Method and apparatus for the assembly of insulators for suspending transmission line cables, using cement of stiff consistency and high-frequency vibrations is disclosed. The use of jigs for holding the parts in assembled relation until the cement has hardened is avoided, the time required per unit insulator is reduced, and the insulator has improved mechanical strength and load-supporting capabilities.

4 Claims, 6 Drawing Figures
MANUFACTURE OF INSULATORS

This is a continuation of application Ser. No. 654,567, filed July 19, 1967, now abandoned.

This invention relates to the production of insulators and, more particularly to insulators used in the suspension of transmission line cables.

The chief purpose and object are to provide an improved method for the fabrication of such insulators, and novel apparatus by which the method may be carried into practice.

A further object is to provide a method and apparatus for the assembly of insulators of the type mentioned, which results in large savings in time per unit item completed.

Yet another object is to provide a method and apparatus as aforesaid, which eliminates the need for the use of jigs or other equipment to hold the parts of each individual insulator in assembled relation during setting, hardening or crystallization of the cement or mortar used to retain them in a unitary structure.

Ancillary to the immediately foregoing object, another object is to use mortar or cement of stiff consistence, and to facilitate assembly of the parts, with such cement, by the use of high-frequency vibrations.

Still another object is to use high-frequency vibrations in assembly of the parts making up the insulator to improve the ultimate strength thereof, size for size, and the load which each is capable of sustaining in use.

A further object is to provide a method which, while having all of the advantages set forth in the preceding paragraph, enables a material reduction in time required per unit of production, with consequent reduced costs per unit.

Another object is to provide a method of production as aforesaid, which is capable of and adaptable to full automation, thus further reducing costs per unit.

Yet another object is to provide apparatus of novel construction for the mixing of cement, proportioning of the mix, and assembly and cleaning of the assembled insulators.

Numerous other objects and advantages will become clear to those skilled in the art after a study of the following disclosure.

Insulators of the type mentioned include a body of dielectric material such as porcelain or glass, surmounted by a metallic cap and having a metallic stem affixed axially thereto and by which a number of insulators may be connected in tandem. The dielectric body, cap and stem are customarily secured together with mortar or cement so that these parts must be rigidly held in proper assembled relation until the cement has hardened to a degree such that no shift or relative movement between the parts is possible. However, the necessity for holding these parts in their assembled relation during the period of setting of the cement, unavoidably results in an undesirably long period of fabrication, the use of a large number of jigs or other devices for holding the parts of each assembly in fixed relation until the cement thereof has set, and considerable skill in manipulation. The present invention avoids and overcomes the difficulties just mentioned.

In conformity with the invention, the sealing or securement of the stem and cap to the dielectric body, is effected by the use of a dense or stiff cement in which the amount of entrained water is just about, or not appreciably greater than that required for setting or crystallization. This cement, during the mixing and employment into the assembled parts of the insulator, is subjected to high-frequency vibrations of the order of 300 per second.

The small amount of water in the cement mix, as just described, imparts a consistency to the cement which makes it unnecessary to employ means such as a jig, to hold the parts in assembled relation during setting. That is to say, the cement, due to the small amount of water used in mixing, is comparably stiff or rigid so that it, alone, is sufficient to maintain the cap and the stem properly assembled with respect to the dielectric body, initially and during crystallization. Furthermore, the high-frequency vibrations act to thoroughly remove entrained air and to enable facile emplacement of the cap and stem into their proper positions with respect to the body. It has been found, moreover, that insulators constructed in accordance with the invention, have a mechanical strength which is particularly high as compared with similar prior art insulators.

Another advantageous feature of the invention is that the cap and stem may be emplaced simultaneously, thus resulting in a material reduction in time required per insulator.

The sequential steps of production, of mixing the cement or mortar, emplacement and securement of the cap and stem in and to the body, washing and climatization of the assembled insulator, are set forth in connection with the accompanying drawing wherein there are shown non-limiting examples of means by which the aforesaid steps may be carried out.

