(No Model.) 5 Sheets—Sheet 1.

L. W. BATES.

ELECTRICALLY HEATED CHARGE FOR CARTRIDGES OR SHELLS.

No. 605,842. Patented June 21, 1898.

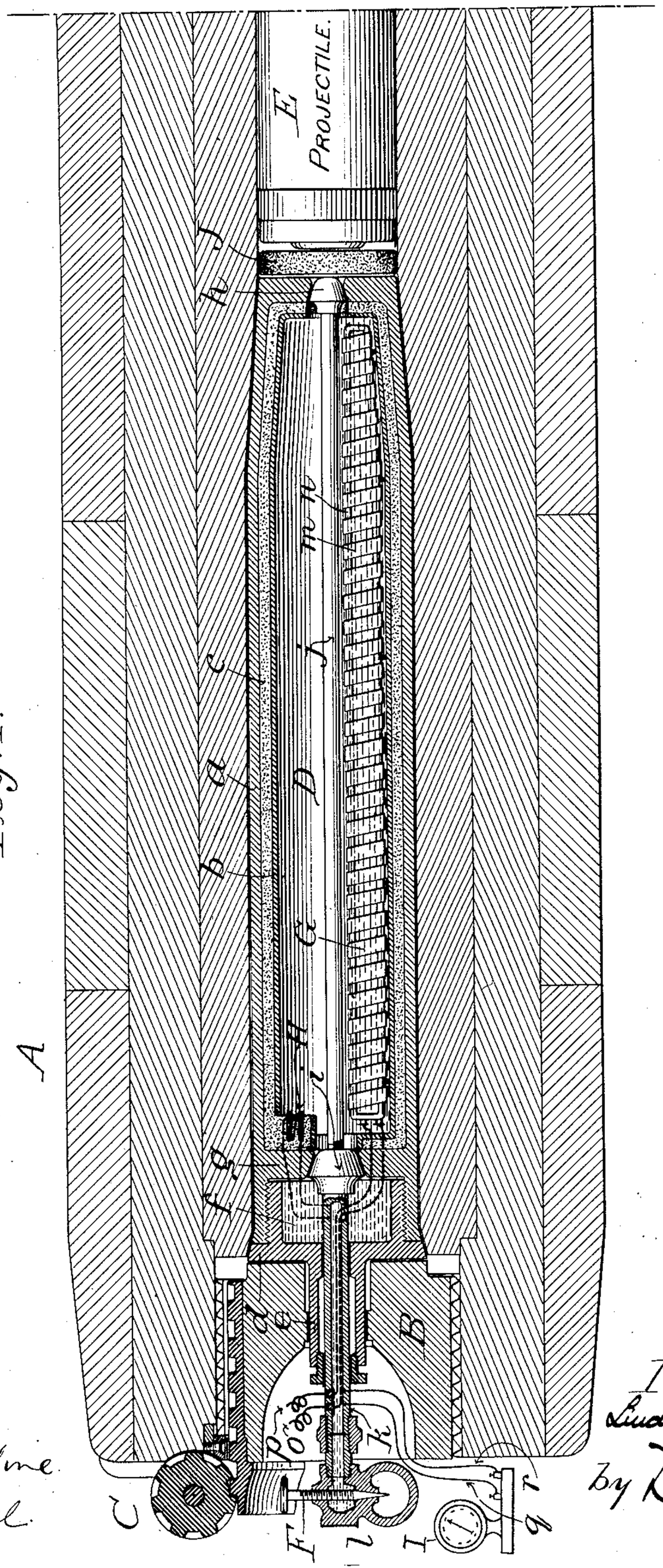

Fig. 1.

