(No Model.) 2 Sheets—Sheet 1.

H. S. MAXIM.

PROCESS OF AND APPARATUS FOR MAKING EXPLOSIVES.

No. 449,687. Patented Apr. 7, 1891.

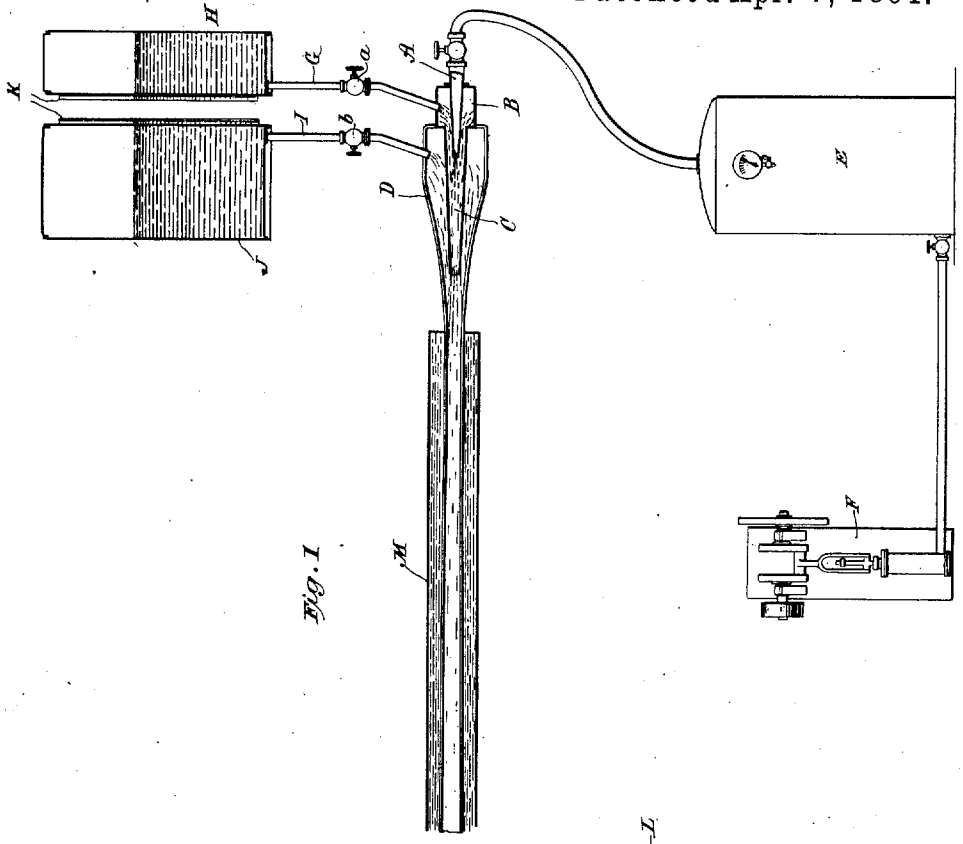
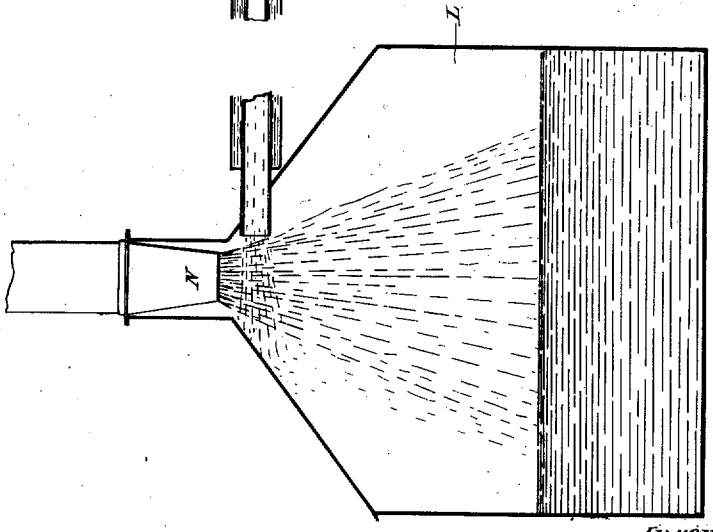


Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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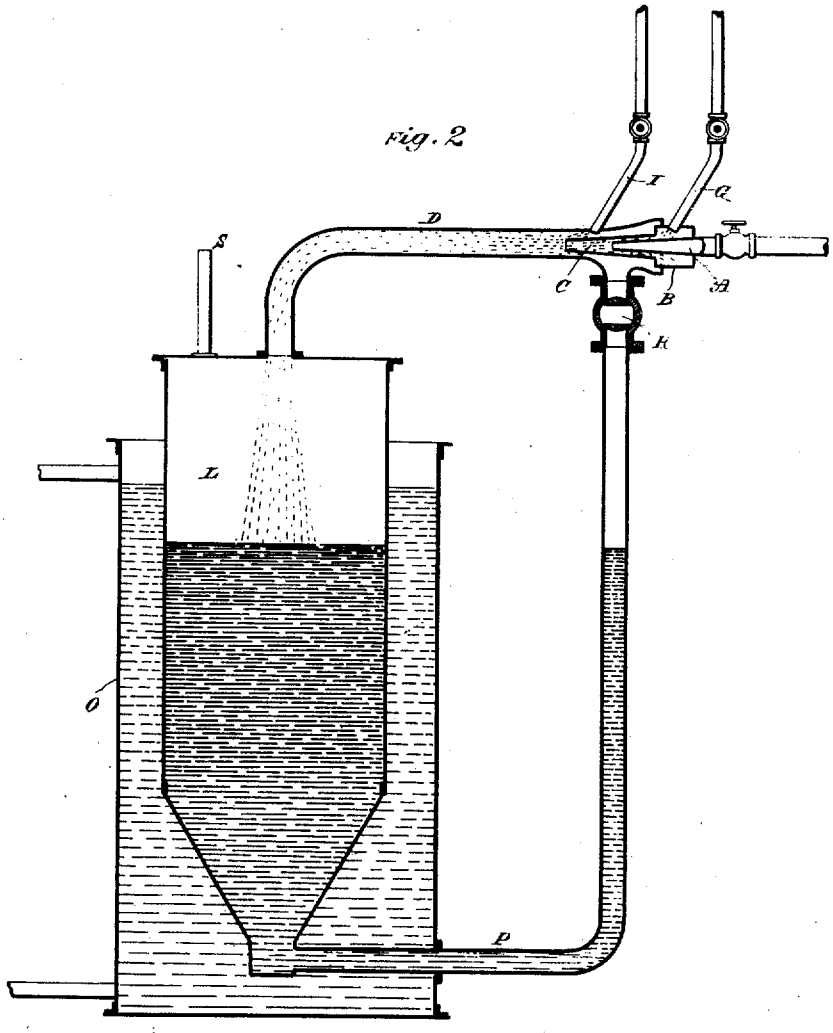
Fig. 2



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UNITED STATES PATENT OFFICE.

HIRAM S. MAXIM, OF CRAYFORD, ENGLAND.

PROCESS OF AND APPARATUS FOR MAKING EXPLOSIVES.

SPECIFICATION forming part of Letters Patent No. 449,687, dated April 7, 1891.

Application filed November 10, 1890. Serial No. 370,853. (No model.)

To all whom it may concern:

Be it known that I, HIRAM S. MAXIM, a citizen of the United States, residing at Crayford, in the county of Kent, England, have invented certain new and useful Improvements in Processes of Manufacturing Explosives and in the Apparatus Therefor, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

My invention relates to the manufacture of explosives of the kind or class known as "nitro-compounds" or "nitrated explosives," such as nitro-glycerine, gun-cotton, and the like, which result from the combination or composition with glycerine, cellulose, or the like of nitric acid or other suitable nitrating compounds.

