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ELECTRICAL CASTING OF METALS.

No. 577,329.

Patented Feb. 16, 1897.

Fig. 2.

Fig. 1.

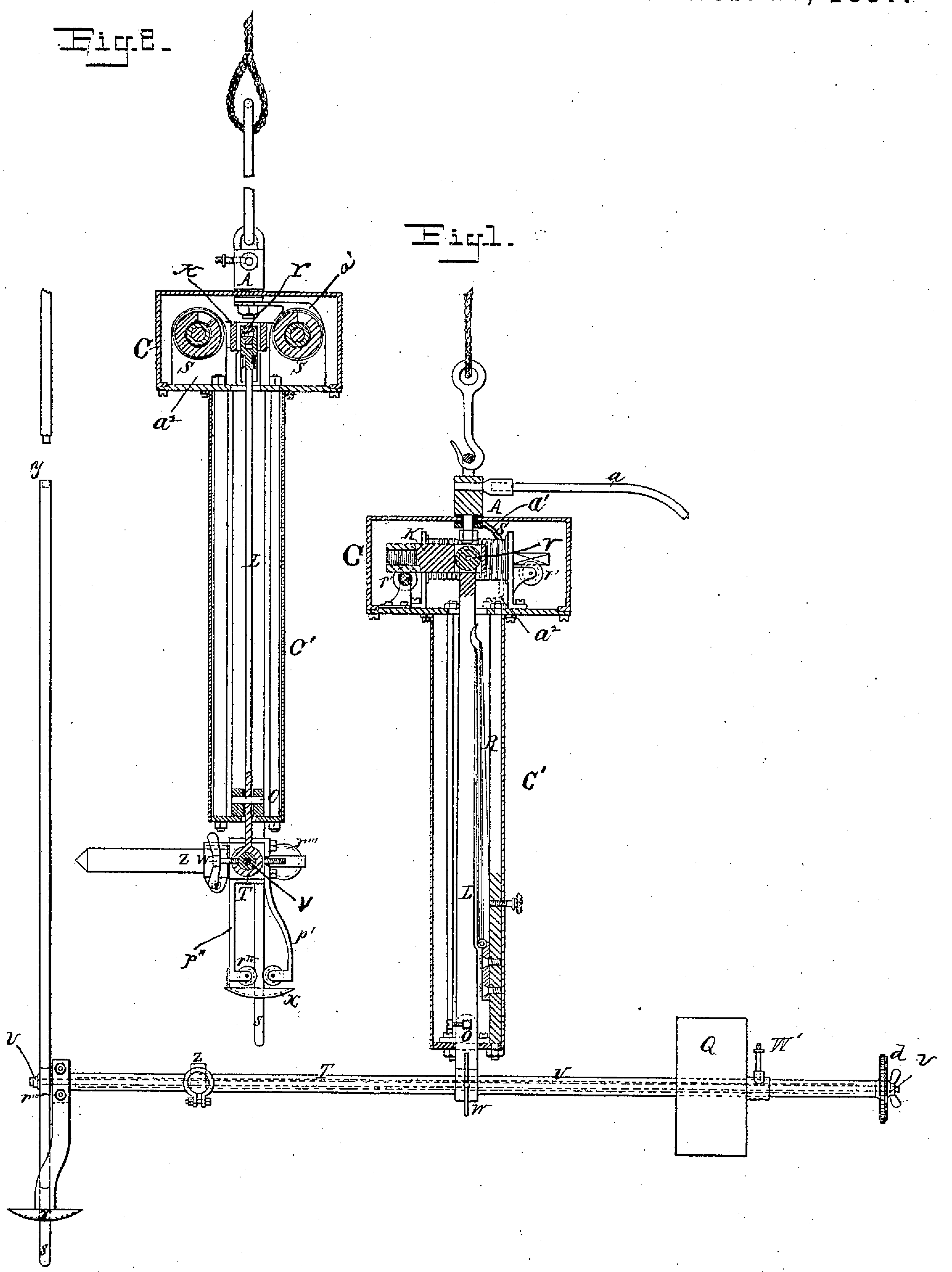

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Fig. 3.