In the drawing:

FIG. 1 is an axial section through a complete insulator of the type mentioned;

Fig. 2 is a perspective view of a mixer in which the cement used is mixed with the aid of vibrations;

Fig. 3 is a view of an assembly adapted to receive the mixed cement and to vibrate it while it is molded into a predetermined geometrical form;

FIG. 4 illustrates a mass of mixed cement, after molding as at FIG. 3, together with a tool by which the mass may be accurately divided into a first part sufficient to attach the cap to the body, and a second part sufficient to secure the stem with one end within the body;

FIG. 5 is a view partly in axial section, of a portion of an apparatus for emplacing the cap and stem into or with respect to their dielectric body; and

FIG. 6 is a view partly in vertical axial section, of an instrument for washing the insulators after assembly.

Referring in detail to the drawing, particularly to FIG. 1, the insulator selected for illustration of the invention, consists of a body 1 of glass or porcelain, a metallic cap 2 which fits down over the crown portion of the body and is affixed thereto by cement mass 3, a metallic stem 4 of the general shape shown, extending with its shank axially of and partly within the hollow crown and secured in position by cement mass 5. A washer 6 is interposed between the rim of the cap 2 and the skirt portion of the body. Likewise, a gasket or pad 7 is interposed between the end surface of stem 4 within body 1, and the inner surface of the crown thereof. For reasons which will appear, these washers or pads are preferably formed of fibrous material, as by depositing fibrous material or flocking onto a base coating of adhesive applied to appropriate areas of the body, and which sets to secure the fibers in place. This procedure is fully disclosed in my French application PV No. 17,277, filed May 17, 1965, for Improvement in Suspended Insulators, and in the first addition thereof, PV No. 59,661,
The cement used for attachment of the cap and stem, as indicated at 3 and 5, FIG. 1, may be, for example, a silica-alumina mix containing an amount of water approximately equal to that required for crystalization.

FIG. 2 shows an apparatus in which the cement is initially mixed. A frame 10 supports a mixer blade 11, for hypocycloidal movement within container 13. A high-frequency vibrator 12 is carried by or is in contact with the bottom wall of the container. Mixture of water and cement under the dual action of the hypocycloidal movement of blade 11, and vibrations imparted to container 13, by item vibrator 12, is effected very rapidly, so that the period of mixing may be reduced to only about 5 minutes. This is in decided contrast to the half-hour period ordinarily required by prior art procedures. The inventive procedure has the added advantage that small particles of mortar adhering to the sides of the container, and normally outside the path of the blade, are caused by the vibrations, to descend to the bottom of the container where they are eventually picked up by the blade.

The mix thus prepared is of relatively stiff consistency and is not readily handled or shaped without vibrations. In order to conform the mixed cement to a measurable mass of geometrical form, it is removed from container 13 and placed into a parallelepipedal mold 14, FIG. 3, resting upon a table 15 equipped with a high-frequency vibrator 16.

The parallelepipedal mass of stiff mortar thus obtained, is illustrated at 17, FIG. 4, and is there readily cut into portions by means of a bladed tool 18 having spaced parallel blades 18a which operate simultaneously to divide the block or mass 17 so that each portion thus separated is closely equal to the volume required for cement masses 3 and 5, respectively. Of course, other means are possible for so dividing the stiff mass of cement, without departure from the invention. Such means, for example might take the form of a machine having knives which are automatically operated to sever or to separate the cement into the desired portions.

FIG. 5 shows an apparatus for simultaneously assembling and securing the cap 2 and stem 4 to the dielectric body 1. This figure shows only one-half of the device apparatus. The remaining half, not shown, may be a duplicate of the portion shown, so that two insulators may be simultaneously assembled in one apparatus. Thus a description of the portion shown is sufficient.

A frame 22 carries one or more vibrators 23. A number of equiangularly-spaced arms 19 have their inner ends fixed to a central ring or band 36 and project therefrom radially outwardly and upwardly. There may be three of these arms spaced about the central vertical axis of ring 36. Each arm mounts a roller 21. As shown, these rollers jointly form a support for the insulator body, by engagement with the peripheral portion of its skirt.

