ELECTRICAL INSULATOR

Filed July 31, 1940

3 Sheets-Sheet 1

FIG. 1

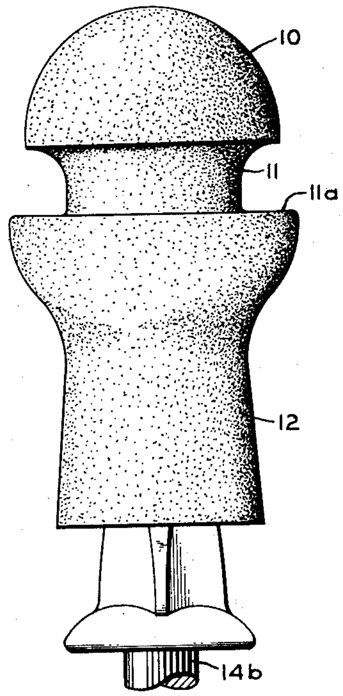



FIG. 2

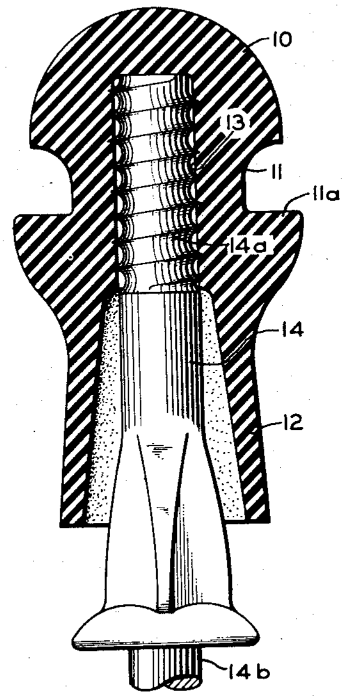



FIG. 3

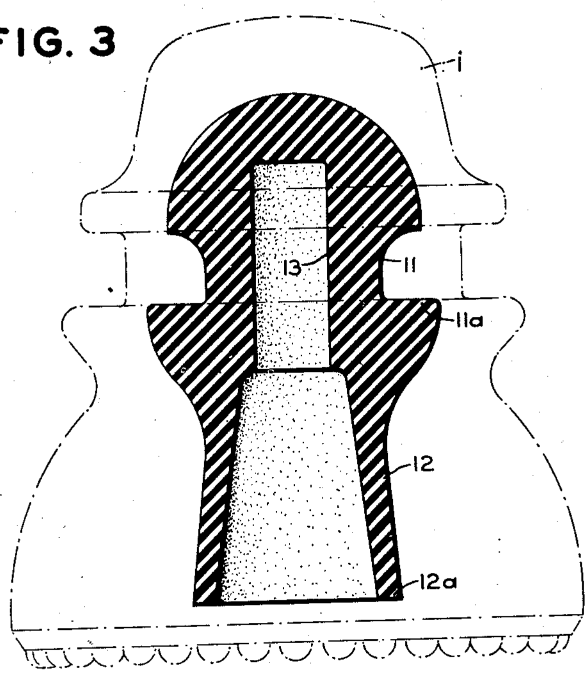
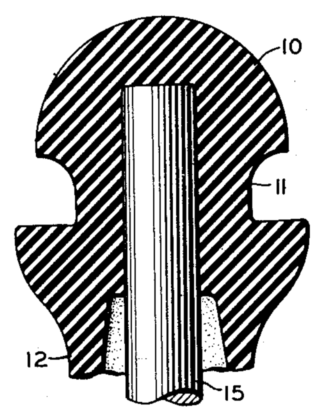



