No. 778,788. PATENTED DEC. 27, 1904.

H. MAXIM.

MOTIVE POWER COMBUSTIBLE FOR AUTOMOBILE TORPEDOES.

APPLICATION FILED MAR. 21, 1901.

Fig. 3.

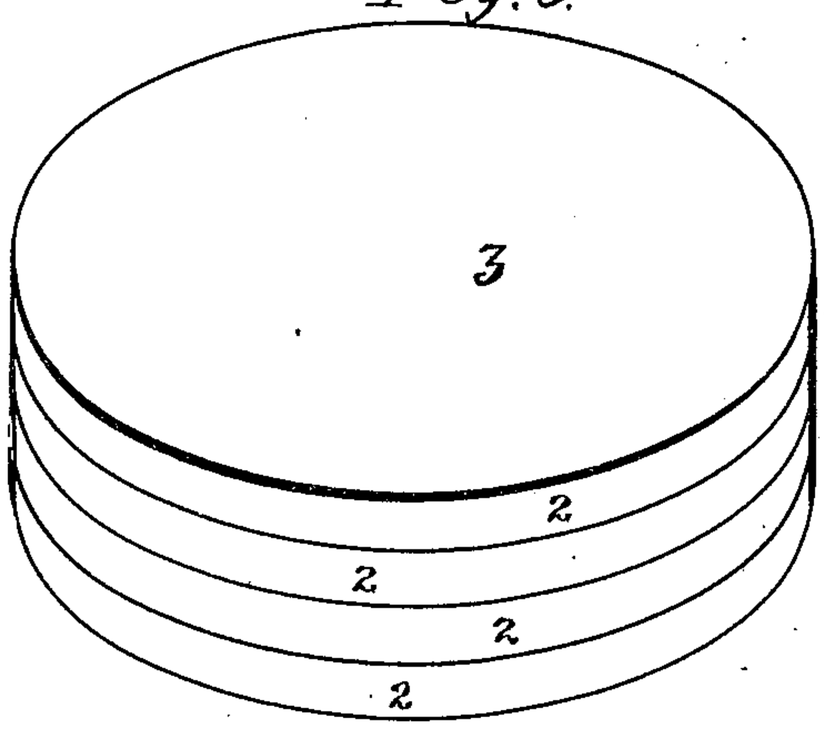


Fig. 1.

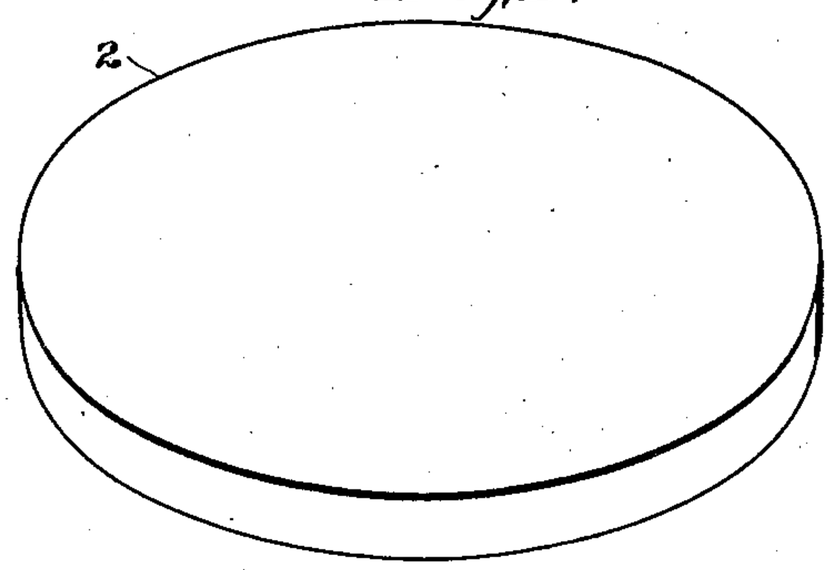


Fig. 2.