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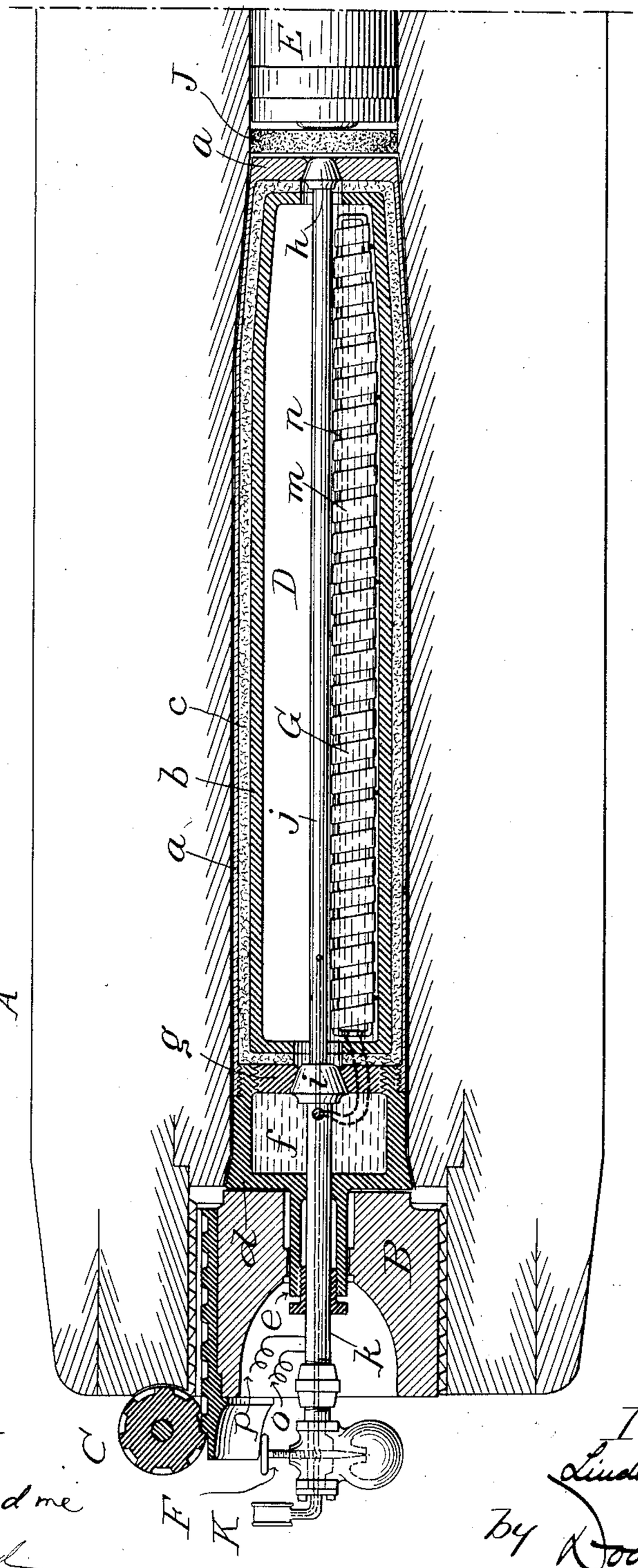

Fig. 2.

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ELECTRICALLY HEATED CHARGE FOR CARTRIDGES OR SHELLS.

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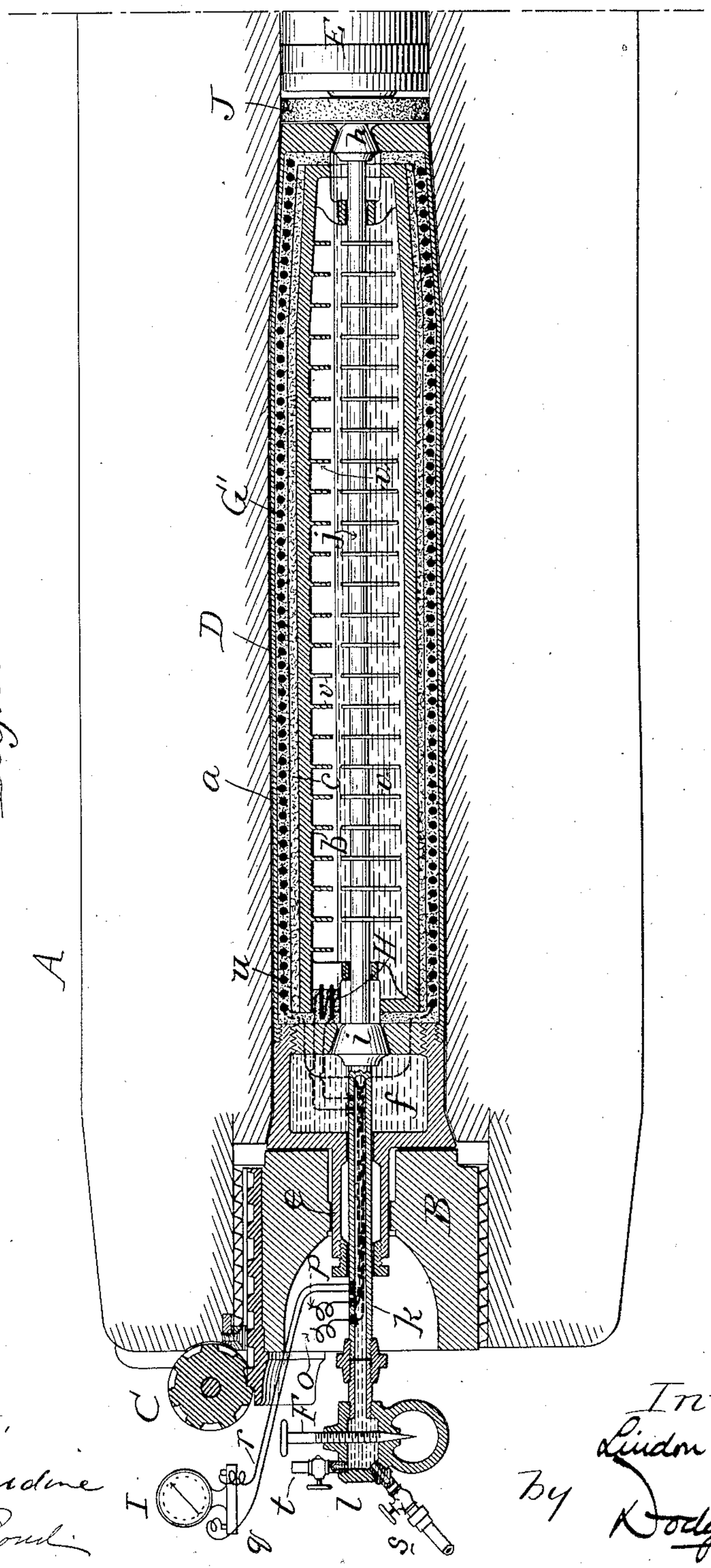

