(No Model.) 2 Sheets—Sheet 1.

H. MAXIM.

APPARATUS FOR MAKING EXPLOSIVE RODS OR GRAINS.

No. 538,618. Patented Apr. 30, 1895.

Fig. 1.

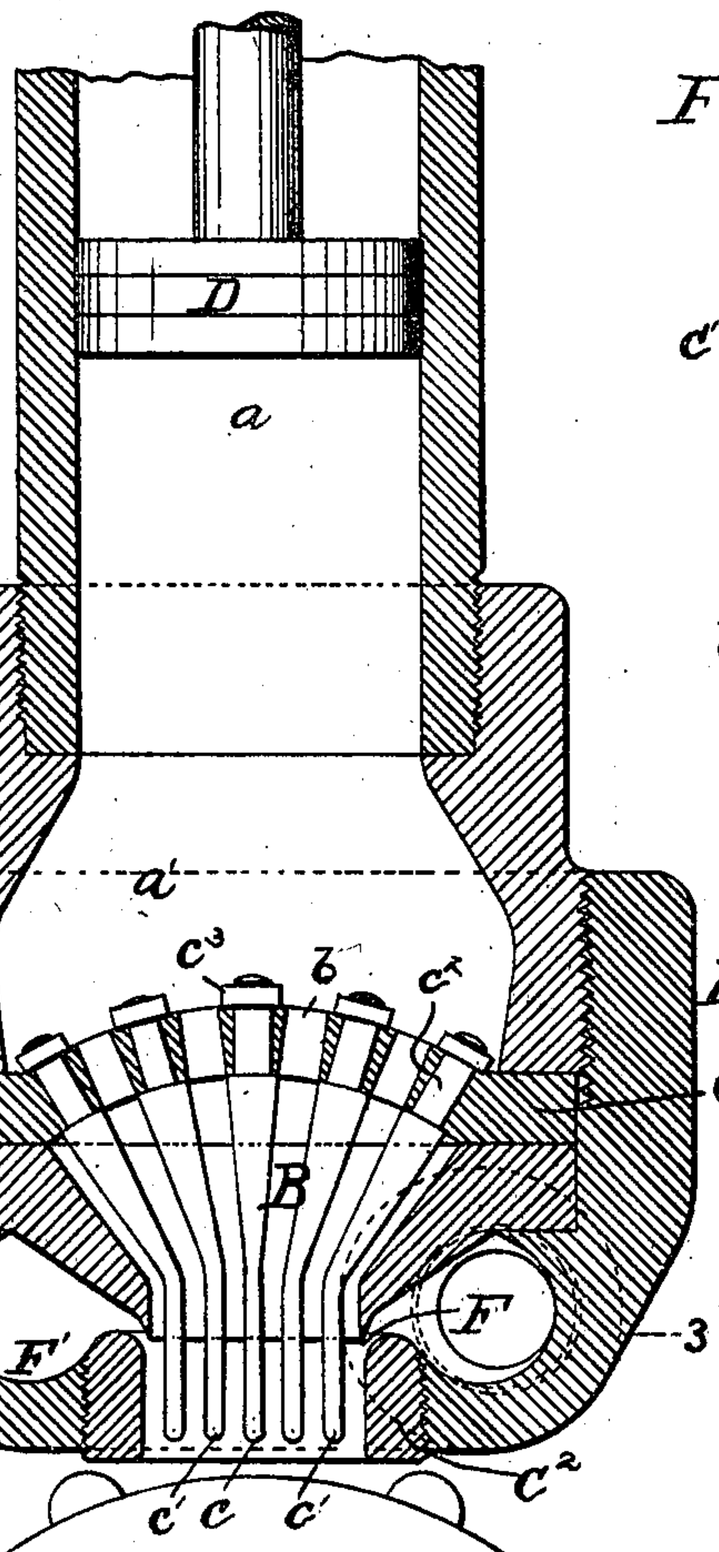


Fig. 4.

