June 4, 1940. F. J. BAIRD ET AL 2,202,820

COMMUTATOR

Original Filed Aug. 22, 1933 2 Sheets-Sheet 1

FIG-1-

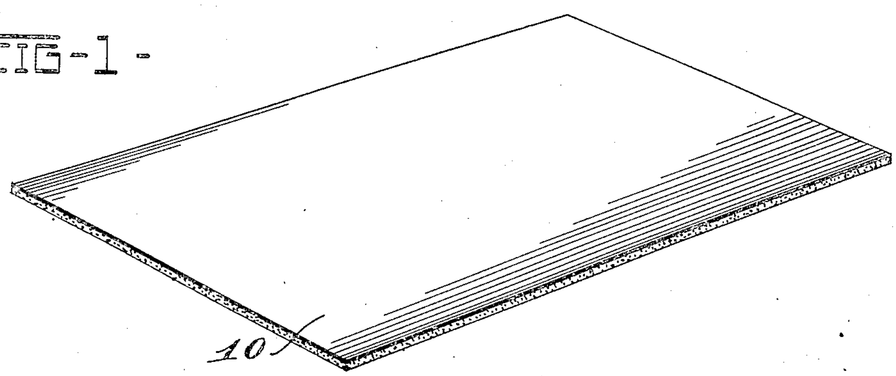


FIG-2-

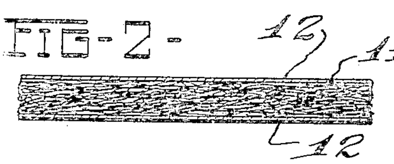


FIG-4-

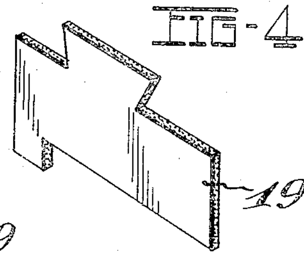
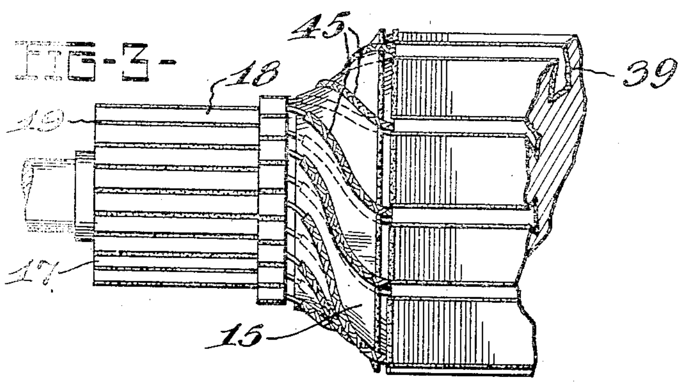


