plurality of extending terminal wires with a high degree of uniformity and with reduced fabrication costs.

Referring to the drawings:

FIGURE 1 is a schematic plan view of a strip conveyor supporting capacitor subassemblies which may conveniently be employed in the practice of the herein disclosed invention.

FIGURE 2 is a plan view of the essentials of a presently preferred embodiment adapted to effect the sequential flux dipping and soldering operations in the manufacture of ceramic disc type capacitors by the above mentioned continuous assembly production line methods;

FIGURE 3 is a side elevational view of certain of the components illustrated in FIGURE 2 as viewed from the line 3—3 in FIGURE 2;

FIGURE 4 is an enlarged and fragmentary front elevational view of certain of the elements illustrated in FIGURES 2 and 3.

FIGURE 5 is a plan view of the essentials of presently preferred mechanical elements adapted to effect the coating of ceramic disc type capacitors with the insulating material in the manufacture of such type capacitors by the above mentioned continuous assembly production line methods;

FIGURE 6 is a sectional view taken on the line 6—6 of FIGURE 5.

FIGURE 7 is an oblique view of a strip reversal mechanism.

As indicated above the subject matter of the herein disclosed and claimed invention is of particular utility in the fabrication of ceramic disc type capacitors by the above mentioned continuous assembly production line methods. As a consequence thereof, the following descriptive material will be directly related thereto. However, as will be apparent to those skilled in the art, some or all of the advantages attendant the practice of the invention are attainable for dip type operation of other and varied articles such as, for example, other relatively small electrical instrumentalities incorporating a plurality of extending terminal wires, that may be fabricated by production line or other varied methods. For the purpose of convenience the herein specifically disclosed and described embodiments will be ones that are particularly adapted for use in conjunction with the fabrication of ceramic disc capacitors by production line methods incorporating a conveyor strip.

Referring to the drawings, FIGURE 1 illustrates a portion of an elongate conveyor strip **10**, which may be formed, for example, of paperlike material as described in my copending application Serial No. 799,200, filed March 13, 1959, now abandoned. The conveyor strip **10** is preferably provided with a series of spaced indexing pilot holes **12** which permits careful indexing of the conveyor material in the individual operating stations as well as conveniently providing means by which the web of conveyor material may be advanced during each operational cycle. In addition the strip **10** is provided with a plurality of spaced pairs of transversely aligned longitudinal slits **14** disposed intermediate successive pilot hole perforations **12**, defining article retaining straps **16**, which when raised above the plane of the remainder of the strip, partly define a transversely disposed terminal wire subassembly receiving channel. Disposed within the terminal wire subassembly receiving channel is a ceramic disc capacitor subassembly comprising an elongate U-shaped terminal wire **18** having the curved end **20** thereof extending beyond one edge of the strip **10** and the open ends thereof extending beyond the other edge of the strip **10** deformed into crossed relationship as indicated at **22**. Disposed intermediate the crossed ends **22** is a ceramic disc **24** having conductive electrode layers **26** disposed on the planar surface thereof.

FIGURES 2 through 4 illustrate, by way of example, the essentials of mechanical elements incorporating the principles of the invention that are includable in a composite flux and solder dip station in the continuous assembly production line method fabrication system for ceramic disc capacitors, and wherein web mounted capacitor subassemblies, constituted as illustrated in FIGURE 1, are initially flux treated and then immersed in solder so as to effect a soldered connection intermediate the metallic electrode layers **26** on the ceramic discs **24** and the portions **22** of the terminal wire **18** disposed in contact therewith.

