Patented June 6, 1939 2,161,385

UNITED STATES PATENT OFFICE

2,161,385

SOLID FUEL FOR LIGHTERS

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No Drawing. Application October 2, 1937, Serial No. 167,077. In Austria October 7, 1936

4 Claims. (Cl. 44—7)

This invention relates to a solid fuel for lighters.

The disadvantage of the known benzine lighters is that the fuel evaporates for the most part during use and makes it necessary to refill the lighter from time to time. Attempts have therefore already been made to use solid fuels for spark operated lighters without however achieving any results of practical use which would have enabled such lighters to replace the well known benzine lighter.

Inter alia it has also been proposed to use metaldehyde and to scrape powder from the surface of the rod before using the lighter, the powder and with it afterwards the rod being ignited by means of a spark (see Swiss Patent No. 108,322). Reliable ignition of the rod by a single shower of sparks could not however be obtained in this way. Atomisation was also disadvantageous. It has also been suggested to use solid mixtures of the fuel proper with considerable quantities of vigorously burning substances as the igniting agents. Thus for example (see Swiss Patent No. 174,405) it has already been proposed to use a mixture of fuels, such as about 80% of naphthalene or camphor, with considerable quantities of powdered or short fibered nitrocellulose, say about 20% of this latter. This mixture was intended to be compressed and the fibrous nitrocellulose laid bare at the particular end of the bar before ignition by a roughing up device. This proposal is however quite unsuitable in practice and has therefore never been put into practical use. The reason for this is that such quantities of nitrocellulose lead to various inconveniences in manufacture and storage and also in use. On the other hand naphthalene, camphor or similar products gives an exceedingly smoky flame and a disagreeable smell, which is particularly manifest when large quantities of this substance are used. Finally this substance gives rise also to inconveniences when kept in the pocket during use. On the whole it is quite impossible to replace the highly developed benzine lighter or the benzine by a material which has so many disadvantages. It has already been proposed also (see German Patent No. 543,023) to use pressings composed of mixtures of metaldehyde with from 10% to 50% of nitro bodies of various kinds in form of powders for this purpose. It is impossible, however, to obtain a fuel which can be ignited with even a fair degree of reliability by a shower of sparks when the above substances are used, as the presence of nitro compounds is not sufficient. They cannot replace the effect of materials which reduce thermal conductivity like fibres (the necessity of which was not recognised when this proposal was made) nor the nature and qualities of the fuel which can only be obtained by such admixture. If for example 20% of nitrocellulose in a dissolved and therefore finest form be intimately mixed with metaldehyde and the product moulded and dried, no perceptibly better effect as regards inflammability by a spark, can be detected in comparison with moulded bodies which consist of metaldehyde only. The same remarks apply to other nitro compounds which have been suggested, namely nitro starch, nitrophenol and the phosphorus compounds mentioned, which latter also have other disadvantageous properties. Besides, if large quantities of nitro compounds be employed they lead to the disadvantages hereinabove referred to. This suggestion also was useless in practice and was never used in the arts.

It has also been proposed (see French Patent No. 666,838) to envelop a textile wick impregnated with greasy substances in wadding provided with nitro cellulose, potassium chlorate or alcohol and to cause such a wick to ignite by sparks instead of benzine. This suggestion also is worthless in practice.

All the many experiments which have been made to endeavour to solve the problem of the production of a solid fuel for a lighter operated by spark ignition go to show how very greatly the need is felt in expert circles for replacing the volatile benzine with all its disadvantages consequent upon its volatility by a solid fuel and how difficult it has been on the other hand to do so seeing that no one has succeeded for decades past in finding a satisfactory solution of this problem.

Mention may also be made of proposals for the production of solid fuels which contain a core of oxygen salts and which are intended to be ignited in lighters by means of suitably arranged frictional surfaces containing phosphorus. Fuels of this kind, however, relate to an entirely different purpose and are based upon a differently acting mechanism and they can no more be caused to inflame by sparks from pyrophoric metallic alloys than can ordinary metaldehyde rods or sticks, as they do not contain fibres.

