UNITED STATES PATENT OFFICE.

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VARIABLE RESISTANCE FOR MICROPHONES AND METHOD OF MANUFACTURING SAME.

SPECIFICATION forming part of Letters Patent No. 506,627, dated October 10, 1893.

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To all whom it may concern:

Be it known that I, ALFRED C. COUSENS, a subject of the Queen of Great Britain, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Variable-Resistance Compositions for Telephonic Transmitter-Circuits and Methods of Producing the Same, of which the following description is a specification.

This invention relates to a composition of matter for use in telephonic transmitter circuits in place of carbon as a tension regulator or medium of variable resistance, the said composition being used in conjunction with the diaphragm, tympan, electrode or other mechanical and electrical devices now commonly used in and forming a part of telephonic instruments wherein carbon in various forms is now commonly used.

This invention has for its object the production of a composition of matter having a variable resistance for telephonic transmitter circuits, whereby the loudness and distinctness of sounds reproduced by the receiving instrument is greatly increased, and a further object of the invention is the process of producing such variable resistance composition.

In accordance therewith my invention consists of a composition of variable resistance for telephonic transmitter circuits containing titanium as the essential element, substantially as will be described.

Other features of my invention will be hereinafter described and particularly pointed out in the claims.

As is well known, carbon in various forms is now used as a tension regulator or medium of variable resistance in telephonic transmitter circuits, either in the form of a button which is acted upon by a membrane or diaphragm vibrated by the sound waves formed in speaking, or the carbon is inclosed in a box-like structure and the vibrations of the membrane are transmitted to the carbon so that an electric current sent through the carbon will be converted into an undulatory current, owing to the change of pressure due to the vibrations of the diaphragm.

Various devices have been used to increase the loudness and distinctness of the sounds reproduced by the receiving instrument, and in the course of my experiments I have discovered that titanium in chemical combination with other elements, as hereinafter set forth, may be used in the place of carbon as a tension regulator or medium of variable resistance, the loudness and distinctness of the sounds being greatly increased.

I have discovered that titanium in chemical combination with nitrogen, forming nitrides of titanium, or combined with oxygen to form the sesqui-oxide, Ti_2O_3, or in combination with nitrogen and cyanogen, or mixtures of said chemical compounds, may be used to vary the strength of an electric current in the same way and under the same conditions as carbon is known to do, and the value of such compounds for the purpose depends largely upon the mechanical state in which they are produced and used, the best results being obtained by me when the compounds are in an amorphous condition, or in the form of minute (microscopical) plates or crystals, the compounds in either condition being preferably formed upon the surface of some substance such as platinum, carbon, iron or silicious material, or a substance which does not melt at the temperature at which said compounds are formed. The platinum, carbon or other material so used does not act as a variable resistance medium, nor need it be necessarily a conductor of electricity, it serving the purpose of a mere support or nucleus for the particles of the titanium compounds, causing a large number of them to act collectively, it appearing that the loudness of the sound produced by the collective action of the particles is due to weight, the distinctness resulting from a fine state of division, that is, numerous points of contact. The nucleus or supporting substance when used may be in any mechanical form or condition such as plates or blocks, but I prefer to use small grains or granules of the substance, which, after they have been coated with a titanium compound as hereinafter described, will be used in bulk. The titanium compound may be used alone, and when obtained in the form of a fine powder, may be compressed or molded into the desired form, such as plates or buttons.

In the course of my experiments, I have found that any of the foregoing compounds

of titanium may be employed, or two or more of said compounds may be combined in various proportions, but I have obtained the best results with the copper-colored nitride, Ti_3N_4, which may be formed by various well known chemical reactions, as may also the other compounds mentioned.

To form the titanium compound upon granules, I proceed as follows: Take hard non-coking nitrogenous coal, powder, sift, wash and dry the same, and mix with about five per-cent. by weight of titanic acid or an equivalent proportion of TiO_2 and twenty per-cent. of K_2CO_3, or Na_2CO_3, place in a closed crucible and heat to about 2,700° Fahrenheit, which is a little less than the melting point of cast iron, for about one hour. In the reaction which ensues the potassium or sodium carbonate melts at a low temperature and dissolves the titanic acid, which at a high temperature decomposes, and the titanium combines with the nitrogen of the coal, the oxygen with hydrogen and carbon to form water and carbon monoxide or di-oxide; two or more nitrides of titanium and more or less of the sesqui-oxide, being formed simultaneously. The percentage of nitrogen in the coal modifies the result, as do other substanances other than nitrogen and carbon which may be present in the coal. When the crucible is cool the contents are washed in water and treated with hot hydrofluoric acid to dissolve out any substances which might interfere with proper telephonic results, and then the substances are washed in hot water and dried. An examination under the microscope shows carbon granules coated with an indigo-colored substance having a copper-red luster, needle-like crystals projecting in various directions from the substance.