Referring to the above-identified drawings, and first considering the flux dip components thereof, there is provided a vertically disposed supporting standard **28**

mounted upon a suitable horizontally disposed base member **29**. Pivotally mounted on the supporting standard **28**, as at **30**, is a rocker arm **32** having an extending cam follower **34** mounted thereon. The remote end **36** of the rocker arm **32** is biased by a tension spring **38** secured to the base member **29** so as to maintain the cam follower **34** in engaged relation against the surface of the drive cam **40** mounted on a rotatable drive shaft **42**. The other end **44** of the rocker arm **32** is pivotally connected to a substantially vertically disposed flux ladle supporting arm **46** having a relatively small flux ladle **48** secured to the dependent end thereof. A pivotally mounted auxiliary link member **50** disposed substantially parallel to the rocker ram **32** connects the lower portion of the flux ladle supporting arm **46** to the supporting standard to prevent oscillation of the dependent flux ladle **48**. Rotation of the cam **40** results in oscillatory annular displacement of the rocker arm **32** about its pivotal mounting **30** and in an alternate raising and lowering of the flux ladle **48** in a substantially vertical path. Positioned beneath the flux ladle **48** and spaced relative to the lower reciprocatory limit thereof so that said ladle is completely immersed therein at its lower limiting position is a relatively large flux containing trough or reservoir **52**.

Associated with the above described mechanical elements is a selectively positionable article positioning means such as a web guide member **54**. The web guide **54** is disposed to position the web mounted ceramic disc capacitor subassemblies, generally designated **56**, so that the dependent ceramic capacitor discs **24** are immersed to a predetermined controlled depth in the flux contained in the flux ladle **48** when said ladle is at its uppermost limit of reciprocatory displacement. As will be apparent to those skilled in the art the uppermost limit of displacement of the ladle **48** is a fixed quantity for any given operation and since the ladle **48** will be brimfull, the positioning of the flux surface is at a fixed and readily determinable location. Such readily facilitates the attaining of any desired immersion depth of the articles to be coated and uniform maintenance thereof by selective prepositioning of the article positioning means relative to the flux surface at the uppermost limit of displacement of the flux ladle **48**.

In operation of the above described unit, the web **10** is conveniently advanced in increments equalling the spacing intermediate successive pilot pin indexing perforations **12** therein by any suitable means. Preferably during web advance the flux ladle **48** is maintained at its lowermost limit of displacement and is completely immersed in the flux contained with the flux trough **52**. Upon cessation of web advance the article to be coated, in this case the dependent portion of the web mounted capacitor subassembly, is desirably positioned directly above the ladle **48** and is located relative to the upper limit of displacement thereof to effect the desired degree of immersion therein of the article to be coated. With the article as poitioned, rotation of the cam **40** effects an angular displacement of the rocker arm **32** and a concomitant upward displacement of the flux ladle **48** to effect the desired degree of immersion of the dependent capacitor disc and the portions of the terminal wire subassembly in engagement therewith in the flux contained within the flux ladle **48**. Continued rotation of the cam **40** permits a return of the flux ladle **48** to the trough **52** to be there maintained during the next cycle of web advance.

In the illustrated apparatus, the parts are proportioned to provide a single flux dip for each of the web mounted capacitor subassemblies. If a multiple dip is desired, all that is required is to enlarge the flux ladle **48** to permit immersion of two or more adjacent dependent discs per stroke.

The character of the immersion action or rate of immersion may be readily controlled by predesign of the contour of the drive cam **40**. In the instant situation,

where the flux is in a molten condition and the article to be immersed is relatively cold, the surface contour of the drive cam 40 preferably should be such as to effect a relatively slow rate of immersion of the web mounted ceramic capacitor disc so as to minimize, if not actually prevent, cracking thereof. It is also preferable that the rate of withdrawal on the down stroke of the ladle 48 should be relatively slow until the web mounted dependent capacitor disc is almost entirely removed from the flux. At this point the speed of withdrawal of the ladle 48 should preferably be increased so as to rapidly remove the remaining portion of the immersed capacitor disc 24 from the flux. Such rapid removal of the flux in the flux ladle 48 from the ceramic disc 24 aids materially in minimizing, if not preventing, meniscus or teardrop flux formation on the dependent end of the ceramic disc assembly.

In the described production line system for the manufacture of ceramic disc capacitors it is convenient to have the soldering station disposed immediately adjacent to the above described flux dip components.

