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# SUSPENSION FOR CASTING A METAL CONTAINING FILM

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1 Claim. (Cl. 252—513)

This invention relates to the composition of a suspension suitable for casting and containing powdered metal dispersed in a plastic combustible binder, the cast film being convertible into a self-supporting porous, light density film of sintered metal, and which may be easily rolled to a greater density, if desired.

Such a cast film has many applications, one of which is disclosed in the Kerstetter and Montgomery application for "Powdered Metal Films," S.N. 105,891, filed of even date herewith, and now abandoned. This companion application discloses the sintering of a plastic film containing nickel to form a cathode base for electron emissive material of the type used in electron tubes.

It is an object of this invention to provide a composition containing metal powder and plastic binder of such nature that the binder can be burned away and the metal can be sintered, whereby a porous metal film of controlled density may be attained.

The density of the film can initially be obtained by varying the proportion of metal powder to the other ingredients of the composition followed by subsequent light rolling if a heavier density than can be obtained by direct casting is desired.

The film may be cast by the process disclosed in the patent to Crosby and Stoll, 2,965,927 (on an application Serial No. 783,788, filed December 30, 1958), and subsequently sintered by passage of the cast film through a sintering oven. In the case of manufacture of a film of metal powders, the drying oven in the Crosby and Stoll patent may be omitted and a sintering oven be interposed between the conveyor belt of the patent and the film take-up roll disclosed therein.

The powdered metal employed will depend upon the intended application. If a cathode metal base material is desired, carbonyl nickel powder or an alloy of nickel powder would be used. The particle size of the powder will again depend on the application and thickness of the cast film. For the cathode base material, particles of nickel alloy of the size between 1$\mu$ and 10$\mu$ may be used.

The binder in the preferred suspension must, of course, be combustible at temperatures below the sintering temperature of the metal and preferably is of the organic type for this reason. Thus, ethyl cellulose, nylon, methyl methacrylate, polyvinyl alcohol or methyl cellulose can be used, the preferred binder being ethyl cellulose, as pointed out more particularly hereinafter.

The mixture of metal powder and binder should be a viscous mass of sufficient viscosity to hold the metal, homogeneously distributed throughout the binder, in suspension until the suspension is cast onto a film and set. In general, it has been found that the solid content of the mixture may be anywhere from 75% to 97% of the weight of the suspension depending upon the viscosity of the binder and the particle size of the powdered metal.

Preferably, to create the suspension, a mixture of organic solvents for the binder is employed, the mixture to have different evaporative ion rates and boiling temperatures in order to, first, properly dissolve the organic



material; second, in order to render it easier to control the viscosity of the suspension and thus insure, when the mixture is dried out, a predicted uniform porosity of the film; and, third, attain stepwise evaporation of the solvent from the film to insure the formation of a good strong film to be handled during the stripping of the film after it has been cast. Particularly, in the case of ethyl cellulose as a binder, though not restricted thereto, toluene and synasol or ethyl alcohol are the preferred solvents in the suspension, but others such as emthanol, benzene, methyl formate, heptane and acetone have been used. Water also may be used with some of the binders, as, for example, hydroxy-ethyl cellulose. A plasticizer is also used to keep the film pliable until it is sintered. There is a wide choice of plasticizers that may be used with the organic materials named above, for example, Butyl Carbitol which is a diethylene glycol monobutyl ether, castor oil, butyl stearate. Whatever the binder used, a known plasticizer for that binder may be employed.

A preferred suspension for casting a four inch wide film .001" to .010" thick containing carbonyl nickel and having a density of approximately 2.0 gm./cm.$^3$ comprises the following:

| | | |
|---|---|---|
| Toluene | ml | 360 |
| Ethyl alcohol | ml | 80 |
| Butyl Carbitol | ml | 16 |
| Ethyl cellulose | gm | 24 |
| 3$\mu$–4$\mu$ carbonyl nickel | gm | 528 |

in which formulation the ethyl cellulose has an ethoxyl content of between 47.5 and 49.0% by weight and a viscosity of approximately 200 centipoises in a 5% solution of 80:20 toluene to ethanol.

The above-mentioned suspensions enable the production of metal films of controlled densities. This is extremely advantageous since, in many applications such as in electron tubes, a controlled low density or porous nickel cathode, for instance, may be easily degassed and may have improved electron emission characteristics. Obviously, controlled high density films can also be produced with the suspensions described above.

Although several embodiments of the invention have been described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claim.

What is claimed is:

A suspension for casting a metal containing film, said suspension having the following composition in the ratio set forth:

| | | |
|---|---|---|
| Toluene | ml | 360 |
| Ethyl alcohol | ml | 80 |
| Diethylene glycol monobutyl ether | ml | 16 |
| Ethyl cellulose | gm | 24 |
| 3$\mu$–4$\mu$ carbonyl nickel | gm | 528 |

in which formulation the ethyl cellulose has an ethoxyl content of between 47.5 and 49.0% and a viscosity of approximately 200 centipoises in a 5% solution of 80:20 toluene to ethyl alcohol.

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