Fig. 3.

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ELECTRICALLY HEATED CHARGE FOR CARTRIDGES OR SHELLS.

No. 605,842. Patented June 21, 1898.

Fig. 7.

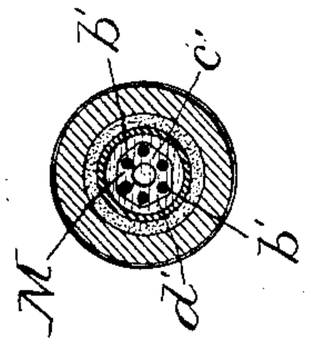


Fig. 6.

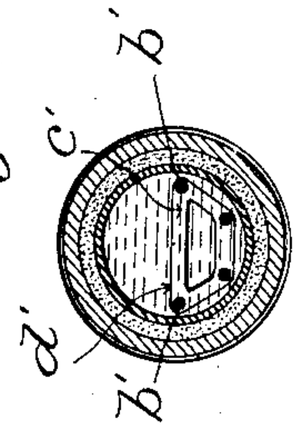


Fig. 4.

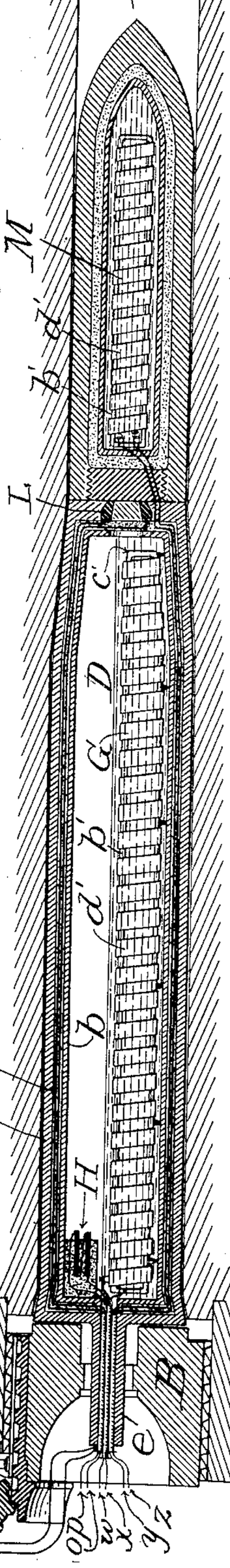
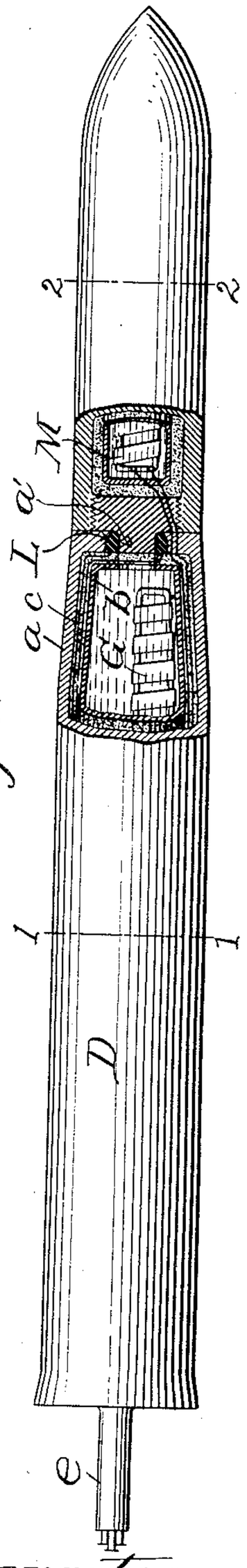


Fig. 5.



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L. W. BATES.