The use of fibres in under lighters is also known. This is, however, such a totally different technical branch that, as the suggestions previously made during the last decades clearly show, the solution of the old problem connected with lighters by using the fibres used in under lighters, does not belong to the range of average technical knowl-

edge, apart from the fact that it must also appear quite uncertain whether the fibres used in under lighters would enable the problems which arise in lighters to be satisfactorily solved in view of the temperature and other conditions which prevail in the case of a lighter.

According to the present invention, therefore, it is now possible to produce a solid fuel for spark operated lighters which is not volatile in practice, that is to say, does not exhibit the disadvantages of benzine lighter, can be just as reliably ignited as a benzine lighter, can be easily, reliably and quite safely handled and burns with a non-sooty, steady and satisfactory odourless flame and can also be easily extinguished.

It has been now found that for the solution of the present problem a great improvement in comparison with the known moulded bodies from metaldehyde can be achieved by reducing the thermal conductivity of the moulded bodies composed of metaldehyde. This may be conveniently accomplished by the addition of substances, which are bad conductors of heat, to the metaldehyde, as the inflammable substance, i. e., the substance which above all things maintains the flame. Such substances ensure that the thermal energy of the impinging spark is not carried off to a deleterious extent but is utilised to heat the spot on which it impinges to the temperature of ignition. As substances which reduce the coefficient of thermal conductivity, use may also be made of kinds of fibres which burn well, particularly textile fibres of low thermal conductivity, also finely ground and well dried cork meal. The reduction of the thermal conductivity is also assisted by a suitable structure of the rod or stick, which preferably should not be made denser than is necessary in view of the amount of strength desired and taking into consideration the addition also of a possible covering or coating.

The part which thermal conductivity plays has also been discovered through a further observation, which is that if metaldehyde dust is produced say in large quantity in a deeper opening in the rod or stick by the use of a roughing up device which works at a greater depth and acts somewhat like a drill and the spark be allowed to impinge at this point, the powder will ignite, provided that the loose quantity of dust is so great that it will act as a heat insulator for the spark in comparison with the pressing which conducts the heat away to a greater extent.

It has also been observed that important advantages can be obtained if, in addition, the particles of the inflammable substance produced when roughing up are held together in a loose state at the place where the roughing up takes place by combustible retaining devices such as a sufficient quantity of long fibres. In many cases 7% for example of fine cellulose fibres, say artificial silk fibres about 0.6 cm. long for example, will suffice for this purpose. These reduce the thermal conductivity and act at the same time as retaining devices for the particles. As these fibres are easily ignited, also, provided they are not in a very dense or too dense a state, a surface will be presented to the spark when the fuel is roughed up which the thermal energy of a spark of the ordinary size will always suffice to ignite.

The fibres consist preferably of such organic material as say, cellulose, which does not yield undesirable products of combustion, or not to any objectionable extent.