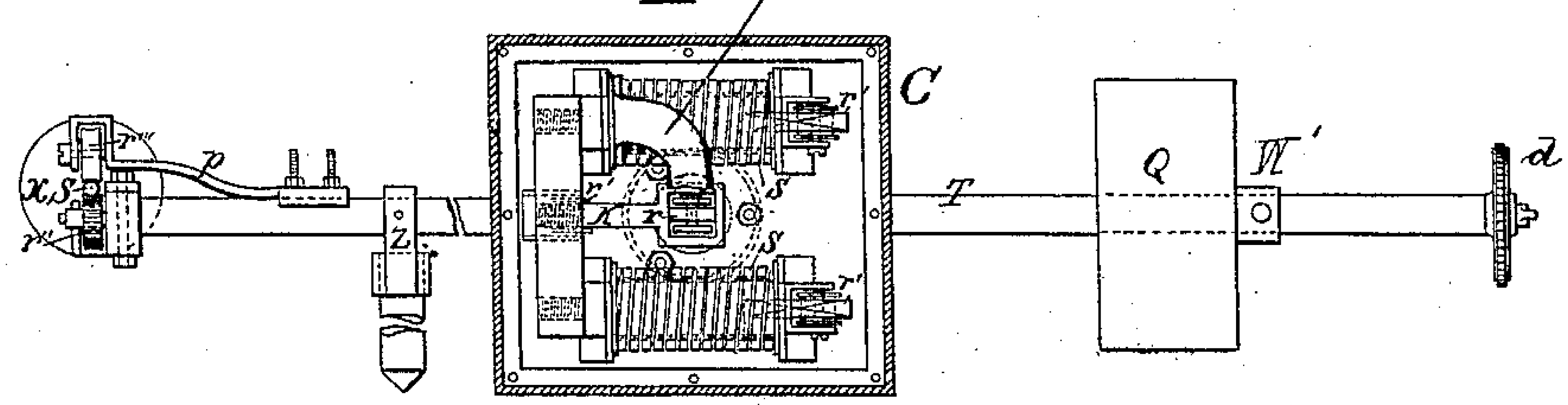

Fig. 4.

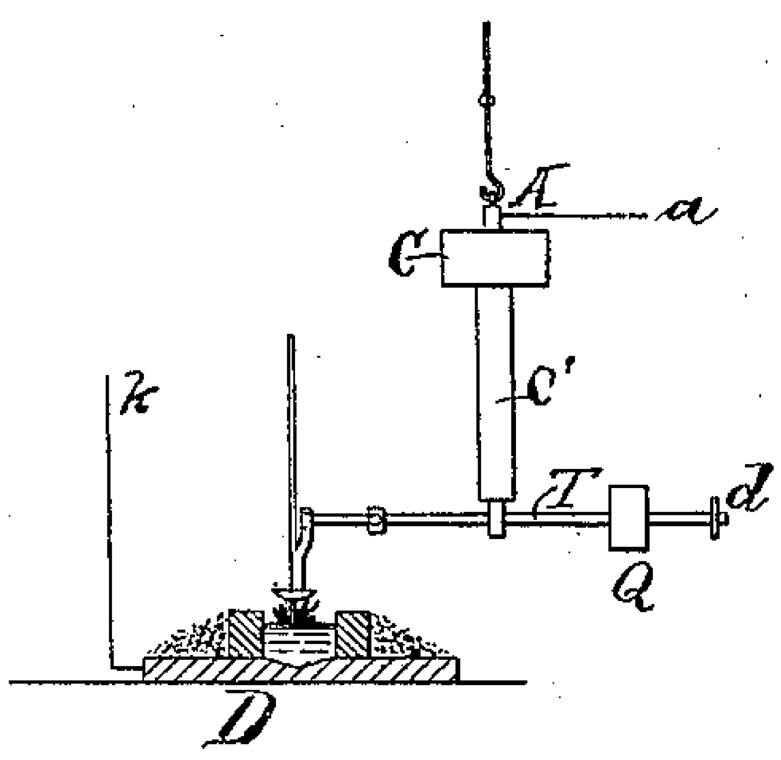

Fig. 5.