FIG. 4




INVENTORS
D. H. SMITH
H. H. WHEELER
BY N F Presson
ATTORNEY

ELECTRICAL INSULATOR

Filed July 31, 1940 3 Sheets-Sheet 2

FIG. 5

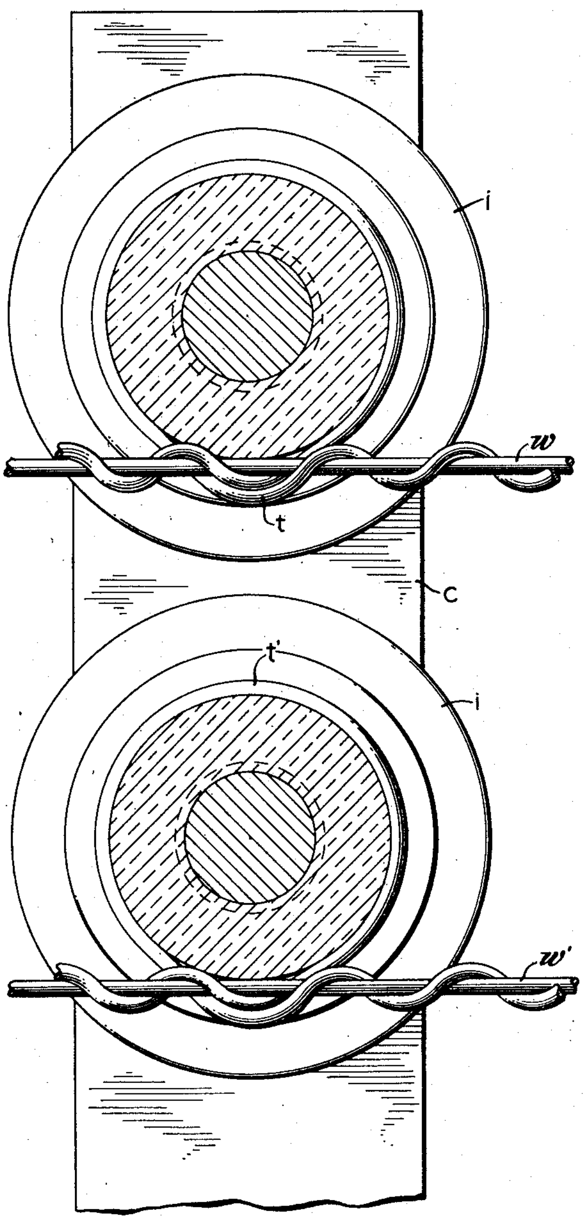
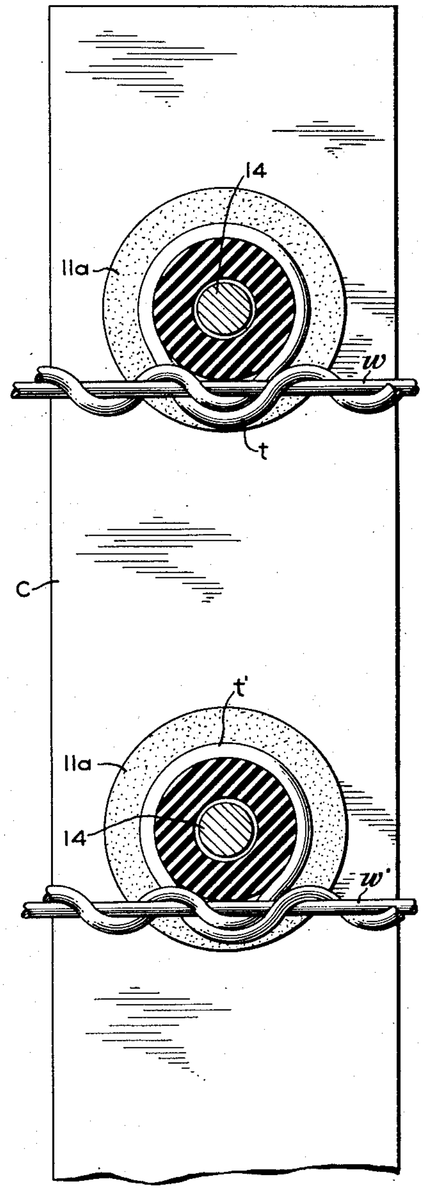



FIG. 6




INVENTORS
D. H. SMITH
H. H. WHEELER
BY [signature]
ATTORNEY

Dec. 8, 1942.

D. H. SMITH ET AL

2,304,483

ELECTRICAL INSULATOR

Filed July 31, 1940

3 Sheets-Sheet 3

FIG. 7

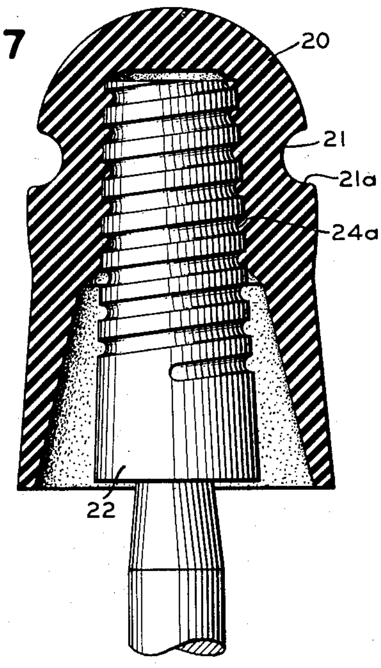



FIG. 8

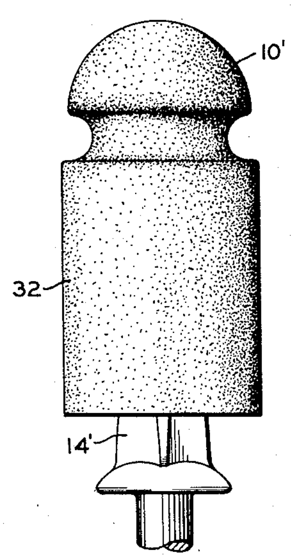
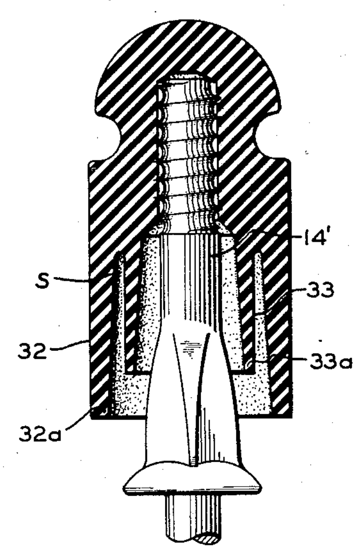



