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METHOD FOR MAKING SEMI-PYROPHORIC IRON

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This invention relates to safety ignition mixtures and to their manufacture and has for its main object to provide for a safety ignition mixture, the combustion of which takes place without flame and without the production of poisonous or bad smelling gases or of both.

The known ignition mixtures used for starting combustion processes generally consist of the following constituents:

(*a*) Easily decomposable substances yielding oxygen by decomposition, such as chlorates, nitrates, chromates, peroxides, and the like.

(*b*) Substances easily inflammable at low temperatures such as phosphorus, sulfur, carbon or compounds of the same.

(*c*) Additions of hard and chemically inert substances increasing friction, such as quartz, clay, pumice stone and the like.

(*d*) Binding agents such as glue, starch, gum arabic and the like.

(*e*) Substances preventing an explosive combustion such as zinc oxide, iron oxide and the like.

Due to the presence of the substances mentioned under *b* all known ignition mixtures are combusted with flames and evolution of poisonous or evil smelling gases or of both. Their use is therefore impossible in all those cases where open flames of the evolved gases are dangerous or noxious.

The present invention provides for a safety ignition mixture which may easily be ignited on the usual friction surfaces for safety matches and are combusted without flame and without evolution of noxious or evil smelling gases. Self-ignition of the new ignition mixtures is impossible. The new ignition mixtures are especially suitable as igniting heads for cigars, cigarettes and matches, which are safely and efficiently lighted by mere friction on one of the usual friction surfaces for matches, which surfaces are preferably arranged on or in the packages for the cigars, cigarettes or matches.

According to the invention the phosphorus, sulfur or the like present in the known ignition mixtures is replaced by metals with a sufficiently low ignition temperature such as magnesium, aluminium, zinc, iron, cobalt and the like, which on combustion do not furnish volatile combustion products but solid oxides in form of a powder. The main feature of the new ignition mixtures is the absence of phosphorus, sulfur, carbon or their compounds, the inflammability of the mixture being solely due to the combination of oxygen yielding substances with easily ignitable metals.

For many purposes ordinary metals would yield ignition mixtures, the ignition of which would be too difficult for the purpose in question. The invention provides for means to bring these metals into a form, in which their rapid oxidation or combustion is facilitated.

It is known, that certain metals such as iron or cobalt may be obtained in the pyrophoric form by reducing at relatively low temperatures suitable compounds of these metals with streaming hydrogen. These pyrophoric metals are, however, ignited and combusted by contact with oxygen or air at room temperature. This pyrophoric form of metals is not suitable for the purpose of the invention and the invention therefore has for its further object, to provide for a method, which enables the manufacture of metals in such a form, that they may be ignited with air at temperatures above atmospheric temperature, preferably above 50° C. but below 300° C. I have named this form of metals semi-pyrophoric, which is an intermediate form between pyrophoric and normal form. This method for making semi-pyrophoric metals consists in a reduction of metal compounds suitable for the manufacture of pyrophoric metals under such modified reducing conditions that neither the pyrophoric nor the normal form is obtained or in treatment of pyrophoric metals which makes them more difficultly ignitable. The reduction of the metal compounds may be carried out by thermal decomposition in presence of inert gases or by treatment with hydrogen at raised temperatures.

A metal is "semi-pyrophoric" when, on the one hand, it is not self-ignitable by mere contact with air and, on the other hand, is not so difficultly ignitable as in the normal state but can be brought into a state of ignition by friction on a friction surface. Or, in other words, a metal is "semi-pyrophoric" when its ignition temperature—

(1) Is not so low that it ignites by contact with air;

(2) Is not so high that it does not ignite by friction on a friction surface;

(3) But is of such a nature that mere friction on a friction surface is sufficient for igniting the metal.

Temperature and duration of these treatments must be kept within limits, outside of which pyrophoric or normal metals are obtained. Starting materials for the method according to the invention are inorganic or organic metal compounds

such as oxides, nitrates, carbonates, sulfates, oxalates, tartrates or the like.

Pyrophoric metals may be converted into semi-pyrophoric metals by a shorter or longer heat treatment in presence of inert gases, such as nitrogen, hydrogen and the like or by mixing or alloying them with substance, not self-ignitable by contact with air, such as oxides.

In both cases for the manufacture of semi-pyrophoric metals the duration of the treatment is a function of the temperature. Moreover temperature and duration of the treatment are different for different metals, gases and pressures employed. It is therefore not possible to give general data for temperature and duration of the treatment, but the following examples may lead the expert in finding the conditions for making semi-pyrophoric metals other than iron or semi-pyrophoric iron from other starting materials or by a modified method.

Example I

10 g. of ferrous oxalate are heated to about 400° C. in streaming hydrogen, which has been dried by passing it through concentrated sulfuric acid before entering the reaction zone and which passes this zone at a moderate rate corresponding to about two gas bubbles leaving the sulfuric acid per second. When the amount of gases leaving the reaction zone decreases, which is the case after about one hour, the reaction is finished. The heating is stopped and a rapid cooling is effected by passing hydrogen through the reaction zone. When room temperature has been reached a black powder is obtained not ignitable by contact with air, at room temperature, but ignitable, when contacting it with air at about 180° C.

Example II

28 parts of the semi-pyrophoric iron produced in the manner described are mixed with 25 parts of potassium chlorate, 1 part of pyrolusite and 18 parts of powdered burnt clay. The mixture is powdered and mixed while stirring with 80 parts of a 4% solution of collodion in volatile organic solvents, some ether and alcohol being added to the pappy mixture if necessary. The mixture is placed on the top of a cigar or cigarette in any convenient manner, thus obtaining a firmly adhering ignition head on the article after evaporation of the volatile solvent at the air.

The igniting mixture described above may contain other substances, such as fillers and the like, or may be combined with other pyrotechnic mixtures. It may be arranged on any inflammable carrier and thus serve to light any combustible substance.

The solution of collodion employed as binding agent in the above example may be replaced by solutions of other binders, such as acetyl cellulose and the like, in volatile organic solvents, such as alcohol, ether, acetone, amyl acetate and the like. Also aqueous solutions of glue, starch, gum arabic and the like may be employed, although binders containing volatile organic solvents are preferred, as the solidification of the ignition mixtures on their carriers is accelerated, when the binder contains volatile liquids as solvent. The amount of binder used is kept as low as possible and preferably such binders are employed, which are easily and completely combusted without the evolution of noxious or bad smelling gases or of both.

I claim:

1. A method for making semi-pyrophoric iron which consists in reducing iron compounds with hydrogen at reaction conditions with respect to temperature and duration of reaction, above which pyrophoric and below which normal iron are obtained, iron oxide being used as starting material.

2. A method for making semi-pyrophoric iron which consists in reducing iron compounds with hydrogen at reaction conditions with respect to temperature and duration of reaction, above which pyrophoric and below which normal iron are obtained, ferrous oxalate being used as starting material.

3. A method for making semi-pyrophoric iron which consists in a reduction by means of hydrogen of iron compounds at increased temperature, keeping the conditions of reaction with respect to temperature and duration within limits, beyond which pyrophoric and normal iron respectively are obtained by the same treatment.

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