No. 711,545. Patented Oct. 21, 1902.

G. THOMSON.

ART OF BLASTING.

(Application filed May 28, 1902.)

(No Model.)

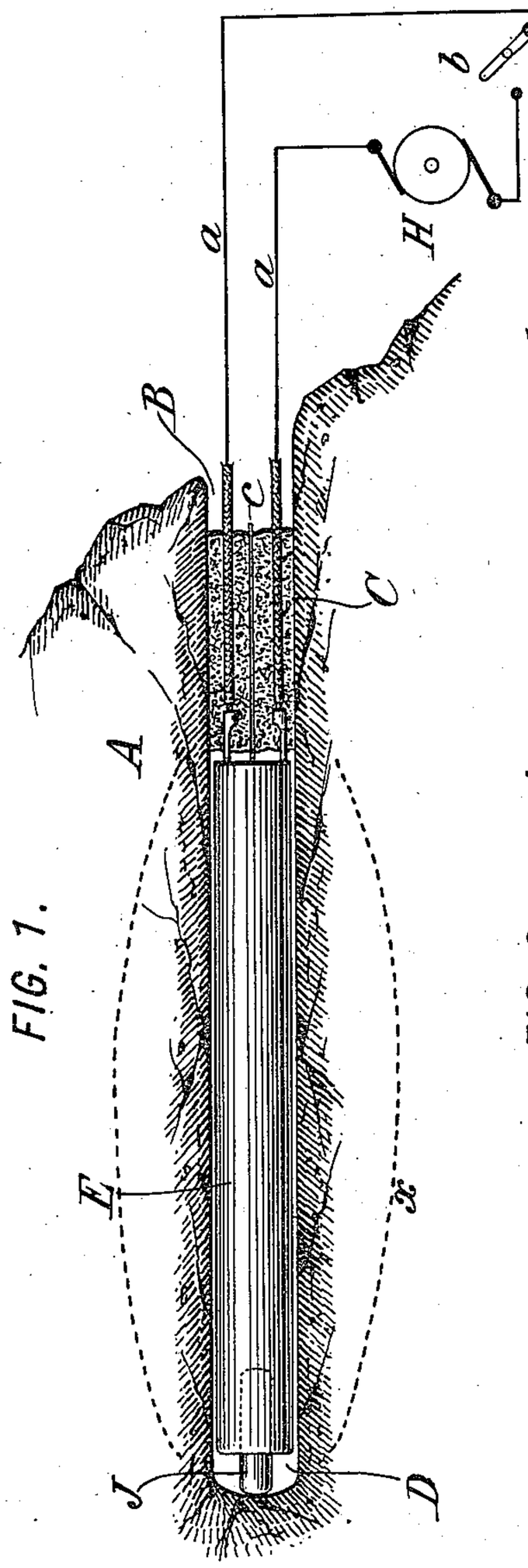

FIG. 1.

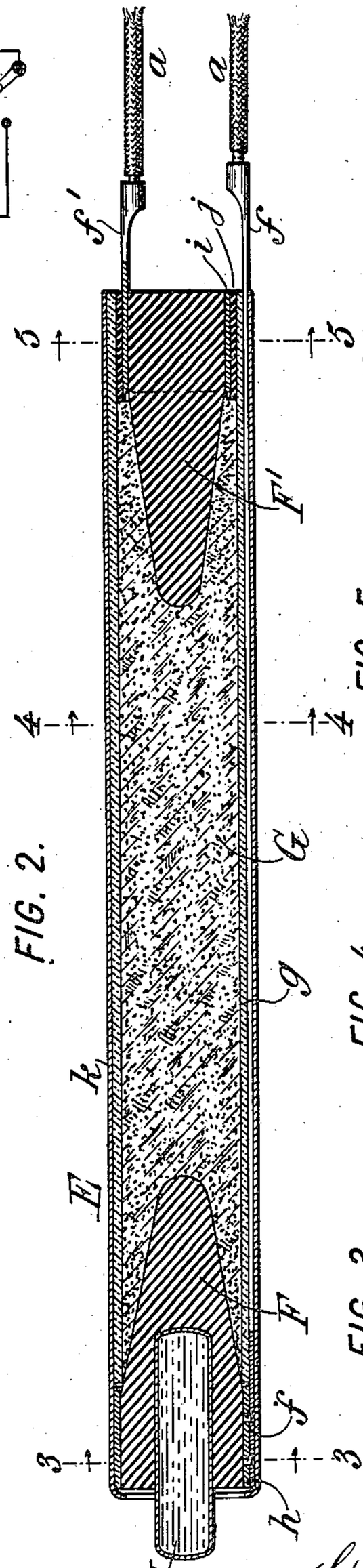

FIG. 2.