The essentials of the presently preferred mechanical elements includable in the solder dip station may be substantially the same as those just previously described in conjunction with the flux dip station. Referring to the above identified drawings and now considering the adjacent solder dip station portion thereof, there is provided a vertically disposed supporting standard 62 mounted on the base member 29. Pivotally mounted thereon, as at 64, is a rocker arm 66 which supports an extending cam follower 68. The remote end 70 of the rocker arm 66 is biased by a tension spring 72, so as to maintain the cam follower 68 in engaged relation against the surface of a suitably contoured drive cam 74 mounted on the aforementioned drive shaft 42. The other end 76 of the rocker arm 66 is pivotally connected to a substantially vertically disposed solder ladle supporting arm 78 having a solder ladle 80 secured to the dependent end thereof. Rotation of the drive cam 74 results in oscillatory angular displacement of the rocker arm 66 about its pivotal mounting and in an alternate raising and lowering of the solder ladle 80 in a substantially vertical path. Positioned beneath the solder ladle 80 and spaced relative to the lower reciprocatory limit thereof so that said ladle is completely immersed well below the surface thereof at its lower limiting position, is a molten solder containing trough 82.

As described earlier in conjunction with the flux coating mechanism suitable selectively positionable article positioning means are employed to position the articles to be coated relative to the path of reciprocation of the solder ladle 30.

In operation of the above described unit, either alone or in conjunction with the above described flux dip station, the web 10 is conveniently advanced in increments equal to the spacing between successive pilot pin indexing perforations 12 therein. During the portion of the operating cycle devoted to web advance, the solder ladle 80 is preferably maintained at its lowermost limit of displacement and is completely immersed in the molten solder contained within the solder troufh 82. Upon cessation of web advance, at which time the article to be coated will be properly positioned above the trough 82, rotation of the drive cam 74 effects an angular displacement of the rocker arm 66 and a concomitant upward displacement of the solder ladle 80 to effect the desired degree of immersion of the previously treated dependent capacitor discs and the adjacent portions of the terminal wire subassembly in engagement therewith in the molten solder contained within the now elevated solder ladle 80. Contineud rotation of the drive cam 74 permits a return of the solder ladle 80 to the trough 82 to be there maintained during the next cycle of web advance.

In the illustrated apparatus the parts are proportioned to provide multiple solder dips for each of the web mounted capacitor subassemblies by making the solder ladle 80 of sufficient length in the line of travel of the capacitor units so as to permit an immersion therein of a plurality of the dependent ceramic discs on each upward displacement thereof. If the incremental advance of the web is made equivalent to the spacing intermediate two adjacent web mounted units the desired number of immersions for each unit may be readily obtained by making the length of the ladle 80 equal to the product of the desired number of immersions and the spacing intermediate the web mounted units.

As was the case with the drive cam 40 i nthe flux dip unit heretofore described, the surface of the drive cam 74 should preferably be such as to effect a relatively slow rate of immersion of the web mounted ceramic capacitor discs in the molten solder contained in the ladle 80 so as to minimize, if not actually prevent, cracking of the relatively cold ceramic unit. It is also preferable that the rate of withdrawal on the downstroke of the ladle 80 should be relatively slow until the web mounted capacitor disc is almost entirely removed from the molten solder. At this point the speed of withdrawal of the solder ladle 80 should preferably be increased so as to rapidly remove the remaining portion of the immersed capacitor from the molten solder. Such rapid removal of the solder in the solder ladle 80 from the ceramic disc aids materially in minimizing, if not in preventing, meniscus or teardrop solder formation on the dependent end of the ceramic disc assembly.

After sequential passage through the flux and solder dip units as described above, the web mounted capacitor subassemblies are constituted as illustrated in FIGURE 1 except that the terminal wires are now both electrically and mechanically secured to the metallic electrode surfaces 26 on the ceramic discs 24.

Among the advantages resulting from utilization of the above described structure in effecting the soldering of terminal leads to the electrode elements of ceramic disc capacitors are the ready attaining of a uniform rate and depth of article immersion, permitted repeated immersions to effect an assured soldered joint, the reproducibillity of such factors irrespective of the number of articles being procured and ready adjustability of the same for varying operations, the continual agitation of the liquid medium in the reservoir and the provision of clean and fresh soldering material into which the articles are immersed and the consequent avoidance of effecting immersion through the normally present surface film of oxides and other deleterious contaminants that often collects on the surface of a solder trough.