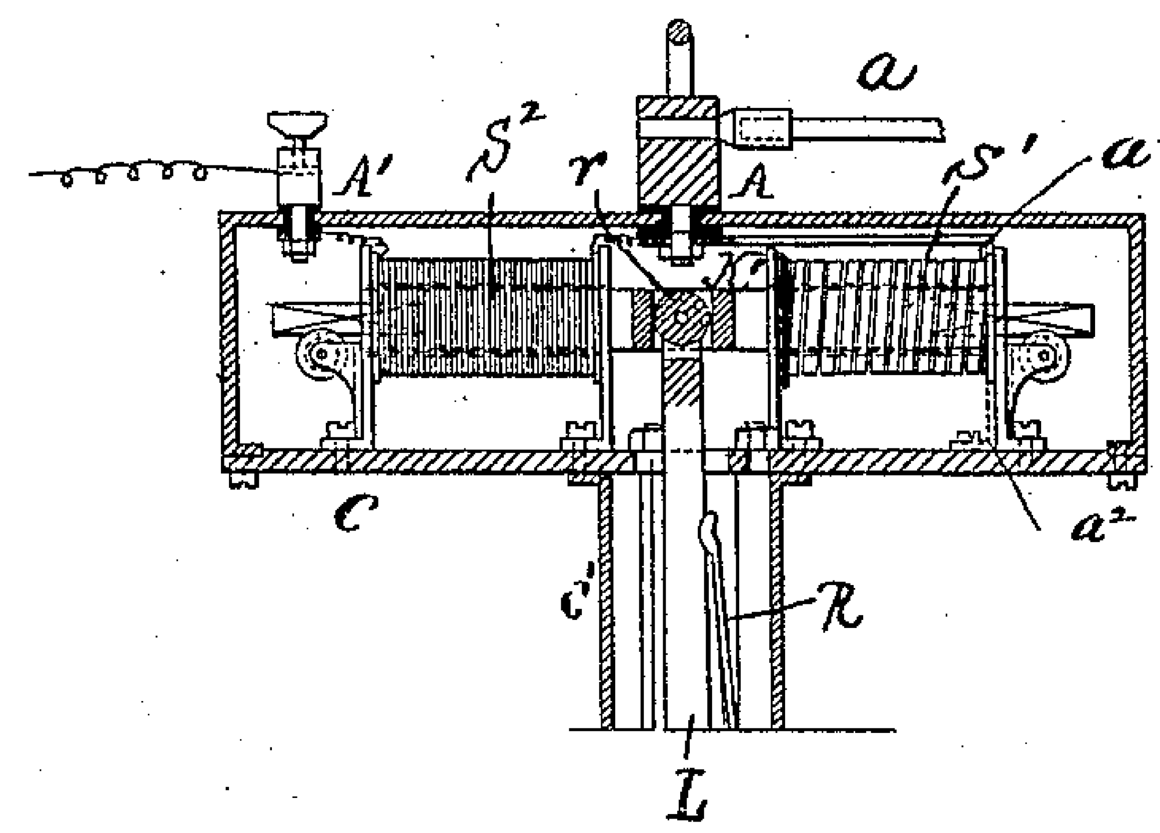

Fig. 6.