In the specification which follows I shall describe the invention as applied to the manufacture of nitro-glycerine only; but its applicability to the treatment or manufacture of other explosive compounds of a similar nature will be understood.

The main objects of my invention are, first, to produce any desired quantity of an explosive by a continuous process or operation, and, second, to bring the acid or nitrating agent and the glycerine or other material to be acted upon thereby into intimate contact with each other while both are in a very finely-divided condition. These objects I accomplish by bringing the glycerine or other material in the condition of spray into a stream or current of acid-spray.

In carrying out the invention practically the mixing of the nitric acid or nitrating agent and the glycerine is effected by means of an injector operated by cold compressed air or by a cold-air blast. The suction produced by the current of air flowing through a nozzle forming a part of the injector draws the glycerine from a tank in which it is contained and the current of air impinges upon and atomizes the glycerine or scatters it in a fine spray. The acid is similarly drawn from another tank and blown into a fine spray, and the two substances while in this finely-divided condition are caused to intermingle in the presence of air which is rapidly expanding, and of which the temperature is rapidly falling. The atomized acid and glycerine are together blown into and conveyed through a mixing pipe or tube, and after issuing therefrom they are washed or quenched by a copious spray or jet of water and collected in a suitable receiver.

The details of this process or method of manufacture will be described by reference to the drawings of the apparatus which I employ and which are hereto annexed.

Figure 1 is a view, mainly in section, of the apparatus which I have devised for carrying out the invention. Fig. 2 is a similar view of a modification of the same.

A is a nozzle entering a chamber B, which is provided with a nozzle C, entering the enlarged end of a tube D, the three concentric parts A, C, and D forming a double injector, of which the inner or first nozzle A is connected with a receiver E of air compressed by a suitable pump F to a pressure of about one hundred pounds to the square inch. A pipe G enters the chamber B back of the orifice of the nozzle A. This pipe contains a suitable cock *a* and leads from a tank or receiver H. A second pipe I, provided with a cock *b*, leads from a second tank or receiver J and enters the closed pipe or tube D back of the orifice of the nozzle C. One of the tanks H J is to contain the acid or nitrating agent and the other the material to be combined therewith, and both are provided with glass gage-tubes K to indicate the levels of the liquids therein.

The tank H is filled with glycerine, and the tank J is filled to the same level with acid. The air is then allowed to flow through the nozzle A. The current of air issuing from the nozzle A produces a partial vacuum in the chamber B, which, upon opening cock *a*, draws the glycerine from the tank H. The air impinging upon the glycerine atomizes it and forces it in a spray through the nozzle C. The air-jet and spray issuing from nozzle C produce in like manner a partial vacuum in the tube D back of the orifice of said nozzle, and this draws in the acid, which, meeting the jet, is blown into spray and mixed with the atomized glycerine. The air being kept under a high pressure in the reservoir E, a considerable amount of refrigeration will

take place in the nozzle C and tube D by reason of its expansion in these places, and the temperature of the acid and the glycerine will thus be prevented from rising too high.

The tube D, into which the atomized mixture of acid and glycerine is blown, serves as a mixing-chamber, and should be of considerable length, so that the materials may have ample time while in the same to complete their reactions on one another in the manner required. The said pipe or tube may be from one inch and a quarter to one inch and a half in diameter at the part which surrounds the injector-nozzle, and for a distance of, say, sixteen inches, or thereabout, from the said injector, and may gradually increase in diameter beyond this point until it reaches a collecting-tank L. It is, moreover, advantageous to arrange the said pipe or tube with a fall of about one in fifteen toward the said tank.

The length of the mixing-pipe D may be from one to two hundred feet, more or less, and a wall or a mound of earth may be built between the injector and the tank L to serve as a protection to the operator. The pipe D, as well as other parts of the apparatus, may be surrounded by a water-jacket M, through which a circulation of cool water is maintained for keeping down the temperature of the explosive compound.