The fibres of materials which it is preferable to use and which consist of substances which do not explode and do evolve objectionable products of combustion when burned, differ advantageously from the fibrous nitro-cellluose which is mentioned in Swiss Patent No. 174,405 as a constituent of the mixture composing the rod or stick, the main components of which differ from those used here and which are useless in practice. It has now been found that it is not necessary to use fibrous nitrated cellulose as an igniting agent and consequently to have to put up with the disadvantages which are connected with the use of large quantities of nitrated cellulose and which cause the evolution of considerable quantities of undesirable products of combustion, the danger of spontaneous ignition and ethers. It has also been found that it is much more important and that it suffices to reduce on the one hand the thermal conductivity of the mixture by fibres which are bad conductors of heat so that the thermal energy supplied by a single shower of sparks is sufficient to produce the necessary increase of temperature and therefore the reliable ignition of the place at which the spark impinges, and on the other hand to afford the spark a surface at the point where the fuel is roughed up which is formed by pulverulent particles and fine fibres and is comparatively large, the particles which are formed by the roughing up of the fuel being held together and prevented from falling off. On the other hand the present invention shall not be evaded by adding to the material, according to this invention, a small quantity of nitrated cellulose or by replacing therewith partially or wholly the fibres of ordinary cellulose. The protection sought is therefore intended to include such inferior forms also because fuels for lighters operated by spark ignition composed of aldehyde derivatives and fibrous nitrated cellulose have not been proposed heretofore, and are, even if they only constitute an inferior product in comparison with the real and preferable embodiment of the present invention, a considerable improvement on the present state of the art. If this constructional form with nitrated cellulose be desired, undenitrated or only slightly denitrated Chardonnet silk may be used.

Cellulose artificial silk has proved to be particularly useful, especially when it is used as a very fine fluff. This can be obtained by cutting up and teasing out the cut up fibres by means of suitable appliances, such for example as brushes revolving towards each other, if it is not preferred to use untwisted single threads as the raw material, which can be obtained by the omission of corresponding stages of manufacture in the production of artificial silk. The length of the fibres is not of paramount importance. Long fibres are advantageous in various ways, but the length will not go so far according to the method of manufacture selected that uniform distribution will meet with any difficulty when the fibres are mixed. In many cases fibres ½ to 1 cm. in length have been found very suitable. The use also of short fibres to be worked into the mixture first, say before granulation, if such be undertaken, and also of longer fibres to be added afterwards, may frequently be advantageous.

In some modes of procedure, other natural or artificial fibres or threads than the preferably used artificial silk fibres, can also be used or used

conjointly with them, such as cotton or other vegetable fibres for example, well teased out wadding fibres or thin squirted artificial threads, also those of suitable artificial resins, although an increased use of substances which, owing to their chemical constitution or excessive thickness, brings about disadvantageous phenomena such as a bad smell or residues left after combustion, and makes the fuel to be produced less suitable or even unsuitable for the present purpose.

The substances which really support or maintain the flame (the inflammable substances) are preferably also incorporated in the mixture in the finest possible state of subdivision. As such inflammable substances the various aldehyde derivatives known for solidified spirit, such in particular as metaldehyde, are used. This, however, may be also partially replaced in some mode of procedure by other materials and in greater measure the better these substitutional substances are suitable for the purpose per se, and the more they burn without smoke, smell and residue, such as in particular various other organic substances which when heated sublime with or without decomposition, and preferably those with groups which contain oxygen and which burn without evolution of smoke and without leaving melts or carbonaceous residues. For example, in some cases polyglyoxal, trioxymethylene, hexamethylenetetramine, certain quinones can be used in small quantities. Metaldehyde is, however, preferable.

According to this invention binding agents are also used. The binding agent must be capable of imparting to the fuel the amount of strength necessary to withstand the mechanical strain put upon it by the lighter and it must also accord with and co-operate with the nature of the moulding of the rod or stick of fuel and any covering or coating which may be applied thereto. The presence of at least small quantities of binding agent is preferable, also because of the reason that pulverulent particles of the inflammable substances shall adhere by means of a thin film of the binding agent to at least a portion of the fibres exposed by the roughing up device since such pulverulent particles, like those which are detached, assist in the reliable ignition of those particles of the inflammable substance which are only mechanically held by the fibres of the fluff, apart from the fact that loss of substance when the fuel is roughed up again is more avoided.

In the proposals above mentioned, which relate to fuels adapted to be ignited by means of sparks from pyrophoric metallic alloys, binding agents were not otherwise used, obviously because it was desired to mould the composition from extremely inflammable materials while avoiding inert binding agents. It has, however, been unexpectedly found that organic binding agents of low inflammability by no means impair the ignition of the whole mass owing to their fine state of sub-division. The most varied kinds of organic binding agents can therefore be employed.