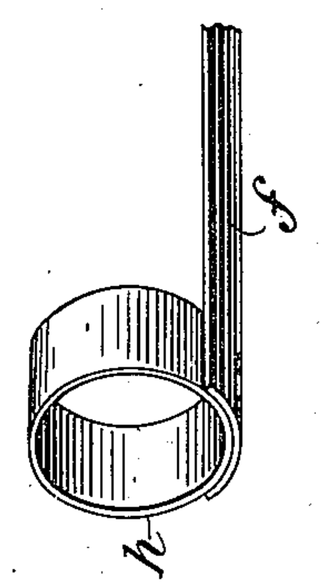

FIG. 6.

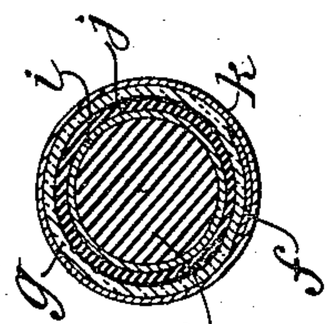

FIG. 5.

FIG. 4.

FIG. 3.

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UNITED STATES PATENT OFFICE.

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ART OF BLASTING.

SPECIFICATION forming part of Letters Patent No. 711,545, dated October 21, 1902.

Application filed May 28, 1902. Serial No. 109,299. (No model.)

To all whom it may concern:

Be it known that I, GEORGE THOMSON, a citizen of the United States, residing in Elizabeth, Union county, New Jersey, have invented certain new and useful Improvements in the Art of Blasting, of which the following is a specification.

This invention relates to blasting, and aims to provide an improved process for blasting.

Explosives have generally been used in blasting heretofore, being ignited either by a primer or detonator exploded by an electric current or by a slow-burning fuse.

My invention aims to dispense with the use of explosives that produce gases after explosion which are injurious to the health of the miner or which, owing to their noxious nature, require that he shall wait until they clear away before proceeding with his work after the explosion.

According to my invention I utilize electrically-generated heat as the means for effecting the blasting operation.

In carrying out my invention I place within a drilled hole in the rock or other material to be blasted an electric furnace of suitable construction, and through this furnace, by means of suitable conductors, I pass an electric current of considerable volume, whereby a most intense heat is generated within the furnace and communicated to the immediately-surrounding portion of the mass of rock. The amount of heat thus electrically generated may be substantially the same as in electric furnaces used for smelting purposes—as, for example, those used for the production of aluminium-bronze, carborundum, or calcium carbid—or, in other words, the temperature obtained is what is commonly known as a "smelting" temperature. The electric furnace is especially designed and adapted for insertion into a drilled hole and is so constructed as to facilitate the rapid escape of heat into the surrounding rock. By this means the surrounding wall or core of rock is rapidly raised to a high temperature, approximately to a white heat. The rock is thus heated at a rate more rapid than that at which the heat introduced into it can escape by conduction outwardly into the surrounding mass of rock. Consequently the inner and most highly heated core or portion of the rock is expanded much more rapidly than the outer mass thereof can expand, and being imprisoned within the outer mass its expansion exerts a strong tendency to disrupt or burst the entire mass of rock. Under some circumstances the means thus described is alone sufficient to disrupt the rock. This is especially the case with comparatively brittle rock of low heat conductivity and with an efficient form of electric furnace worked to a high heating capacity. Under these circumstances my invention provides a very simple and readily-applied means for blasting, since all that is necessary is a suitable dynamo or transformer and a small cylindrical electric furnace of shape to be inserted into the drilled hole with connecting-wires of proper capacity, the miner having only to insert the furnace into the hole and by means of a switch to turn on the electric current, an operation which is followed in a short time by the cracking open of the rock without any violent explosive action and without the formation of any deleterious gases. For those instances in which the mere heating of the rock, as thus described, is insufficient to effect the blasting my invention provides a further step. According to this part of my invention I first apply heat within the drilled hole in the rock in the manner already described until the rock surrounding the hole is heated to a high degree, and then I cause the introduction into contact with the heated mass of a suitable quantity of water or other suitable liquid, which is vaporized with great suddenness, whereby is generated within the drilled hole a pressure sufficient to disrupt the mass of rock. I prefer water to other liquids, because in its gaseous form it is innocuous, its steam quickly condensing after the explosion, so that the miners can immediately return to work without inconvenience or danger. In carrying out this part of my invention it is necessary to close the drilled hole by some suitable tamping—such, for example, as is commonly used in blasting with an explosive charge. In order to prevent the blowing out of this tamping by any gradually-accumulating pressure preceding the liberation of the liquid and the consequent generation of an explosive pressure, I provide through the tamping a mi-