FIG-3-



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COMMUTATOR

Original Filed Aug. 22, 1933 2 Sheets-Sheet 2

FIG-5 -

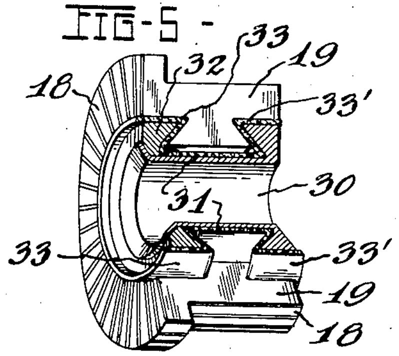


FIG-6 -

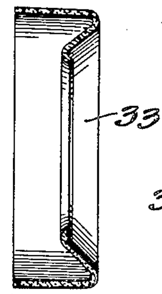


FIG-7 -

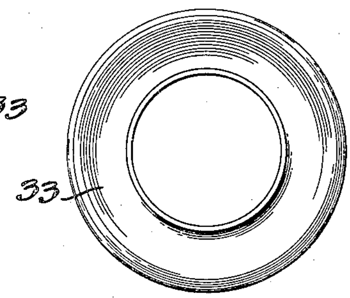


FIG-12 -

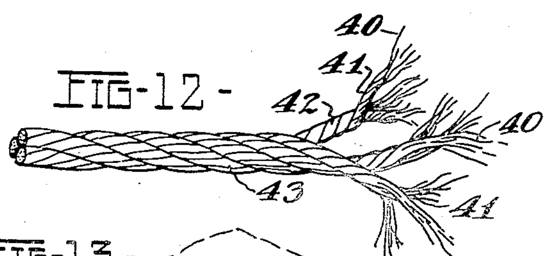


FIG-8 -

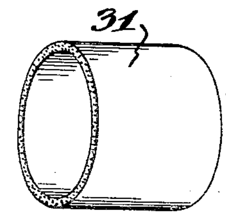


FIG-13 -

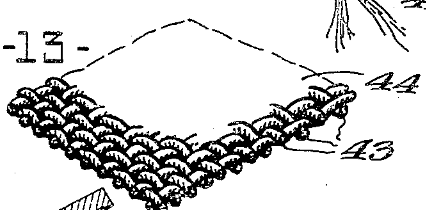


FIG-14 -

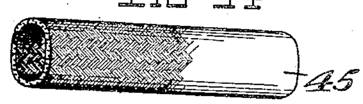


FIG-10 -

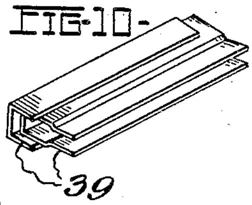


FIG-11 -

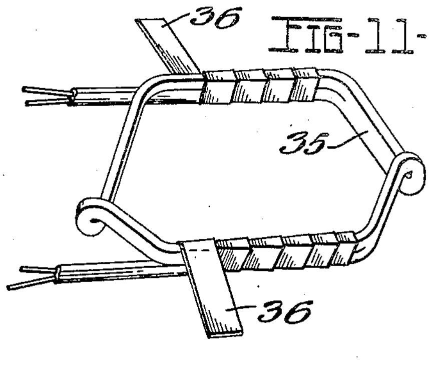
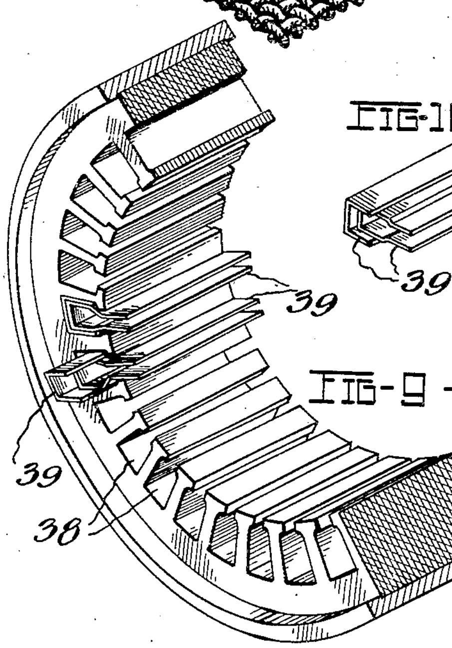


FIG-9 -



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2,202,820

UNITED STATES PATENT OFFICE

2,202,820

COMMUTATOR

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Original application August 22, 1933, Serial No. 686,270. Divided and this application November 20, 1935, Serial No. 50,626

3 Claims. (Cl. 171—321)

Our invention relates to electric generators and motors, and particularly to insulating material combined with and forming a part of the commutators and other portions of such apparatus.