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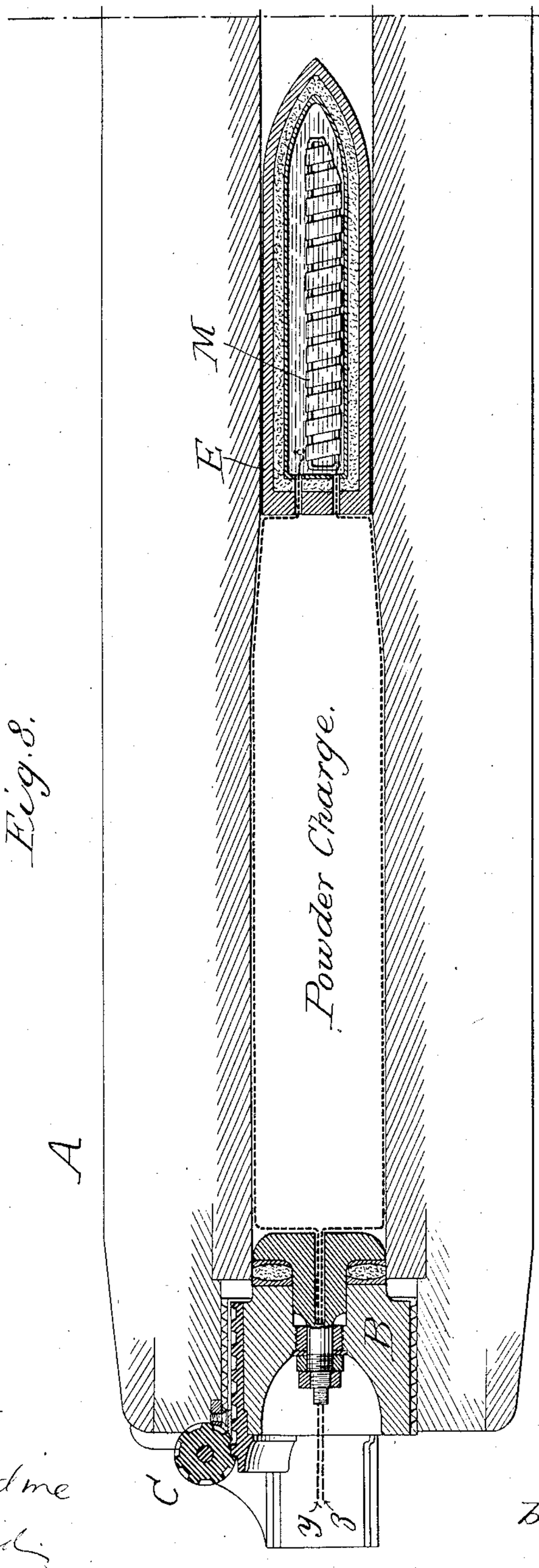

Fig. 8.

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UNITED STATES PATENT OFFICE.

LINDON W. BATES, OF CHICAGO, ILLINOIS.

ELECTRICALLY-HEATED CHARGE FOR CARTRIDGES OR SHELLS.

SPECIFICATION forming part of Letters Patent No. 605,842, dated June 21, 1898.

Application filed June 30, 1896. Renewed November 18, 1897. Serial No. 659,017. (No model.)

To all whom it may concern:

Be it known that I, LINDON W. BATES, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Cartridges or Charges for Guns or Ordnance, of which the following is a specification.

My invention is directed to the employment of modern ordnance or guns for the projection of high explosives and missiles; and it consists, essentially, in a cartridge or made-up charge containing an agent adapted to be converted into gas or vapor by heat, together with means for producing the heat necessary to such conversion.

The projectile forming part of the cartridge or charge may also be supplied with a heater and charged with an agent which shall be converted into an asphyxiating gas or vapor or which shall be otherwise so affected by heat as to cause injury or destruction when liberated. The two features may be combined in one complete cartridge or charge or either may be used without the other.

The present invention is one embodiment of the general principle or plan set forth and made the basis of generic claims in an application filed in my name on the 25th day of June, 1895, Serial No. 596,863, the purpose being to set forth and claim in the present application a prepared charge embodying the means of generation set forth in the aforesaid application.

In the accompanying drawings, Figure 1 is a longitudinal section of the rear portion of a built-up or hooped gun containing a cartridge or charge constructed in accordance with my present invention; Fig. 2, a similar view showing a slight modification in the construction of the cartridge case or shell; Fig. 3, a similar section showing a different form of heating apparatus in the generator; Fig. 4, a sectional view of the rear portion of the gun and of a cartridge or charge therein, both the projectile and the shell or charge chamber being represented as provided with heaters; Fig. 5, an elevation, partly in section, showing the projectile attached to and constituting a part of the cartridge; Figs. 6 and 7, sections on the lines 1 1 and 2 2, respectively, of Fig. 5; Fig. 8, a sectional view illustrating the invention as applied to a projectile to be used with an ordinary powder charge.

