

Feb. 6, 1940.

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2,189,340

MOSAIC ELECTRODE MANUFACTURE

Filed March 31, 1938

Fig. 1

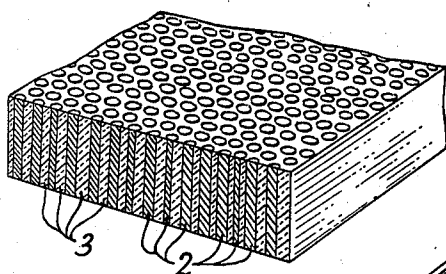


Fig. 2

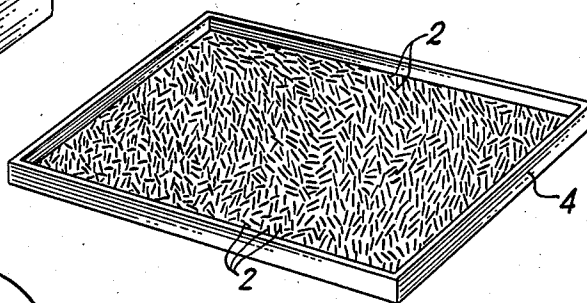


Fig. 3

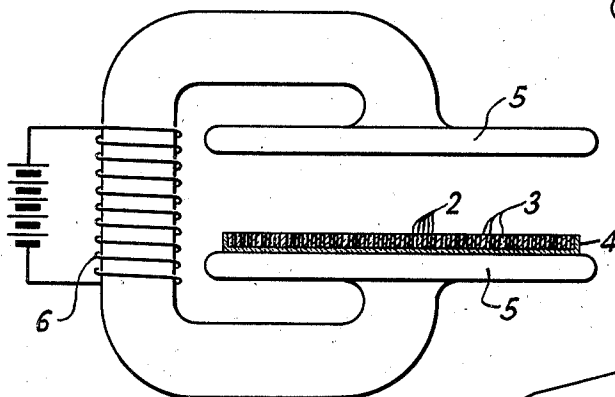


Fig. 4

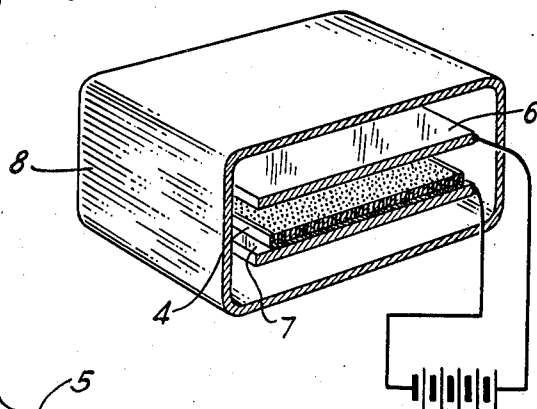
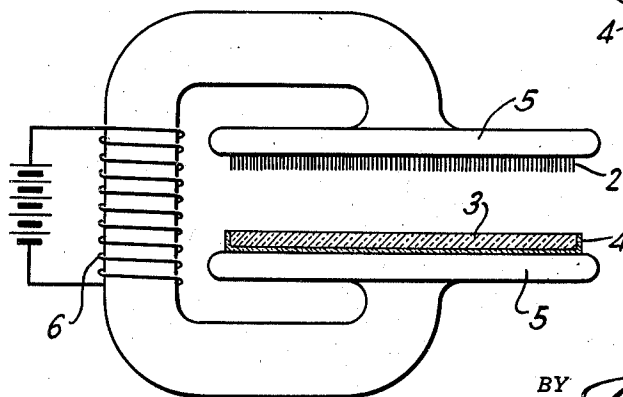


Fig. 5



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2,189,340

MOSAIC ELECTRODE MANUFACTURE

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Application March 31, 1938, Serial No. 199,273

7 Claims. (Cl. 250—27.5)

My invention relates to electrode structures and particularly to a method of manufacturing mosaic electrode structures suitable for use in television transmitting, receiving, and facsimile applications.

Certain cathode ray tubes such as the tube described by Sabbah, U. S. Patent 2,015,570, utilize a mosaic type electrode formed from a multitude of fine parallel wires, which serve as electrically conducting paths, embedded in insulation so that the distal ends of the wires are exposed on each side of the electrode. Similar electrodes having light transparent insulation have also found application in light valves, where the fine parallel wires are electrostatically charged, such as by scanning them with a cathode ray beam, to control the amount of light passing through the electrode by utilizing the charged wires to attract particles of opaque or light absorbing material thereby limiting the light transmitted through the insulation in accordance with the electrostatic charges.

Such electrodes have been very difficult to manufacture and in accordance with my invention I provide new and improved methods for manufacturing such electrodes.