At the present time, mica is extensively used as an insulating material in such equipment. The insulating segments used in the commutators and which are interposed between the copper bars or segments of such commutators are usually made of mica. This applies to most, if not all, of the higher grade commutators. Mica is a mineral which always contains invisible metallic impurities and microscopic clefts that weaken its insulating properties and render it comparatively unreliable. The methods of treating the raw material to prepare it for use as an insulator are costly and the resultant product expensive. The mica has certain physical properties which are detrimental to its use as insulating segments for commutators or in similar situations. The thin laminae or layers of mica which comprise the insulating segments tend to slip when subjected to the high pressure applied to them in assembling the commutator bars, making the assembling operations difficult and also making it difficult to reliably hold the parts in assembled position. When these mica segments are placed between the commutator bars they must be undercut, or in other words, the mica at the surface of the commutator must be cut down below the adjoining copper bars in order to prevent excessive arcing. When the commutator bars during use wear down to the level of the mica, further undercutting of the latter becomes necessary.

An object of our invention is to overcome the above noted difficulties and objections to the use of mica, by providing an insulating material which is inexpensive to manufacture, which when assembled with the commutator bars will retain its position without liability of slipping, and which in use will wear down as rapidly as the adjoining copper bars and thereby eliminate the necessity of undercutting or other special treatment to avoid excessive arcing.

An aim of the present invention is to provide an insulating material which when used with commutator segments as a substitute for mica, practically eliminates the usual shorts between adjoining commutator bars and also minimizes the time and labor involved in testing the commutators for such shorts. It is customary to test each two adjoining commutator bars at comparatively high voltages which may range from 110 volts to 440 volts, or considerably higher. When any short occurs during this test, scraping of the mica segment, or other manipulation, is necessary. This involves much time and labor when it has to be frequently repeated in testing a single commutator. Such shorts are due in part to the surface conductivity of the mica, and to various other factors. The present invention provides an insulating material which is substantially free from these objections, and which in use has been found to practically eliminate shorts and thus greatly reduce the labor involved in testing the commutator.

A further difficulty encountered with the use of mica for commutator segments is due to the fact that in finishing the commutator with a cutting tool there is a tendency for the edges of the mica to project above the commutator bars. This necessitates a sanding or other operation. An object of our invention is to overcome this difficulty by the provision of a material which turns even with or below the copper.

A further feature of the insulating material forming the subject-matter of our invention, which renders it superior to mica for use in electric motors and generators and in various other situations, relates to its flexibility and compressibility. Thus, for example, in building commutators, this property permits a wide tolerance in the thickness both of the insulating material and the commutator bars. Mica has very little compressibility so that when the commutator is assembled difficulty is often experienced in compressing or drawing it down to specified dimensions. This difficulty is overcome by the present invention.

A further object of the invention is to provide an insulating material which when used for insulating the various parts of electric motors and generators will successfully and permanently withstand the combined effects of temperature changes and continuous vibration to which it is subjected in use. With the materials which at present are generally used as insulating materials, it appears to be impossible to build a motor with the parts held together so securely that looseness of parts will not develop in time. The heat and continuous vibration gradually misplace and destroy the insulation, causing weaknesses and a final breakdown. This trouble is aggravated by the wide temperature variations and sometimes high temperatures to which the motor is subjected. An aim of our invention is to overcome these objections and provide an insulating material which, owing to its elasticity, flexibility, heat-resisting qualities and high insulating values, permits the motor to be compactly built in a manner to withstand vibration, high temperatures and temperature variations without deterioration, thereby greatly prolonging the life and efficiency of the motor and adapting it for use in situations and under conditions where it would be impractical or impossible to use motors in which other materials are employed and relied on as the insulating material.

Cheap substitutes for mica, such as cotton cloth, paper and other organic materials impregnated with a binder, are extensively used in the manufacture of armatures and other electrical equipment. Such materials are inferior and unsatisfactory. Paper and cotton cloth carbonize at high temperatures so that their insulating value is destroyed as well as their physical properties. The present invention provides an inexpensive insulating material which is not destroyed and does not deteriorate at high temperatures and which meets the requirements of a high grade insulating material.

In its preferred form, the insulating material comprises fine glass wool which may be felted or matted and compressed, rolled or woven into sheets and impregnated with a suitable binding material or materials, or may be molded into various forms.