In this, as in the prior case, the invention contemplates the generation of high pressure for the propulsion of projectiles or missiles by the employment of heat electrically generated within a confined space containing a suitable agent, such as water, which under the influence of heat and of the resulting pressure shall be converted into high-pressure steam or vapor or into a high-tension gas, according to the degree of heat employed and the period of time during which it is continued.

As above indicated, the present invention is designed to enable the entire generating apparatus to be introduced into the gun after the manner of the ordinary cartridge or prepared charge, the projectile being either attached to or separate from the remainder of the charge, as may be found expedient in any given case.

In the present, as in the previous invention, the form of electric heater employed is a matter of secondary importance, and I propose to use at will either a heater acting by resistance or one based upon the development of Foucault or eddy currents, and these may in turn take such varying shapes as other considerations render expedient.

A leading object of the present embodiment of my invention is to enable high-explosive charges to be thrown from modern ordnance without modification of the latter and without the necessity of either the exceedingly long barrel or of the elaborate mechanical appliances now generally employed for the projection of such charges.

The invention may be better understood when explained in connection with the accompanying drawings.

Referring first to Fig. 1, A indicates the rear portion of a gun, which may be either of the built-up or hooped construction or of any other approved type, though I have represented for convenience a breech-loading gun of the type employed at the present time in the United States Navy.

B indicates the breech-block provided with the usual interrupted screw, and C the pinion by which the longitudinal movement of

said block is effected. For these may be substituted, however, any other breech mechanism adapted or capable of adaptation for use with the cartridge or charge hereinafter described.

D indicates a cartridge embodying my invention, and E a projectile of any desired type containing a high-explosive charge, an asphyxiating-gas, or merely an ordinary exploding charge, or it may be made solid after the manner of armor-piercing projectiles. The cartridge D will comprise ordinarily an inner and an outer shell or casing separated by a layer of insulating material to prevent the outward conduction and radiation of heat and serving also, in some cases at least, to prevent the escape of electricity.

In Fig. 1 I have represented the outer case *a* as of comparatively thick metal to give great strength and as containing a thinner shell or lining *b*, between which latter and the shell *a* is interposed a layer of asbestos, mica, mineral wool, or other substance capable of withstanding the effects of high temperatures and affording but a poor path for the escape of heat. The inner shell in this instance serves mainly to keep the non-conducting layer *c* in proper position. Shell *a* is formed with a recessed or chambered rear end, into which is screwed a hollow cap or plug *d*, having a tubular neck or extension *e*, as seen in Fig. 1. The inner wall of the recess or chamber *f* at the rear of the shell or casing *a* is formed by a diaphragm or partition *g*, which, like the front end wall of the cartridge-shell *a*, is provided with an opening, as shown. The opening in the diaphragm or partition *g* is of larger area than that in the front end wall of shell *a*, and each is closed by a conical or tapering valve, as shown. The valve *h*, which seals the forward end of the shell *a*, and the valve *i*, which seals the opening in the partition or diaphragm *g*, are connected by a rod *j*, which should have such a coefficient of expansion as will preclude the unseating of either valve through the expansion of the shell or casing *a*. This may probably be best attained by making the rod *j* of the same metal or alloy as the shell or casing *a*, though if made of metal or alloy of somewhat higher expansibility it would, perhaps, the more certainly remain sealed. The valve *i* being of larger area than the valve *h* in order to correspond with its relatively larger seat of course offers a greater surface to any pressure that may be exerted from within the cartridge D, and other things being equal such pressure would cause the valve *i* to move backward and to carry with it the valve *h* whenever a pressure should be developed within the cartridge. To prevent the backward movement or the opening of the valve until the attainment of a predetermined pressure within the shell or cartridge D and until the gun is properly pointed and steadied, the chamber *f* in rear of the valve *i* is completely filled with water or other liquid, which, being practically incompressible, precludes the movement of the valve *i* until a vent or outlet is opened for the escape of liquid from said chamber *f*.

As shown in Fig. 1, a tubular extension *k* is carried backward from valve *i* through the tubular neck *e* of the cartridge shell or casing, and to the rear end of this extension *k* there is applied a cap or casting *l*, having a vent adapted to be sealed and unsealed by a pin-valve F. From this it will be seen that whenever an adequate pressure is developed within the shell or cartridge and it is desired to unseal said shell and permit the escape of the fluid, vapor, or gas therefrom to act upon the projectile it is only necessary to withdraw the pin-valve F and permit the liquid to escape from the chamber *f*, whereupon the differential pressure of the vapor or gas upon the valves *i* and *h* will cause a backward movement of said valves and the consequent opening of the escape-orifice at the front end of the cartridge shell or casing and directly in rear of the projectile.