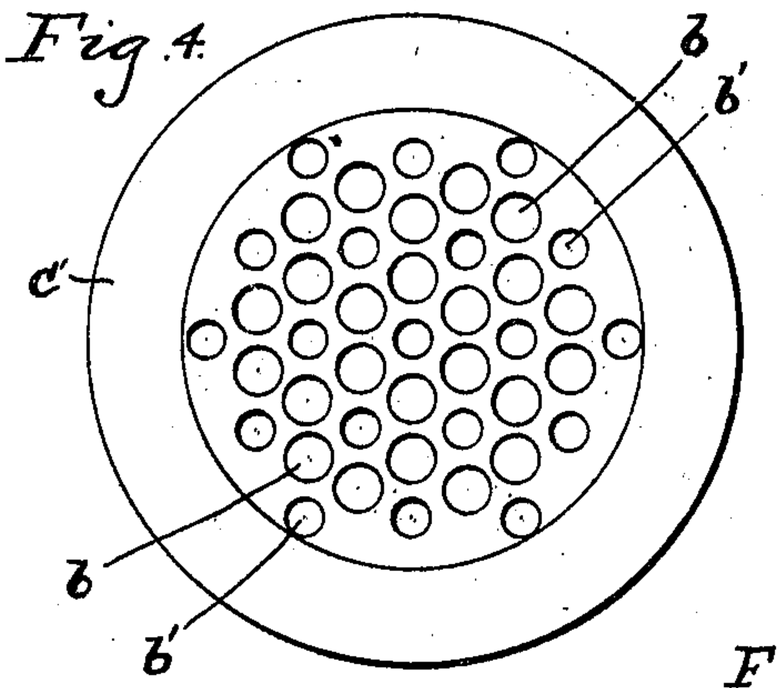


Fig. 3.

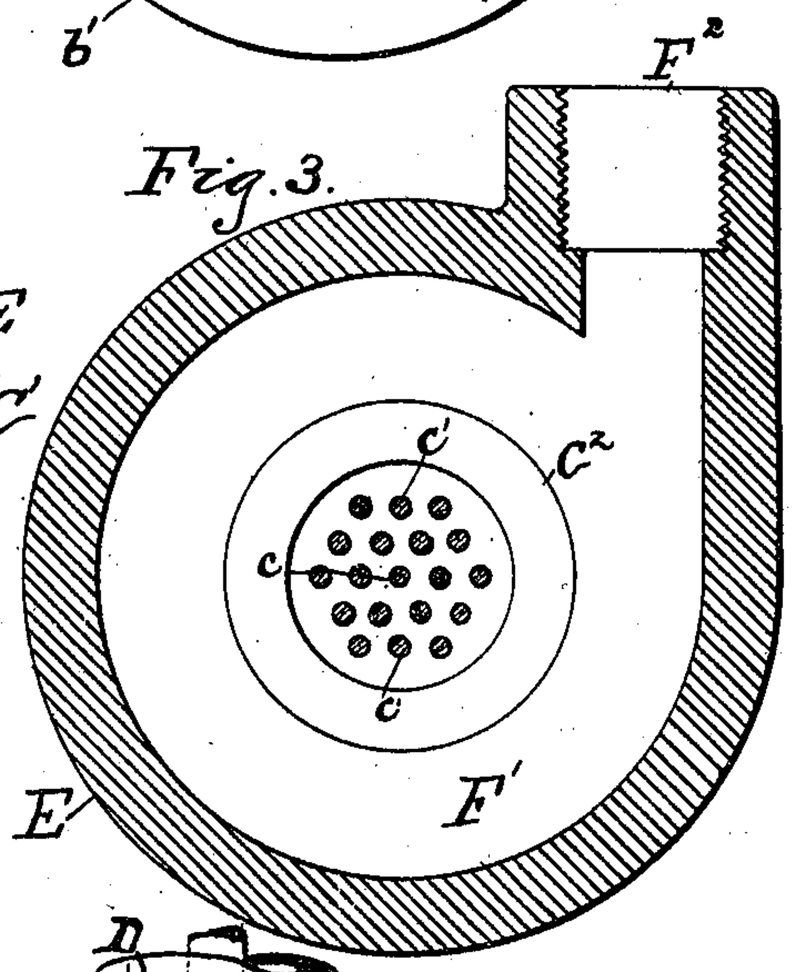


Fig. 2.