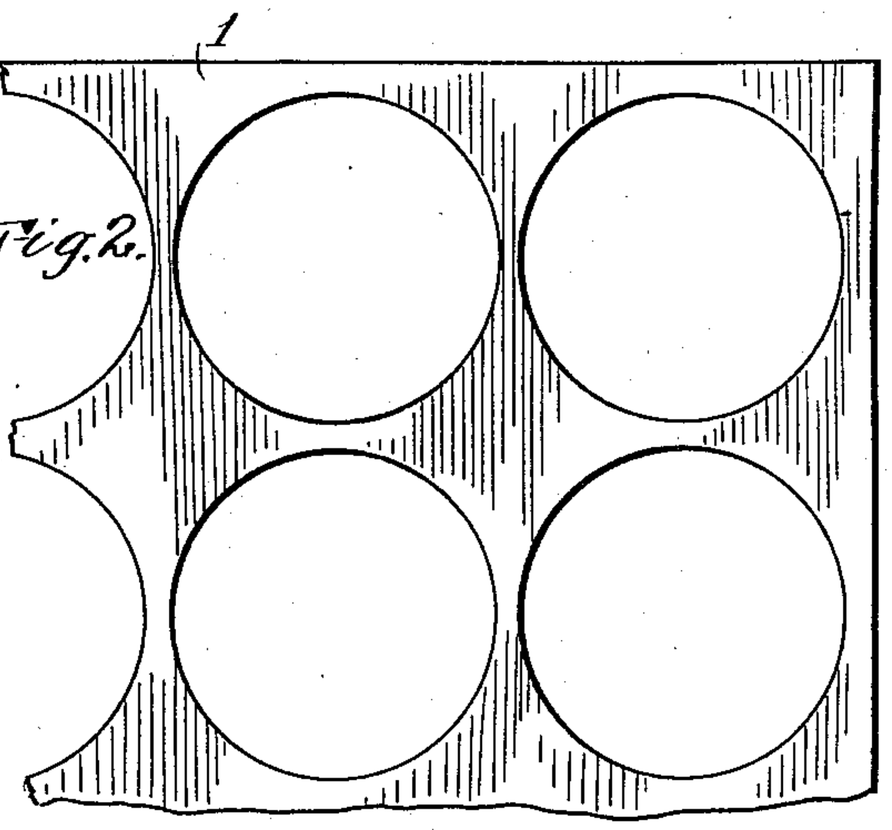
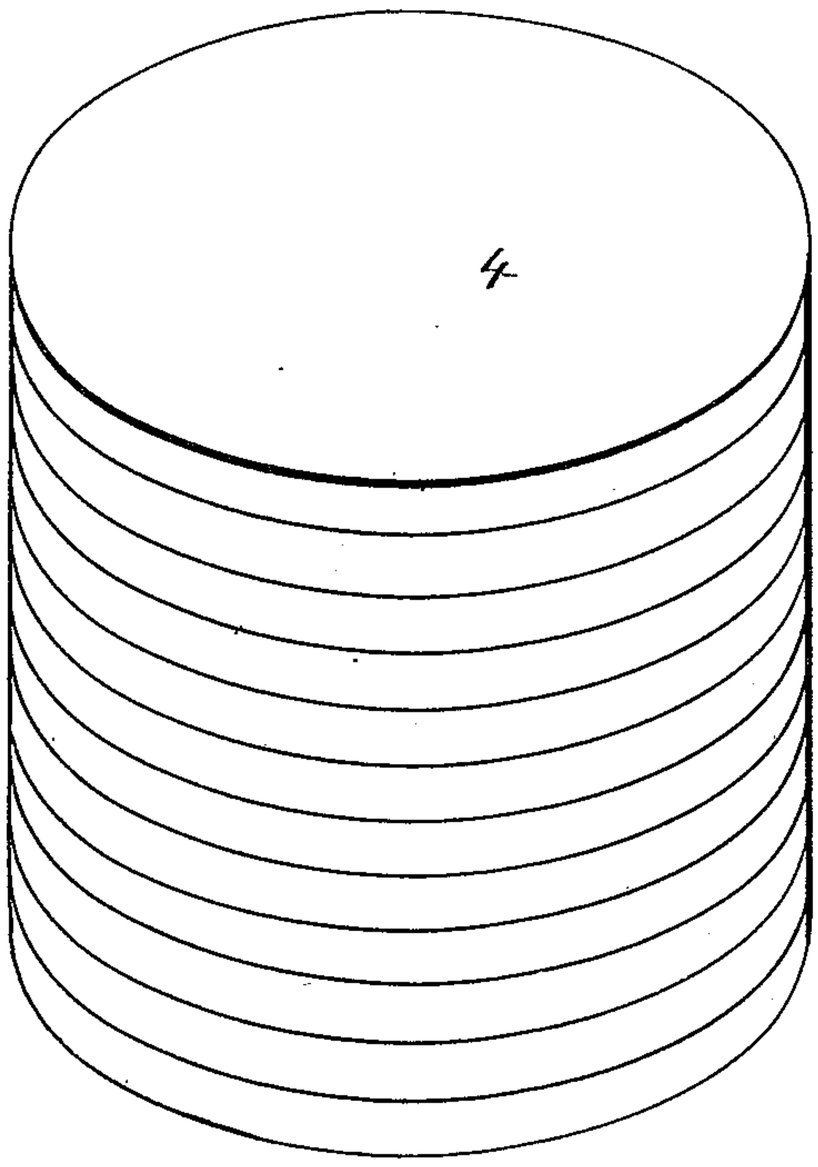