FIG. 9




INVENTORS
D. H. SMITH
H. H. WHEELER

BY V. F. Presson

ATTORNEY

# UNITED STATES PATENT OFFICE

2,304,483

## ELECTRICAL INSULATOR

Donald H. Smith, Hempstead, N. Y., and Herbert H. Wheeler, Millburn, N. J., assignors to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

Application July 31, 1940, Serial No. 348,708

6 Claims. (Cl. 174—211)

This invention relates generally to electrical insulators, and more particularly to pole line insulators for use with telegraph, telephone and other communication circuits.

This application is a continuation-in-part of our copending application Serial No. 243,762, filed December 3, 1938, now Patent No. 2,218,497, issued October 15, 1940.

The signaling currents employed in communication circuits are usually of small amplitude, and a definite and considerable portion of each signal impulse transmitted is required for operating the receiving apparatus, such as relays in telegraph circuits. While repeaters are employed at convenient locations, in certain instances the repeater points are necessarily spaced considerable distances apart and the signals reaching the receiving apparatus may become considerably attenuated, and since the margin of operation on communication circuits under favorable conditions is relatively small, any substantial loss of signaling current due to line leakage seriously interferes with the normal operation of the system. Also, communication circuits frequently are disposed along highways and railroad right of ways in connection with other signaling and power lines, and are subject to interference therefrom, and a considerable portion of the signaling current is required to override the transient or interfering currents set up therein because of such adjacent signaling and power lines, and this further reduces the operating margin of the communication signals.

In order to maintain the insulation of communication circuits as high as possible, it has heretofore been the practice to employ vitreous material, such as glass or porcelain, for pole line insulators, since such material, especially glass, was found the most practicable for such purposes. Glass and other vitreous insulators, however, are subject to various disadvantages. Pole line insulators form ideal targets for malicious persons who throw stones and missiles or shoot at them, with resultant breakage of the insulators. When an insulator is thus cracked or broken, it enables dirt and other foreign matter carried by the elements to collect in the cracked or broken portion and this forms a conducting leakage path over the surface of the insulator, particularly in rainy or humid weather, and if a portion of the skirt or petticoat of the insulator is broken away, this reduces the length of the leakage path over the insulator with the result that the insulator loses its desired insulation value. Also, when insulators are cracked or broken, there is a tendency for the insulators to be pulled or to fly off the pins on which they are supported, and the wire carried by the loose insulator may ground on the crossarm or swing into the adjacent wire, thus either grounding or short-circuiting the communication circuit or causing the same to be crossed with an adjacent circuit.

In an effort to avoid breakage of insulators, it has heretofore been proposed to employ shields, usually of metal, to protect the insulator. The installation and maintenance of such shields, however, is expensive and is disadvantageous because the shields reduce the clearance between adjacent wires and also introduce additional undesired capacity between the conductors of a circuit and between these conductors and ground, which capacity effect materially attenuates the signals.

A further disadvantage of glass and other vitreous insulators is that when dry and clean they may provide a negligible leakage path for the signal current, but when exposed to rain or moisture, they are subject to considerable surface leakage, and thus the insulation of the circuit varies between wide limits and may necessitate frequent readjustments of the terminal and repeater apparatus, or the insulation of the circuit may become so low as to render the circuit inoperative. The most severe conditions of surface leakage in such insulators occur during periods of rain, fog, and high humidity. During rainfall the outer surface of the insulator becomes completely wet and the inner surface also becomes wet due to splash and condensation. By reason of the relatively low interfacial tension characteristics of the glass with water, the splash or condensation on the inner surface of the insulator usually produces a continuous film of water on the surface, thereby materially increasing leakage over the insulator. During periods of fog the particles of moisture deposited on the insulator surfaces also tend to run together and form a continuous film of water. During periods of high humidity and varying temperature conditions, the moisture condenses on the surfaces of the insulator, and this also forms a continuous film of water. Even though the temperature conditions during periods of high humidity are not such as to induce condensation, nevertheless considerable leakage is often experienced as a result of the absorption of moisture from the air by the hygroscopic free alkalies and other chemicals which are present in the surface of the glass or other vitreous material.

In an effort to prevent the formation of continuous films of water, particularly on the inner surfaces of the insulator during periods of rain, fog and condensation, it has heretofore been proposed to employ a special iridescent coating on glass insulators in the manner disclosed in the Wheeler and McGinnis application, Ser. No. 621,478, filed July 8, 1932, now Patent No. 2,165,773, issued July 11, 1939, which coating exhibits the characteristic of high interfacial tension with water. Such insulators, however, retain various inherent disadvantages of glass and other vitreous insulators, in that they are relatively fragile and subject to breakage, and have to be made large and bulky to provide a reasonable measure of strength. Furthermore, the material of such insulators has a relatively high coefficient of thermal conductivity. This results in a relatively large amount of condensation of moisture on both the outer and inner surfaces of the insulators when the insulators are subjected to currents of warmer moisture-bearing air. Since these insulators are large and bulky, the dielectric losses are considerable, and it is difficult to obtain the close spacing which is desirable between conductors in high frequency communication circuits to counteract interference and crosstalk.