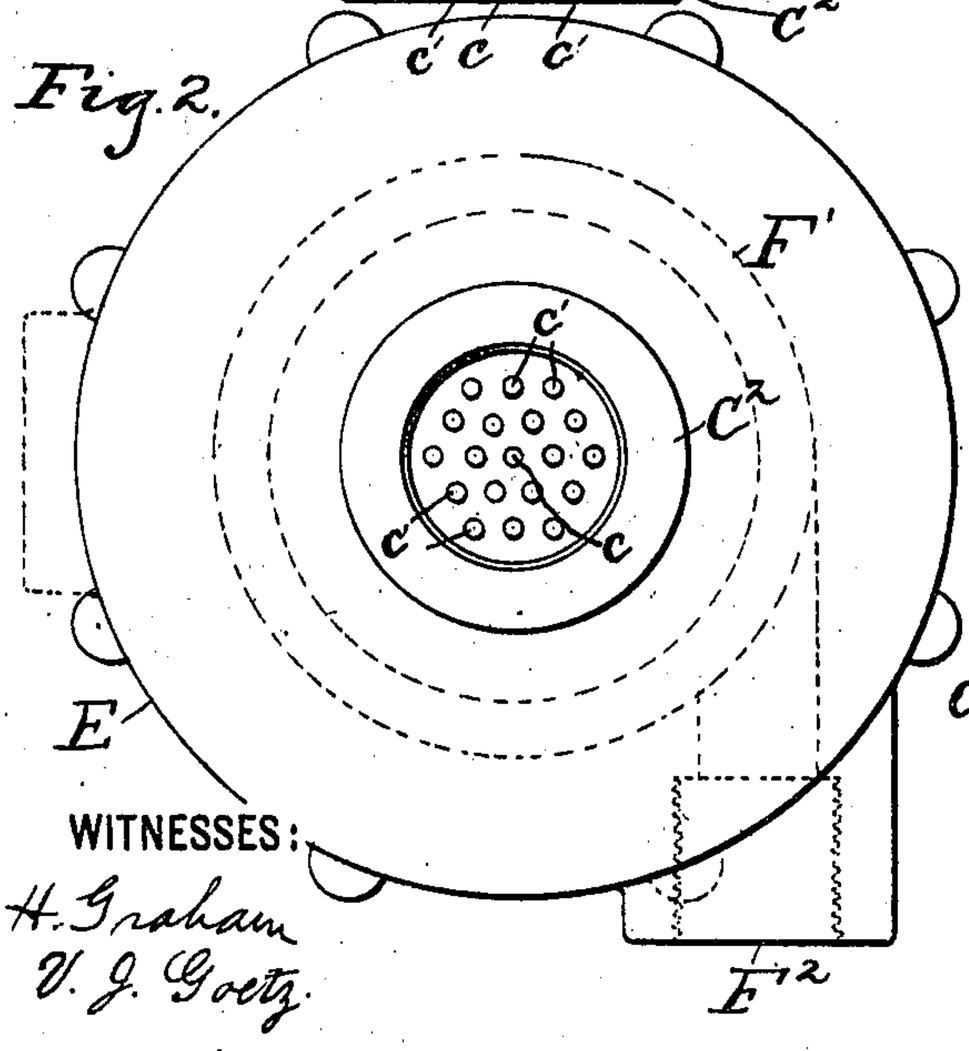
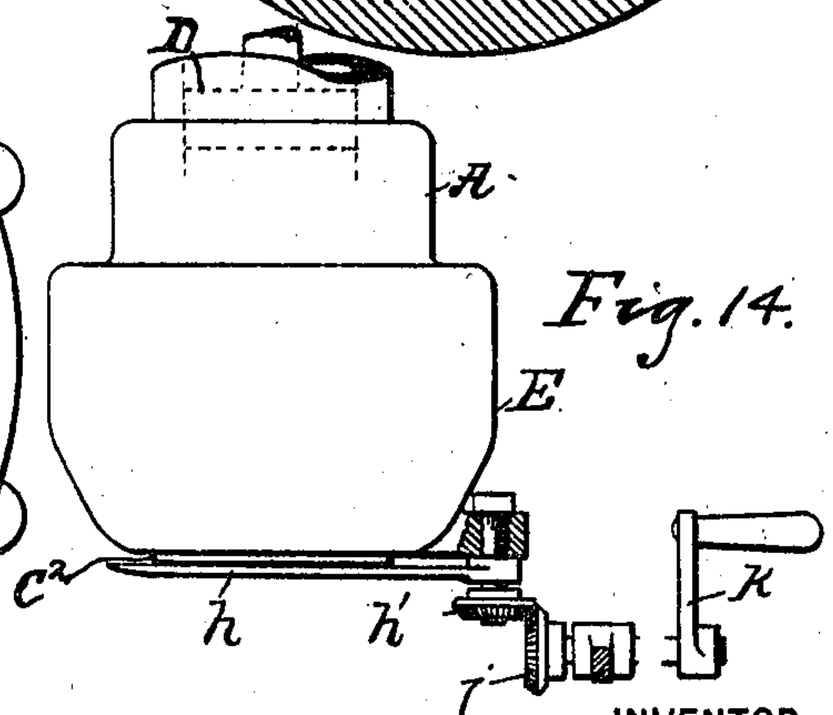