nute vent-passage or needle-hole, so that any gradually-generated gas may freely escape. For introducing the liquid at the proper time into contact with the heated mass I may place a suitable quantity of the liquid in a sealed vessel or can in any suitable location within the drilled hole, so that it shall be somewhat protected from the most intense heat in order that the rock may be highly heated before sufficient heat is communicated to this vessel to liberate the liquid. The liquid may be liberated either by the melting of some portion of the wall of the vessel, as, for example, its soldered joints, by the accumulating heat or by the bursting of the vessel by the expansive force of the liquid due to the heat which is transmitted to it. In either case the liquid is liberated in sufficient mass so that, flowing into the drilled hole or bore around the electric furnace, it comes in contact with the nearly-white-hot rock and is vaporized with great suddenness so as to generate a large volume of steam (or other gas as the case may be.)

Having now made clear the novel mode of blasting introduced by my invention, I will proceed to describe the preferred means for carrying my invention into practice, for which purpose I will refer to the accompanying drawings, wherein—

Figure 1 is a section through a mass of rock into which is drilled a hole and into which hole is inserted the electric furnace provided by my invention with suitable tamping. Fig. 2 is a longitudinal mid-section of the electric furnace or electric blasting-cartridge on a larger scale. Figs. 3, 4, and 5 are transverse sections of Fig. 2, cut on the lines 3 3, 4 4, and 5 5, respectively. Fig. 6 is a perspective view showing one of the electrical connections.

Referring to the drawings, let A in Fig. 1 designate as a whole the mass of rock to be blasted; B, the hole or bore drilled for blasting; C, the tamp, and D the confined space or chamber within the tamp.

E is the electric furnace as a whole.

It will be understood that in Fig. 1 the drilled hole is shown as very short compared with the usual practice. In carrying out my invention the hole may be drilled to the usual depth or to any suitable depth.

