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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Method of Compacting Silicon Particles

We, TEXAS INSTRUMENTS INCORPORATED, a Corporation organised according to the laws of the State of Delaware, United States of America, of 13500 North Central Expressway, Dallas, Texas, United States of America, do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of compacting small silicon particles.

The method according to the invention includes the steps of placing a large number of such particles in an elongated flexible sleeve free of substances which would contaminate the silicon particles, closing each end of the sleeve, enclosing the closed sleeve within a flexible bag and subjecting them both to hydrostatic pressure of sufficient magnitude to compress the particles contained in the sleeve into a compacted mass of silicon. A suitable range of hydrostatic pressures is 10,000 to 60,000 p.s.i.

A silicon mass produced by the method of the invention is in the form of compacted discrete silicon particles enclosing pores, the mass having a density less than that of silicon. If desired, the compacted mass can be subjected to a sintering process to bond the discrete particles to each other and form a continuous body of silicon enclosing closed pores.

By way of example, the invention will be described in greater detail with reference to the accompanying drawings of which:—

Fig. 1 is a longitudinal part section of an apparatus for carrying out the method of the invention,

Fig. 2 shows on an enlarged scale a compacted silicon mass formed by the present invention and

Fig. 3 shows the mass illustrated by Fig. 2 after a sintering step.

The apparatus includes a perforated elongated metal tube 1 having a flexible liner sleeve 2 of surgical quality latex to prevent contamination of silicon particles 3 disposed therein. A large number of these silicon particles 3 of suitable particle size, for example 75 — 150 microns mean cross-section, is placed in the liner and the open ends of the tube 1 and liner 2 are closed by stoppers 4. Any entrapped atmosphere within the latex liner 2 is removed by any convenient method, for example by use of a hypodermic needle inserted through one of the stoppers 4.

The stoppered tube 1 and its contents are then sealed within a thin latex shielding bag 5 and placed in a hydrostatic pressing cylinder partially filled with glycerine. The entire assembly then is subjected to pressures in the range 10,000 to 60,000 p.s.i. total pressure. In one particular instance, the silicon powder 3 was subjected to a total pressure of about 50,000 p.s.i. of hydrostatic pressure. However, other pressures can be used and the choice of pressure will depend upon the desired density of the compacted mass of silicon which results from the pressing operation.

The resultant compacted mass of silicon is a porous body having a density less than that of silicon. In a specific instance using a pressure of 50,000 p.s.i., the density of the resultant compacted mass was found to be 1.7 grams/cm^3 whereas the density of silicon is 2.4 grams/cm^3.

A process as described above can be used to form a porous mass of silicon 6 compacted around a rod 7, as shown in Fig. 2, the rod being embedded in the silicon particles 3, as shown in Fig. 1, and after the pressing operation the particles 3 will be compacted together and to the rod 7.

A compacted silicon mass produced in the manner described can, if desired, be subjected to a sintering process to bond the compacted particles to each other. For example, the compacted silicon mass can be sintered at about 1300° C for an hour or so under a small positive pressure of hydrogen atmosphere. Sinter-

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ing can be effected in any suitable vessel, for example a quartz tube through which hydrogen is flowed during sintering. The sintering process results in a continuous mass of silicon (including the rod 7 when present) as compared with a body of discrete particles compacted together. Fig. 2 shows the body 6 of discrete compacted silicon particles 8, in which is embedded the rod 7, produced by the method of the invention and Fig. 3 shows the same body 6 following the sintering process described above. In both Figs. 2 and 3 it will be noted that the body 6 contains closed pores 9.

The compacting process described above can, for example, be utilised in the manufacture of solid electrolytic capacitors described in copending Application No. 38859/63 (Serial No. 1066847).

WHAT WE CLAIM IS:—

1. A method of compacting small silicon particles, including the steps of placing a large number of such particles in an elongated flexible sleeve free of substances which would contaminate the silicon particles, closing each end of the sleeve, enclosing the closed sleeve within a flexible bag and subjecting them both to hydrostatic pressure of sufficient magnitude to compress the particles contained in the sleeve into a compacted mass of silicon.

2. A method according to claim 1, in which the sleeve is closed by stoppers placed in both ends of the sleeve.

3. A method according to claim 1 or claim 2, in which the said hydrostatic pressure is in the range 10,000 to 60,000 p.s.i.

4. A method of compacting small silicon particles substantially as described herein with reference to Fig. 1 of the accompanying drawings.

5. A method according to any one of the preceding claims, in which the compacted mass of silicon is sintered to bond the compacted silicon particles to each other.

6. A silicon mass produced by a method according to any one of the preceding claims.

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