An object of our invention is to provide a commutator in which the insulating segments comprise a material which may be either molded or made in sheets of varying thickness and which material is inexpensive to manufacture, possesses high insulating qualities, has high dielectric resistance and strength so that it is not easily broken down by disruptive electrical discharges, will withstand comparatively high temperatures without destruction or deterioration, has substantial elasticity and compressibility, particularly adapting it for the purpose indicated, and which is free from the objectionable features above noted in connection with mica and other insulating materials commonly used as insulator segments in commutators.

Other objects of the invention will appear hereinafter.

Referring to the accompanying drawings:

Fig. 1 is a perspective view of a sheet of insulating material made in accordance with our invention.

Fig. 2 is a fragmentary sectional view of the sheet on an enlarged scale.

Fig. 3 is a fragmentary view of an electric armature showing particularly the commutator.

Fig. 4 is a perspective view of an insulating segment of the commutator.

Fig. 5 is a part sectional perspective view of the commutator.

Fig. 6 is a sectional view of an insulating ring or collar.

Fig. 7 is a face view of the same.

Fig. 8 is a perspective view of an insulating tube.

Fig. 9 is a sectional perspective view showing a stator.

Fig. 10 is a perspective view showing slot cell insulation.

Fig. 11 is a perspective view of an armature coil and shows a method of applying insulating material thereto.

Fig. 12 is a view of a cord made of our insulating material.

Fig. 13 is a perspective view of a piece of cloth or fabric made of the insulating material.

Fig. 14 is a perspective view of a woven insulating tube.

The present application is a division of our copending application Serial Number 686,270, filed August 22, 1933, Electrical insulation, now Patent No. 2,133,183, dated October 11, 1938.

Referring to the drawings, the insulating material may be made in the form of sheets 10 of varying sizes, shapes and thickness, which sheets may be stamped or cut to provide pieces of insulating material of the sizes and shapes required for the particular uses to which they are to be put. In general terms, the sheet of insulating material comprises a body of glass wool 11 which is matted or felted and compressed to provide a sheet of desired thickness, a binder of insulating material with which the wool is impregnated and, if desired, an outer layer 12 of thin sheet material covering both surfaces of the sheet 10.

The glass wool 11 which forms the body of the insulating material consists of individual fibers or strands of glass, the fineness of which may vary as hereinafter pointed out. These fibers are woven, matted, felted, or otherwise manipulated to form an elastic compressible body or mass of wool. The particular methods of making such material are not a part of the present invention, but one such method may be briefly stated as follows: Small streams of molten glass are blown by air or steam which is applied at a high pressure and draws the glass out into fine threads or filaments which are instantaneously solidified while suspended in the air and accumulate to form a mass known as glass wool. The wool is spread uniformly on a conveyor or the like and transferred thereby to rolling equipment by which it is rolled and compressed to the desired thickness and density. A binding material may be applied either before or after the rolling or compressing operation.

The insulating material which is used as a binding medium for the wool may consist of shellac, phenolic condensation product (commonly known under the trade name "Bakelite"), latex, rubber, rosin, silicate of soda, varnish, either bake drying or air drying varnish, or some other material, or a combination of such materials, depending on the specific properties and results desired, which evidently will vary to a considerable extent with the particular use to which the insulation is to be put. We have found that very satisfactory results are obtained with the use of either shellac or a phenolic condensation product as a binding medium alone or in combination with other materials, throughout a wide range of uses for which the insulating material is adapted. The binding material may be used in sufficient quantity and have sufficient body to fill or substantially fill the interstices of the wool base and thereby provide a dense, compact, impervious sheet having high tensile strength and permanency of shape, and which at the same time is elastic and compressible.

A small amount of latex may be used as a binding material in combination with either shellac or a phenolic condensation product, as it is found that the latex materially improves the product. Particularly, it greatly increases its flexibility without detrimentally affecting the dielectric properties and electrical resistance of the product. The latex also renders the material easier to cut or work with tools, admitting of smooth clean cut edges, free from chipping and breaking.