Various substitutes, including hard vulcanized rubber, have been suggested in place of glass and porcelain for insulators, but none of these substitutes has proved electrically and mechanically satisfactory in service, and in none of these insulators has the surface portion thereof that comprises a leakage path over the insulator had the desired high interfacial tension with water.

An object of this invention is an insulator in which the foregoing disadvantages of vitreous insulators and substitutes therefor are obviated.

A specific object is a non-breakable insulator substantially composed of a rubber compound or the like, which has improved mechanical characteristics and which exhibits and maintains in service high insulation characteristics.

Another object is an insulator of the character disclosed, in which the dielectric losses are low.

A further object is an insulator which may be mounted directly on a metal pin, without the necessity of providing a cob or shim between the metal pin and the insulator, and which will accommodate itself to pins having appreciably different diameters and different threads.

Still another object is an insulator which exhibits the desired physical and electrical properties, and which facilitates close spacing between adjacent wires of a high frequency circuit.

Other objects and attendant advantages will appear from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a view, in elevation, of a communication type insulator substantially composed of a rubber compound in accordance with our invention;

Fig. 2 is a longitudinal section of Fig. 1, showing the manner in which the insulator is mounted on its supporting pin;

Fig. 3 illustrates the relative sizes and configurations of an insulator embodying our invention and a standard glass insulator of the type heretofore employed for the same type of service;

Fig. 4 shows a modified form of an insulator in accordance with the invention;

Fig. 5 illustrates the small spacing and clearance present with standard glass insulators when it is attempted to obtain the optimum spacing between adjacent conductors in high frequency communication circuits;

Fig. 6 illustrates the large effective clearance obtainable between the conductors of the circuit of Fig. 5, when supported by insulators in accordance with the present invention;

Fig. 7 shows a further form of an insulator in accordance with the invention, adapted to be mounted on a wooden cob or wooden pin;

Fig. 8 shows a double petticoat type of insulator in accordance with the invention; and

Fig. 9 is a longitudinal section of Fig. 8.

Referring particularly to Figs. 1 and 2, there is shown a communication type insulator substantially composed of a vulcanized rubber compound in accordance with the invention, the insulator having a crown portion 10, a wire groove portion 11 for receiving the line wire, a reentrant skirt or petticoat portion 12, and a pin hole 13 for receiving the threaded portion 14a of a metal insulator pin 14 which is secured, by a reduced portion 14b thereof, to the cross-arm of a pole line in known manner.

The losses in signaling current occasioned by line insulators are, in general, due to three causes: First, the leakage from the line conductor, including its tie wire, over the outer surface of the insulator and under its skirt or petticoat to the supporting insulator pin; second, the leakage from the line conductor and tie wire through the material of the insulator to the insulator pin; and third, the dielectric losses. As hereinbefore stated, the first cause of losses in signaling current, which is surface leakage, causes considerable trouble under rainy or humid conditions in insulators of the types heretofore employed and in which both the outer and inner surfaces of the insulator may become covered with a film of moisture. The second cause of losses will also become considerable if the material of the insulator does not have a high specific volumetric resistance and maintain this high resistance in service. With respect to the third cause of losses, which are dielectric losses, these may be considerable if the material of the insulator has a high dielectric constant or if the mass of the insulator material disposed in the static field about the line wire and the tie wire is large, these losses becoming increasingly important in high frequency circuits since they increase with the frequency of the communication currents employed.

In accordance with the preferred embodiment of the invention claimed herein, the insulator is composed of a soft vulcanized rubber compound, and we have discovered that if an appreciable amount of one or more of certain substances of the character hereinafter disclosed is compounded with the rubber, this causes the surfaces of the rubber compound to have a high interfacial tension with water and thus prevents the formation of moisture films on the insulator surfaces to give the effect obtained by the iridized coating in the aforesaid Wheeler and McGinnis patent. In other words, the moisture occurring on the surface of the insulator by reason of any condensation, splash or direct rain, forms in separate globules which run off the surface freely without leaving a trail of free moisture behind, and thus there is produced a non-wetting surface which maintains high insulation values under the most adverse weather conditions, thereby substantially reducing any loss of signaling current due to line breakage and obviating the necessity of frequent readjustment of the repeater and receiving apparatus employed in telegraph and other communication circuits.