G indicates an electric heater, which is here represented as comprising a band or ribbon *m*, of metal, wound about a skeleton frame *n*, of non-conducting material. Suitable insulation will be applied between the heater G or its ribbon *m* and the lining *b* of the shell or cartridge to prevent the passage of current from one to the other or the formation of an arc between them. The shell or chamber and the cartridge D will be supplied with water or other suitable agent, liquid, solid, or gaseous, capable of being converted into high-pressure steam or vapor or into a high-tension gas under the influence of great heat. Being so charged and inserted into the bore of the gun, with the projectile in advance of it and the breech being closed behind it, it is only necessary to turn on a proper current of electricity, which will be introduced to the heater G through feeder-wires *o* and *p* from a suitable generator or source of supply, whereupon the heater G will cause the water or other agent to be vaporized and to develop a high degree of pressure within the shell or casing of the cartridge D. For the purpose of indicating to the gunner the degree of pressure existing within the chamber or shell of the cartridge any suitable indicating device may be employed, as a pressure-gage, a thermo-electric pile and galvanometer, or pyrometer, the pressure-gage showing the actual pressure in pounds, the pyrometer indicating the temperature, from which the pressure may be readily deduced, and the galvanometer indicating the current generated by the thermopile, and consequently indicating the temperature and giving a basis for judging the pressure within the chamber.

In the drawings I have represented the cap or closure *l* as detachable from the tubular neck or extension *k* in order that the breech-block B may pass to position over the tubu-

lar extensions *k* and *e;* but with other forms of breech mechanism than that here represented this may be unnecessary.

H indicates a thermo-electric pile, which is conventionally represented, the wires from which are led to a galvanometer I, so that by noting the deflection of the needle or indicator the current can be ascertained, and from this the pressure within the chamber of cartridge D may be accurately estimated. The wires *o p*, by which current is conducted to the heater, and the wires *q r*, connecting the thermopile and the galvanometer, are here represented as passing through the tubular extension *k*, which arrangement will be found quite convenient, the tube being thus made to serve as a conduit both for containing the wires and for the passage of liquid from the chamber *f* to the vent or outlet. The chamber *f* may likewise be filled through said pipe or extension, though it is intended, ordinarily, to charge said chamber before the cartridge is placed within the gun and to seal its rear end by a cap or diaphragm of any suitable character. A light diaphragm capable of being ruptured or removed by the back pressure of the liquid in chamber *f* will be found convenient ordinarily, and the interior space or chamber of the closure or cap *l* may be similarly sealed by a light diaphragm, so that each may be completely charged with liquid and all air eliminated and excluded before the cap or casting *l* is finally applied to the cartridge. It may be found expedient, however, to charge the cap *l* after it is screwed upon or connected with the tubular neck or extension *k;* but in any case it is essential that all air be excluded, so that the valve *i* may not move backward until the vent-valve F is opened. The projectile may, as above suggested, be of any suitable construction and contain a charge of high explosive, as dynamite or the like, or it may be a solid armor-piercing projectile of any approved pattern. When a projectile containing a high explosive is to be used, I contemplate employing, in some cases at least, a wad or insulating-packing J between the forward end of the cartridge casing or shell D and the projectile E, as shown in Figs. 1, 2, and 3. This is designed to prevent the radiation or conduction of heat from the shell or casing D to the projectile in the event of said shell becoming highly heated; but this provision may be and often will be unnecessary, owing to the employment of pyro-insulating material within the shell or casing. The charge being thus prepared and inserted into the gun, the gun closed, and the proper current being supplied to the heater G, the water or other agent within the chamber of the cartridge or shell D is converted into vapor or steam, and the pressure is carried to any desired point, determined, primarily, by the distance to which the projectile is to be thrown or the desired flatness of trajectory. When the proper pressure is attained, as indicated by the galvanometer or other gage connected with the pressure-chamber, the vent-controlling valve F is opened sufficiently to permit the escape of a small quantity of liquid from the chamber *f* and the consequent gradual backward movement of the valve *i* under the pressure within the chamber of shell or cartridge D. This backward movement of the valve *i* is transmitted to the valve *h* through the rod *j*, and said valve *h* is consequently caused to open the orifice or outlet at the forward end of the shell or cartridge-chamber D and to permit the escape of a limited quantity of the vapor, steam, or gas from said chamber into the barrel or bore of the gun immediately in rear of the projectile E, thereby starting the projectile forward. By continuing the backward or opening movement of the valve F the escape of the liquid from chamber *f* will be permitted to take place more rapidly, and the valve *h* will consequently be opened more fully and a larger quantity of gas, vapor, or steam permitted to escape and to act upon the projectile, thus increasing its velocity to the degree required to carry it the intended distance.

It will of course be understood that the term "gradual" is here used in a relative sense, and that as a matter of fact the opening of the valve F is made as nearly instantaneous as is practicable under manual actuation or control, the action of the gas or vapor being so prompt and the time required to carry the projectile the length of the barrel being so short that no appreciable period of time can be allowed for the opening of the valve.