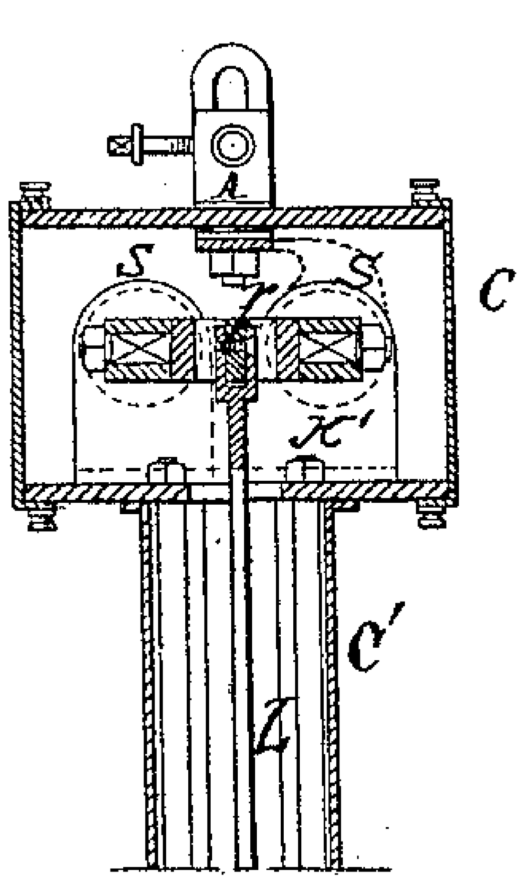

Fig. 7.

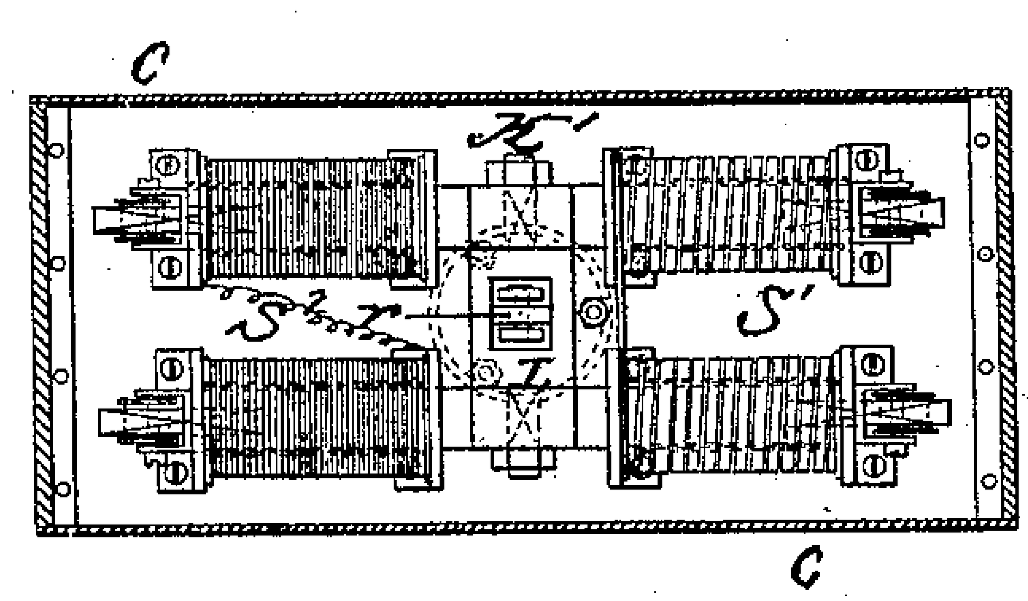

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Fig. 8.

