No. 687,612. Patented Nov. 26, 1901.

C. DAVIS.

PROCESS OF CEMENTING IRON OR STEEL.

(Application filed Sept. 27, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

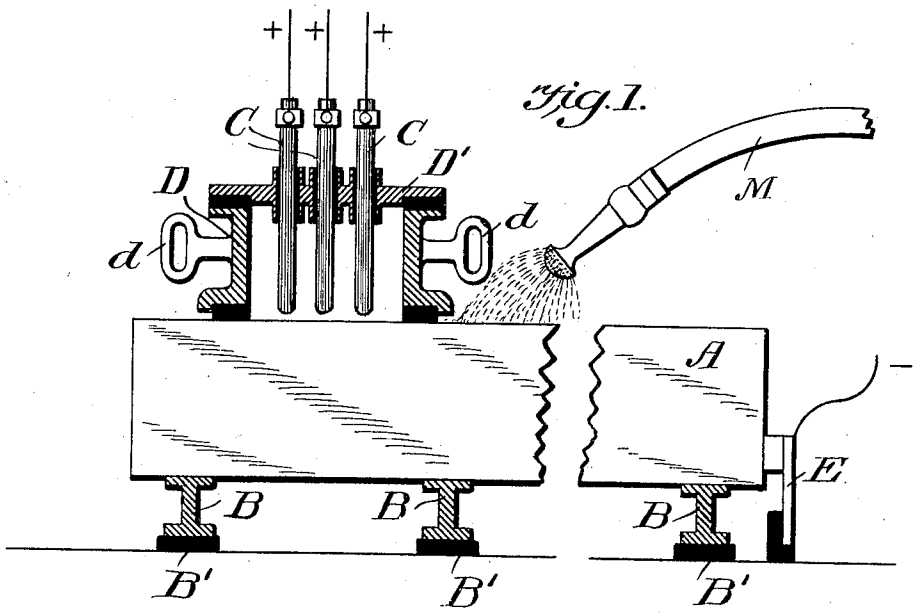


Fig. 2.

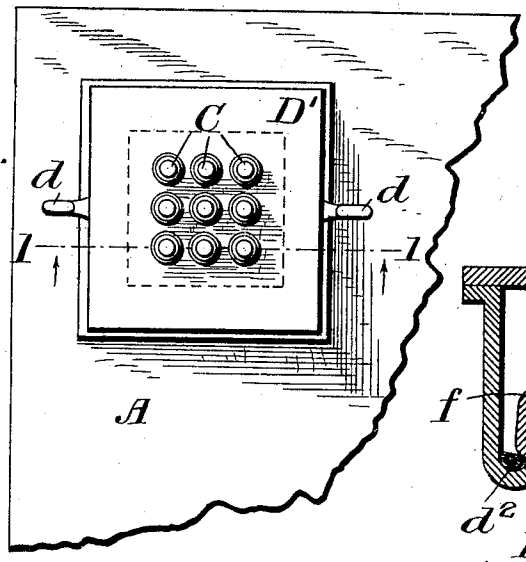
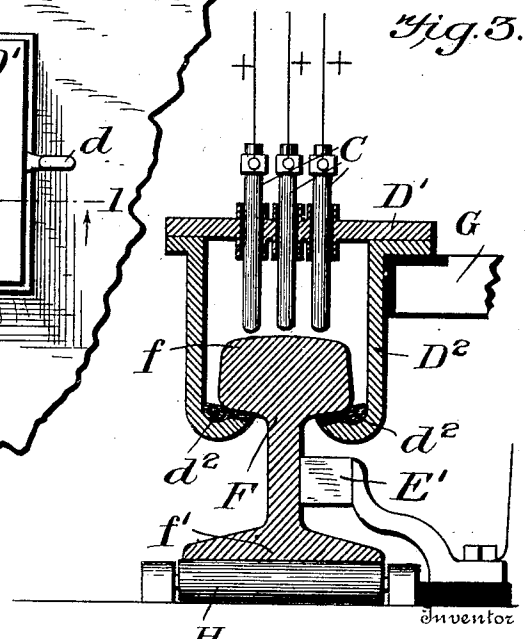


Fig. 3.



Witnesses

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(No Model.) 3 Sheets—Sheet 2.