The fineness of the glass wool may be varied through rather a wide range, depending upon the specific results desired. Generally speaking, superior results are obtained with wool, the fineness of which comes within the range of .0001 to .002 of an inch in diameter of the individual filaments. Wool of this fineness can be more readily compressed than a coarser wool and results in a superior product. If a coarse wool is used, compression tends to crush the glass, particularly where the fibers cross each other.

The sheet 10 of insulating material may be provided on both its upper and lower surfaces with a thin layer or sheet of insulating material 12 such as tissue paper, regenerated cellulose (known in the trade as "Cellophane"), or other material. This surface layer serves to materially stiffen the sheet and also protects the body of the insulating material. Further, it facilitates the stamping or cutting of the sheet into smaller pieces, permitting such pieces to be cut or stamped with a sharp clean edge. The surface layer 12 is of particular value when handling the pieces of material in large numbers, as, for example, insulating segments for commutators, as it materially facilitates the ease with which the insulating segments are assembled. It provides a smooth surface which facilitates the assembly of the insulation with the commutator bars. We have found that regenerated cellulose is a superior material for the above purposes. It is to be understood, however, that the sheet material 11 may be used without the surfacing material, and this is sometimes preferable, particularly where it is desirable to cause the insulation to firmly adhere to the commutator bars or other surfaces to which it is applied.

The binding material with which the wool is impregnated, as, for example, shellac or phenolic condensation product, may be so applied as to impregnate the entire mass, or it may be applied in a manner to penetrate only part way through the mass. When the binder is applied only to the surface portions of the sheet it may serve simply as a binder to retain the size or shape of the material, the interior layer or portion of glass wool which is not impregnated with the binder serving to produce the necessary resistance to the passage of electric current.

In Figs. 3 to 11, we have shown adaptations of our invention for use in electric motors and generators. The machine comprises an armature 15 and a commutator 17, mounted on a rotating shaft. The commutator may be of conventional form and construction, except as regards the particular insulating material used. It comprises an annular series of copper bars or segments 18 with interposed segments or layers 19 of insulating material. The individual segments 19 (Fig. 4) may be stamped from a sheet 10. The parts of the commutator may be assembled in the usual manner. The properties of the insulating material as heretofore pointed out especially adapt it for this use.

As shown in Fig. 5, the commutator comprises a central metal sleeve or spool 30 surrounded by the copper bars 18 and insulating segments 19. The metal sleeve 30 is surrounded by a tube 31 (Figs. 5 and 8) which may comprise a strip of the sheet material 10, or may be molded or formed to size. The bars 18 and segments 19 are clamped in position by a V-shaped metal ring 32 and the metal sleeve 30. V-shaped collars or rings 33 and 33′ of insulating material are interposed between the copper segments 18 and the parts 30 and 32. The rings 33 and 33′ may be molded or otherwise formed of glass wool impregnated with a binding material, as herein described.

The flexibility and compressibility of the insulating segments permit a comparatively wide tolerance in the thickness of the parts and at the same time permit them to be compactly assembled. The flexibility and compressibility of the material permits it to readily conform to any irregularities in the surfaces with which it contacts.

The flexibility and compressibility of the insulating sheet also builds up a frictional resistance, due to its compression against mating members when assembled, which resistance opposes any tendency for the material to be thrown or moved out of position, as, for example, by centrifugal force when used with a commutator rotating at a high speed. The frictional resistance when the material is assembled under compression, results in stability or absence of movement of the insulation relative to the part to which it is applied, prevents slipping, creeping or crawling of the insulation whether used with rotating or non-rotating parts, and also when subjected to vibration or heat. By omitting the smooth surface layers 12 from the insulating material, the frictional resistance is increased and may be further augmented by the use of an adhesive material or binder, so that the insulation will adhere with tenacity to the surfaces to which it is applied.

The insulating material composed of glass wool or glass wool felt with a binder such as above described has been found to be heat resistant to an extent which renders it satisfactory for use in commutators and in other situations where it may be subjected to temperatures which may range as high as 750 to 1000° F.