Fig. 2 illustrates a construction essentially the same as the preceding, except that the outer shell or casing *a* of the cartridge D is made relatively thin and the inner shell or casing *b* is made relatively thick, the same interposed packing or insulation *c* being provided, and that a pressure-gage is employed instead of a thermopile and galvanometer. The pressure-gage K is shown attached to the cap or casting *l*, which closes and communicates with the rear end of pipe or extension *k* and which contains the valve F for sealing or venting the chamber *f*. The gage is or may be connected with the interior chamber of the cartridge shell or casing by a small pipe or tube extending through the tubular extension *k* and valve *i* into the interior chamber of the shell or casing D and opening into the latter, as indicated by dotted lines in Fig. 2. Obviously the connection may be made in any other convenient way.

In Fig. 3 I have represented essentially the same construction as in Fig. 1, including the thermo-electric pile and galvanometer, but with an electric heater designed to heat by Foucault or eddy currents instead of by resistance. I have also shown the cap or casting *l* as provided with a charge-cock *s* and vent-cock *t*, whereby the liquid may be introduced into chamber *f* and the communicating space in the pipe *k* and cap *l* or into

the latter only, as may be required. The heater G′ in this case consists, essentially, of a coil or helix *u*, suitably insulated and placed between the outer shell *a* and the inner shell *b* of the cartridge D, as shown. The valves *h* and *i* and connecting-rod *j* remain substantially as before; but said rod and the interior of the shell or casing *b* are both provided with radiating plates or studs *r* to better give off and radiate the heat generated in them upon the passage of an alternating current of electricity through the coil or helix *u*. Under this construction the inner shell *b* and the rod *j*, or one of them, should be made of suitable metal to facilitate the generation or development therein of Foucault or eddy currents. The form, proportion, and metal to be adopted will depend very largely upon the particular conditions of use, and these are matters falling within the domain of the practical electrician and are not necessary to be set forth in detail herein. The formula for calculating the proportions of parts, the properties of different metals, their relative suitability for use in such a heater, and other information useful in the construction thereof are all matters well known to electricians of the present time and fully disclosed and explained in standard works upon electrical construction at the present time. Owing, therefore, to the varying conditions under which the present invention will be carried out and to the common and general knowledge existing upon this subject it is deemed unnecessary to incorporate such data in this specification. I desire it to be understood, in other words, that my invention is not restricted to specific proportion, materials, or details of construction as regards these matters, but comprehends, broadly, the construction of a cartridge or charge for introduction into and use within modern ordnance and containing within itself an electric heater and an agent which under the influence of the heat electrically developed shall generate or afford a pressure sufficient to effect the propulsion of the missile or projectile from the gun.

In Fig. 4 I have represented a cartridge or charge in which both the shell or chamber D and the projectile E are supplied with heaters, the purpose being to develop within the shell or chamber D the pressure necessary for the propulsion of the projectile E and to generate within the projectile a heat sufficient to affect an agent therein and convert it into a gas or vapor either at once or when the projectile shall be fractured by impact, and which shall have the effect of asphyxiating or otherwise injuriously affecting persons into whose midst the projectile is thrown. As shown, the shell or casing D comprises the outer shell *a*, inner shell *b*, and intervening layer *c;* but the liquid-chamber *f* is omitted and the opening at the forward end of the shell is sealed by a fusible plug L. The heater G is present, as before, and the thermopile H and galvanometer I are also represented, though either a pressure-gage or pyrometer may be substituted for these members. The wires *o p* and *q r* for energizing the heater and for conducting the current from the thermopile to the galvanometer are carried through the rearward extension *e* of the shell or casing D, and in addition thereto other wires *w x* and *y z* are likewise carried through said neck to deliver current to the fusible plug L and to an electric heater M in the projectile E. These wires are not only thoroughly insulated, but where they pass through the neck *e* they should be completely surrounded and enveloped by a filling or packing which shall absolutely preclude the escape of the gas or vapor generated within the shell D. The fusible plug L is made of such composition or alloy as will withstand a high pressure and effectively seal the shell D against escape of gas or vapor, but which will nevertheless fuse at a temperature readily producible by the passage through it of a suitable electric current, which, as above indicated, is introduced by the wires *y z* from any suitable source of electricity.

In Fig. 5 I have represented a construction essentially like that of Fig. 4, but have shown the projectile as formed with a boss or tang *a′*, which is inserted into the discharge-opening of the shell D and is connected with said shell by the fusible ring or plug L, as shown. This forms a simple and convenient method of attaching the projectile to the shell or casing. The preferred form of the heaters employed in the shell or casing and in the projectile is indicated in Figs. 6 and 7, wherein *b′ b′* indicate rods connecting skeleton frames *c′*, about which are wound strips of metallic tape or ribbon *d′*, as shown in the several figures. I do not, however, mean to restrict myself at all to this or to any other particular form of heater, but contemplate using any electric heater which may be found suited to the service. Under the constructions shown in Figs. 4 and 5 the cartridge will be placed within the gun, and if the projectile is detached from the shell or casing proper electrical contact will be established between the leading-in wires and the electric heater M of the projectile, as by concentric contact-rings or otherwise, after which the necessary current will be supplied to the heater or heaters to produce a proper temperature in the projectile and in the cartridge shell or casing, either or both.