Fig. 8a

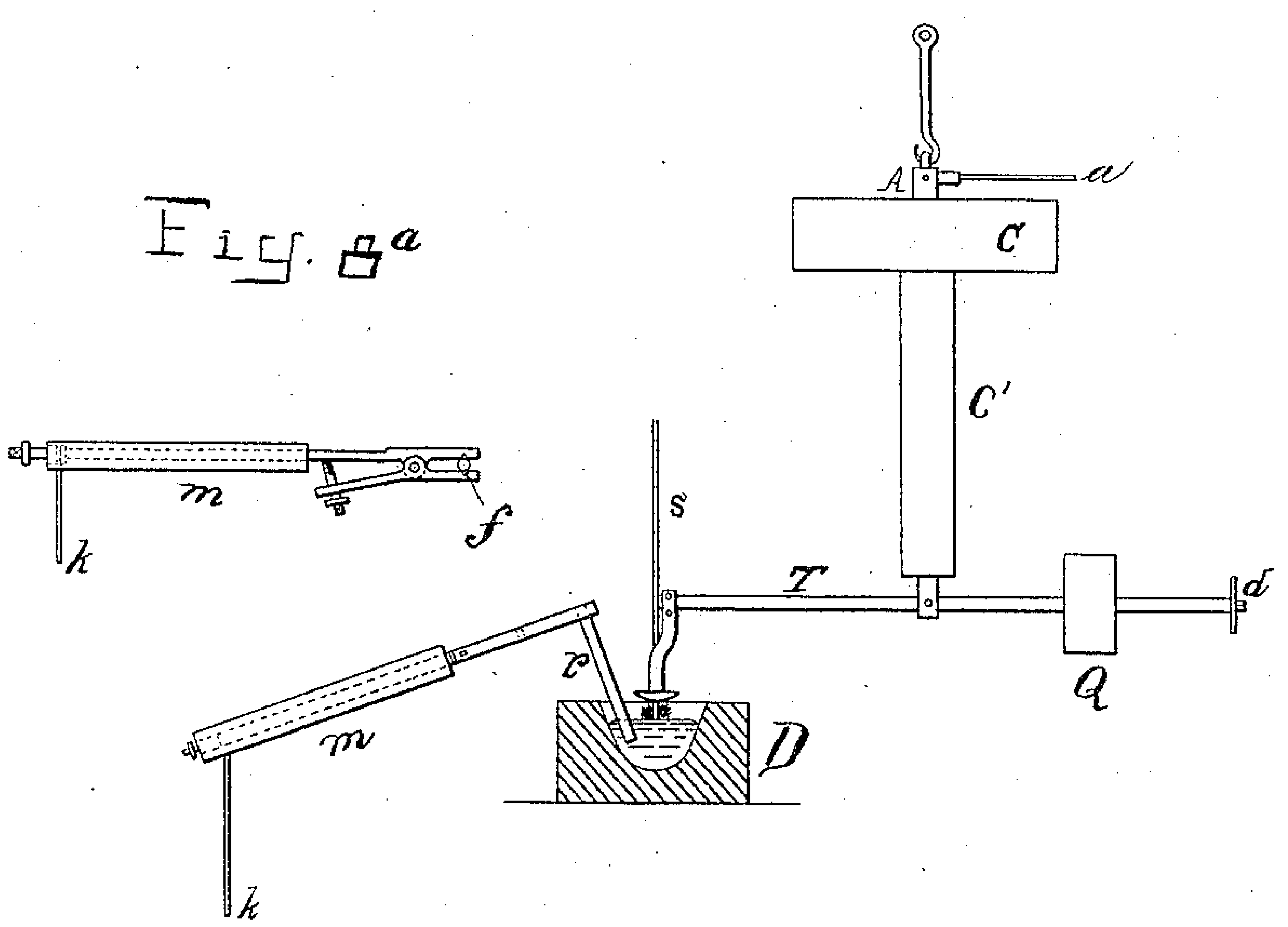

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Fig. 9.