FIGURES 5 and 6 illustrate the essentials of an alternative embodiment of the invention that is particularly adapted for utilization as an insulation dip unit or station wherein the dependent ceramic discs 24 and adjacent portions of the terminal leads soldered thereto are provided with an external coating of suitable insulating material of predetermined depth and thickness.

Referring to the above-identified drawings, there is provided a substantially vertically disposed supporting standard 90 mounted on a horizontally disposed member 92. Pivotally mounted thereon, as at 94, is a rocker arm 96 which supports an extending cam follower 98. The remote end 100 of the rocker arm 96 is biased by a tension spring 102 so as to maintain the cam follower 98 in engaged relation against the surface of a drive cam 104 mounted on the shaft 106. The other end 108 of the rocker arm 96 is pivotally connected to the upper end of a dependent link member 110. The lower end of the link member 110 is pivotally connected to one arm of a crank member 112 as at 114. The crank member 112 is mounted on and adapted to rotate in conjunction with a horizontally disposed shaft 116. The other arm of the crank member 112 is positioned to abut an adjustable stop 118 and thereby limit rotational displacement of the crank 112 in the clockwise direction as viewed in FIGURE 6. Mounted on the shaft 116 is an

elongate ladle 120 adapted to be rotatably displaced, in conjunction with rotative displacement of the shaft 116, into and out of a trough 122 containing suitable coating material of an insulating character in liquid form. Positioned above the limit of upward displacement of the ladle 120 is a selectively positionable article positioning member, such as the web guide 124, adapted to carefully position the web 10 and the capacitor subassemblies mounted thereon relative to the path and upper of displacement of said ladle 120.

In operation of the above described unit, the web 10 having the capacitor subassemblies mounted thereon is conveniently advanced through the guide 124 in increments equal to the spacing intermediate successive pilot pin indexing perforations 12 therein. During the portion of the operating cycle devoted to web advance, the ladle 120 is preferably disposed so as to be completely immersed in the liquid insulating material contained within the trough 122, that is, the rocker arm 96 is positioned so that the link member 110 is in its lower limiting position, with the crank member 112 and shaft 116 being disposed at their limit of counter clockwise displacement (as viewed in FIGURE 6) so that the ladle 120 is deeply immersed in the trough 122. Upon cessation of web advance, the article to be coated, in this case the dependent portion of the web mounted capacitor subassembly, is desirably positioned directly above the ladle 120 and is located relative to the upper limit of displacement thereof to effect the desired degree of immersion therein of the article to be coated, with the article so positioned, rotation of the cam 104 permits a rotation displacement of the rocker arm 96 about its pivotal mounting 94 by the spring 102 in a clockwise direction (see FIGURE 6), raising the link member 110 and rotatively displacing the crank member 112 and shaft 116 in a clockwise direction. Such rotative displacement of the shaft 116 effects a concurrent rotative displacement of the ladle 120 connected thereto with the limit of rotative displacement thereof being controlled by the positioning of the adjustable stop 118. The rotative displacement of the ladle member 120 results in a raising thereof from its completely immersed position in the trough 122 and in a controlled immersion of the dependent web mounted capacitor discs in the insulating material contained therein dependent upon the position of the discs and the adjustable stop 118.

As illustrated, the elongate ladle 120 is preferably sized to permit immersion of a plurality of dependent ceramic disc capacitors 24 during each operating cycle. The immersion of a plurality of units per operational cycle in conjunction with the above described incremental advance of the web mounted capacitor subassemblies permits ready control of the number of immersions of each web mounted capacitor subassembly and thereby permits ready control of the desired coating thickness of insulating material as described earlier in conjunction with the embodiment of FIGURES 2 to 4.

For the particular utilization of the described apparatus in the production line manufacture of capacitors the surface contour of the drive cam 104 preferably should be such as to effect an initial relatively slow rate of withdrawal of the ladle 120 from the immersed web mounted ceramic capacitor units to permit draining of excess insulating material therefrom. When the insulating material ladle 120 has been withdrawn to a point where the web mounted ceramic capacitor discs are almost entirely removed from the insulating material, the speed of withdrawal of the ladle 120 should preferably be increased so as to effect a rapid separation of the insulating material from the capacitor units. Such speed control aids materially in minimizing, if not actually preventing, undue meniscus or teardrop formation of the usual viscous character insulating material on the dependent ends of the web mounted capacitor units.