Fig. 14.



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(No Model.) 2 Sheets—Sheet 2.

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APPARATUS FOR MAKING EXPLOSIVE RODS OR GRAINS.

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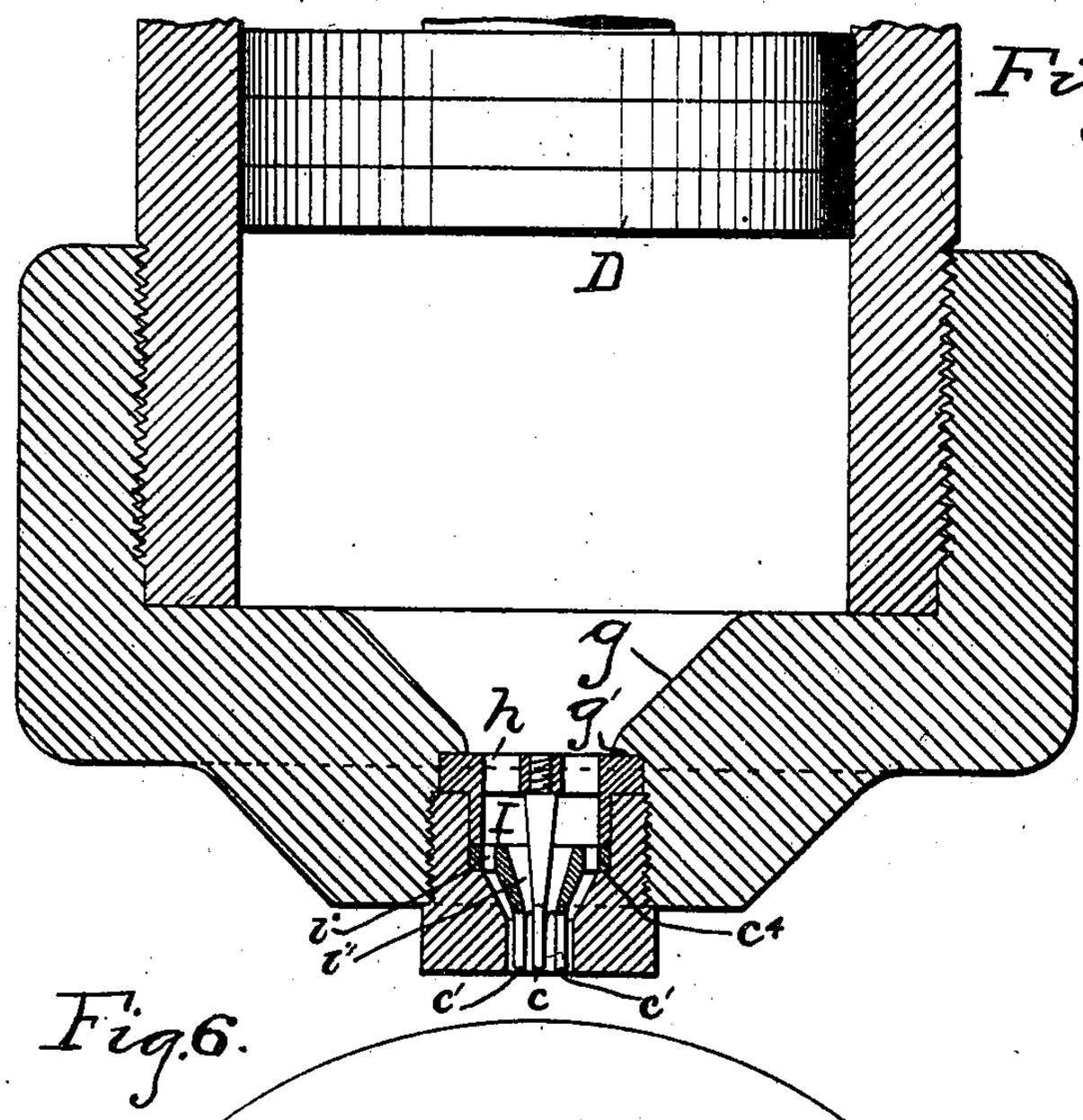

