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F. L. SLOCUM & W. E. COREY.

METHOD OF MAKING CARBONIZED STEEL FOR ARMOR PLATES.

No. 574,637 Patented Jan. 5, 1897.

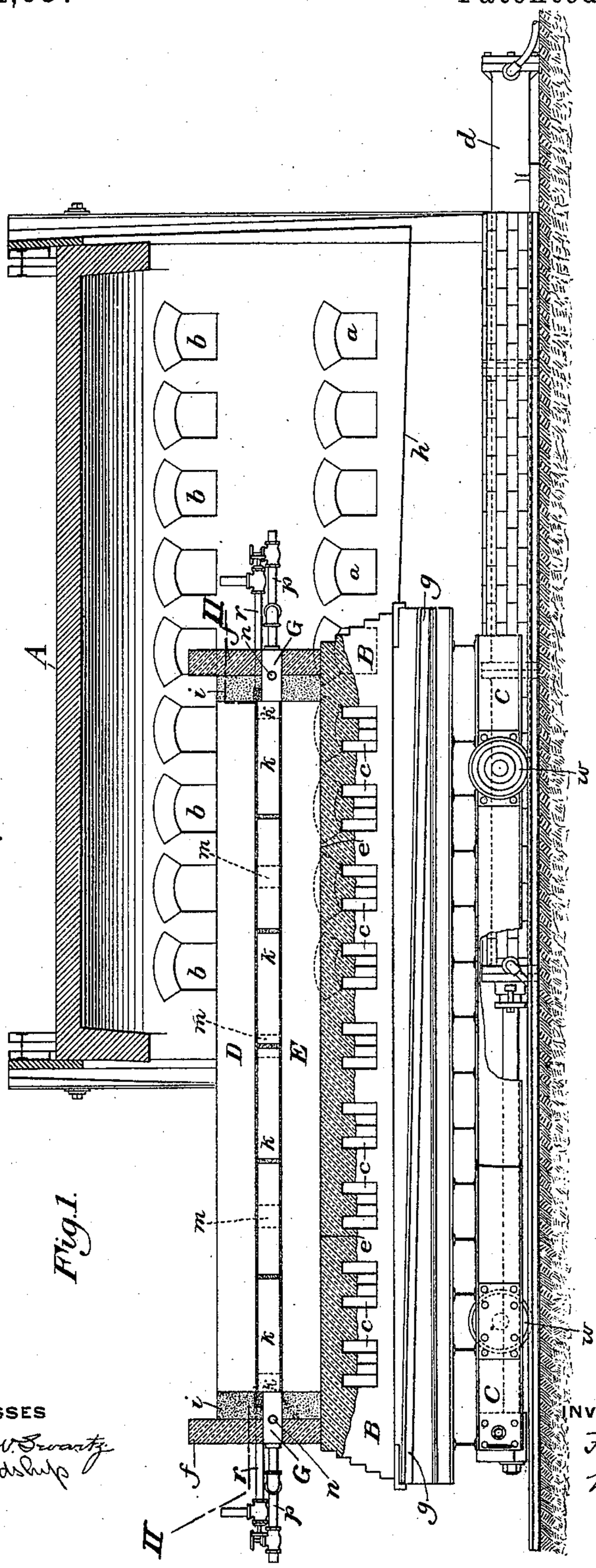

Fig. 1.