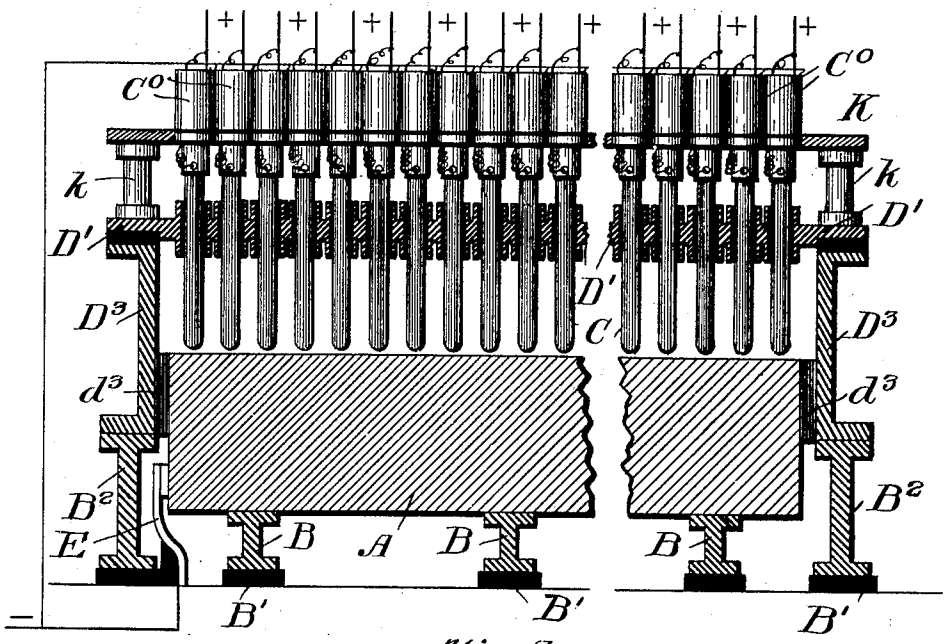


Fig. 4.

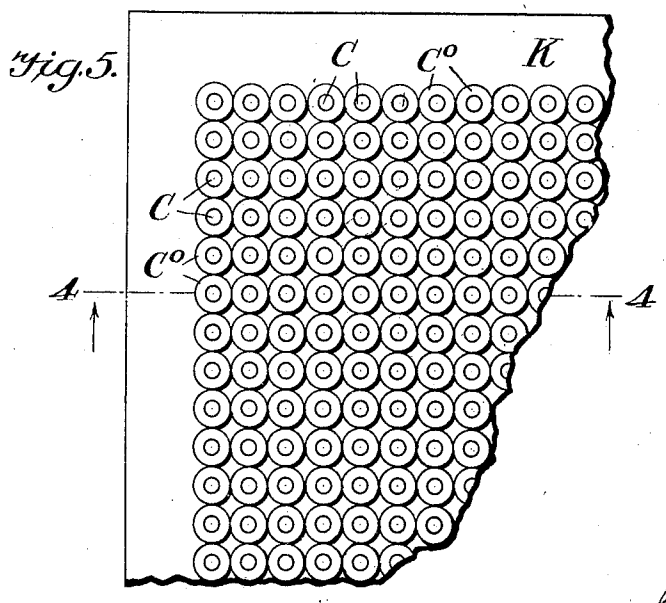


Fig. 5.

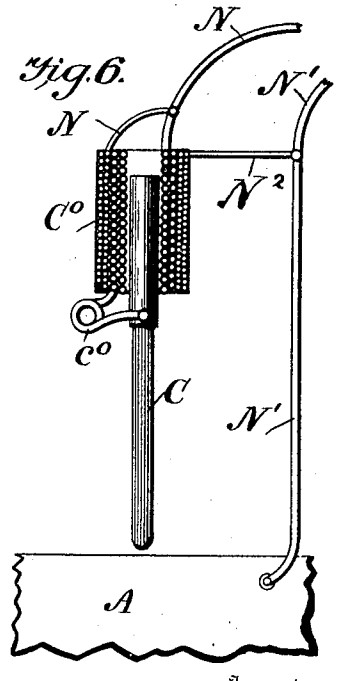


Fig. 6.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 7.