Fig. 6.

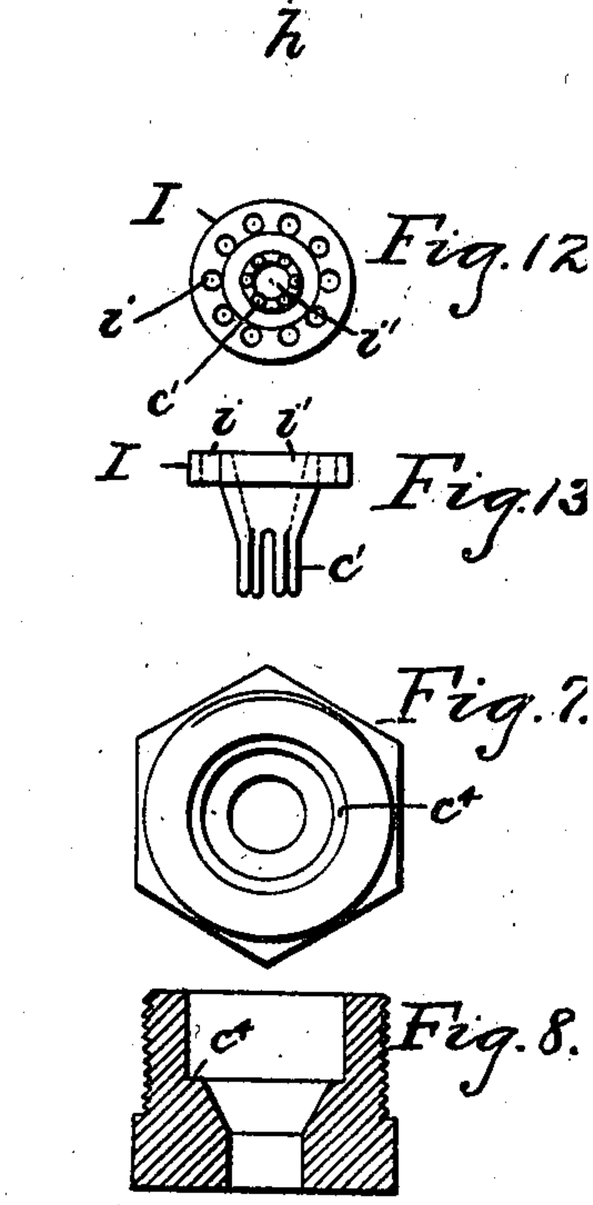

Fig. 15.

Fig. 5.

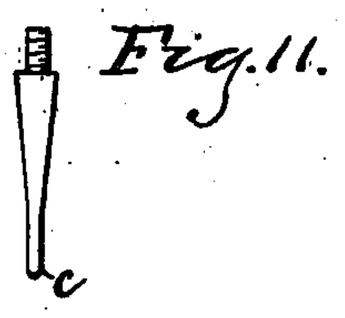

Fig. 11.