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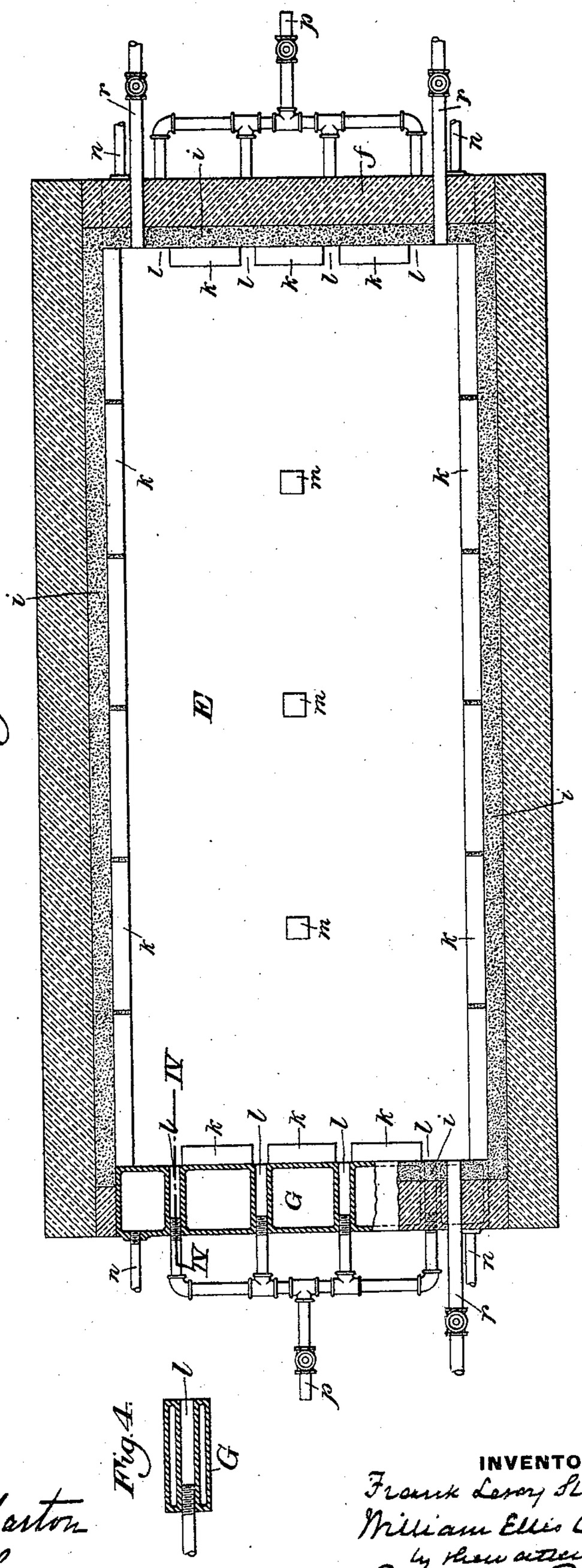

Fig. 2.

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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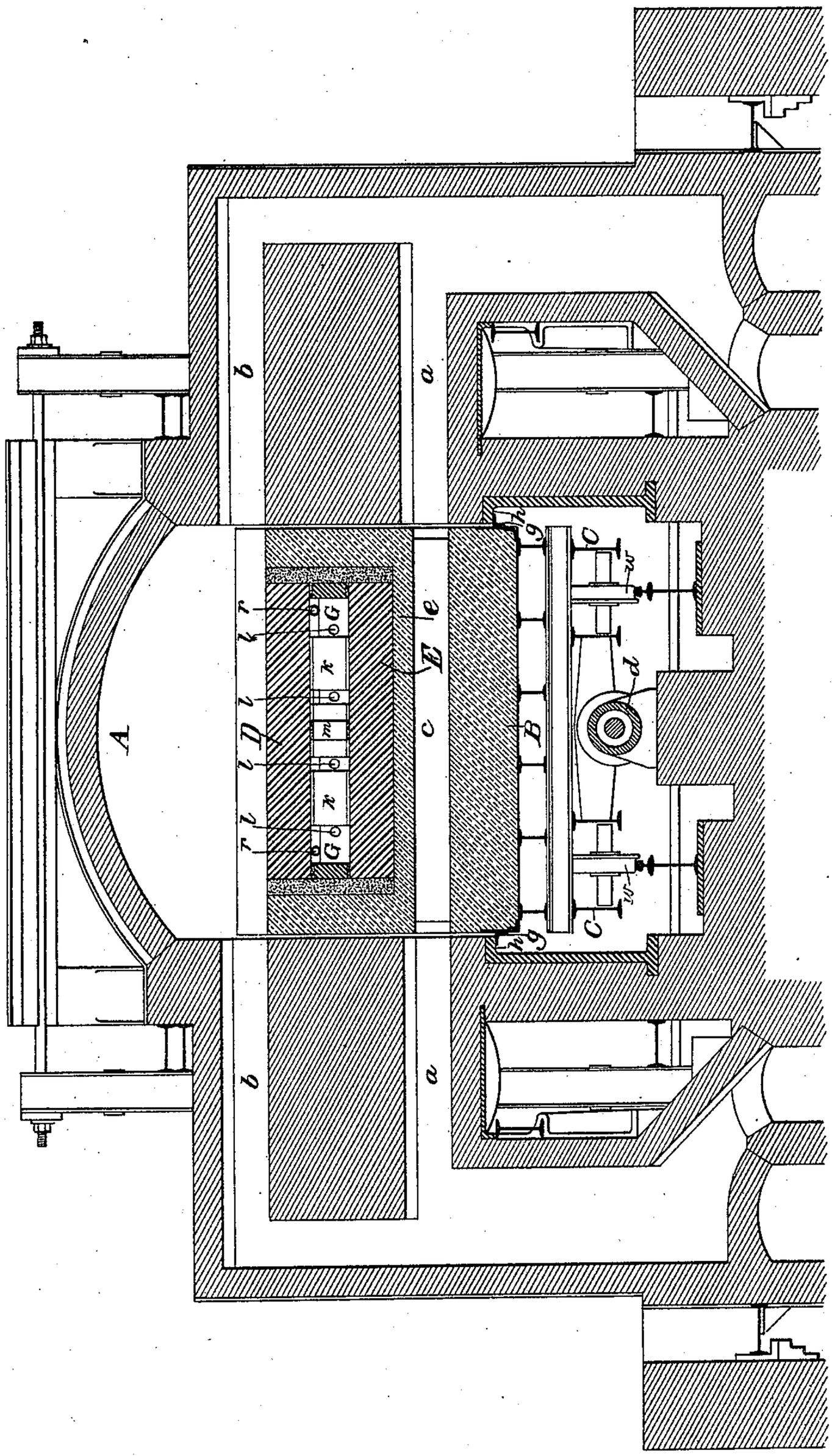