Also each arm 19 pivotally supports a bellcrank 20. The pivot axis of each bellcrank is coincident with the axis of its associated roller. The inner arm of each bellcrank carries an abutment 37. These abutments are so disposed that when an insulator body 1 is at rest, supported by rollers 21, pivoting of the bellcranks in unison in a direction indicated by arrow F, FIG. 5, causes abutments 37 to engage the rim of the insulator and to hold it firmly seated upon the rollers. Means, not shown, may be connected to the outer end, such as at 20a, of each of the bellcranks, so that all of them are simultaneously pivoted to the insulator-holding position shown. As depicted upon FIG. 5, frame 22 is provided with three equiangularly-spaced depending legs 38. The upper ends of these legs are rigidly connected with ring 36.

Each leg 38 has one end of a respective bracket 39 secured to its depending end. These brackets extend inwardly and downwardly and conjointly support at their lower and inward ends, coaxially of the central vertical axis 40 of the assembly, a cup 41. A centrally apertured cover 41a rests upon the top edge of the cup and has notches in its periphery to receive with a smooth fit, a respective one of brackets 39. The cover is thus prevented from rotation about axis 40.

A pneumatic or hydraulic cylinder 42 fits down within the central aperture in cover 41a and has a threaded and enlarged upper end to receive a knurled and internally threaded flanged ring 43. A washer 26 of rubber, neoprene, or other resilient material is interposed between cover 41a and the lower rim of ring 43 for damping vibrations from vibrator 23 to thus assure that vibrations are not transmitted to cap 2 being emplaced through the frame 22 and structure including the depending legs 38.

The lower end of cylinder 42 is provided with a packing gland 44, receiving a hallow piston rod 45 for vertical sliding in and along axis 40. The lower end of this rod has a flange 46 secured thereto. A coil spring 47 is interposed between this flange and the lower end of cylinder 42 and thus acts to urge the rod 45 downwardly to its limiting position. The upper end of the spring fits smoothly about a sleeve 42a integral with and depending from the bottom of the cylinder, coaxially of axis 40. A liner 48 of bearing metal fixed in and concentric with sleeve 42a, has a smooth fit about rod 45 and acts to guide it for vertical reciprocation along the axis. At its lower end, rod 45 is equipped with means such as a nipple 49 by which a source, not shown, of pneumatic or hydraulic fluid under pressure, may be connected.

A piston 25 is enlarged at its lower end for an accurate pressure-tight fit in cylinder 42. The piston has a central vertical bore receiving the upper end of rod 45 with a smooth, sliding, right-pressure-tight fit. The upper reduced end of piston 25 slidable fits a second cylinder 50.

Means for effectively supporting a cap 2 to be assembled as a part of a completed insulator, is provided by a spider 24. This spider comprises a central inverted flanged item 24a fitting down over and about the top end of cylinder 50, and a central upward extension 24b which enters into the recess in the cap which, as shown, is in the inverted position. The upper end of piston rod 45 is fixed centrally to the closed end of cylinder 50. The spider 24 has three equiangularly-spaced legs which extend upwardly. Each of these legs journals a roller 51 at its top end. The rollers are so radially spaced from central axis 40 that they engage and support a cap 2 when the latter is dropped into the space between them, axially guided by extension 24b. In FIG. 5 the portion of piston 25 fitting cylinder 42, is shown in its uppermost position, under the influence of pressure fluid acting upon its lower surface. When the pressure is released, spring 47 acts, aided by gravity, to move the piston assembly and parts carried thereby, downwardly so that at this time rollers 51 are well
below the position shown, and a cap 2 may be freely emplaced on extension 24b, to rest with its expanded external surface on these rollers. When pressure fluid is applied at nipple 49, cylinder 50 is urged upwardly on and with respect to the reduced upper end of piston 25, having a pressure-tight fit therein. This acts in a way obvious from inspection of FIG. 5, to urge the cap upwardly about and over the crown portion of the dielectric body 1.