It is important that the commutator when completed shall have the parts firmly and securely united to form a rigid structure in which there can be no movement of one part relative to another. If, for example, any movement of an insulating segment takes place so as to project even slightly beyond the adjoining bars, it results in arcing a destructive action which soon ruins the commutator. In accordance with our invention, the glass wool is impregnated with a binder, as, for example, shellac or phenolic condensation product, which when cold results in a comparatively stiff sheet. When the commutator is assembled, heat is applied which softens the material to a certain extent, sufficient to permit compression in the manner above described, the material, however, retaining sufficient stiffness and resistance to compression to permit the assembled commutator parts to be subjected to the high pressure which is applied for firmly uniting and compacting the parts. While under this pressure, the commutator is subjected to a heating or baking process by which the more volatile parts of the binding material are driven off and such material hardened. The result of this method of treatment is a commutator in which the copper bars and insulating segments are firmly united in substantially an integral piece or unit so that it is practically impossible for relative movement or displacement of the parts when the commutator is in use.

An alternative method of applying the insulating binder to the glass wool as used, for example, in commutators, consists in dipping or spraying the wool with the insulating varnish or binder at the time the material is installed or assembled in the commutators.

Fig. 11 shows an armature coil 35 and a method of winding the coil with strips 36 of glass wool insulating material. These strips may be cut from sheets of insulation 10 or may consist of strips of tape cut from a woven fabric such as shown in Fig. 13, or made of strands of spun glass wool woven into tape.

Fig. 9 illustrates a stator made up in the usual manner of iron sheets or laminations 37, provided with slotted cells 38 for receiving the coils. Insulating pieces 39 shaped to fit the cells 38 provide insulation for the coils within said cells.

Fig. 12 illustrates a cord made of glass wool. The fine individual fibers 40 of glass wool are spun into strands 41. A plurality of these strands are wrapped to form a strand or cord 42. These cords in turn may be combined to form a rope or cord 43. The spun strands or cords may be woven or fabricated into the form of a sheet 44 (Fig. 13). The methods of making the fabric 44 from glass wool may be substantially the same as used in the manufacture of cotton or woolen fabrics and need not be herein described in detail. The fabrics thus made from glass wool may be used as an insulation for the purposes hereinbefore described. The glass wool fabrics can be made and are adapted for use without a binding material or other materials combined therewith. For instance, such glass wool fabric without other ingredients may be used as the sole insulating material in an electric motor such as above described, with the result that the motor can withstand extremely high temperatures indefinitely without injury and is practically fireproof. For certain uses, however, it is preferable to impregnate or treat the fabric with latex, shellac, phenolic condensation product or other materials, or a combination of such materials.

Fig. 14 shows a tube 45 made of woven or braided glass wool. The tube may, if desired, be impregnated with a binding or stiffening material so that it will retain its shape independently of the article to which it is applied. It may also have a coating either internally or externally, or both, of any suitable surfacing material as varnish, shellac, regenerated cellulose, woven cotton or silk or the like. Such tubes may be used as indicated in Fig. 3 for insulating the leads or terminal wires of the armature coils between the armature and commutator.

Modifications may be resorted to within the spirit and scope of our invention.

We claim:

1. A commutator comprising an annular series of conducting bars and interposed segments of insulating material, each said segment comprising a fibrous body of vitreous material, a binder with which said body is impregnated, and a thin surface layer of cellulose overlying said body.

2. A commutator comprising conducting bars and insulating segments arranged in alternation in an annular series, each said insulating segment comprising a body of fine glass wool, a shellac binder impregnating said body of wool, and surface layers of cellulose film covering said body in contact with the adjoining surfaces of the commutator bars.

3. A commutator comprising metal segments and insulating segments alternating therewith, each of said insulating segments comprising a highly resilient and compressible body of glass fibers woven into a textile fabric, and a layer of imperforate material by which the insulating segment as a whole is rendered imperforate.

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