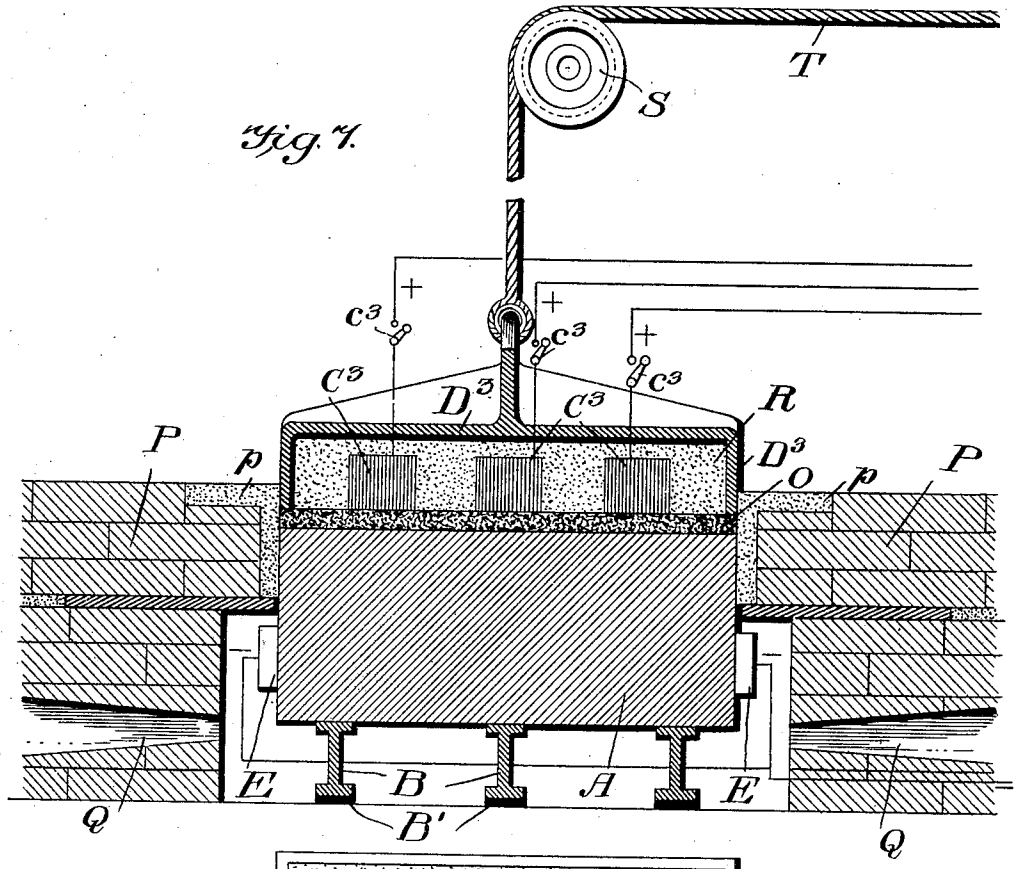
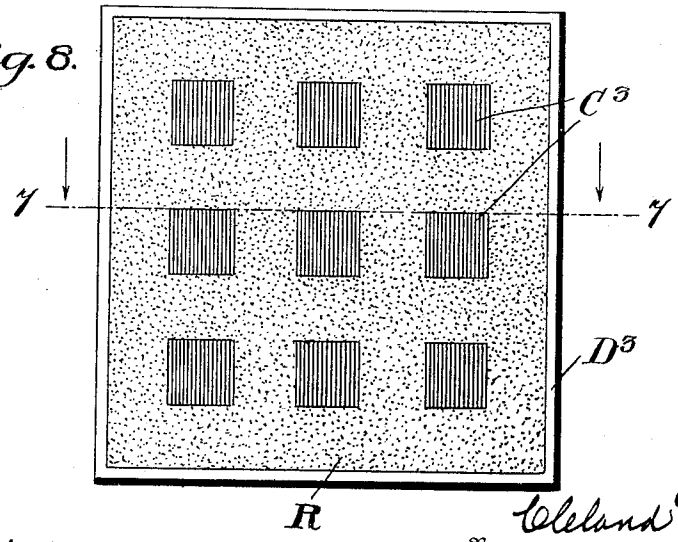


Fig. 8.



Witnesses

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UNITED STATES PATENT OFFICE.

CLELAND DAVIS, OF THE UNITED STATES NAVY.

PROCESS OF CEMENTING IRON OR STEEL.

SPECIFICATION forming part of Letters Patent No. 687,612, dated November 26, 1901.

Application filed September 27, 1901. Serial No. 76,765. (No specimens.)

To all whom it may concern:

Be it known that I, CLELAND DAVIS, lieutenant United States Navy, stationed at Washington, in the District of Columbia, have invented certain new and useful Improvements in Processes of Cementing Iron or Steel; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to an improved method of cementing or supercarbonizing steel or iron plates or rails, ingots, or like articles made of iron or steel in which it is desired to obtain a hard surface capable of resisting the penetration of foreign bodies or of resisting wear.

My invention is particularly adapted to the manufacture of hard-faced armor-plate; but it is also applicable to hardening the tread of rails of steel or iron or of hardening the face of other plates of steel or iron when desired.