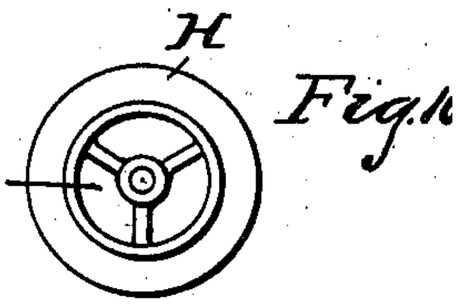

Fig. 4

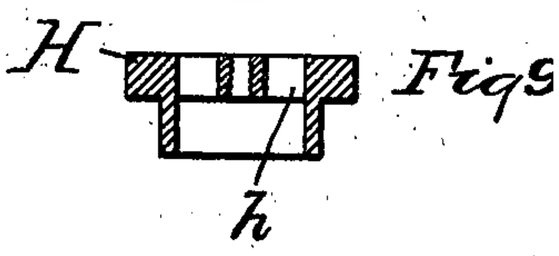

Fig. 9

Fig. 12

Fig. 13

Fig. 7.

Fig. 8.

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UNITED STATES PATENT OFFICE.

HUDSON MAXIM, OF NEW YORK, N. Y.

APPARATUS FOR MAKING EXPLOSIVE RODS OR GRAINS.

SPECIFICATION forming part of Letters Patent No. 538,618, dated April 30, 1895.

Application filed January 31, 1894. Serial No. 498,614. (No model.)

To all whom it may concern:

Be it known that I, HUDSON MAXIM, a citizen of the United States of America, residing in the city, county, and State of New York, have invented certain new and useful Improvements in the Manufacture of Rods or Grains from Plastic Material, of which the following is a specification.

This invention relates generally to an apparatus for making perforated grains or rods of plastic material, and the product made thereby; and more particularly to the making of perforated explosive grains or rods for use as powder charges in ordnance and in small arms.

In practicing the invention in the making, for instance, of an explosive grain or rod, I employ an impervious explosive compound, such, for example, as that described in my Letters Patent No. 411,127, dated September 17, 1889, which consists of an impervious colloid of pyroxylin made by means of a volatile solvent of the pyroxylin with or without an admixture of nitro-glycerin, providing an amorphous mass which, while in a plastic condition, is capable of flowing under pressure and partaking of any desired shape. In adapting such explosive compound for practical use it is advantageous to form it into grains or rods of uniform size as distinguished from masses thereof, and it is furthermore of importance to furnish such grains with one or more perforations to thereby provide for their combustion along the perforation which as the combustion continues constantly presents gradually increasing explosive surface to the flame whereby the gases of combustion are more gradually evolved and the projectile propelled with an accelerating speed.

It is the object of the present invention to provide means by which such perforated grains or rods may be readily, economically and advantageously formed; and to this end it consists in producing a plastic explosive material, molding such material into a continuous body or rod and simultaneously forming therein one or more continuous perforations and then cutting such body or rod into section or grains.

It furthermore consists in means for molding a plastic material into a continuous body or rod and simultaneously applying an exterior coating or envelope thereto either alone or in conjunction with simultaneously forming in such body one or more continuous perforations, and whether or not such coated body be cut into grains.

The improved apparatus capable of practically carrying out the process consists substantially of a chamber adapted to contain the plastic material with means for exerting pressure on such material, a forming chamber into which the material is forced, a die or mold communicating with the forming chamber and one or more mandrels in the die or mold and preferably extending thereinto from the forming chamber, around which mandrel or mandrels and between them and the surrounding wall of the die the material is caused to flow in the act of being shaped and forced outward in completed form. In conjunction with the die or mold there may be provided an annular mouth opening into the die from a supply passage or chamber through which mouth suitable material may pass or be forced to exteriorly coat or envelop the material passing through the die. In connection with this improved apparatus means may also be provided for cutting the formed material passing from the die into grains.

With this general statement of the leading features of the invention, I have, in order to make the same more clearly understood, shown in the accompanying drawings means for carrying it into practical effect, without thereby limiting the improvements in their useful applications to the particular construction taken for illustration herein.