One of the objects of my invention is to provide a method of manufacturing an electrode having a multiplicity of parallel electrically conducting paths without the disadvantages of electrically connecting various groups of the conducting paths. It is another object of my invention to provide a method of manufacture for such an electrode wherein the material between the electrically conducting paths is optically uniform and substantially transparent. It is a further object of my invention to provide a method of manufacturing such a structure in a rapid and economical manner.

In accordance with my invention I have provided a new method of manufacturing electrode structures having a plurality of electrically conducting paths transverse to the plane of the electrode by maintaining a plurality of electrically conducting particles in a desired orientation while securing the particles in an insulating matrix.

Other objects, features, and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which,

Figure 1 is a greatly enlarged sectionalized view of a portion of an electrode made in accordance with my invention, and,

Figures 2, 3, 4 and 5 illustrate steps which may

be used in manufacturing the electrode shown in Figure 1.

Referring to Figure 1 the ciliary or hairlike electrically conducting particles 2 are supported within a matrix of insulating material 3 which is preferably of optically transparent material. In accordance with my invention, all of the particles 2 are oriented in such a manner that they are substantially parallel one to another while the insulating material 3 is in a plastic or semi-fluid condition and the particles are held in their oriented positions while the material 3 is solidified or vitrified thereby forming an electrode which is composed of electrically conducting paths mutually insulated one from another and extending from one side of the electrode to the other. By orienting the ciliary particles I mean that the particles are individually aligned so that their longitudinal axes are parallel to each other. This is to be differentiated from a mere grouping of the individual particles which merely determines the density or number of the particles over a given area. Preferably the particles are oriented and the intervening spaces between the particles then filled with an insulating material while the particles are maintained in the desired orientation.

In making the electrode shown in Figure 1, I prefer to select an insulating material 3 for the foundation of the electrode which, following the assembly, possesses substantially uniform optical properties and which is preferably transparent to light. Such materials, for example, may be glass, rosin, or a vitreous enamel. The particles 2 are of electrically conducting material preferably having an elongated shape and of hairlike form, that is, the length of the particles is greater than the diameter or thickness of the particles, the distal ends of the particles being exposed from the surface of the insulating material between the particles.

As best shown in Figure 2 and in accordance with one teaching of my invention, the particles 2 are distributed fairly uniformly over a crucible or base 4 which is shaped as a shallow tray and is preferably of non-metallic material. The base is then mechanically vibrated to uniformly distribute the particles over the base. An electric field is developed and the base carrying the electrically conducting particles is subjected to the field in such a manner that the particles are oriented or caused to stand in such a manner that the long dimensions of the particles are parallel one to another and perpendicular to the plane of the base. The base carrying the par-

ticles may be further agitated or vibrated to uniformly distribute the particles if they tend to bunch together. The electric field may be either an electrostatic or electromagnetic field but for magnetic particles such as particles of iron, nickel, and cobalt or magnetic alloys incorporating these metals, I prefer to orient the particles magnetically. A convenient way of orienting the particles, if of magnetic material and as best shown in Figure 3, is to insert the base 4 carrying the particles between the magnetic pole pieces 5 which are energized by the magnetic coil 6.

I have found that particles of almost any electrically conductive material may be used for the purpose of forming the electrically conducting paths provided an electrostatic field is used for orienting the particles. An electrostatic arrangement for orienting the particles is shown in Figure 4, the base 4 being positioned between the two electrostatic plates 6 and 7 which are energized by a potential source such as from a battery as shown. I have thus been able to manufacture electrode structures of the type described, using for the conducting particles shavings of metal, such as silver, gold, platinum, iron, nickel, cobalt and others. If, however, it is desired to use an electromagnetic field for orienting the particles, and the insulating material in which the particles are to be embedded is of glass or other relatively high melting point material, I prefer to use shavings of cobalt or other metal having a high Curie point which retain their magnetic properties under the temperatures necessary to vitrify the insulating material. For the same reason the pole pieces of the electromagnet generating the electric field must be of metal having a high Curie point so that the pole pieces will retain their magnetic properties at the temperatures necessary for melting the glass. However, if a low melting point insulating material such as rosin is used for the insulating material, any metal or alloy having magnetic properties will be found suitable.

The insulating material, such as glass, rosin or vitreous enamel in powdered form is then deposited around the particles while maintaining the developed electric field and consequently the particles in the oriented condition. As shown in Figure 4, the entire assembly including the foundation member is then inserted into the furnace 8 and heated to melt or vitrify the insulating material while maintaining the orientation of the particles by means of the applied electric field. Following the melting step the insulating material is allowed to cool and solidify, the electric field being maintained until the insulating material has solidified sufficiently to hold the particles in their oriented positions.