Among the substances which when compounded with rubber have been found to produce a surface having the desired high interfacial tension with water, are hydrocarbon waxes, including paraffin, ceresin, ozokerite, and amorphous types such as wax tailings, "mineral beeswax," and the like, vegetable waxes such as carnauba, montan, and others, and animal waxes such as stearin, stearic acid, beeswax, Chinese insect wax, tallow, spermaceti, and the like. Also, synthetic waxes such as hydrogenated montan wax, and higher alcohols, and substances chemically similar to waxes, such as lanolin, may be used. The proportions of such substances may vary within relatively wide limits; satisfactory results have been obtained by using one to five percent by weight of various of the foregoing substances. These substances may be used in lesser or greater proportions, with varying results, except that a sufficient amount of the substance must be employed to cause the surface of the rubber compound to have the desired high interfacial tension with water, without employing such amount of the substance as deleteriously affects the physical properties of the rubber compound. The desired proportions of these substances relative to the rubber may readily be determined empirically in each instance. It will be apparent that various waxes, synthetic waxes and substances chemically similar to waxes, other than those specifically mentioned, and derivatives thereof, may be employed. In the specification and claims, wherever applicable, the term "waxlike" is employed in a generic sense to define waxes, synthetic waxes, substances chemically similar to waxes, wax substitutes and/or equivalents thereof, which exhibit high interfacial tension with water and/or when compounded with or incorporated in the rubber compound cause the surface of the insulator to have the desired high interfacial tension with water.

As is well known, rubber compounds ordinarily include numerous ingredients other than rubber, such as ingredients for reinforcing, filling, coloring, softening, vulcanizing, and as age-resistors, some of the well known compounding ingredients including silica, clay, carbon, zinc oxide, sulphur and magnesium carbonate. These compounding ingredients, however, should be of such character or employed in such amounts that they will not, to a material extent, detrimentally affect the desired physical and electrical characteristics of the rubber compound, particularly in regard to its specific electrical resistance, dielectric losses and the like. Also, various synthetic and artificial rubber and rubber-like products may be used in the compound in combination with or to replace the rubber in whole or in part, the permissible extent of such addition or replacement being limited only in so far as such substitutes undesirably affect the desired physical and electrical properties of the insulator. In the specification and claims, wherever applicable, the term "rubber compound" is employed in a generic sense to define compounds of rubber and/or synthetic and artificial rubber, and rubber substitutes and rubber-like products, including the various other compounding ingredients and the waxlike substance or substances employed. By varying the amounts and character of the compounding ingredients, including the vulcanizing agents, the desired degree of softness or hardness and other physical characteristics of the rubber compound can be obtained and, in so far as obtaining the high interfacial tension with water, the rubber compound may be relatively hard when vulcanized, although, as above stated, the soft vulcanized rubber compound is preferable.

In addition to the advantages attendant to the high interfacial tension with water, it has been found that an insulator composed of a soft vulcanized rubber compound in accordance with the invention is non-porous and is substantially nonabsorbent, and even though certain of the materials used as fillers, pigments and other compounding ingredients may in themselves be hygroscopic, such materials are substantially sealed in the surface of the insulator against moisture by the rubber and the substance or substances employed for causing the surface to have a high interfacial tension with water. Thus the formation of conducting films resulting from the presence of free alkalies and other chemicals in glass and vitreous materials are obviated.

Furthermore, an insulator composed of a soft vulcanized rubber compound in accordance with the invention has a much lower coefficient of thermal conductivity than glass, hard rubber and other materials heretofore proposed for line insulator purposes. For example, the composition of the insulator herein disclosed may be such that it has a coefficient of thermal conductivity of approximately .109, whereas the coefficient of glass varies between approximately .33 and .5, and that of hard rubber is approximately .9, these values being expressed in the English system of measures, i. e., B. t. u. per hour per square foot per foot thickness per degree of Fahrenheit difference in temperature. It will be appreciated that hard rubbers of specifically different formulas will present a considerable variation in values of thermal conductivity; this is also true with regard to the various glasses, and to a lesser extent to soft rubbers. For example, depending upon the particular formulas employed, hard rubber may have a coefficient of thermal conductivity ranging down to .093 B. t. u.; the coefficient of Pyrex glass may be approximately .63 B. t. u.; and soft rubber .075 to .093 B. t. u.; the important consideration, however, is that of the relative values of soft vulcanized rubber and glass. Compounds of such rubbers having compounded therewith a waxlike substance or substances in accordance with the present invention will have substantially the same coefficients of thermal conductivity as those of the rubbers themselves. By reason of the low coefficient of thermal conductivity obtainable with the insulator disclosed herein, the surface of the insulator, under conditions of varying temperature, assumes more rapidly the temperature of the surrounding air, and this minimizes the amount of condensation of moisture. Furthermore, the skirt in the insulator of this invention may be made relatively thin, and as a result the time required to bring the material of this portion of the insulator to the temperature of the surrounding air is short, and hence the amount of condensation is further reduced.

Because of the foregoing characteristics, insulators in accordance with the invention retain the desired insulating characteristics for a considerably longer period of time than vitreous and other insulators heretofore known. Tests have shown that insulators embodying our invention which have been subjected to severe conditions of rain, fog and dirt have retained their high insulating properties to a degree substantially in excess of that exhibited by vitreous insulators, including iridized insulators, exposed to the same conditions.