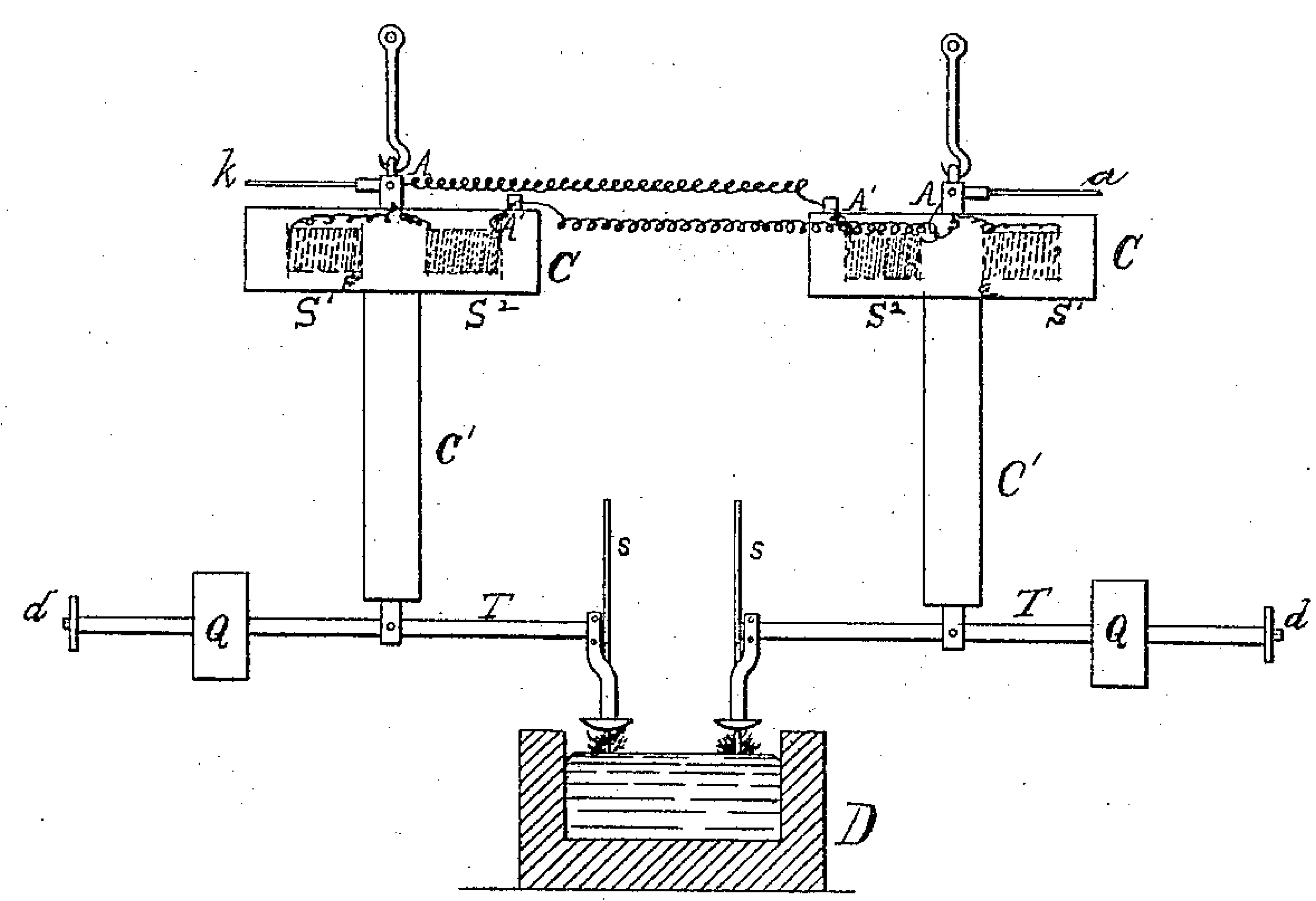
