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METALLURGY

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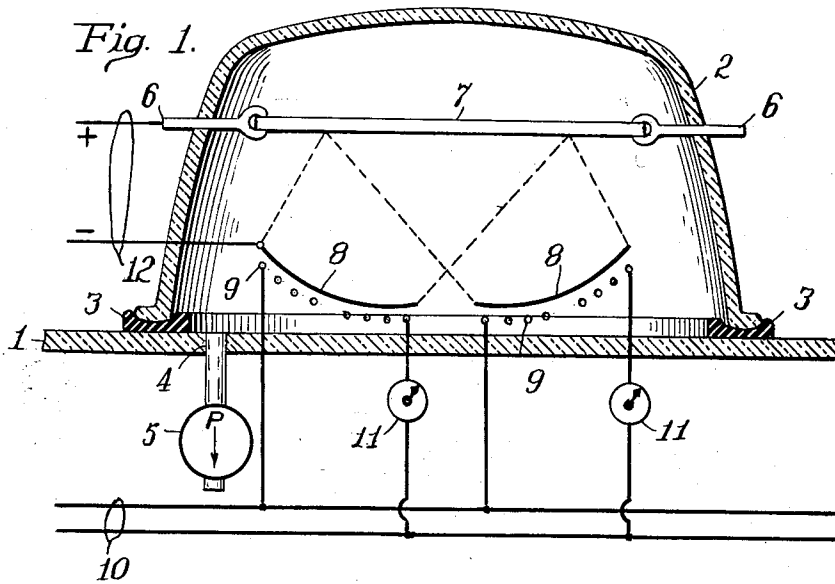


Fig. 2.

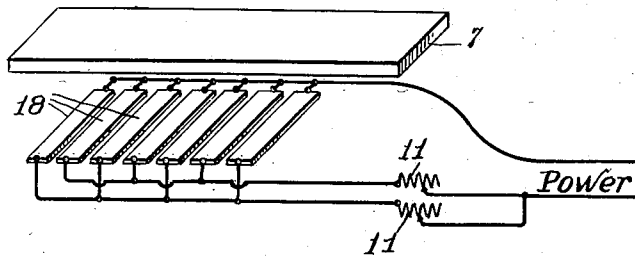
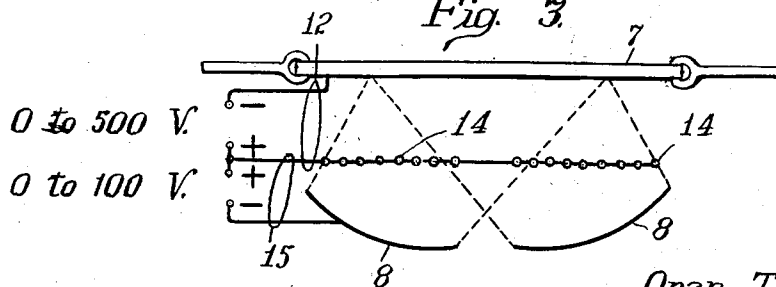


Fig. 3.



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1 Claim. (Cl. 118—49.1)

This invention relates to improvements in metallurgy, and more particularly to a process of making metals having novel characteristics.

In attempting to combine metals and other materials having different characteristics, difficulties have been encountered heretofore due to the fact that such metals and other materials will not alloy satisfactorily under extreme conditions. Attempts have been made to combine them by using powdered or sintered materials in an effort to use them together, but these still lack the properties of a substance having true molecular structure.

One object of this invention is to provide entirely new effects in combining metals and/or non-metals in a homogeneous body.

Another object of the invention is to provide a process of molecular intermingling of the substances into one homogeneous mass, comprising a homogeneous mixture of molecules of the various substances.

These objects may be accomplished by the simultaneous evaporation of the several metals and/or non-metals used and adapted to be combined, and bringing together the vapors thereof in molecular intermingling relation of the substances by molecular mixture into one homogeneous mass where the several materials will retain the properties of each, and will not form an alloy.

It is also preferred that an electrostatic voltage or field may be provided between the evaporating elements and the depositing surface, or a magnetic field may be used therebetween for some purposes, or a combination of the two. This is particularly advantageous in making metals for semi-conductor devices. By controlling the voltage pattern the metal deposit pattern can also be controlled, as well as the nature of the mix to be produced thereby.