If platinum is to be treated instead of carbon, I use powdered coal with titanic acid or TiO_2 and potassium or sodium carbonate as in the foregoing process, in about the same proportions, placing the mixture in a crucible in the presence of the platinum in the form desired, and raise the temperature considerably above the melting point of iron, and when cooled and examined, the platinum is found to be covered with copper-colored sesqui-oxide and Ti_3N_4.

The platinum is made crystalline and exceedingly brittle by the reaction, and if it is present in the form of fine wire or thin foil it may be finely powdered and used as the variable resistance composition.

I may form the composition by another process, as follows:—Take dry potassium titanium fluoride (K_2TiF_6) or sodium titanium fluoride (Na_2TiF_6), (the latter formed by dissolving titanic acid or TiO_2 in HF, and neutralizing the sirupy liquid with soda or potash) and add an equal weight of powdered nitrogenous coal, and place the mixture in the bottom of an earthen crucible, and place in the top of the crucible granules of coal, platinum or iron, according to the substance which is to be used as the nucleus or support for the titanium coating. The granules of the nucleus substance may be about twenty times the weight of the titanium salt in the crucible, more or less, and the crucible is luted and heated for about one hour to substantially near the melting point of iron, or higher if platinum be the nucleus substance. In the reaction, the titanium salt appears to be decomposed into gases TiF_4 (tetra fluoride of titanium) which rises to the upper part of the crucible and is decomposed

The titanium has a greater affinity for nitrogen at high temperatures than it has for fluorine, and combines therewith to form Ti_3N_4, while the fluorine combines with the hydrogen of the coal to form hydro-fluoric acid, which escapes, or enters the material of the crucible.

The deposit upon the nucleus granules is of a violet or indigo color with a copper or golden luster, and is more evenly deposited and with fewer needle-like crystals than in the first process mentioned.

If coal granules are to be coated, and five per cent. of titanic acid be added thereto, brass or gold-colored Ti_2N_2 is formed as well as Ti_3N_4.

When iron granules are treated, care must be taken to keep the temperature below the melting point of iron, but with platinum or coal granules, the heat is greater.

While it is not absolutely necessary to place the nucleus granules in the top part of the crucible above the titanium mixture, the best results are obtained by so doing.

The nitride of titanium is easiest formed on coal granules owing to the presence of nitrogen in the coal, and good results are obtained by using such a composition in the transmitter circuit. For long circuits, however, or where the tones are to be produced as loudly as possible by the receiver, granular platinum or an alloy of platinum having a high melting point forms the best support or nucleus substance for the titanium nitride. The improved result in such case appears to be due to the high specific gravity of the platinum or its alloy, which causes the diaphragm of the transmitter, vibrating under the action of sound waves, to strike with great force against the particles or against the material enveloping them, and the moving particles strike others at rest or moving in opposite directions against the contact electrodes, and a good electrical contact is made, and thereby a greater variation in the strength or tension of the current is obtained than could be with a nucleus substance having less specific gravity.

In carrying out the processes described, the temperature and the time of heating vary with the quantity of the material treated, and its mechanical condition, and also with the thickness of the crucible used.

While I have herein pointed out various proportions or percentages of the different in-

gredients used in the described processes, I do not wish to confine myself strictly thereto, as the same may be varied within quite wide limits without materially affecting the result, the affinity of nitrogen for titanium at high temperatures being so strong that substantially the only essential condition to be observed in carrying out the processes is that a sufficient quantity of both elements should be present to combine readily at a high temperature.

While I have obtained the best results by using a granulated nucleus substance coated with the titanium compound, I do not wish to be restricted thereto, as the various compounds of titanium hereinbefore described may be pressed into plates, blocks or any other form desired, or plates, blocks, &c., of the nucleus substance may be coated or surfaced with the titanium compound and used in various kinds of transmitters in place of carbon.

For the purposes of my invention, I consider oxygen or cyanogen to be the equivalent of nitrogen when used to form a chemical titanium compound.

I claim—

1. A composition of variable resistance for telephonic transmitter circuits, containing titanium as the essential element, substantially as described.

2. A composition of variable resistance for telephonic transmitter circuits, containing titanium as the essential element, and a nucleus or supporting substance for the titanium, substantially as described.

3. A composition of variable resistance for telephonic transmitter circuits, containing titanium chemically combined with a substance having a high melting point, substantially as described.

4. A variable resistance material consisting of a support or nucleus of suitable material having a chemically deposited surfacing of a titanium compound, substantially as described.

5. A composition of variable resistance for telephonic transmitter circuits, &c., consisting of a chemical combination of nitrogen or its described equivalent with titanium, substantially as described.

6. The process of producing variable resistance compositions for telephonic transmitter circuits, which consists in heating powdered coal and a titanium compound with nitrogen in the presence of a nucleus substance, to a temperature slightly below the melting point of said substance, substantially as described.

7. The process of producing variable resistance compositions for telephonic transmitter circuits, which consists in heating powdered nitrogenous coal and a titanium compound, in a closed vessel in the presence of a nucleus substance, and raising the temperature to substantially near but below the melting point of said nucleus substance, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALFRED C. COUSENS.

Witnesses:

JOHN C. EDWARDS,

FREDERICK L. EMERY.