The preferred internal construction of the electric furnace is shown in Figs. 2 to 5, inclusive. This furnace is in the form of a cartridge, such as will slip freely into the drilled hole. Accordingly it is externally cylindrical and slightly smaller than the bore. This electric blasting-cartridge consists, essentially, of any suitable type of electric furnace with proper conducting wires or rods leading to its terminals. In the electric smelting art it is well understood that electric furnaces may be either those operating by incandescence, such as the Cowles furnace, or those operating by the formation of an electric arc, such as the furnace used for making calcium carbid. Either of these types of furnaces may be employed in carrying out my invention; but I regard the incandescent furnace as presenting some advantages over the other type, and accordingly I have shown this kind of furnace in the accompanying drawings. The furnace shown is constructed with two terminals F F′, of carbon, at its opposite ends, between which is a filling G, of resistant material, preferably granular carbon or coke, which may be advantageously commingled with particles of sand or lime in order to increase its resistance. The terminals F F′ are connected, respectively, to conducting wires or rods *f f′*. As the terminal F is at the farther or inner end of the furnace or cartridge the conductor *f* has to traverse the entire length of the cartridge, and consequently must be insulated from the resistant mass G and from the outer terminal F′. To effect its insulation from the mass G, I provide an insulating tube or envelop *g*, surrounding this mass, the conductor *f* being outside of this tube, as shown in Fig. 4. The tube *g* may be made of asbestos or other suitable material, asbestos being preferred, because it will longer resist the high heat of the generator. The conductor *f* is preferably a flat strip of wrought-iron or steel. For making a good electrical connection between this conductor and the carbon terminal F, I have shown a metal ring *h*, fastened to the inner end of the conductor *f* by riveting or otherwise, the ring *h* being preferably slightly coned and the carbon F having its base slightly coned and being driven or forced into the ring. The carbon F′ is in a similar manner joined to the conductor *f′*, which is shown as being formed integrally with a ring *i*, into which the carbon F′ is forced, so as to make close contact therewith. For more effectually insulating the carbon F′ from the conductor *f*, I provide a ring *j*, of insulating material, surrounding the ring *i*. This ring *j* may be advantageously made of mica. To give strength and consistency to the entire electric cartridge, I prefer to inclose the whole in an outer tube *k*, which should be of non-conducting material. Ordinary paper or pasteboard, preferably waterproof, is suitable. The outer ends of the conductors *f f′* are joined in any suitable manner to the conducting-wires *a a* of an electric circuit which leads from the terminals of a dynamo H, Fig. 1, or any other suitable electric generator. It will of course be understood that a transformer may be interposed between the source of electric energy and the electric furnace or cartridge. In Fig. 1 I have shown a switch *b* for closing the circuit.

For operating upon rock which can be disrupted by heat alone it is only necessary after drilling the hole and after inserting the electric furnace or cartridge E therein, as in Fig. 1, to complete its electrical connection with the generator, as by closing the switch *b*,

whereby a current of suitable volume flows between the terminals F and F', and by reason of the imperfect conductivity of the mass G this mass is rendered incandescent and the heat is rapidly disseminated therefrom through the thin-wall of the furnace and into the mass of rock. Thus the rock immediately adjacent to the furnace is rapidly heated, so rapidly, in fact, that the heat enters it faster than it can escape outwardly into the larger mass of rock beyond, so that the inner portion of rock becomes a highly-heated core, the limits of which may be approximately indicated by the dotted line *x* in Fig. 1. This core will of course be of greater or less diameter according to circumstances, its temperature gradually diminishing outwardly. As this core of rock is heated it tends to expand, and as soon as the heated portion has acquired sufficient mass, so that its expansive tendency becomes greater than the surrounding rock can resist, the mass of rock is burst open. The current may then be cut off and the loosened rock immediately removed.

In those cases where an explosive action is required I provide in addition to the means thus far described a can or vessel J, filled with water or other suitable liquid. I prefer to place this vessel at the inner end of the bore. It might be entirely distinct from the electric cartridge; but I prefer to attach it thereto. This is conveniently done by forming a recess or bore in the carbon terminal F, as shown in Fig. 2, into which recess the vessel J enters. The vessel J may be made of tinned iron with soldered joints or it may be of spun copper or other metal or of cast-iron, according to the requirements of different locations. The vessel is preferably filled with the water or other liquid and sealed. In using this form of electric cartridge it is necessary to close the hole by a tamping, as shown at C in Fig. 1. This tamp may be the same as is now commonly used for ordinary blasting. It is important, however, to provide it with a minute vent, and for this purpose I introduce a small tube *c* through the tamp, as shown in Fig. 1, or in any other way. I provide the tamp with a minute vent or needle-hole through it. One way of making this vent is by forming the tamp with a wire passing through it and then subsequently to pull out this wire. The purpose of this vent is to permit any gradually-generated pressure of gases to freely escape, thereby avoiding the accumulation of such a pressure as might blow out or displace the tamp. Such a minute vent does not, however, impair the sudden expansive action which occurs when the liquid in the vessel J is liberated and vaporized.