The binding agents may be added in a dissolved form but the cohesion can be effected without solvents by using binding agents of the desired composition which set at ordinary or higher temperatures under slight pressure, such for example as stearin gelatine, gum arabic which set at ordinary temperature or thermoplastic binding agents which soften and become adhesive at higher temperatures.

In many cases it may be suitable to mix the mixture first with a solution of a binding agent and to granulate and then to press the thoroughly dried grains. In such case only short fibres may be added before granulation and the grains then pressed together with longer fibres.

Both water-soluble binding agents and those which are soluble in organic solvents may be used. In the case of water-soluble binding agents care must be taken to see that the rod is well dried before any coating is applied to it. Only such binding agents are also preferably employed which do not attract moisture from the atmosphere to an inconvenient extent under the particular climatic conditions which may prevail. Good results were obtained with bead glue for example. In many cases, however, the water-soluble binding agents known in the manufacture of tablets, such as gelatine or gum-arabic may be used or used with others. Water-soluble cellulose compounds may also be used, such for example as "Cellofas". For damp climates, however, the latter binding agents are less suitable. As binding agents which are soluble in organic solvents, nitrated cellulose or solutions thereof for example may be used and best those with a low degree of nitration, such as is usual for varnishes. Acetylcellulose, for example, may however also be used, or resins in alcoholic solution, such as spirit varnishes.

The proportions of the ignition substances, that is, of the fibres and the inflammable substances (such as metaldehyde preferably) vary within wide limits, within which the action of both is still present. There must therefore be at least as much fibres present that ignition by means of sparks will still take place under the given conditions.

In the preferred mode of carrying out the invention the inflammable substances, such as metaldehyde in particular, are in preponderant quantities and may with advantage be more than 70% relatively to the weight of the rod.

The most favourable quantity of fibres depends on their nature and on the possible conjoint use of other substances which reduce thermal conductivity. In most cases a quantity of fibre less than 10% would be suitable. In the preferable modes of procedure in which fibres only are used, a percentage of fibre of about 7% has been found very favourable when well teased out artificial silk is used.

The specific volume of the fuel should be greater by 20% and preferably by 50% than if the inflammable substance metaldehyde were pressed under pressure by itself. The specific weight of the moulded products is preferably less than 1.

It is desirable that the inflammable substances and the fibres should be used simultaneously in practically sufficient quantity and that there should not be a lack of inflammable substances which would cause the accumulation of quantities of carbonaceous fibrous residues, even when such residues, if only fine fibres be used, are removed by the roughing up apparatus when the lighter is used next time. The fibres may be impregnated with ammonium nitrate solution, dried and teased out so as to prevent the formation of carbonaceous residues. Oxygen salts of fixed alkalies cause the fibres impregnated with them to glow afterwards. In most cases, however, it is preferable not to exceed the best possible quantity of fibre whereby carbonaceous residues in inconvenient quantities are avoided.

In the preferred forms of carrying out the in-

vention, the amount of binding agents employed is less than 7% (the dry substance of the binding agent calculated on the mass of the rod). This quantity may also be exceeded but roughing up must not be made difficult or the production of slightly coated fibres at the roughing up point which is still sufficient for ignition prevented. The amount of binding agent is always less than 20%.

In some forms of carrying out the invention with a looser core it is convenient to use more binding agent in the outer layers than in the inner layers or to add more binding agent in the outer layers by coating with solutions of binding agents. In some binding agents it is convenient to granulate first in some way and then to spray with a solvent which in the cold only moistens but when used hot causes the binding agent to swell up, so that any admixture of long fibres to the cores is facilitated and greater cohesion obtained on subsequent pressing.

The binding agents used should be fairly brittle at ordinary temperature and therefore facilitate the subsequent roughing up when the lighter is used by the formation of extremely fine particles.