Fig. 4.



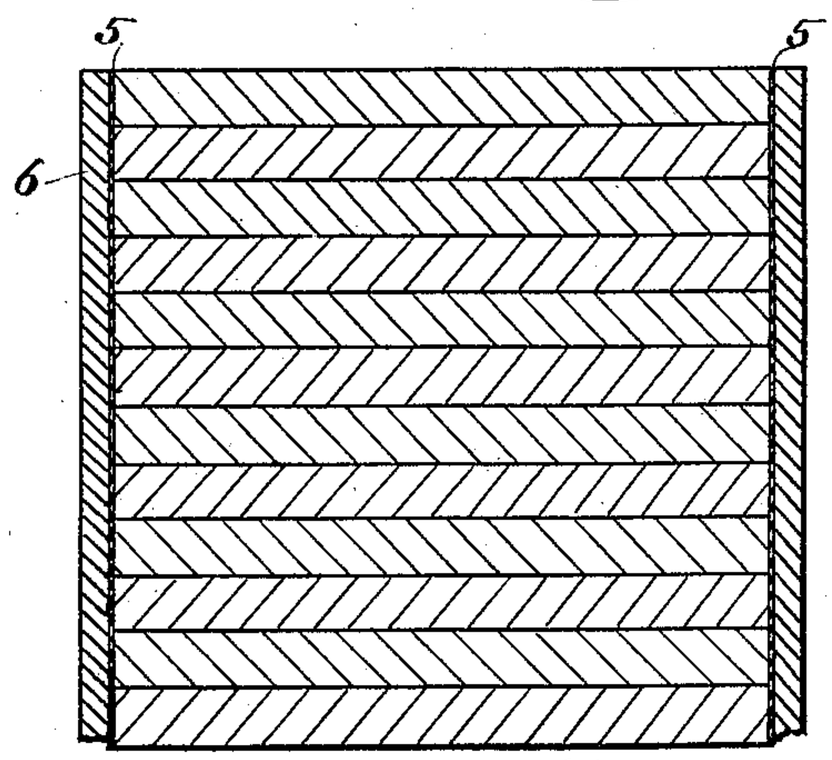


Fig. 5.

Witnesses.
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Hudson Maxim,
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his attorney.

No. 778,788. Patented December 27, 1904.

UNITED STATES PATENT OFFICE.

HUDSON MAXIM, OF BROOKLYN, NEW YORK.

MOTIVE-POWER COMBUSTIBLE FOR AUTOMOBILE TORPEDOES.

SPECIFICATION forming part of Letters Patent No. 778,788, dated December 27, 1904.

Application filed March 21, 1901. Serial No. 52,220.

To all whom it may concern:

Be it known that I, HUDSON MAXIM, a resident of Brooklyn, New York, have invented a new and useful Improvement in Motive-Power Combustibles for Automobile Torpedoes, which invention is fully set forth in the following specification.

The present invention relates to an improved process of manufacture of a self-combustive compound adapted to be burned in a confined space under pressure for producing motive power, especially for driving automobiles, torpedoes, and light torpedo-boats, which compound is hereinafter designated "motorite," and has reference to the production of rods or bars of such material in the most economical and practical manner and to the product itself as an article of manufacture.