Fig. 3.

WITNESSES

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UNITED STATES PATENT OFFICE.

FRANK LEROY SLOCUM, OF PITTSBURG, AND WILLIAM ELLIS COREY, OF MUNHALL, PENNSYLVANIA, ASSIGNORS TO THE CARNEGIE STEEL COMPANY, LIMITED, OF PITTSBURG, PENNSYLVANIA.

METHOD OF MAKING CARBONIZED STEEL FOR ARMOR-PLATES.

SPECIFICATION forming part of Letters Patent No. 574,637, dated January 5, 1897.

Application filed January 24, 1896. Serial No. 576,674. (No specimens.)

To all whom it may concern:

Be it known that we, FRANK LEROY SLOCUM, of Pittsburg, and WILLIAM ELLIS COREY, of Munhall, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of Making Carbonized Steel for Armor-Plates, of which the following is a full, clear, and exact description.

Our invention relates to the supercarburization of plates or pieces of steel of any size or description, but is specially designed to be applied in the manufacture of large plates or masses of steel to be forged or otherwise shaped into armor-plate.

Steel for the manufacture of armor-plates is usually made by first manufacturing the steel in any of the usual methods, but preferably by converting cast-iron into steel in the hearth of a furnace by the method known as the "open-hearth" process. The steel so manufactured may be alloyed with nickel, with addition of manganese, spiegeleisen, aluminium, or other metallic ingredient, and our invention is applicable to steel manufactured by any suitable process and of any desired composition of ingredients containing such amount of carbon as may be desired, that is, the steel before subjecting it to supercarburization (as in the case of armor-plate) should receive a certain percentage of carbon while in the furnace and before pouring, so that an increased amount of carbon may be added on one side of the plate by the process known as "supercarburization," which renders the finished plate extremely hard on one face, while it is much softer on the other face, the degree of carbon gradually increasing from the soft to the hard side, which effect has for many years been known to be the necessary result of cementation applied to one side only of a plate or mass of iron or steel, while the other side is protected from the external application of the carburizing agent.

In the recarburizing, or, as it is termed more properly, the "supercarburizing," of steel, and especially in the manufacture of armor-plate, it is desirable to use a sufficient degree of heat, preferably below that of the melting-point of cast-iron, and especially so because a high degree of heat is very injurious to the quality of the steel.