At the top of FIG. 5, a second spider or guide 52 comprises a central guide sleeve 52a, from which outwardly- and downwardly-extending, angularly-spaced arms are so spaced from axis 40, and so related, that they fit smoothly within the dielectric body and thus locate and temporarily maintain sleeve 52a coaxially of axis 40. This sleeve is sized to receive with a smooth fit, the outer or protruding end 42 of the stem 4, and thus guide the stem into its final emplaced position as shown in FIG. 1.

The operation of the apparatus shown upon FIG. 5 will be generally clear from the foregoing description thereof. With pressure released from the cylinders 42 and 50, and rollers 51 in lowered position, a quantity of mixed cement as determined by tool 18, FIG. 4, is deposited into the cavity 2 and the latter is then sealed into place, supported by rollers 51 and guided by extension 24b. An appropriate mass of mixed cement as also determined by tool 18, is deposited into the crown of body 1, and the body is emplaced in inverted position with the periphery of its skirt resting upon and supported by rollers 21. Bellcranks 20 are then pivoted, either manually or automatically, as indicated by arrow F, until abutments 37 engage the rim of the skirt and firmly hold it upon the rollers 21. Guide 52 is then positioned with the distal ends of its legs fitting within circular ridge 1a of the skirt, as shown upon FIG. 5, and a stem 4 is dropped into guide sleeve 52a.

With vibrator 23 in operation, fluid under pressure is introduced into cylinder 50 through nipple 49, tube 45 and the radial port at the upper end of the latter. This effect elevation of spider 24 so that the cement 3 mass in cap 2 is brought into contact with the crown of the body 1. Upward movement of the cap is delayed for a short period while the vibrations to which the cement is now subjected, act to expel any air entrained in the cement.

Upward thrust upon the cap is then resumed by fluid pressure introduced into cylinder 42 below piston 25, and because of the high-frequency vibrations to which the parts are subjected, the cement mix yields readily and shapes rapidly about the crown so that the cap rises readily and quickly. Since the lower end of piston 25, that is, the end fitting cylinder 42, is larger than the top end fitting cylinder 50, the force urging piston 25 upwardly in and relatively to its cylinder 42, is greater than the force urging cylinder 50 upwardly relatively to piston 25.

When the larger lower end of piston 25 reaches its limit of upward travel, shown upon FIG. 5, the continuously-acting force of the fluid acts to move upwardly cylinder 50, spider 24 and rollers 51, relatively to the upper end of piston 25. This effects the final and completed emplacement of cap 2 to its limiting position as depicted upon FIGS. 1 and 5, wherein washer 6 is pinched between the skirt of insulator body 1 and the rim of cap 2.

At the same time that cap 2 is being thus emplaced about the crown of body 1, the high-frequency vibrations effective upon the cement mix in the crown, causes the rapid descent of the stem, guided by sleeve 52a, as the cement yields and shapes about the stem until the latter is fully emplaced as shown upon FIG. 1, centrally disposed along axis 40 and having its inner end separated from the crown only by gasket 7.

As soon as cap 2 and stem 4 are thus fully emplaced in and with respect to the body, bellcranks 20 are pivoted in a direction opposite from that indicated by arrow F to release the assembled insulators, and at the same time pressure effective upon piston 25 is cut off. Spring 47 then become effective to lower the piston in preparation for the next cycle of operations.

The insulators, of which at least two are assembled in each cycle, are removed and positioned for washing in a device a part of which is shown at FIG. 6. This device comprises means for supporting at least two assembled insulators, only one of which is shown. Because of the stiff consistency of the cement mix, it is advantageous to use a spray consisting of water and air projected upwardly at great speed, to impinge upon the exposed areas of the cap and contiguous areas of the skirt.

Referring in detail to FIG. 6, a frame generally identified at 27, has side walls 28 and top wall 29 conjointly forming an enclosure. This top wall has two diametrically-opposite openings one of which is only shown and identified at 53. The rim of the opening mounts a ring 54 having an upwardly-facing surface for seating the skirt of the insulator.