Instead of forming the insulating matrix from powdered insulating material, the particles if of magnetic material may be embedded in a manner illustrated in Figure 5. The particles 2 are uniformly deposited on, and distributed over, one face of a magnet having oppositely disposed faces 5. The magnet is then energized and inverted so that the particles are suspended from the face on which they were deposited. A substantially flat crucible or base 4 containing a thin layer of molten glass or other electrically insulating material in a liquid state is raised to a position where the particles are embedded or submerged in the glass or insulating material. The crucible is maintained in this position and the magnet kept energized by the flow of an electric current in the magnetizing coil 6 until

the insulating material has solidified such as by cooling.

Instead of using metal shavings, I have made satisfactory electrodes using powdered metal and have found that, under the influence of the electrostatic or electromagnetic fields, the metal powder forms electrically conducting chains so that following the formation of the electrode, the chains of powder form continuous electrical conductors from one side of the electrode to the other.

In the manufacture of electrodes in accordance with my invention, it may be found that following the solidification of the insulating material around the conducting paths that the distal ends of the particles forming the conducting paths are not exposed on one side or on both sides of the electrode in which case it is desirable to grind away a portion of either one or both sides of the electrode for the purpose of exposing the conducting particles. This grinding step may be accomplished without destroying in any way the insulation between the particles or electrically connecting the particles or any group of particles.

Electrode structures manufactured in accordance with my invention have a high degree of light transparency in a direction parallel with the oriented particles and are especially suitable for electrodes in television and facsimile tubes.

While I have indicated the preferred methods of practicing my invention of which I am now aware and have indicated certain specific applications for which the article made in accordance with my invention may be used, it will be apparent that my invention is by no means limited to the exact procedure indicated and illustrated but that many variations, such as orienting the particles after the insulation has been applied and while the insulation is in a liquid or plastic state, may be made without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. The method of embedding a plurality of elongated electrically conducting particles in an insulating matrix which comprises subjecting the electrically conducting particles to a mechanical vibration to distribute the particles uniformly, subjecting the particles to an electric field to cause said particles to be oriented substantially parallel one to the other, maintaining said particles in the oriented condition by maintaining said electric field constant, partially embedding said particles in an insulating matrix while said matrix is in a plastic condition and said particles are maintained oriented, by maintaining said electric field constant, and solidifying said matrix.

2. The method of forming an electrode structure having a plurality of elongated conductors supported between their distal ends in an insulating matrix which comprises subjecting a plurality of elongated metal particles of substantially equal length to mechanical vibration to distribute the particles uniformly, orienting the particles by subjecting the particles to a magnetic field so that they are parallel to each other, maintaining the particles in the oriented condition by maintaining the magnetic field constant, filling the spaces between the particles with powdered insulating material leaving the distal ends of the particles uncovered by said insulating material, melting the insulating material and

subsequently solidifying the material onto a solid mass containing the oriented particles.

3. The method of forming an electrode structure which comprises uniformly distributing a plurality of elongated electrically conducting particles by subjecting said particles to mechanical vibration, generating an electric field, subjecting the conducting particles to said field to orient said particles, maintaining said field constant to maintain the orientation of said particles, partially submerging said particles in insulating material while said material is in a liquid state and solidifying said insulating material while maintaining said electric field constant and said particles in the oriented condition.

4. The method of forming an electrode structure which comprises subjecting a plurality of ciliary particles of cobalt to mechanical vibration to distribute the particles uniformly, subjecting said particles to a magnetic field to separately space and orient said particles, maintaining said particles in the spaced and oriented condition by the continued action of said magnetic field, embedding a portion of said particles in molten glass, and cooling said glass to a temperature at which said glass is solidified while maintaining said particles of cobalt in the spaced and oriented condition by the continued application of said magnetic field.

5. The method of forming an electrode structure which comprises forming parallel chains of electrically conducting material, embedding said chains of material in electrically insulating material while said insulating material is in a liquid state, solidifying said insulating material while maintaining said chains of conducting material

substantially parallel, and removing a portion of said insulating material to expose at least one end of said chains along one surface of said insulating material.

6. The method of forming an electrode structure which comprises subjecting a plurality of elongated particles of magnetic material to mechanical vibration to uniformly distribute said particles over a desired area, subjecting said particles to a magnetic field to orient said particles so that the longest dimensions of said particles are substantially parallel, embedding said particles in a sheet of insulating material while maintaining constant the magnetic field and removing a portion of the insulating material from at least one side of the sheet to expose said metal particles on at least one side of said sheet.

7. The method of forming an electrode structure having a plurality of ciliary metal particles exposed at their distal ends, the body of the particles being embedded in an insulating matrix which comprises distributing the particles uniformly over a base by subjecting the particles to mechanical vibration, orienting the particles, maintaining the particles in the uniformly distributed and oriented condition, depositing fusible insulating material to form a matrix between the distributed and oriented particles leaving the distal ends of the particles exposed from said insulating material, melting the said insulating material and solidifying the said insulating material while maintaining said particles in the oriented condition.

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