In said drawings, Figure 1 is a vertical sectional elevation of the apparatus embodied in my invention and adapted to carry out the improved process. Fig. 2 is a bottom view thereof. Fig. 3 is a horizontal section taken on the line 3 3 of Fig. 1. Fig. 4 is a plan view of the mandrel supporting or carrying plate. Fig. 5 is a vertical sectional view illustrating a slightly different form of apparatus. Fig. 6 is a bottom plan view of the same. Figs. 7 and 8 are respectively a bottom and a sectional view of the die. Figs. 9 and 10 are respectively a sectional and a bottom plan view of one of the mandrel-supporting plates. Fig. 11 is a side view of the central mandrel. Figs. 12 and 13 are respectively a bottom and a side view of the other mandrel-carrying plate.

Fig. 14 is a vertical sectional elevation illustrating a means for cutting the continuous rod into sections. Fig. 15 is a sectional view of a finished rod-section or grain.

Referring to the drawings A indicates a chamber of sufficient capacity for the amount of plastic material to be treated. Such chamber may consist of two portions as shown, the one, *a*, adapted to receive the charge of material to be operated upon and to serve as a cylinder in which the compressing means may operate, and the other *a'* secured to the part *a* and receiving the compressed material from such cylinder on its way to the forming chamber. The latter is shown at B and is preferably of conical or equivalent form as illustrated, connected and communicating with the chamber A.

The die for giving external form to the grain or rod is indicated at C, and may be integral with the chamber B as shown in the shape of an extension or lip.

The means for exerting pressure on the material may be variously constructed. A simple and effective device is illustrated consisting of a piston D fitting in the chamber or cylinder *a*, which will be connected with and operated by an engine or by hydraulic apparatus (not shown) or other source of power. By raising the piston opportunity will be afforded for introducing the already prepared plastic material hereinbefore described into the cylinder, and a downward movement of the piston will force it into the forming chamber B and through the contracted die or mold C, in shape of a continuous body or rod cylindrical or prismatic or of other form, in cross section. One or any desired number of mandrels may be employed for forming in it simultaneously with the production of such continuous rod, the continuous longitudinal perforation or perforations.

In Figs. 1, 2 and 3 of the drawings, I have shown situated within the die nineteen such mandrels, one indicated at *c* being concentric with the die and adapted to form a central perforation, and the others shown at *c'* arranged intermediate between the mandrel *c* and the wall of the die and preferably at equal distances from each other. The number of mandrels will depend upon the diameter of the rod to be produced, and its desired interior ignition surface. Various means may be employed for holding the mandrels in place.

In Figs. 1 and 4 I have shown a transverse plate C' arched or convex toward the direction from which the plastic material is forced, having openings *b* through which the latter may pass, and having other openings *b'* in which may fit the shanks c^2 of the mandrels. The latter are clamped in place by nuts c^3 screwed upon the threaded mandrel shanks and engaging the plate C'. While the mandrels may be straight and parallel for their whole length with the axis of the die I prefer to shape them to correspond with the lines of flow of the plastic material, as indicated in Fig. 1, in which their upper portions are inclined to wholly or partly correspond with the angle of the converging walls of the forming chamber B, thus causing the pressures of the plastic material upon the different sides of the mandrels to balance each other and relieve the mandrels of lateral strain which might otherwise displace them and improperly distribute the perforations in the rod or grains. The plate C' is clamped between the chambers A and B, the latter being secured together by a sleeve E, having a shoulder *e*, which engages a lateral flange b^2 of the chamber B, and which is screwed upon the chamber A.

It will be seen that the passage of the plastic material through the devices thus far described will produce a continuous and continuously multi-perforated rod. For coating this rod exteriorly with a suitable material, such as one which is combustible but of less explosive quality than the incased grain, for instance, a compound of celluloid and nitronaphthalene, as hereinafter specified I may provide an annular mouth F opening from a chamber or duct F' into the die. I accomplish this conveniently by forming such duct in the sleeve E and making the portion of the die beyond or below such mouth in a piece C^2 independent of the chamber B and secured, as by a screw-thread, in the said sleeve. This piece C^2 in effect forms a second die of slightly greater area than the die portion above the mouth F to properly form the coating material around the rod issuing from the other portion of the die as it passes through the aperture of the piece C^2. The coating material may be fed into the duct F, at a rate to correspond with that of the formation of the rod, through a pipe or opening F^2.