In my application for United States patent filed October 4, 1899, Serial No. 732,563, I have shown an automobile torpedo wherein rods or bars of self-combusting material are adapted to be burned in a confined space under pressure to supply the motive power to propel the torpedo. In order that such compounds may be successfully employed to supply motive power in the manner indicated, it is essential that combustion should be evenly progressive from the ignited end surface inward, and the simultaneous combustion of the whole or any considerable mass of the material would result in sudden and violent explosion. Moreover, it is essential that the motorite should be free from longitudinally-extending flaws or rifts, whereby the flame may penetrate to the interior of the rod or bar of motorite, and thus form gases at high pressure, which by reason of their confinement within the rifts or minute cracks would act to violently disrupt the rod or bar of motorite, as well as its containing tube or case, within which it is designed to be burned. For this reason it is essential that the material should be free from longitudinal rifts or flaws which would enable the frame to penetrate the mass of the material. I have found that when motorite constituted as hereinafter described is formed into rods or bars by placing the material in a press and forcing it through a mold or die after the manner of making smokeless-powder grains it is practically impossible to make the bars or rods of sufficient size and at the same time give them sufficient compression in their exit from the molds or dies to cause the material to be free from flaws or rifts extending longitudinally through the rods or bars. The texture of the rods or bars when thus made somewhat resembles the fibrous nature of defective drawn wire, in which the lines of cleavage between the fibers extend longitudinally of the wire—that is to say, the rifts or flaws in the large rod of motorite are apt to exist in the form of longitudinal seams. Although such longitudinal rifts or seams may be so small as not to be detected by the naked eye, nevertheless when the rod is ignited at one end and burned under pressure the flame is forced into these minute longitudinal rifts or seams, and instead of burning with progressive combustion the rod of motorite is disrupted with great violence. This has repeatedly occurred with me in actual practice. Furthermore, when rods or bars of motorite are made in the last above-mentioned manner whatever faults or seams may exist are much enlarged and increased by the process of drying or seasoning of the rods or bars, and the larger these latter the greater the tendency to crack and open up the longitudinal seams, while it is obviously out of the question to make rods or bars of material of such diameter (often as high as three inches or more) as would adapt them to the purposes of this invention with the full amount of solvent necessary for that manufacture and then eliminate the solvent from the thick mass of material.

The object of the present invention is to produce in the form of rods or bars a self-combusting compound capable of burning under pressure in a confined space for producing motive power for driving automobile torpedoes and light torpedo-boats, which rods or bars shall be free from longitudinal rifts, seams, or flaws and shall burn progressively from the ignited end without danger of disruption or of explosion.

With these objects in view the invention consists in a novel form of rod or bar com-

posed of a compound capable of sustaining its own combustion when confined under pressure and in the process of making the same. In this novel rod or bar of my invention any rifts or flaws that may exist extend diametrically across the same rather than in a longitudinal direction, and hence in no way contribute to a penetration of the flame into the rod in such way as to cause its disruption.

I have illustrated in the accompanying drawings the manner of forming my improved rod of motorite, in which—

Figure 1 represents in isometric perspective an approximately full-sized disk of motorite; Fig. 2, a sheet of motorite, on a reduced scale, from which the disks are cut; Fig. 3, a view similar to Fig. 1 of a thickened or compound disk; Fig. 4, a like view of a section or portion of a completed rod or bar, and Fig. 5 a vertical broken transverse section of a combustion-tube with the completed rod in place therein.