In many cases it is advantageous to add to the fuel compounds which while it is burning evolve oxygen, preferably organic compounds, such as benzoyl superoxide for example which inter alia also improve the smell. Preferably about 3 to 6 per cent. of benzoyl superoxide are used. The oxygen compound added favours the complete combustion of the fibres. Such large quantities as would make extinction difficult must not, however, be added, or so much as would cause any considerable evolution of smoke after extinction.

Other additions to the fuel may be made which improve the effects or bring about desirable subsidiary effects. Thus for example substances which improve the smell while the lighter is burning and after the flame has been extinguished, such as suitable crystallised perfumes, essential oils etc. may be added in small quantities, and/or if desired additions may be made which affect the colour of the flame. When essential oils are used the vapour tension thereof may be reduced by the conjoint use of viscous substances which are miscible with the essential oils or which dissolve them, such as a fatty acid, so as to enable the perfume to keep better when stored for a long time. An essential oil which can be used with good results is oil of lavender. As a crystallised artificial perfume borneol or the more easily subliming isoborneol, but if desired artificial xylol musk, Jara-Jara and other artificial perfumes may be used conjointly in small quantities, but preferably those which at least sublime partially and therefore leave but little residue when they burn. If balsams and pleasant smelling resins be used conjointly they must be used in such small quantities that when they are used they do not melt which would prevent the lighter from being lighted again.

As additions which affect the colour of the flame, salts may be used inter alia, the actions of which impart to the flame a well known bright flame colouration, such for example as sodium salts, which colour it yellow, calcium salts which give it a reddish colour etc. For example, an addition of 1% of calcium stearate produces a flame colouration which is frequently regarded as desirable.

It is advantageous to give the stick or rod a coating consisting of one or more layers of collodion for example so as to give it greater strength and to protect it from external influences, particularly moisture, to enable it to withstand protracted storage and for other purposes.

Admirable results can be obtained with sticks or rods produced in this way. The feed necessary from time to time can be obtained with all kinds of brake apparatus as no parts which would interferewith this operation are present which would be melted or softened by the heat of the flame.

In modified constructional forms which, however, are less advantageous, the fuel may also be used in form of flexible wicks. For this purpose it may contain as the flexible carrier material, fibres or threads of still greater or continuous length.

In other modified forms it may also be used in the form of thin bands or films in lighters adapted for this form with suitable feeding or advancing devices.

The constructional examples:

(1) The materials used are—

	Per cent
Metaldehyde	85
Fine artificial silk fibres	7
Benzoyl superoxide	3
Collodion (dry substance)	5

The artificial silk fibres are cut into pieces of about 0.5 to 1 cm. in length. The volume of fibres corresponds in a loose fluffy state to the volume of the other substances approximately. The collodion is used in a 6% acetone solution.

The metaldehyde and the benzoyl superoxide are reduced to the fineness of dust and mixed and then mixed intimately with the artificial silk in such a way that the fibres are compressed as little as possible by the mixing and agglomeration. The collodion solution is then added and simultaneously intimately mixed, compression and agglomeration of the fibres being again avoided as much as possible.

The mass is then moulded into slabs on a smooth support. This may be conveniently carried out with the use of pressure or by lightly beating or patting the mass. The slabs are cut up into sticks or rods as soon as they are sufficiently dry and are afterwards dried completely. After drying they are dipped into a 6% collodion solution, which in order to avoid confusion in such rods may contain a gaudy colouring matter, so that such rods shall exhibit a characteristic colour which will not escape attention. If desired the rod may also be coloured throughout its whole mass, for which purpose "Zapon" colours are well suited.