In order to prevent undesired thickening of the insulating coating, due to flow thereof on the dependent portions of the web mounted capacitor subassemblies, it is preferred, when the characteristics of the insulating material so require, to effect a reversal of web position, so as to elevate the dependent coated portions thereof. Such web reversal is readily effected, as shown in FIGURE 7, by utilization of two pairs of guide rollers 130 and 132, which gradually elevate the dependent coated discs to an elevated position and thereby minimizes, if not actually prevents, undesired misdirection of gravitational flow of the coating material during the initial portion of the setting period.

The term "dependent" as used in the foregoing paragraph and throughout the specification and claims refers to the condition of the web mounted capacitor subassemblies in the sense of hanging down. The web alters the condition of the initially dependent coated discs by moving them to an elevated position and in so doing alters the attitude of the capacitor subassemblies into a non-dependent or non-depending position, this change minimizing if not preventing undesired misdirection of gravitational flow of the coating material. The terms "non-dependent" and "non-depending" refer to the positions attained by the subassemblies in which they do not hang down.

After passage through the described insulation dip apparatus, the web mounted capacitor subassemblies are provided with a uniform external coating of insulating material of controlled thickness and of a longitudinal extent covering any desired portion of the dependent ceramic discs and if desired any desired adjacent portion of the terminal leads connected thereto.

As the foregoing material clearly shows, the herein described invention provides for the raising, by a displaceable ladle, of a relatively small quantity of flux, solder or other liquid material above the normal surface level of the liquid material in a reservoir or trough to a readily predetermined and constant height. Such elevation coupled with the positioning of the article to be immersed permits a close control of the immersion depth of the article irrespective of the height of liquid in the reservoir. In addition thereto the cyclic operation of the ladle effects continued agitation of the reservoir material and the continual utilization of fresh material for the immersion operation free of any deleterious impurities or contaminants that may be present upon the surface of the material in the reservoir. These advantages contribute materially to the production of uniform capacitors and similar relatively small electrical instrumentalities having extending terminal wires by the above described continuous assembly production line methods by assuring uniform and improved soldered joints and external coatings of uniform depth and thickness.

Having thus described my invention, I claim:

1. In fabrication apparatus for electrical components of the type having a body portion and terminal wires that extend in a common direction from said body portion, said apparatus being of the class wherein a web of conveyor material serves as an incrementally advanceable carrier for uniformly spaced pluralities of progressively formed subassemblies mounted thereon, an immersion coating device for effecting the successive application of liquid material to the body portion and the adjacent terminal-wire portions of said subassemblies comprising a reservoir for holding a relatively large quantity of liquid material, means for sequentially dependently positioning said subassemblies above said reservoir at a predetermined level with said body portion and the adjacent terminal-wire portions to which said liquid material is to be applied defining a pair of locations spaced apart a substantial extent in the vertical plane, and cyclicly operable ladle means for elevating relatively small contained portions of said liquid material above the surface of said reservoir and therebeyond to elevate the surface of the

small contained portions of liquid material to the height necessary to effect immersion therein of said body portions and said adjacent terminal-wire portions of said subassemblies disposed intermediate said pair of spaced locations.

2. Apparatus as set forth in claim 1 wherein said ladle means is of an extent in the direction of web advance sufficient to effect immersion of a plurality of subassemblies therein during each elevation thereof.

3. Apparatus as set forth in claim 1 wherein said ladle means includes wall means disposed transverse to the direction of subassembly advance and said wall means are interposed intermediate the subassembly undergoing immersion and adjacent subassemblies when said ladle means is in an elevated position.

4. Apparatus as set forth in claim 1 in combination with means for gradually displacing said subassemblies from said dependent position subsequent to immersion to a non-depending position to counteract gravity induced displacement of said applied liquid material.