In carrying out my invention I subject the face of the plate, either progressively or the entire face at one time, to the action of heavy electric currents passing either from carbon electrodes or through a mass of carbon which may be in a granulated form. The face of the plate within the path of the current is soon brought to a high heat and is impregnated to a greater or less depth with particles of carbon carried either from the electrodes or from the mass of granular carbon placed over the face of the plate. The depth to which the carbon will be carried and the consequent hardening which will occur will vary with the electric current and with the time that the treatment lasts. Where it is desired to harden to a considerable depth below the surface, the treatment may be prolonged; but where it is desired to harden only to a slight depth the treatment will be shorter. Since it would be ordinarily difficult to secure current enough to treat the entire face of a large armor-plate at one time, it may be preferable to treat portions of the plate progressively, which may be done either by moving the electrodes over the plate or by moving the plate under the electrodes or by shifting the current from one group of electrodes to another, in the meantime keeping the plate and the electrodes in the initial position. In the same way, where rails or plates are to be treated the electrodes can be moved along the rail or the rail moved under the electrodes, as may be preferred. Where portions of the plate are treated progressively, the conductivity of the metal will ordinarily speedily produce the desired chilling effect, or this may be supplemented by means of a spray of water or other chilling agent.

My invention will be understood by reference to the accompanying drawings, in which the same parts are indicated by the same letters throughout the several views.

Figure 1 is a diagrammatic view showing an armor-plate with electrodes arranged to treat the face of the plate progressively. The box containing the electrodes is shown in section on the line 1 1 of Fig. 2. Fig. 2 is a plan view of a portion of the plate and of the box of electrodes shown in Fig. 1. Fig. 3 is a sectional elevation of a rail moving under fixed electrodes. Fig. 4 is a sectional elevation of a plate and box of electrodes, in which the plate and electrodes are mounted in the fixed position during the process. Fig. 5 is a plan view of a portion of the electrode-box shown in Fig. 4, the feed-wires being omitted. Fig. 6 is a sectional elevation showing one means of automatically feeding electrodes to the surface of the plate. Fig. 7 is a sectional elevation showing the plate covered with a layer of granular carbon and being treated according to my invention, and Fig. 8 is an inverted plan view of the movable cover containing the electrodes shown in Fig. 7.

Referring now to Figs. 1 and 2, A represents the plate to be treated, which is mounted on suitable supports B, insulated, as at B'. C represents the electrodes, which are shown diagrammatically and which should preferably be arranged so as to feed automatically in the well-known way—such, for instance, as shown in Fig. 6 of the drawings—where C^0 represents a compound-wound solenoid. c^0 represents a yielding attachment for the carbon electrode C, and N and N' are terminal conductors. N^2 is a shunt-conductor by means of which the carbon electrode is automatically kept at the desired distance so as to form an arc with the face of the plate A.

This automatic feed is not a part of my present invention, and any other suitable automatic feed may be adopted, if desired. These carbon electrodes are mounted in a cover D′ on the box D, which is preferably insulated from the plate A, on which the box is moved. The box may be moved by handles *d* or in any other convenient way. The electrodes are preferably connected to the positive pole of the source of electricity, and the broken-off fragments of carbon are carried down into the face of the plate, which speedily becomes highly heated locally on the surface and to a depth below the same. The current may be carried off through any suitable contact E. The surface of the plate shown in Figs. 1 and 2 is treated progressively, and when the carbon is introduced to the desired depth the carburized portion may be hardened by shutting off the current, when the conductivity of the metal will speedily carry off the heat. The spray M is used during the carburizing operation to prevent annealing of the metal of the plate outside the box, and it may be used after the operation on the carburized portion to assist in the chilling.

Referring now to Fig. 3, the box D^2, carrying the electrodes, is secured on a suitable support G, and the rail F slides longitudinally through the box, the latter having approximately air-tight ends. The bottom of the box may be packed with asbestos d^2, so as to keep the joint air-tight. The bottom of the rail *f*′ slides along over the rollers H. The current from the electrodes C enters the face of the rail *f*, which speedily becomes highly heated and impregnated with carbon, and the current passing through the upper portion of the rail escapes through the contact E′.

In both the above-mentioned forms of device any oxgen in the air in the box containing the electrodes is speedily consumed, leaving inert nitrogen and other inert gases, and particles of carbon from the electrode are carried into the body of the plate or rail being treated.

In the form of device shown in Fig. 4 the box D^3 includes the entire face of the plate and is packed with asbestos or like fireproof material, as at *d*. Carbon electrodes pass through the cover D′ of said box, and the solenoids C^0 rest on the cap K, which is supported on the posts *k*. These electrodes are automatically fed, so as to maintain the electric arc, in any desired manner, such as that shown in Fig. 6 and already described.