Our improvement is therefore directed especially to effecting the supercarburizing of steel plates as rapidly and at as low a degree of heat as is practicable; and with this in view we make use of acetylene gas as our carburizing agent, which we have discovered effects the desired result with great rapidity and thoroughness. It is easily decomposable at low temperature, and contains nearly ninety-two per cent. of available carbon, while ordinary illuminating coal-gas has a much lower percentage of carbon. Such gas can be obtained readily by decomposition of calcium carbid in contact with water. The reaction in such case is that the carbon of the calcium carbid combines with the hydrogen of the water to form acetylene gas, while the calcium of the carbid precipitates as hydrated calcium oxid.

We shall now proceed to describe the manner in which our invention is practiced.

The steel having been manufactured in a suitable furnace (such, for example, as an open-hearth furnace) containing the ordinary amount, say one-fourth of one per cent. of carbon, is cast into an ingot of suitable dimensions and then rolled or otherwise shaped to the desired form.

In our process of supercarburizing steel by means of acetylene gas we prefer to evolve the gas from the calcium carbid by the addition of water. The gas so produced is introduced into the supercarburizing-furnace, either in the gaseous form or in a liquid state, obtained by means of condensation, by pressure, as acetylene gas readily becomes liquid at a temperature of about 98° Fahrenheit, and at a pressure of sixty-eight atmospheres.

The process is preferably conducted in an ordinary gas-furnace with flues underneath the hearth, so as to heat it externally. The plate or plates to be supercarburized are heated in the furnace to about 1,700° Fahrenheit or until the plate is hot enough to combine with the carbon, when acetylene gas is introduced and brought in contact with the plate, the heat of the furnace being maintained at the

point stated or gradually increased. Before heating it up the plates to be carburized are introduced into the furnace in the following way: One plate is laid on the bottom of the furnace-chamber and a second plate is placed above it and parallel thereto, being supported at a sufficient distance therefrom to leave a space between them, so that the acetylene gas may have free access to the opposed surfaces of the two plates. The second or upper plate may be supported at the requisite distance from the lower one by means of a series of iron or steel blocks about six inches wide and four inches high, placed at suitable distances apart on the surface of the lower plate, on which blocks the upper plate is made to rest. In order to secure the carburization of the plates at the points where the plates are supported or rest upon them, the actual contact of the plates and blocks is prevented by interposing a coating of carbon mixed with the best grade of silica sand. The sides and ends of the space between the plates should be closed with refractory material, preferably silica sand, placed all around and against the sides of the plates. This does not necessarily make an air-tight joint, but any of the acetylene gas that passes through the sand barrier would be decomposed and would deposit its carbon in the sand and the hydrogen will pass through and burn on the outside. To prevent a large plate from sagging at a point or points intermediate between the ends, the upper plate may be supported by small blocks similar to those before described, with carbon placed between them and the surfaces of the plates. The gas is introduced, preferably at both ends of the surface alternately, through a manifold or gas box with a number of apertures or ports opening into the space between the plates, so that the gas may pass uniformly over their surface. To prevent the gas depositing solid carbon in the gas-box and its apertures, it is kept cool by means of a water-jacket.

The apparatus which we employ, as stated in the above specification, is not claimed, but is referred to in order to make the operation of the process clear and intelligible, and is shown in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional elevation of the gas-furnace or heating-chamber, showing one half of the furnace, the other half being of similar construction and also showing the movable hearth. Fig. 2 is a horizontal section on the line II II of Fig. 1. Fig. 3 is a vertical cross-section through the furnace, showing the movable hearth B in position. Fig. 4 is a vertical section on the line IV IV of Fig. 2, showing the gas-box G with its water-cooling apparatus.

The gas-furnace or heating-chamber A has two ranges of gas-ports *a* and *b* on each side, through which on one side of the furnace the heating-gas is introduced and out of which the gas passes on the other side. The direction of the gas is reversed from time to time.