5. In fabrication apparatus for the manufacture of an electrical component that has a body portion and terminal wires that extend in a common direction from said body portion, said apparatus being of the class wherein a web of conveyor material serves as an incrementally advanceable carrier for uniformly spaced pluralities of progressively formed subassemblies mounted thereon an immersion coating device for effecting the successive application of liquid material to the body portion and the adjacent terminal-wire portions of said subassemblies comprising a reservoir for holding a relatively large quantity of liquid material, means for sequentially dependently positioning said subassemblies above said reservoir with said body portion and said adjacent terminal-wire portions thereof defining a pair of locations spaced apart a substantial extent in the vertical plane and cyclicly operable ladle means for elevating relatively small contained portions of said liquid material above the surface of said reservoir to immersedly envelope the body portion and the adjacent terminal-wire portions of said subassemblies disposed intermediate said pair of spaced locations relative to the adjacently disposed subassemblies on said web.

6. In fabrication apparatus for the manufacture of an electrical component that has a body portion and terminal wires that extend in a common direction from said body portion, said apparatus being of the class wherein a web of conveyor material serves as an incrementally advanceable carrier for uniformly spaced pluralities of progressively formed subassemblies mounted thereon, immersion coating mechanism for sequentially applying hot liquid materials to the body portion and the adjacent terminal-wire portions of said subassemblies comprising at least two reservoirs for holding relatively large quantities of differing liquid materials, means for sequentially dependently positioning said subassemblies above said reservoirs with said body portion and said adjacent terminal-wire portions thereof defining, in each instance, a pair of locations spaced apart a substantial extent in the vertical plane and cyclicly operable ladle means associated with each of said reservoirs for elevating relatively small contained portions of said liquid materials contained therein above the surfaces of said reservoirs to effect immersion therein of the body portion and the adjacent terminal-wire portions of said subassemblies disposed intermediate said pair of spaced locations.

7. Apparatus as set forth in claim 6 which includes a pair of adjacently disposed reservoirs containing hot flux and molten solder respectively.

8. In the the manufacture of an electrical instrumentality that has a body portion and terminal wires that extend in a common direction from said body portion, said body being subject to thermally induced cracking, the method of applying liquid material to said body portion and the adjacent portions of said terminal wires, comprising the steps of dependently positioning the electrical instrumentality above the surface of a reservoir containing liquid at an elevated temperature with said body portion and the adjacent terminal-wire portions thereof extending intermediate a pair of locations spaced apart a substantial extent in a vertical plane, upwardly displacing a relatively small portion of the liquid material in said reservoir above the surface thereof into contact with said electrical instrumentality and decreasing the rate of upward displacement of the small portion of liquir prior to introduction of said body portion therein and continuing the upward displacement of said small portion of liquid at the decreased rate through a substantial distance subsequent to said contact and sufficiently to raise the surface of said small portion of liquid material to the required level to effect immersion therein of the body portion and the adjacent terminal-wire portions of said electrical instrumentality disposed intermediate said vertically spaced locations.

9. In the manufacture of an electrical instrumentality that has a body portion and terminal wires that extend in a common direction from said body portion, the method of applying liquid material to said body portion and the adjacent portions of said terminal wires, comprising the steps of dependently positioning the electrical instrumentality above the surface of a liquid material reservoir with said body portion and the adjacent terminal-wire portions thereof extending intermediate a pair of locations spaced apart a substantial extent in a vertical plane, upwardly displacing a relatively small portion of the liquid material in said reservoir above the surface thereof into contact with said electrical instrumentality and through a substantial distance subsequent thereto sufficiently to raise the surface of said small portion of liquid material to the required level to effect immersion therein of the body portion and the adjacent terminal-wire portions of said electrical instrumentality disposed intermediate said vertically spaced locations, thereafter downwardly displacing said relatively small portion of liquid material and limiting the rate of downward displacement thereof until just prior to separation of the immersed portion of the electrical instrumentality therefrom and then rapidly increasing the rate of downward displacement of said relatively small portion of liquid material to minimize meniscus formation of said applied liquid material on the lowermost end of said electrical instrumentality.