Another important advantage of the use of a soft vulcanized rubber compound in accordance with our invention is that the insulator is nonbreakable. Also, as disclosed in Fig. 2, the pin hole 13 in the insulator does not have to be threaded for engagement with the threaded portion of the pin 14, but may comprise a smooth bore since the diameter of the pin hole may be made slightly less than the outer diameter of the pin, the elasticity of the rubber compound enabling the insulator readily to be forced on the pin, after which it resiliently grips the pin and thus minimizes or precludes the possibility of the insulator unscrewing off the pin because of vibration or flying off the pin because of a pull exerted thereon by the line wire. Furthermore, the insulator requires no wooden cob, shim or other cushioning material between the metal pin and insulator which generally has to be employed in the case of vitreous insulators to prevent cracking of the insulators due to the different temperature coefficients of expansion of the insulator and pin. Since no cob or shim is required, the mass of material in the static field is greatly reduced, with consequent reduction of dielectric losses, and the dielectric losses present in wooden cobs are eliminated. It is, in fact, not necessary that the insulator pin be provided with a threaded portion, since any protuberance or roughened surface will enable the insulator to effectively grip the pin, and by reason of the elasticity of the material the insulator is adapted to receive pins with different diameters and different threads. If desired, and as shown in Fig. 4, the insulator may be molded and vulcanized on the pin 15, and thus the pin and insulator become an integral structure so that there is no possibility of the insulator flying off the pin. An additional advantage of the insulator is that it has a dampening effect on vibration set up in the line wires, and there is no injurious or abrasive effect on the line wires by reason of the wires rubbing against the insulator, as is the case when vitreous insulators are employed.

Referring again to Fig. 2, it will be seen that the crown and wire groove portions 10 and 11 are built up so that they are relatively inflexible and thus enable the insulator to be rigidly mounted on an insulator pin or other supporting member, and thereby prevent displacement of the insulator on its support and accurately maintain the desired clearance between the wire and the adjacent conductors and the supporting crossarm, and rigidly support the line wire in a predetermined fixed position. The crown and wire groove portions, however, are sufficiently elastic to cause them to withstand the force of impact when struck by an object without permanent deformation of or injury to said portions. As shown, the underlip 11a of the wire groove is also relatively rigid and inflexible, so that it can hold the weight of the wire even when loaded with ice, at which time there may be a weight of from 300 to 400 pounds per span exerted on the pin by the line wire.

The skirt 12, however, may be provided with a very thin wall, thereby to obtain the benefits with respect to reduced condensation of moisture above referred to, and to cause the skirt to be sufficiently flexible to withstand better and partially absorb the force of impact when struck by an object, the skirt thus materially preventing the force of impact from being communicated to the upper portion of the insulator and possibly causing displacement of the insulator.

Fig. 3 illustrates the relative proportions and configurations of an insulator in accordance with the present invention, shown in full line in the figure, and a conventional glass insulator i, the relative size and configuration of which is shown approximately by broken lines in the figure. The two insulators are each designed for the same circuit or the same class of service. In the insulator in accordance with the present invention, the largest diameter of the insulator, which is across the outer edges of the reinforced lip portion 11a, is 1⅞ inches whereas the largest diameter of the glass insulator *i*, which is across the outer surfaces of the outer petticoat shown, is 3¾ inches, the necessary overall dimension of this insulator being approximately twice that of the insulator of our invention. Also, the overall height of the insulator of the invention, from the top of the crown to the bottom of the skirt is 3$\frac{5}{16}$ inches, whereas the overall height of the glass insulator *i*, from the top of its crown to the bottom of its drip point portion, is nearly 5 inches. Furthermore, the insulator of the invention requires but one skirt or petticoat 12 which may be made quite thin; a skirt which at its bottom portion 12a is only $\frac{3}{32}$ inch thick has been found satisfactory. Since no cob or shim is required, the inner diameter of the skirt may be appreciably reduced, so that the skirt may closely approach the pin on which the insulator is mounted, as will be seen from Fig. 2, and thereby appreciably reduce the splash effect and also reduce the amount of dirt and other foreign material that may come in contact with the inner surface of the insulator. An insulator, such as shown in Fig. 3, in which the inner diameter of the bottom portion 12a of the skirt is only 1⅛ inches has been found suitable.

In the case of high frequency circuits it is often desirable to reduce the spacing between conductors of a circuit to limit cross-talk and interference, as shown in Figs. 5 and 6. In Fig. 5 in which standard glass insulators are used, it will be seen that, with a desired close spacing between conductors, only a very limited separation is obtainable between the tie wire *t* of conductor *w* and the tie wire *t'* of conductor *w'*, and that the separation between the insulators is still more limited. This condition not only results in undesirable increase in capacity between the conductors, but also results in the possibility of serious leakage between the conductors due to spider webs and other foreign substances extending or lodging between the insulators and tie wires. With the same spacing between the conductors *w* and *w'* of Fig. 6, in which insulators of the invention are employed, it will be seen that nearly twice the spacing is obtained between the tie wires *t* and *t'*, and that the spacing between the insulators is many times that obtainable by the standard glass insulators, thereby preventing undesirable increase in capacity between the conductors, and reducing the likelihood of serious leakage between the conductors of the circuit.