These objects may be carried out by an apparatus, certain embodiments of which are illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic view illustrating evaporation means in a vacuum;

Fig. 2 is a diagrammatic view partly in perspective, illustrating an alternate type of heating means that may be used; and

Fig. 3 is a diagrammatic view illustrating an additional heating source for the material.

It is to be understood that the invention is not limited to the details of construction and arrangement of parts illustrated in the accompanying drawings, since it is capable of being carried out and practiced by other embodiments. However, I have illustrated a suitable apparatus for practicing this process and for making the new metal or material.

In the illustrated embodiment of the apparatus, I have shown a supporting base 1, upon which is mounted a housing 2. The housing 2 may be in the form of a bell-jar, or other suitable chamber that may be evacuated to the degree necessary. It is shown as having a semi-spherical top portion and is seated upon and preferably sealed at 3 to the base 1, so as to permit of an effective

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evacuation of the interior of the housing. An opening 4 is shown in the base 1 through which evacuation may be effected by a suitable pump 5. A super high vacuum is usually necessary, more than can be obtained with a mechanical pump, but a vapor pump will provide a sufficiently high vacuum.

Provision may be made for supporting a base material within the housing 2. This may be provided by supports 6 at opposite sides thereof fixed and sealed in the housing 2 for supporting a piece of base material 7 therebetween. Any suitable support may be mounted in the housing 2 on which the formed mass may be collected.

Mounted within the housing 2 are a plurality of receptacles 8, one or more for each material to be used in the process and adapted to contain said material, either a metal or non-metal, as desired. The receptacles 8 are mounted in any suitable manner on the base 1, and in such relation to each other and to the base material 7 as to ensure a proper intermingling of the vaporized materials from the receptacles and the collection on the base material 7. The receptacles 8 should be relatively shallow and, where more than one material is to be vaporized, they may be tilted so the vapors therefrom will pass out and cover the same area.

Provision should be made for heating the materials in the receptacles 8 to vaporizing temperatures. Resistance heaters usually are sufficient for this purpose, but high frequency or magnetic fields or infra-red heat may be used for the purpose. As an example, in the embodiment being illustrated, the heating is provided by an electric resistance coil 9 connected with opposite sides of an electric power line 10. The several electric coils for the receptacles are connected in parallel with each other, and separately controlled, as by a rheostat 11 in the circuit of said heating coil, so as to provide any desired temperature in the respective receptacles.

It is also possible to add an electrostatic voltage or field between the evaporating elements and the depositing surface 7. A magnetic field may be used for some purposes, or a combination of electrostatic and magnetic in other cases. This may be accomplished by using a conductor as the material support 7, as well as conductor material for the supports 6. These elements 6, 7 may be connected with one side of a source of electrical supply, while the opposite side of said source may be connected with the receptacles 8, as indicated generally as forming a power line 12 in Fig. 1. Upon connecting the source of electrical supply with the power line 12, an electrostatic field will be provided between the elements 7 and 8, in place of or in addition to the resistance heating coils 9, to facilitate the evaporation of the metals from the receptacles.

In practicing this process, with the example of apparatus described above and illustrated in the drawing, a separate metal or material is placed in each receptacle. True metals or distinct alloys of metals may be used, if desired, where the metals have been effectively alloyed with each other. However, some metals will not alloy effectively, or only under extreme conditions. Non-metals may be used, such for example as quartz, and other materials.

After these materials are placed in the receptacles 8 and the housing 2 evacuated, the respective materials are heated to vaporizing temperatures thereof so that evaporation of the several metals or materials takes place simultaneously from the receptacles. The vapors therefrom are brought together, or combined in molecular intermingling of the substances into one final element or substance, which is collected on the support 7 in one homogeneous mass, not by distinct layers or coatings of the several materials, but in a single coating or mass that is homogeneous throughout. This will not form an alloy,

but the several metals, or other materials, will retain their respective properties and will produce a distinctly different substance, or mass, by a molecular intermingling of the materials or metals.

Conditions will vary for different metals, especially as to temperatures of the vapors, time requirements, vacuum, etc. However, such conditions may be controlled to produce a molecular mixture of the several metals and/or materials.