10. In the manufacture of an electrical instrumentality that has a body portion and terminal wires that extend in a common direction from said body portion, the method of applying liquid material to said body portion and the adjacent portions of said terminal wires, comprising the steps of dependently positioning the electrical instrumentality above the surface of a liquid material reservoir with said body portion and the adjacent terminal-wire portions thereof extending intermediate a pair of locations spaced apart a substantial extent in a vertical plane, upwardly displacing a relatively small portion of the liquid material in said reservoir above the surface thereof into contact with said electrical instrumentality and through a substantial distance subsequent thereto sufficiently to raise the surface of said small portion of liquid material to the required level to effect immersion therein of the body portion and the adjacent terminal-wire portions of said electrical instrumentality disposed intermediate said vertically spaced locations, and gradually displacing said liquid coated electrical instrumentality from said dependent position to a non-dependent position subsequent to immersion thereof to utilize gravity induced displacement of said applied liquid material in the obtaining of a uniform liquid material coating thickness thereon.

11. In the manufacture of an electrical instrumentality that has a body portion and terminal wires that extend in a common direction from said body portion, the method of applying a liquid material to said body portion and the adjacent portions of said terminal wires, compris-

ing the steps of dependently positioning the electrical instrumentality above the surface of a liquid material reservoir with said body portion and the adjacent terminal-wire portions thereof extending intermediate a pair of locations spaced apart a substantial extent in a vertical plane, upwardly displacing a relatively small portion of the liquid material in said reservoir above the surface thereof into contact with said electrical instrumentality and through a substantial distance subsequent thereto sufficiently to raise the surface of said small portion of liquid material to the required level to effect immersion therein of the body portion and the adjacent terminal-wire portions of said electrical instrumentality disposed intermediate said vertically spaced locations, gradually inverting said dependent electrical instrumentalities subsequent to the immersion thereof to utilize gravity induced displacement of said applied liquid material in the obtaining of a uniform liquid material coating thickness thereon.

12. In fabrication apparatus for the manufacture of an electrical component that has a body portion and terminal wires that extend in a common direction from said body portion, said apparatus being of the class wherein a web of conveyor material serves as an incrementally advanceable carrier for uniformly spaced pluralities of progressively formed subassemblies mounted thereon, an immersion coating device for effecting the successive application of liquid material to the body portion and the adjacent terminal-wire portions of said subassemblies comprising a reservoir for holding a relatively large quantity of liquid material, means acting on a web of conveyor material bearing subassemblies as aforesaid and with the body portions thereof offset into a position of clearance below the web for sequentially dependently positioning said subassemblies above said reservoir at a predetermined level relative thereto with said body portion and said adjacent terminal-wire portions thereof defining a pair of locations spaced apart a substantial extent in the vertical plane, and cyclically operable ladle means for elevating relatively small contained portions of said liquid material above the surface of said reservoir and therebeyond to a uniform controlled level to immersedly envelope the body portion and the adjacent terminal-wire portions of said subassemblies disposed intermediate said pair of spaced locations relative to the adjacently disposed subassemblies on said web.

13. Apparatus in accordance with claim 12 wherein said means acting on the web of conveyor material further includes means acting on the web as the latter is incrementally advanced beyond the position above said reservoir to twist the web and thereby to effect gradual displacement of the subassemblies from their depending positions above the reservoir to non-depending positions to counteract gravity induced displacement of said applied liquid material.

14. Apparatus in accordance with claim 13 wherein said last-named means is adapted to effect a half-twist of the web so as to invert the subassemblies following immersion coating thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

452,584	Senca	May 19, 1891
1,103,067	McCall	July 14, 1914
1,783,642	Ferguson	Dec. 2, 1930
1,860,048	Myers	May 24, 1932
2,159,850	Haynes	May 23, 1939
2,321,071	Ehrhardt	June 8, 1943
2,764,953	Mullan	Oct. 2, 1956
1,766,510	Heibel	Oct. 16, 1956
2,770,875	Zimmerman	Nov. 20, 1956
2,771,048	Zimmerman	Nov. 20, 1956
2,857,878	Matson et al.	Oct. 28, 1958

OTHER REFERENCES

A Textbook of Glass Technology (Hodkin and Cousen), published by D. Van Nostrand Co., New York; copyright 1925, page 28 relied on.