In making an explosive blast according to my invention the electric furnace or cartridge E, provided with the liquid vessel J, is inserted into the drilled hole, which latter is then closed by the tamping C. The electric circuit connections being completed as before, the current is turned on and the heat generated in the furnace is communicated in the same manner to the surrounding rock. This continues until the vessel J bursts and liberates its liquid. This will occur when the heat reaches the liquid and so expands it as to overcome the restraint of the vessel, or the heat may become sufficient to fuse the vessel or its soldered joints. Thus the liquid is liberated, preferably, by the bursting of the vessel and runs out into the highly-heated chamber D, where it is instantly vaporized by the intense heat stored in the wall of rock and in the electric furnace itself. Thus an expansive pressure is instantly generated which rends the rock. This mode of utilizing my invention is liable to destroy the electric furnace, so that it cannot be used for a subsequent blast; but this furnace or cartridge is of very simple and cheap construction, as is apparent, so that a new one may well be used for each new blast.

My invention is to be distinguished from those proposed schemes of electric blasting in which the expansion of a material confined within the cartridge is relied upon to effect the blasting, this material being gradually heated by the passage of an electric current. Such gradual pressure will almost inevitably force out any tamping that can be provided before it will rend the rock. By my invention I especially provide against any such gradually-accumulating pressure within the bore by permitting its escape through the vent *c*.

It will be understood that the term "rock" as used in this specification is intended to mean any mass to be blasted, such as stone, coal, ore, or the like.

It will be understood that in the practice of my invention the particular construction of the electric furnace or heating means may be greatly varied, my invention in its broader aspects not being limited to any specific construction of electric heating means.

What I claim is—

1. The improved mode of blasting, which consists in introducing an electric furnace within a blast-hole, passing a suitable current through said furnace to generate a great quantity of heat, and continuing this heat until the surrounding rock is heated to a high temperature, whereby its expansion exerts a disruptive effect against the outer mass of rock.

2. The improved mode of blasting, which consists in introducing an electric furnace within a blast-hole, passing a suitable current through said furnace to generate a great quantity of heat, whereby to heat the surrounding rock to a high temperature, and introducing heat thus into the rock at a more rapid rate than it can escape outwardly through the mass of rock by conduction, whereby to utilize the expansion of the heated rock to exert a disruptive effect against the outer mass of rock.

3. The improved mode of blasting, consisting in confining a volatile medium in a blast-hole, generating heat in an increasing degree in proximity to said volatile medium, and subjecting said volatile medium to said heat after the latter has reached a high degree.

4. The improved mode of blasting, consisting in confining a volatile medium in a blast-hole, generating heat in proximity to said volatile medium, and continuing the generation thereof until the heat is great enough to instantly volatilize the entire quantity of said medium and then admitting said heat to said medium, whereby a tremendous and instantaneous pressure is obtained.

5. The improved mode of blasting, which consists in introducing an electric furnace within a blast-hole, passing a suitable current through said furnace to generate a great quantity of heat, and continuing this heat until the surrounding rock is heated to a high temperature, then introducing into contact with the heated mass a sufficient quantity of liquid which is suddenly vaporized, whereby to generate within the hole a pressure sufficient to disrupt the mass of rock.

6. The improved mode of blasting, which consists in introducing an electric furnace within a blast-hole, stopping said hole by a suitable tamping through which is formed a minute vent-passage, passing a suitable current through said furnace to generate a great quantity of heat, continuing this heat until the surrounding rock is heated to a high temperature, then liberating in contact with the heated mass a sufficient quantity of liquid which is suddenly vaporized whereby to generate within the hole a pressure sufficient to disrupt the mass of rock.

7. The improved mode of blasting, which consists in introducing within a blast-hole an electric furnace and a closed vessel containing liquid, closing said hole by suitable tamping, passing a suitable current through said furnace to generate a great quantity of heat, and continuing this heat until the surrounding rock is heated to a high temperature and the liquid vessel is opened by the heat, whereby to liberate the liquid and introduce the latter into contact with the heated mass so as to suddenly vaporize it, whereby there is generated within the hole a pressure sufficient to disrupt the mass of rock.

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

GEORGE THOMSON.

Witnesses:

BARBARA THOMSON,

BELLA BROWAN THOMSON.