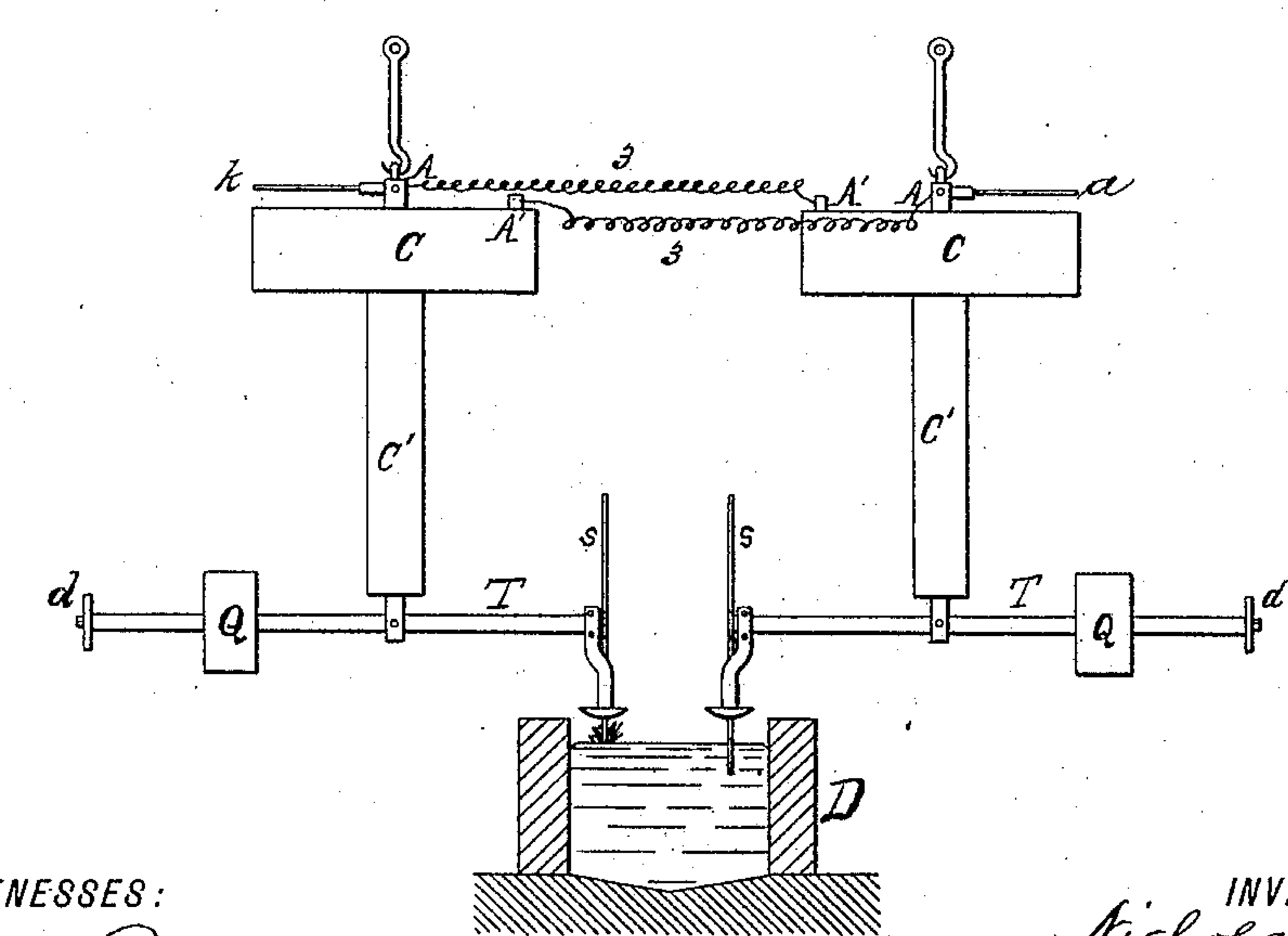