The movable hearth B is carried upon a truck C, mounted on wheels *w*, and is adapted to be moved into and out of the heating-chamber by means of a motor-cylinder *d*. This hearth B consists of a horizontal bed *e*, of brick or other refractory material, below the surface of which and extending across the hearth are flues *c c*, which are at such height as to coincide with the lower range of gas-ports *a* in the furnace, while the upper range of gas-ports *b* are at or about the level of the upper surface of the upper armor-plate D, as shown in Fig. 1. By this arrangement the heating-gas passes through the upper and lower ports *a b* on one side, passing through the flues under the hearth or bed B and over the top of the upper plate, whereby the furnace is suitably heated to the degree requisite or desired for treating the armor-plates, the heating-gas being supplied in the usual manner to the furnace from a generator outside. At each end of the bed *e* of the hearth is built a temporary wall *f* of such shape and size as to fit into and close the open ends of the furnace. From each side of the movable hearth B there projects an inclined flange *g*, of iron, which, when the truck C, carrying the movable hearth, is run into the furnace, fits against an inclined projection *h h* from the bottom of the inner wall of the furnace, thus closing the heating-chamber on both sides as well as at the ends.

The armor-plates to be carburized by the acetylene gas are placed in the hearth of the furnace in the following manner: The lower plate E is deposited on the bed *e* of the hearth, and a packing of sand *i* on all four sides. Blocks *k k*, of wrought-iron or other suitable refractory material, are placed around and on the upper surface of the lower armor-plate E, the blocks at the side being connected by cement between their abutting surfaces and the blocks at the ends having spaces *l* between them for the admission of the carburizing gas-pipes. Small blocks *m* of suitable material may also be placed at intervals on the bed of the furnace, which are of the same height as the side blocks, so as to form a uniform level bearing for the upper arm or plate D, which is then laid upon them, as shown in Fig. 1, the space between the armor-plates forming the carburizing-chamber.

The temporary character of the end walls *f f* of the movable hearth enables them to be removed and replaced readily when the armor-plates are to be introduced into or removed therefrom. The silica sand *i* is kept in place at the ends of the armor-plates by these temporary walls.

Comminuted carbon, such as animal or vegetable charcoal, is interposed on the upper and lower surfaces of the supporting-blocks

k and *m*, so that the plates may be properly carburized at those points.

At each end of the bed *e* of the movable hearth is placed a gas-box G, which is introduced through the end temporary walls *f f* on a level with the upper surface of the lower armor-plate E, and is protected from the intense heat of the furnace by being provided with a water-jacket supplied by the pipes *n n*. Each gas-box G is supplied from outside with acetylene gas by a pipe *p*, which may be branched, as shown, and has ports or pipes introducing the gas into the carburizing-chamber formed between the two armor-plates D and E. There are also at each end of the carburizing-chamber, extending through the temporary walls *f f*, outlet-pipes *r r*, (one or more,) so that the acetylene gas entering through the gas-inlet pipes *p p* at one end of the chamber passes over one face of each of the armor-plates and then out at the other end. In order to secure a more perfect and uniform action of the acetylene gas on the armor-plates, the gas-inlet pipes are open at one end only for a time, while the gas-outlet pipes are open at the other end, and then the direction of the gas is reversed, the outlet-pipes being always closed at the end at which the gas is being introduced.

Other apparatus may be used for heating the armor-plates to be carburized on one side and for introducing the carburizing gas, and, if desired, one plate only at a time may be treated, or a series of plates may be treated in the furnace at the same time by making obvious changes in the apparatus, which we have described in this specification, not for the purpose of basing any claims thereon, but for the purpose of illustrating a practical method of using our improved process.

The special advantages resulting from the use of our improvement are due to the employment of the highly active acetylene gas. Said gas is decomposed by contact with the hot steel, and its carbon unites with the steel much more rapidly and efficiently than when the carburization or supercarburization of steel is effected by the ordinary processes involving the employment of animal or vegetable charcoal, or of mineral carbon, or of hydrocarbon vapor, as of petroleum, or of the ordinary coal-gas, so that whereas in the process as heretofore practiced the time required for supercarburizing a steel armor-plate was about twenty-seven days, or six hundred and forty-eight hours, it can be done by our process in a much shorter time.

We do not limit ourselves to the mode by which the acetylene gas is generated, nor to the specific manner in which it is brought into contact with the heated steel.

What we claim as our invention, and desire to secure by Letters Patent, is—

The herein-described process of supercarburizing steel for armor-plates and other purposes, which consists in subjecting the same in a heated condition to contact with acetylene gas, substantially as described.

In testimony whereof we have hereunto set our hands.

FRANK LEROY SLOCUM.
WILLIAM ELLIS COREY.

Witnesses:
G. I. HOLDSHIP,
H. M. CORWIN.