A pair of frusto-conical deflectors are provided. One of these is shown at 31, as supported by the distal end of arm 55 extending radially from a central hub carried by a post 56. This post is supported by a piston slideable within a vertical hydraulic or pneumatic power cylinder 35. A second arm 57, like arm 55, extends in the opposite direction from the hub and supports a second deflector, not shown, positioned below a second opening in wall or cover 29.

In the figure the deflector is shown in position of maximum elevation. However, at first, that is, at the start of a cleaning operation, these deflectors are in their lowermost position in order to avoid interference with placement of the insulators to be cleansed. Then the spray of moisture and entrained air is released and directed upwardly into and through the deflectors which are then slowly translated upwardly by introduction of pressure fluid into cylinder 35, until they arrive at the upward limiting positions shown. For the purpose of supplying blasts of water and air spray upwardly, each deflector has mounted directly beneath it, a nozzle 32 supplied with air by way of pipe 34 and with water through a connection 33. In order to thoroughly remove all cement or mortar adhering to the exterior surface of the cap and adjacent areas of the skirt, the period for this washing or cleansing is about 6 seconds. The spray is then interrupted, manually or automatically, fluid pressure effective in cylinder 35 is cut off, and the post 56 descends with the deflectors, to their lowermost positions, free and clear of the insulators.

The insulators are then released and transferred at once to a tank of water in which they are immersed for about 24 hours. This immersion has the advantage of preventing overheating of the cement as it hardens, and supplies any additional quantity of water necessary for crystallization. At the end of this step of climatization, the insulators are given a final washing and cleaning, as with a power-driven rotary brush, particular attention being paid to that part of the insulator body from which
the stem protrudes. Finally all detritus is washed off with a spray of water. The insulators are then graded and packed.

I have thus disclosed an invention which fulfills all of the objects stated. Due to the stiff consistency of the cement at the time the parts are assembled, these parts are thereby held in proper relation until the cement has set, without the need for jigs or other means for holding them. At the same time, the high-frequency vibrations not only enable the facile assembly of the parts but also act to free the cement from air bubbles. This improves the strength of the completed insulator. Further, these vibrations and the absence of the need for jigs in holding the assembled parts pending crystallization of the cement, results in a materially reduced time for the fabrication of each insulator, and a corresponding reduction in cost per unit.

While I have disclosed the method and apparatus presently preferred by me, numerous substitutions of equivalent apparatus, alterations and change in sequence of steps, will readily occur to those skilled in the art, after a study of the foregoing description. Hence the disclosure should be taken in an illustrative rather than in a limiting sense; and all modifications, substitutions, variations and changes in sequence of steps, within the scope of the subjoined claims, are reserved.

Having fully disclosed the invention, what I claim and desire to secure by Letters Patent is:

1. The method of assembling an insulator comprising a hollow metallic cap member, a dielectric body having a hollow crown adapted to fit within said cap member, and a stem member fitting at one end within said hollow crown, which comprises disposing said cap member, body, and stem member in telescoping relation with the body between said cap and stem members and with a quantity of cement between the cap member and body, and with a further quantity of cement between the body and stem member, and applying vibratory motion directly to the body without passage through either of said members.

2. The method according to claim 1 including the further step of interposing damping means between one of said cap and stem members and the source of said vibratory motion substantially to isolate said one of said cap and stem members from said source of vibratory motion.

3. The method according to claim 1 wherein said cap member, body and stem member are supported coaxially along a substantially vertical axis, and wherein the uppermost of said cap and stem members is supported with freedom for downward movement upon compaction of the cement between said uppermost member and body.

4. The method according to claim 1 wherein said cap member, body, and stem member are supported coaxially along a substantially vertical axis with said stem member uppermost and wherein said body is affixed to the source of vibratory motion, and including the further step of applying an elastic stress upwardsly on said cap member for compaction of said first-named quantity of cement by action of said vibratory motion and elastic stress.