Prior to entering the collecting-tank L the current of spray is met by a stream or a number of jets of cold water from a nozzle N or other suitable device, which serves to cool or quench the said spray as it enters the tank.

The tanks J H for containing the acid and the glycerine are preferably arranged side by side above the injector and mixing tube or chamber, and should be made of such relative capacities or dimensions that they will contain the required proportions of acid and glycerine, and will therefore both be emptied at the same time.

By the use of an apparatus such as that above described it will be seen that the quantity of explosive material operated upon at any time in the apparatus is very small. The collecting-tank should, however, be of large dimensions, so that it will contain a great quantity of water.

The acids and glycerine being blown into a fine spray, as above described, an instantaneous nitration will be effected, while the expansion of the air as it issues from the injector serves to lower the temperature. Moreover, by the use of my improved apparatus the chemical reaction may be readily controlled, and should any undue production of heat take place or nitrous fumes be developed the supply of air to the injector may be increased and the temperature thus brought down.

In cases where the space available for the apparatus does not admit of the use of a long mixing pipe or tube, such as I have herein described, the mixing-tube D is carried direct to a tank L_1 surrounded by a water-jacket O. A pipe P leads from this tank, from the bottom or near it, back to the mixing-chamber or space at the rear of the nozzle C. This pipe contains a cock R, which while the atomized acid and glycerine are being mixed is closed. When a quantity of explosive has been thus made, the acid and glycerine supply-pipes are closed and the cock R opened. The continued flow of air under pressure produces a rapid flow of the mixture from pipe P back into the tank. The expanding air, with its refrigerating effect, keeps down the temperature, while by the circulation and agitation the substances are thoroughly and intimately mixed.

An air-vent S is provided in the tank L, and the same disposition as in the previous case may be used for quenching the mixture by jets of water.

The subsequent treatment of the nitroglycerine or other compounds made by this process may be the same as in the case of similar compounds as hitherto manufactured.

What I claim is—

1. The method or process of manufacturing explosives herein described, which consists in separately atomizing or finely dividing the nitrating agent and the material to be acted upon thereby, and uniting the two or causing them to intermingle while in such finely-divided condition.

2. The continuous process herein described of manufacturing explosive compounds, which consists in uniting and causing to intermingle jets of the acid and material to be acted upon thereby, in the condition of spray, carrying off the spray in a mixing-chamber, and collecting the resulting compound in a tank or receiver.

3. The method or process of manufacturing explosives herein described, which consists in atomizing or spraying glycerine by a jet of air under pressure, separately atomizing or spraying in a similar manner a nitrating agent, and mixing the two substances while in the condition of spray.

4. The method or process of manufacturing explosives, which consists in separately atomizing and uniting the spray of the nitrating agent and the substance to be acted upon thereby, and then quenching the mixture with water.

5. The combination of a nozzle, a receiver or source of compressed air connected therewith, a tube or chamber surrounding the nozzle, a tank or receiver for glycerine connected with said chamber, a second chamber, and a tank or receiver for acid connected with the same, the first chamber being formed with a contracted nozzle that enters the second or mixing chamber, the above parts being arranged in substantially the manner set forth to constitute an injector for atomizing and mixing glycerine and acid.

6. The combination, with a collecting-tank, a mixing tube or chamber leading thereto, and a nozzle or means of quenching with wa-

ter an explosive mixture delivered from the mixing-tube into the collecting-tank, of an injector at the end of the mixing-tube, tanks for containing acid and glycerine, respectively, connecting with the injector, and a receiver or source of compressed air for operating the injector.

7. The combination, with a receiving-tank and mixing tube or chamber, of two concentric injector-nozzles, receivers for containing glycerine and acid, respectively, connected to the chambers surrounding the nozzles in the rear of the orifices of the same, and a source of compressed air, as herein set forth.

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