If it be desired to employ this apparatus for the production of a rod having a single central perforation, the mandrels *c'* may be individually removed from the plate C'. They may, however, be arranged to be collectively removed, and such a construction is shown in Figs. 5 to 13, in which also is shown a construction adapted to the production of rods of various diameters, by the interchangeability of its die and mandrels. In this form of the machine coating devices are not shown but may be added, or the rod may be subsequently coated in any preferred way. Referring to the last mentioned figures the die is shown as secured directly into the bottom of the cylinder in which the compressing piston travels, said bottom being concave as shown at *g*, to direct the plastic material inward toward the die. By removing this die and substituting another of different internal diameter the size of the rod or grain may be modified. The central mandrel is supported by a plate or bushing H into which it is secured which has openings *h* for the passage of the material, and which is clamped between the die and a shoulder *g'* on the bottom plate. I is a somewhat similar and separate plate

having formed with it one or more circular series of mandrels and clamped between the plate H and the shoulder c^4 of the die. The plate I has a circular series of openings i for the material and a central opening i'. In this construction also the upper portions of the mandrels are inclined to conform to the direction of movement or flow of the material, but are here united one with another, as best seen in Fig. 13, constituting a funnel shaped conduit i'.

The explosive material forced through the die in the form of a continuous body or rod, will extend therefrom and from the lower surface of the mass, and said continuous body or rod may be cut or divided into very short lengths by a suitable cutter arranged to operate parallel with the surface of the die at proper intervals of time according to the speed of compression and movement of the material through the die. In Fig. 14 I have shown by a view partly in section and partly in elevation one such means for cutting off the said rod into sections or grains, consisting of a revolving blade h having a bevel gear h' that is engaged by another wheel j which may in turn be operated by a crank k or other source of power. It is obvious that the cutter and the means for operating it either by hand or by power may be changed widely from that shown.

The grains or sections thus formed, while protected on their sides by the less explosive or retarding material, will have at their ends the explosive material exposed to immediate ignition. The result will be that the combustion of the grain will begin on the ends, proceeding inward as succeeding portions of the explosive are uncovered by the consumption of the outer and overlying portions as indicated by the dotted lines in Fig. 15. The surface on which combustion takes place will, therefore, be gradually increased, with a corresponding progressive increase in the volume of gas evolved and gradual acceleration of the movement of the projectile.

The coating for the grain hereinbefore referred to composed of a compound of celluloid and nitro-naphthalene may be made by mixing the celluloid and nitro-naphthalene together and adding a solvent thereof, such as acetone.

I claim—

1. The combination with a chamber, and a source of supply for a plastic material communicating with the chamber, of mandrels arranged in the chamber, and a mandrel support therefor provided intermediate of the mandrels with openings communicating with said source of supply and with the space between the mandrels, substantially as described.

2. In a machine of the class described, the combination with a chamber and pressing means, of a die for giving exterior form to the material, and a series of mandrels having inclined shanks or supports for forming longitudinal perforations in the product, as set forth.

3. The combination with a chamber and pressing means, of a die for giving exterior form to the material and a series of mandrels arranged in the path of the material and bent or curved to correspond with the direction of flow thereof, as set forth.

4. The combination with a conical or tapering chamber, of mandrels arranged in said chamber and having their shanks or supports inclined relative to the axis of the chamber so as to be in a line substantially parallel with the flow of the material, substantially as described.

5. The combination of a plurality of mandrels, another and independent mandrel or mandrels coacting with the plurality of mandrels and a surrounding die, as set forth.

6. The combination with a die, and a plurality of outer or eccentric mandrels within the same, of a mandrel support therefor, a mandrel or mandrels within said outer mandrels, and a support for the intermediate mandrel or mandrels independent of the first mentioned support, substantially as described.

7. The combination with a die, and a plurality of outer or eccentric mandrels within the same, of a mandrel support therefor having a shoulder, a mandrel or mandrels within said outer mandrels, and a support for the intermediate mandrel or mandrels independent of the first mentioned support and resting on said shoulder, substantially as described.

In witness whereof I have hereunto signed my name in the presence of two witnesses.

HUDSON MAXIM.

Witnesses:
GEO. H. GRAHAM,
H. N. LOW.