In the form of apparatus shown in Figs. 4 and 5 it would ordinarily be difficult to keep all of the electrodes in operation at the same time, owing to the immense volume of current required, and therefore it would ordinarily be desirable to operate the electrodes in groups, which may be done by any suitable switch arrangement well known in the art, one of which is shown in Fig. 7. In the form of device shown in Figs. 4 and 5 the plate and the box for the electrodes remain in position until the cementation of the plate is completed, when the box D^3 is removed and the plate is taken out and subjected to such subsequent treatment as may be desired.

Instead of depending upon the carbon in the electrodes C to impregnate the surface of the plate, as described with reference to Figs. 1 to 6, the carbon may be applied to the face of the plate in the powdered or granulated form and the current passed from the electrodes through this carbon, as shown, for instance, in Fig. 7. In this case high heat would be generated by imperfect contact of the electrodes and by the resistance offered by the powdered carbon. In this view the surface of the plate is preferably packed air-tight in the masonry P, having the refractory lining *p*, and the face of the plate is covered with a layer of powdered carbon O, beneath the cover D^3. This cover contains refractory material R, in which the electrodes C^3 are embedded. These electrodes may be of carbon or other suitable conductor, and when the cover is in position they rest on top of the layer of carbon O. These electrodes may be cut in or out in groups by switches c^3. The bottom of the plate may be kept cool by air-currents through the twyers Q. When the curren is turned on the electrodes C^3, the face of the plate speedily becomes intensely heated, and the particles of carbon are absorbed to a depth depending upon the length of time that the current is continued. When the treatment is completed, the cover may be removed in any convenient way, as by means of the cable T over the pulley S. All parts of the face of the plate A may be treated simultaneously if current enough can be secured, or the parts of the face of the plate may be treated progressively, as by cutting in and out the switches c^3. When the electrodes C^3 are of carbon, the granular mass may be omitted, although I prefer to interpose a layer of powdered carbon.

It will be seen that in all the instances hereinbefore mentioned the opposite side of the plate will be at a lower temperature than the side being treated, and this difference in temperature may be further increased, if desired, by artificial means, as by the twyers shown in Fig. 7.

It is well known in the art that the affinity of steel or iron for carbon increases with the temperature until, when the metal is molten, carbon is rapidly diffused throughout the entire mass. It will be seen that by the herein-described method of treating steel or iron the face may be brought to any desired high temperature, even to the point of fusion, and that this high temperature may be carried to any desired depth below the surface, being limited only by the necessity of keeping the back of the plate cool enough to maintain the shape of the plate. Thus it will be seen that carbon can be introduced to any desired depth below the surface of the plate. Moreover, by

having the face of the plate fused to a prescribed depth, as may be done with the apparatus herein described, the carbon may be uniformly diffused through the molten part of the plate and will then shade off decrementally as the depth below the molten portion increases. Moreover, at the same time the process of cementation is effected rapidly and completely. Again, it is possible to treat the face of the plate progressively a portion at a time without the expensive apparatus ordinarily required for this purpose and without liability to the cracking and warping that result from the tedious process now in use.

In the form of device shown in Fig. 7 it is essential that the face of the plate and the layer of carbon above the same be screened from the atmosphere. In the form of device shown in Figs. 1 to 5 it is preferable that the face of the plate and the carbon electrodes be screened from the air; but this screening is essential only when the surface of the plate is to be heated to a very high temperature.

It will be obvious that various modifications might be made in the apparatus for carrying out the herein-described process, and I do not mean to limit my invention to any particular apparatus for the purpose stated; but what I claim is—

1. The process of carburizing steel or iron plate, which consists in intensely heating one face of the plate by means of an electric current passing through that face of the plate from a carbon conductor, and during the operation screening the conductor and the part of the plate under treatment from the air, substantially as described.

2. The process of carburizing steel or iron plate, which consists in intensely heating one side of the plate by means of an electric current passing through that face of the plate from a carbon conductor, and during the operation screening the conductor and the part of the plate under treatment from air, and simultaneously maintaining at a lower temperature the opposite side of the plate, substantially as described.

3. The method of cementing steel or iron plate which consists in maintaining for a limited time an electric arc between a carbon electrode and the face of the plate, and simultaneously screening the said electrode and that part of the plate to be treated from the atmosphere, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CLELAND DAVIS.

Witnesses:

J. STEPHEN GIUSTA,

JANE LEE HART.