The benefits derivable from the use of the heater within the projectile may be secured regardless of the particular means employed for throwing the projectile from the gun, as will be readily understood by referring to Fig. 8. In this figure the projectile E, with its heater M, is represented in the gun with an ordinary powder charge, which may be contained in a metallic shell, a canvas casing, or other suitable holder. Under this embodiment of the invention the current will be supplied to the heater M until the agent con-

tained within the shell shall have been sufficiently acted upon and affected by the heat produced to convert said agent into a gas or vapor or otherwise to prepare it for the special work it is designed to accomplish when the projectile shall strike an object and burst or be fractured.

It is to be understood that in the foregoing description I have set forth only a few of many embodiments of my invention that are possible to be made; but the constructions here set forth are the result not only of elaborate and careful calculations, involving strength of materials, generation of heat, and development of pressure under actual working conditions of time and space, but these calculations have been supplemented by actual tests and verified thereby. As a result of these tests I am able to state that it is feasible not only to develop a pressure sufficient for throwing dynamite charges and the like from ordinary guns or ordnance to distances as great as or greater than they are now thrown by other systems, but that solid shot may also be thrown to great distances, probably as great as or greater than those now attained by the use of powder charges. By properly regulating and controlling the delivery of the vapor or gas to the projectile tube or barrel and owing to the highly-elastic nature of such gas or vapor the projectile may be started as gradually as desired, and all danger of exploding the charge within the gun by impact or concussion will be avoided.

I am aware that it has been proposed to construct a cartridge for guns of a metallic shell closed at its rear end, a projectile inserted in its forward end, a charge of water or other liquid within the shell, and an electric heater also within the shell for heating the water and converting it into steam; but no adequate provision was made for retaining the projectile during and after generation of great pressures, nor for withholding the pressure from the projectile until the proper moment of firing. Absence of such provisions renders the device incapable of effective use, since it is manifest that the projectile will start from the shell the instant the pressure behind it exceeds the strength or tenacity of its attachment to the shell.

My invention differs from that mentioned in that in addition to the shell and heater I have provided means for confining the pressure within the shell and preventing it from reaching or acting upon the projectile until the desired moment, thus enabling me not only to generate the requisite pressure before starting the projectile, but also to hold said pressure until the gun is properly sighted and the order for firing is given.

Having thus described my invention, what I claim is—

1. A cartridge or prepared charge for use in guns, comprising a suitable projectile; a shell or casing; an agent contained within said shell or casing, adapted to be converted by heat into a vapor or gas; means for retaining and releasing the gas or vapor as required; and an electric heater applied to said shell or casing, substantially as and for the purpose set forth.

2. The combination of a cartridge shell or casing provided with an orifice or vent; a sealing device adapted to close or open said vent as required; an electric heater applied to the shell or casing; and an agent or substance contained within said shell or casing and adapted to be converted into a gas or vapor under the action of the electric heater, substantially as set forth.

3. A cartridge shell or casing provided near its rear end with a diaphragm or partition, and with a liquid-chamber in rear thereof; a valve-controlled vent for said liquid-chamber; an opening through the diaphragm, connecting the liquid-chamber and the interior of the shell; an opening at the forward end of the shell; connected valves applied to and sealing said openings, that of the partition being of larger area than the other; an electric heater applied to the shell or casing; conductors for supplying electricity to the heater; and water or other suitable agent contained within the shell or casing, all substantially as set forth.

4. In combination with a hollow shell or casing adapted to be introduced into a gun; a sealing device serving to seal the chamber within the shell or casing; an electric heater within the shell or chamber; an agent contained within the shell or chamber, and adapted to be vaporized by the heat of the electric heater; means for retaining and releasing the pressure at will; and a gage adapted to indicate in suitable units the pressure within the shell or chamber.

5. A prepared charge or cartridge for guns and ordnance comprising the following elements in combination; an outer shell or casing; an inner shell or casing; an intermediate insulating substance; an electric heater; a differential valve mechanism for sealing and unsealing the chamber within the inner shell; a liquid-chamber in rear of the larger valve; and a valve-controlled vent for said liquid-chamber; whereby the liquid may be retained within its chamber and the valves thereby held to their seats until the requisite pressure is attained within the shell or chamber, and then released, substantially as set forth.

In witness whereof I hereunto set my hand in the presence of two witnesses.

LINDON W. BATES.

Witnesses:
HORACE A. DODGE,
C. C. BURDINE.