If desired, and as shown in Fig. 7, the insulator may be made so that the pin hole is sufficiently large to accommodate the conventional wooden pin or cob, so that it is unnecessary to change the pins on an existing circuit in order to replace the insulators thereon with insulators in accordance with the present invention. As in the embodiments of Figs. 1 to 4, the crown and wire groove portions **20** and **21** are built up so that they are relatively inflexible, thereby enabling the insulator to be rigidly mounted on the pin **22** or other supporting member, thus preventing displacement of the insulator on its support and rigidly supporting the line wire in a predetermined fixed position. Due to the elasticity of the rubber compound, the threaded portion **24***a* of the insulator grips the threads of the pin **24** and prevents loosening and unscrewing of the insulator which in the case of glass or porcelain insulators frequently occurs due to strain and vibration. The crown and wire groove portions are sufficiently elastic to prevent deformation or injury when struck by a missile or other foreign object, although the underlip **21***a* of the wire groove is relatively rigid and inflexible to hold the weight of the wire under adverse service conditions. Notwithstanding that the insulator of Fig. 7 is used with a pin of larger diameter than the pin shown in Figs. 1, 2 and 4, the spacing between the adjacent insulators is considerably greater than that obtainable when conventional glass or porcelain insulators are employed. While a threaded portion **24***a* is shown in Fig. 7, the threads may be replaced by protuberances which are suitably spaced to enter or engage the threads on the pin. In either case, the diameter of the pin hole in the insulator is preferably made slightly less than the diameter of the threaded portion of the pin hole to cause the insulator to resiliently grip the pin.

Figs. 8 and 9 show how the invention may advantageously be applied to a double petticoat type of insulator. Preferably, and as shown, the outer wall or petticoat portion **32** is substantially cylindrical, without flaring outwardly, and thus the spacing between adjacent insulators is not decreased even though a second petticoat portion **33** is provided. In the embodiment illustrated, the largest diameter of the insulator, which is the outer diameter of the petticoat **32**, is 1$\frac{9}{16}$ inches. The addition of the second petticoat greatly increases the effective length of the leakage path over the surface of the insulator, and what is more important it more than doubles the length of the "dry" leakage path, i. e., the leakage path over the under surface of the insulator, while at the same time the overall diameter of the insulator is not increased, and by reason of this fact the developed width of the leakage path is very much less than that of the conventional double petticoat glass or porcelain type of insulator, and the area of the surface leakage path is greatly reduced as compared to the conventional glass or porcelain insulators heretofore employed. The various portions of the insulator are drawn to scale in Figs. 8 and 9.

Another advantage of the double petticoat type of rubber insulator is that the petticoat portions **32** and **33** may be made much thinner than the petticoat portions in glass or porcelain insulators, and thus may be spaced closely together and the slotted portion or space *s* between them may be carried up much higher. The bottom portion **32***a* of the outer petticoat may be only $\frac{3}{32}$ inch thick or less, and the bottom portion **33***a* of the inner petticoat may be only $\frac{1}{16}$ inch thick or less. This not only enables the dry leakage path to be made much longer than is possible in glass or porcelain insulators, but due to the closer spacing obtainable between the petticoats (from ⅛ to $\frac{1}{16}$ inch, as shown) the possibility or likelihood of rain splashing up into the space between the petticoats is minimized or precluded, and thus a considerable portion of the leakage path remains substantially dry even under the most adverse weather conditions, in contrast to glass and porcelain insulators in which the leakage path between the petticoats may and frequently does become wet due to the splashing action of the rain. Since the walls of the petticoats are quite thin, the tendency for moisture to condense or form on the surfaces of these walls is also substantially minimized or precluded.

Since the outer wall or petticoat **32** and the inner wall or petticoat **33** are substantially cylindrical, this simplifies the molding of the article, which ordinarily would present difficulty particularly where two petticoats are employed; by reason of the cylindrical configuration of the insulator it may be removed more readily from the mold and thus enable production to be materially speeded up and also reduce the cost of manufacture. It is to be understood, however, that flared petticoat portions may be employed, if desired, instead of the cylindrical configuration illustrated.

While there are shown and described herein certain preferred substances and embodiments, many other and varied forms, uses and substances will suggest themselves to those versed in the art without departing from the invention, and the invention is therefore not limited except as indicated by the scope of the appended claims.

