In powdered fuel engines only such fuels can be used as will ignite and burn up during the short time space of one stroke of the engine. This capacity to burn is small if the grains of powder are large, or if the fuel powder is moist (e. g. peat or wood-meal), high in ash content (e. g. coke from the distillation of coal or lignite) and low in materials volatilizable by heat (e. g. coke or anthracite coal, etc.).

Such fuel powders which ignite with difficulty or burn up too slowly can be adapted for driving internal combustion engines, in accordance with my invention by utilizing them together with quick igniting or burning kinds of powder. One may use a ready mixture of slow igniting powders (e. g. coke powder, moist peat dust, coal dust with high ash content or low in volatile gases, etc.), and easily igniting kinds (e. g. lignite powder or dust of naphthalene, anthracene, sugar or the like). On the other hand, one may, instead of using the previously prepared mixture, bring the two kinds of powder having good and poor ignition qualities together as it is introduced into the machine, that is, either in a small reservoir on the machine, in the injection nozzle, or even in the combustion chamber of the engine itself. These various possibilities are illustrated in my copending application Serial No. 390,097, filed September 3, 1929.

Since the quick igniting kinds of powder are nearly always more costly than the slow igniting kinds it is advantageous in employing my method to use a greater quantity of the slow igniting powder as the primary driving fuel and to add only a small quantity of the quick igniting kind as a primer. The quick igniting powder can be made of different kinds of combustible material from the slow igniting powder, or under certain conditions may consist of the same material as the latter.

In the case of moist fuel or that which is high in ash one need only subject a fraction thereof, which can easily be determined by experiment, to a more complete drying or de-ashing (e. g. by flotation or sifting), or in other words, by purifying it with respect to its ignition properties, in order to obtain a mixture which will operate satisfactorily in an internal combustion engine.

With many fuel powders it is sufficient merely to grind a relatively small part of the fuel powder very fine, leaving the greater part in the form of larger grains so as to reduce the cost of production. The finest powder grains then inflammation during the operation of the machine and sufficiently quickly, because the heat of compression of the combustion air rapidly drives the gases out of the fine grains. The coarser grains are then ignited by the flame of the finer grains.

My invention therefore provides the means for reducing the grinding cost of the fuel powder. The fine grinding needs to be carried only so far that in the ground powder just-quick igniting finest particles are present to bring the combustion air of the cylinder to that temperature which will result in the ignition and burning up of the part of the powder which is in the form of larger grains within the time limit determined by the machine.

In order to surely bring about the ignition of the coarser ground powder grains in the combustion chamber of the engine they should be introduced into the cylinder only after the finer more rapidly igniting powder grains. For this purpose the mixture of coarse and fine particles can be subjected to a separation as it enters the cylinder, for example by sifting or the like. This can be accomplished in the manner shown in my copending application Ser. No. 390,097 by arranging reflecting surfaces in the inlet conduits for retarding the fuel powder flowing through. By these reflecting surfaces the coarser and heavier grains are thrown back and retarded in their motion, while the finer and lighter grains follow more easily the changes in direction of the conveying air current necessitated by these hindrances, and do not strike against the reflecting walls. They therefore suffer no decrease in velocity and pass into the combustion space of the engine sooner than the coarser grains.

By means of my invention every too uncertainly, or too slowly igniting, or too slowly burning kind of powder (e. g. anthracite, coal of high ash content, coke residues from distillation, de-oiling or bitumen removing operations, moist peat, wood-meal, fallen leaves, animal carcasses, etc.) can be adapted for utilization in internal combustion engines by utilizing these slow igniting materials together with greater or less quantities of lignite powder, low ash coal dust, finest ground coal, powder of naphthalene or other solid hydro-carbons such as anthracene or sugar or any other easily ignitable powder.

In certain cases the slow igniting powder can also be impregnated with substances favoring ignition such as saltpeter, potassium chloride, phosphorous solution, or with vapors or gases of easily ignitable substances. This may be done either before the fuel is fed into the engine or in the engine itself.

The capacity for igniting and burning of vari-
ous powdered fuels is dependent upon a number of different factors, principal of which are grain size, moisture content, ash content, and content of readily volatile combustible substances. The present invention is concerned with the capacity of powdered fuels to ignite and burn in an internal combustion engine during a single stroke. Fuel powders which are unable to ignite and burn up completely within a single stroke, due to large grain size, high moisture content, etc., I refer to as having slow ignition and burning qualities. Substances which are capable of igniting and burning completely in less than a single stroke of the engine I refer to as having rapid ignition and burning qualities. Since the capacity of a certain fuel powder to ignite and burn up within a single stroke is dependent upon the type of engine, the form of the combustion chamber in the working cylinder, and the driving conditions of the engine, as well as the nature of the fuel powder itself, what would be a slow igniting and burning powder for one engine might be a rapid igniting and burning powder for another engine.

In carrying out the process according to my invention any internal combustion engine of the reciprocating type (e.g. Diesel, semi-Diesel, hot bulb or any other high pressure motor) or any engine working on the turbine principle (e.g. according to the Holzwarth system) may be used. The process can also be used in the type of internal combustion engines not used for the production of power, but primarily for the production of certain chemical products as waste gases.

Having described my invention, I claim:
1. A fuel for internal combustion engines composed of a powder all particles of which are sufficiently small to pass through the fuel valve of an internal combustion engine, the major portion of the fuel consisting of a carbonaceous powder having such slow igniting and burning characteristics that it is intrinsically incapable of burning up completely within a single engine stroke, the remainder of the fuel consisting of a predetermined proportion of a priming powder consisting of a material having a lower ash content than the powder having slow igniting and burning characteristics.

2. A fuel for internal combustion engines composed of a powder all particles of which are sufficiently small to pass through the fuel valve of an internal combustion engine, the major portion of the fuel consisting of a carbonaceous powder having such slow igniting and burning characteristics that it is intrinsically incapable of burning up completely within a single engine stroke, the remainder of the fuel consisting of a predetermined proportion of a priming powder consisting of a material characterized by a greater capacity for quickly yielding combustible gases under the influence of heat than the powder having slow igniting and burning characteristics.

3. A fuel for internal combustion engines composed of a powder all particles of which are sufficiently small to pass through the fuel valve of an internal combustion engine, the major portion of the fuel consisting of a carbonaceous powder having such slow igniting and burning characteristics that it is intrinsically incapable of burning up completely within a single engine stroke, the remainder of the fuel consisting of a predetermined proportion of a priming powder consisting of a material characterized by a greater capacity for quickly yielding combustible gases under the influence of heat than the powder having slow igniting and burning characteristics.

4. The method of making a fuel for internal combustion engines from a carbonaceous powder having such slow igniting and burning characteristics that it is intrinsically incapable of burning up completely within a single engine stroke, which comprises grinding a small portion of said powder to a very small average particle size, and mixing said finely ground powder with the remainder of the powder.

5. A fuel for internal combustion engines consisting of a mixture of anthracite coal powder and lignite powder, the powders being sufficiently fine to pass through the fuel valve of an internal combustion engine, the anthracite coal powder forming the larger portion of the mixture, and the lignite powder being in sufficient amount to cause the ignition and complete burning of the entire mixture in a single stroke of the internal combustion engine with which the fuel is to be used.

6. A fuel for internal combustion engines composed of a carbonaceous powder having slow igniting and burning qualities impregnated with a sufficient quantity of a volatile substance to cause the ignition and complete combustion of the powder within a single stroke of the internal combustion engine in which the fuel is to be used, the powder being sufficiently fine to pass through the fuel valve of the internal combustion engine.

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