In carrying out the invention I incorporate together in a mixer or kneading-machine about sixty parts, by weight, of nitroglycerin and about five parts of gelatin guncotton and about thirty-five parts trinitrocellulose or military guncotton, to which is added about thirty parts of a suitable solvent of the military guncotton, such as acetone. When the material has been thoroughly gelatinated or rendered sufficiently plastic, it is worked between rolls such as are employed in the manufacture of celluloid at atmospheric temperature until the mass is rendered perfectly homogeneous and of uniform texture. The rolls are then warmed to 120° Fahrenheit and the material continually worked between the rolls until the quantity of solvent shall be reduced to from ten to fifteen per cent., or even less, of a total weight of the material. Then the material is rolled out into thin sheets 1 from an eighth to a quarter of an inch in thickness, and while still warm from the rolls they are cut up into disks 2 by punching and of such size as may be desired for the purpose of the invention. (Here shown as about three inches in diameter.) The disks are then superimposed one upon another in a cylindrical press or mold. The mold should be maintained at an elevated temperature, and the disks should be placed in the mold as warm as practicable and then subjected to pressure sufficient to cause them to adhere and become sealed together by their own adhesiveness. There should be sufficient residual solvent left in the material before placing in the press to enable them to adhere and become sealed together under the warmth and pressure of the press or mold.

A sufficient number of disks should be employed to build up in the mold a body of material and to constitute a disk of about an inch in thickness. These thick disks 3 are then placed in a drying-room or in a room maintained at a temperature of from 100° to 120° Fahrenheit, where, as far as practicable, the solvent is evaporated from the material or sufficient of it to adapt the material to the purposes of this invention. The thick disks are next taken from the dry-room and while yet warm are moistened with acetone or other suitable solvent and placed in a cylindrical mold warmed for the purpose, the disks being superimposed one upon another in such numbers as shall be required to build up a rod or cylinder 4 of the material of such length as may be desired for carrying out this invention. By proceeding in this manner but very little solvent is left in the cylinder, and the quantity necessary to be applied to the adjacent surfaces of the disks where they come together when placed in the mold may be so slight that its presence in the material does no practical harm and in no way serves to defeat the purpose of the invention, and in this manner, furthermore, bars or cylinders of the material may be made of any desired or required diameter and of such diameter as to render it impracticable, if not impossible, to evaporate the solvent from them if made in a continuous solid rod after the manner of making smokeless-powder grains. The cylinders of motorite thus constructed are then coated with varnish 5 or other suitable material incapable of supporting its own combustion—that is to say, of a material containing insufficient oxygen to enable it to burn without atmospheric oxygen or oxygen supplied from an exterior source. For this varnish or coating I prefer to employ a mixture of about equal parts collodion-guncotton and gum-camphor, and as a solvent therefor I may employ any of the well-known substances in general use—such as ether and alcohol, wood-alcohol, acetone, of amyl, &c.; but I prefer to employ acetone. The cylinders are then placed in the usual dry-house and the coating thoroughly dried. The cylinders are next forced under pressure into metallic cylinders or casings 6 for use.

By proceeding in the foregoing manner the cylinders of motorite are made absolutely impervious to the gases of combustion when burned from the end, and the coating forming a perfect gas and flame seal between the cylinder and its casing prevents ignition of the motorite on its sides and between it and the casing.

When the material is rolled into sheets and then these sheets cut into disks, the grain or cleavage to the material is in the direction of the diameter of the disks, so that when cylinders of the material are built up according to my invention the lines of cleavage and whatever faults may exist lie in a direction transverse to the axis of the cylinders. This renders my rods of motorite absolutely safe when used in the manner hereinbefore described,

while rods or bars made by squirting or stuffing through a die have their lines of cleavage in a longitudinal direction, which constitutes an element of great danger, as already described.

While I prefer to build the rods or bars in the above manner, yet I may construct them according to a part of the invention without carrying out the whole invention. For example, I may form the material into disks simply by means of compression without rolling and then proceed with the carrying out of the invention in other respects, as it is obvious that thin disks made by compression, although they might have faults running in all directions, would when superimposed upon one another break joints with the faults of adjacent disks, while, furthermore, the application of solvent to the surfaces of the thicker disks would cause the faults upon those surfaces to disappear, and thereby form transverse barriers to the passage of the flame through the rods in a longitudinal direction. Furthermore, I may, without departing from the invention and without practicing the whole invention, form disks by rolling, as already described, and I may evaporate a sufficient quantity of the solvent, so that the material will burn with sufficient readiness to effect the purpose of this invention, and I may then form bars or cylinders by superimposing these disks upon one another under pressure and warmth and without any further drying than is effected in the process of rolling.

I have found that I may evaporate so much solvent on the rolls that there would be left in the material only about five per cent. of its weight and which is not a quantity sufficient to materially affect disadvantageously the practical use of the rod or bar of motorite in the manner described.