(2) If it be desired to colour the flame slightly, say red by a calcium salt, and/or if it be desired to perfume the rod so as to make the smell of the metaldehyde which is particularly noticeable when the flame is extinguished, the following mixture may be used:

	Per cent
Metaldehyde	76
Fine artificial silk fibres	6
Benzoylsuperoxide	6
Calcium stearate	1
Oil of lavender	3
Fatty acid	1
Collodion (dry substance)	6
Borneol	1

The oil of lavender is preferably mixed first with the fatty acid and both then intimately stirred into the mixture compounded as above.

(3) In the mixture according to example 1 only 1% of artificial silk fibres and 6% of the finest dry cork meal are used instead of 7% of artificial silk fibres.

The cork meal may be reduced to a particularly fine state of sub-division in the dry way by means of ball mills for example, but also if desired in an aqueous suspension using homogenising jets and subsequent drying. In this way an embodiment of the invention is obtained which can be easily moulded, but is inferior in respect of combustion free from residue yet is a form which can be used nevertheless.

What I claim is:

1. Spark-ignitable solid fuel for pyrophoric lighters consisting essentially of a molded intimate and substantially uniform admixture of a member of the group consisting of the combustible non-fusing aldehydes and non-fusing derivatives thereof in finely-subdivided solid form as the major flame-supporting constituent, and of finely divided combustible fibrous material of low thermal conductivity and low burning velocity and also a combustible organic binding agent as minor constituents, said solid fuel being roughenable at a spark-impinging portion with only partial detachment of finely-subdivided combustible particles and with simultaneous substantial fluffing of the corresponding fibrous material, the resultant fluffy fibers constituting a retaining framework for the said detached combustible particles, whereby the spark-impinging portion comprises a spark-ignitable intermingling of combustible particles and fibers of enlarged surface area.

2. Spark-ignitable solid fuel for pyrophoric lighters consisting essentially of a molded intimate and substantially uniform admixture of metaldehyde in finely-subdivided solid form as the major flame-supporting constituent, and finely-divided combustible fibrous material of low thermal conductivity and low burning velocity and also a combustible organic binding agent as minor constituents, said solid fuel being roughenable at a spark-impinging portion with only partial detachment of finely-subdivided combustible particles and with simultaneous substantial fluffing of the corresponding fibrous material, the resultant fluffy fibers constituting a retaining framework for the said detached combustible particles, whereby the spark-impinging portion comprises a spark-ignitable intermingling of combustible particles and fibers of enlarged surface area.

3. Spark-ignitable solid fuel for pyrophoric lighters consisting essentially of a molded intimate and substantially uniform admixture of metaldehyde in finely-subdivided solid form as the major flame-supporting constituent, and of finely-divided combustible fibrous material of low thermal conductivity and low burning velocity and also a combustible organic binding agent as minor constituents, said fibrous material consisting essentially of artificial silk fibers, said solid fuel being roughenable at a spark-impinging portion with only partial detachment of finely-subdivided combustible particles and with simultaneous substantial fluffing of the corresponding fibrous material, the resultant fluffy fibers constituting a retaining framework for the said detached combustible particles, whereby the spark-impinging portion comprises a spark-ignitable intermingling of combustible particles and fibers of enlarged surface area.

4. Spark-ignitable solid fuel for pyrophoric lighters consisting essentially of a molded intimate and substantially uniform admixture of metaldehyde in finely-subdivided solid form as the major flame-supporting constituent, and of finely-divided combustible fibrous material of low thermal conductivity and low burning velocity and also a combustible organic binding agent and benzoyl superoxide as minor constituents, said solid fuel being roughenable at a spark-impinging portion with only partial detachment of finely-subdivided combustible particles and with simultaneous substantial fluffing of the corresponding fibrous material, the resultant fluffy fibers constituting a retaining framework for the said detached combustible particles, whereby the spark-impinging portion comprises a spark-ignitable intermingling of combustible particles and fibers of enlarged surface area, said solid fuel containing about 70 to about 85% of metaldehyde, about 7 to about 10% of fibrous material, about 5 to about 20% of binding agent, and about 3 to about 6% of benzoyl superoxide.

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