We claim:

1. A non-breakable pole line insulator comprising an integral body substantially composed of a soft vulcanized rubber compound, said insulator body having crown and wire groove portions which are sufficiently massive to enable the insulator to be rigidly mounted on an insulator supporting member and to rigidly support a line wire in predetermined fixed position, said crown and wire groove portions being sufficiently elastic to cause them to withstand the force of impact when struck by an object without permanent deformation of or injury to said portions, said insulator body having a reentrant elastic skirt portion which is relatively flexible to partially absorb the force of impact when struck by an object and prevent substantial deformation or displacement of the crown and wire groove portions, said rubber compound including fillers, pigments, a wax-like substance and other compounding ingredients for giving desired physical characteristics to the compound, the character of said compounding ingredients and the relative proportions thereof being such that the compound has high specific volumetric electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent.

2. A non-breakable pole line insulator comprising an integral body substantially composed of a soft vulcanized rubber compound and adapted to be mounted on an insulator body supporting member, said insulator having crown and wire groove portions which are sufficiently massive to enable the insulator to be rigidly mounted on said insulator supporting member and to rigidly support a line wire in predetermined fixed position, said crown and wire groove portions being sufficiently elastic to cause them to withstand the force of impact when struck by an object with-

out permanent deformation of or injury to said portions, said insulator body having a reentrant elastic skirt portion which is relatively flexible to withstand and partially absorb the force of impact when struck by an object, and a portion forming an inner bore for receiving the insulator supporting member, the inner diameter of said bore being less than the outer diameter of said supporting member, the portion of the insulator body forming the bore being sufficiently elastic to stretch and firmly grip the supporting member in service, said rubber compound including fillers, pigments, a waxlike substance and other compounding ingredients for giving desired physical characteristics to the compound, the character of said compounding ingredients and the relative proportions thereof being such that the compound has high specific volumetric electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent.

3. A non-breakable pole line insulator for supporting a line conductor, adapted to be mounted on a pole line insulator supporting pin and to maintain high line insulation values over long periods of time and under adverse weather conditions, said insulator comprising an integral body substantially composed of a soft vulcanized rubber compound and having a pin hole for securing the same to said insulator supporting pin, a wire groove portion for supporting the line conductor in predetermined fixed position with respect to said supporting pin and a thin, circular reentrant skirt portion for increasing the leakage path between the line conductor and insulator supporting pin, the inner diameter of said skirt portion being sufficiently small to cause the skirt to closely surround said supporting pin and minimize the splash effect of rain when the insulator is in service, said rubber compound including fillers, pigments, a waxlike substance and other compounding ingredients for giving desired physical characteristics to the compound, the character of said compounding ingredients and the relative proportions thereof being such that the compound has high specific volumetric electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent.

4. A non-breakable pole line insulator for supporting a line conductor, adapted to be mounted on a pole line insulator supporting pin and to maintain high line insulation values over long periods of time and under adverse weather conditions, said insulator comprising an integral body substantially composed of a soft vulcanized rubber compound and having a pin hole for securing the same to said insulator supporting pin, a wire groove portion for supporting the line conductor in predetermined-fixed position with respect to said supporting pin and a plurality of thin, depending skirt portions, one within the other, for increasing the leakage path between the line conductor and insulator supporting pin, said rubber compound including fillers, pigments, a waxlike substance and other compounding ingredients for giving desired physical characteristics to the compound, the character of said compounding ingredients and the relative proportions thereof being such that the compound has high specific volumetric electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent.

5. A non-breakable pole line insulator for supporting a line conductor, adapted to be mounted on a pole line insulator supporting pin and to maintain high line insulation values over long periods of time and under adverse weather conditions, said insulator comprising an integral body substantially composed of a soft vulcanized rubber compound and having a pin hole for securing the same to said insulator supporting pin, a wire groove portion for supporting the line conductor in predetermined fixed position with respect to said supporting pin and a thin, depending reentrant skirt portion for increasing the leakage path between the line conductor and insulator supporting pin, the outer surface portion of said skirt being cylindrical in shape, said rubber compound including fillers, pigments, a waxlike substance and other compounding ingredients for giving desired physical characteristics to the compound, the character of said compounding ingredients and the relative proportions thereof being such that the compound has high specific volumetric electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent.

6. A non-breakable pole line insulator for supporting a line conductor, adapted to be mounted on a pole line insulator supporting pin and to maintain high line insulation values over long periods of time and under adverse weather conditions, said insulator comprising an integral body substantially composed of a soft vulcanized rubber compound which includes rubber and fillers, pigments and other compounding ingredients including a wax-like substance for giving desired physical characteristics to the compound, the character of said fillers, pigments and other compounding ingredients including a wax-like substance and the proportions thereof relative to the rubber being such that the compound has a high specific electrical resistance, low dielectric losses, and is non-porous and of low hygroscopicity such that it is substantially non-absorbent, said insulator body having a pin hole for securing the same to said insulator supporting pin, a wire groove portion for supporting said line conductor in predetermined fixed position with respect to said supporting member and a thin reentrant skirt portion for increasing the leakage path between the line conductor and insulator pin, the diameter of said pin hole being less than the diameter of said pin to cause the insulator to resiliently grip said pin when mounted thereon.

DONALD H. SMITH.