As an example, lead and tin may be evaporated simultaneously and molecularly intermingled into a homogeneous mass. This mass will not have the properties of an alloy of lead and tin, but will have distinctly different properties retaining all of those of the individual elements. Another example of like effect is provided by copper and tungsten, which may be vaporized simultaneously and combined molecularly by mixing the vapors thereof into a homogeneous mass.

Hard metals of high vaporizing points require high temperatures, which can be produced more effectively by heating in a very high vacuum.

The process is not confined to thin coatings, but may be continued to produce a metal of substantial thickness as a mass on the support 7.

In the manufacture of material for semi-conductor work it is quite important to have the molecular arrangement in a specific manner. This has been done heretofore by heat treating, but such methods are very unreliable and produce only random results. By my process, as described, and with the proper field connected in the system, the molecules can be oriented or all lined up in the same direction, which gives the material its unidirectional current properties. This can be done uniformly and the material is thereby rendered much more efficient than materials produced heretofore where only part of the molecules were so arranged.

Other important factors with these materials involve their content of the impurities and the arrangement of the impurity molecules. This has also been uncertain in methods used heretofore, producing widely variable results. By this process the results can be controlled accurately to any desired degree. For example, in the matter of purification, since each element has a different molecular weight, its action in the electric field will be different. By proper field arrangement only one kind of molecule can be deposited, thereby resulting in absolute purity, where desired.

The impurity element can be controlled by rate of evaporation as to the amount added, as well as by the electric field as to its orientation. For example, if germanium were being used as the base element, all of its molecules might be lined up in one direction by the electric field connected to its evaporator. If arsenic was used as the impurity element, the quantity added might be lined up at right angles to the germanium or in any other direction which by experiment is found to give the desired results. It will be seen that all of the important factors are under absolute control and the quantity of any element, as well as its molecular arrangement, can be provided and determined, as desired. This makes it possible to get uniform crystal rectifiers, transistors, and the like, in addition to getting far more desirable devices.

The voltage applied between the receptacles 8 and the material support 7 might be of either polarity depending upon the type of substance used, or the vapor may be first charged positive and then attracted to the negative material, as will be apparent from the modification shown in Fig. 3 which is the same as illustrated in Fig. 1 with

certain additions. A wire screen 14 is provided over the receptacles 8 and connected in an electric circuit 15, one side of which is connected with the screen 14, while the other side is connected with the receptacles 8. One side of the circuit 15 may be in common with the circuit 12, and the latter is connected with the base support 7 and the wire screen 14. In some cases magnetic fields may be used in conjunction with the electrostatic field resulting therefrom, as shown in Fig. 3.

As an example, in making extremely pure germanium, by applying the voltage field the molecules will be accelerated toward the support 7, and if a magnetic field is applied these molecules will travel in a circular orbit. By locating the support at the proper distance and place with respect to the receptacles 8, only one type of molecules will strike it, the other being lighter or heavier will miss it on one side or the other.

Fig. 2 shows an alternate type of heating arrangement in which strips of heater ribbon indicated generally at 18 are plated or otherwise coated with the material to be evaporated. These are connected in one side of the power circuit at each end of the strips, whereby the current passes therethrough and thereby evaporates the coating material onto the base support 7.

The homogeneous mass produced on the support is not necessarily the end product, but may be stripped off and used in any desired manner, as for one of the metals.

Suitable provision may be made for controlling the percentages of the respective elements in the final homogeneous mass. This may be accomplished by the control of the temperatures by the rheostat 11 or by partial shielding of the respective receptacles.

According to the process herein set forth, it is possible to make transistors quite accurately and at low cost on a production line basis as contrasted with making these as laboratory samples, as heretofore. They may be produced accurately in large quantities by the examples herein set forth.

While the invention has been illustrated and described in certain embodiments, it is recognized that variations and changes may be made therein without departing from the invention set forth in the claim.

I claim:

Apparatus for making a new material comprising a base support, a plurality of receptacles arranged for directing vapors therefrom onto the base support, means for vaporizing materials from said receptacles, a screen arranged between the receptacles and the base support in the path of the vapors to the base support, an electric circuit including a source of electrical supply connected at one side with the screen and at the opposite side with the base support, and a separate circuit including a source of electrical supply connected at one side with the screen and at the opposite side with the receptacles.

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