The rods or bars of motorite thus formed constitute a fuel capable of maintaining its own combustion and which may be employed for any of the purposes for which fuel is desired, as the evaporation of water or other liquids, the heating of air, &c. It is however, especially adapted for use as a fuel for producing motive power for the propulsion of automobile torpedoes, and in such case I prefer to use it to generate steam which, mixed with the products of combustion of the motorite, constitutes the motive power.

What is claimed is—

1. The herein-described process of making rods or bars of motive-power combustible, which consists in forming colloidal explosive material into disk-like sections free from rifts or flaws whose line of extension is at an angle to the plane surfaces thereof, and then building up a rod or bar by superimposing said sections one upon another and subjecting them to pressure.

2. The herein-described process of making rods or bars of motive-power combustible, which consists in cementing together thin layers of colloidal explosive under pressure, whereby a rod or bar free from longitudinal rifts or flaws is formed.

3. The herein-described process of forming rods or bars of motive-power combustible which consists in forming sections of a colloidal explosive superimposing a plurality of the sections upon one another to form a thicker section, then evaporating a whole or a part of the contained solvent, then forming these thicker sections into rods by superimposing them upon one another and subjecting them to pressure.

4. The herein-described process of making rods or bars of motive-power combustible, which consists in forming disks of a colloidal explosive, superimposing a plurality of the disks upon one another and causing them to adhere together to form a thicker disk, then evaporating a whole or part of the contained volatile solvent, and then forming the disks into a cylinder by superimposing them upon one another, and then coating the cylinders with a material containing insufficient oxygen for the support of its own combustion.

5. The herein-described process of making cylinders of motive-power combustible, which consists in forming disks of colloidal explosive, then making the disks into thicker disks by superimposing one upon another and causing them to adhere one to another, then evaporating a contained solvent, then rendering the surfaces of the thicker disks adhesive, and superimposing them upon one another to form a cylinder.

6. The herein-described process of making rods of motive-power combustible, which consists in rendering the materials plastic by means of a volatile solvent, then forming the material into flattened sections, evaporating a portion of the solvent in the formation of the sections, compressing together a plurality of said sections while a portion of the solvent remains therein to form thicker sections, then evaporating the residual solvent, then adding more solvent to the surfaces of the thickened sections, then pressing these sections together to form rods.

7. The herein-described process of making rods or bars of motive-power combustible which consists in forming disks or sheets of colloidal combustible material, superimposing said disks or sheets one upon another, coating all the surface of the rods or bars so formed with a material containing insufficient oxygen for the support of its own combustion, and then compressing the rod or bar into a metallic case, whereby a rod or bar free from longitudinal rifts or flaws is formed.

8. The herein-described article of manufacture, which consists of a rod or bar of colloidal material containing sufficient oxygen

to support its own combustion, and consisting of a plurality of sections free from longitudinal rifts or flaws superimposed upon and cemented to one another, said rod or bar having a coating of a material containing insufficient oxygen to support its own combustion.

9. The herein-described rod or bar of fuel, consisting of a plurality of layers of a self-combusting material free from longitudinal rifts or flaws superimposed one upon another in combination with a metallic casing inclosing the bar and protecting it from the flame of combustion except on one end.

10. The herein-described rod or bar of fuel consisting of a plurality of disks or layers of a self-combusting material free from longitudinal rifts or flaws, and superimposed one upon another and cemented together, in combination with a metallic casing inclosing the rod or bar and protecting it from the flame of combustion except on one end.

11. The herein-described motive-power-combustible rod or bar composed of an integral mass of colloidal material free from longitudinal rifts or flaws.

12. The herein-described motive-power-combustible rod or bar composed of an integral mass of colloidal material free from longitudinal rifts or flaws and coated with a material containing insufficient oxygen to support its own combustion.

13. The herein-described motive-power combustible consisting of a plurality of colloidal disks free from longitudinal rifts or flaws, and inclosed in a metallic case, and having a sealing-varnish closing the joint between the disks and said case.

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

HUDSON MAXIM.

Witnesses:

CLARENCE M. REYNOLDS.

EDWARD LYONS.