Fig. 10.



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NICHOLAS SLAWIANOFF, OF ST. PETERSBURG, RUSSIA.

ELECTRICAL CASTING OF METALS.

SPECIFICATION forming part of Letters Patent No. 577,329, dated February 16, 1897.

Application filed January 29, 1891. Serial No. 379,555. (No model.) Patented in Germany October 11, 1890, No. 57,417, and in England October 13, 1890, No. 16,279.

To all whom it may concern:

Be it known that I, NICHOLAS SLAWIANOFF, a subject of the Emperor of Russia, residing in St. Petersburg, Russia, have invented certain new and useful Improvements in Electrical Casting of Metals, (for which I have obtained British Patent No. 16,279, dated October 13, 1890, and German Patent No. 57,417, dated October 11, 1890,) of which the following is a specification.

This invention relates to a new process of casting metals and metallic articles or wares by means of an electric arc. Any metal or alloy may be employed for casting, but the material should be in the form of rods or bars more or less long, such as iron or steel rods, hoops, &c., rolled or forged steel, pig-iron, or cast-copper alloys of various thickness, depending in respect of dimensions upon the strength of electrical current and the size of the casting. Such a rod forms the one electrode of a self-regulating electrical arc, by the action of which it is rapidly melted. The continuous melting moderates more or less the temperature of the arc according to the fusibility of the melted electrode. This moderating of the temperature is of advantage, as thus is avoided the overheating of the metal resulting from the use of a carbon electrode. During the casting operation one pole of the electrical machine is connected to the mold, the other to the terminal of the automatic regulator, through which the current flows through the melting metal rod and thence through the arc into the mold. If the mold is non-conducting, the pole can be connected to a carbon or preferably a metal rod like that of the regulator, or thicker, placed in the mold, so that the arc is formed between the two rods until a certain quantity of melted metal has collected, whereupon the arc is formed between the regulator-rod and the fluid metal, while the mold-rod, being in contact with the fluid metal, rapidly melts, considerably accelerating the operation and also lessening the burning of the metal.

It is not immaterial which pole of the machine is connected to the mold and which to the regulator. For casting pig-iron the positive pole should be connected to the regulator, which is the melting rod. In casting other metals the one pole or the other is connected according to the result desired. Thus the part which is desired to be most heated is to be connected to the positive pole, which gives out higher temperature. Moreover, the positive and negative poles differ in respect of their chemical action on the melted metal. For example, if the melting rod of pig-iron is connected to the negative pole a hard useless casting is the result.

The best material for molds for pig-iron and copper alloys is compressed coke. For iron and steel the best is quartz sand with admixture of binding material. Electrical casting cannot be carried on without means of regulating the length of the arc. Any of the lamp-regulators may be employed as automatic regulators. It is only necessary to remove the carbon-holder and to place in the other the rod to be melted and finally to provide the solenoid or electromagnet with a greater number of coils.

Figure 1 is a vertical section of an apparatus for an electrical casting in accordance with my invention. Fig. 2 is a section at right angles to Fig. 1. Fig. 3 is a plan view, but with the casing which incloses the regulating-coils in section. Fig. 4 is a diagram drawn to a smaller scale. Figs. 5, 6, and 7 are sectional views illustrating a modification in which a differential regulator is employed; and Figs. 8, 8^a, 9, and 10 are diagrams illustrating different methods of operation.

A simple, substantial, and practical regulator is represented in longitudinal and transverse section in Figs. 1 and 2 and in sectional plan by Fig. 3. Its arrangement is as follows: On a fulcrum-pin O is pivoted a lever L, which carries a roller r, engaged in a slot of a bar k, connected to the horseshoe-shaped iron cores of the double solenoid S, which cores can move on three rollers r' within the casing C. A spring R, fixed to the lower part C' of the exterior casing of the regulator, acts on the lever L to urge the cores out of the solenoids. Each solenoid-coil is one piece of copper tube helically cut, so that no insulation is required and the coil can sustain considerable heat. The lower end of the lever L is formed with an eye through which passes an iron or steel tube T, capable of sliding to and fro in the eye unless held by the setting-screw W. Through the tube passes a spindle V, carrying at one end a hand-wheel *d* for turning the spindle and at the other end a grooved roller r'', of hard steel, against which another roller r''' is pressed by a strong spring *p*, Fig. 3. Below this are two other rollers, of which the one r^{iv} is fixed in position on a bracket p'' and the other is mounted on a spring p'. These four rollers serve to guide the melting rod *s*. A weight Q, adjustable on the tube T and secured by a set-screw W′, balances the rod and its guides. On the tube T is a clamp *z* with a carbon rod, the purpose of which is hereinafter explained. *x* is an iron shield through which the rod *s* passes and which protects the roller-guides from the heat and sparking of the metal.

In casting by aid of two regulators, as hereinafter described, a differential regulator is employed. Figs. 5, 6, and 7 represent the upper part of such apparatus. It has four solenoids, two wound with fine coils s^2 s^2 and two with thick coils s' s', with the cores in the form of the letter H. The current in Figs. 1, 2, and 3 takes the following course: The conductor *a*, the insulated clamp A, conductor a', the solenoid-coils, conductor a^2, the framing C C′, the melting rod *s*, the arc, the melted metal, or the mold and other rod, as indicated by Fig 4. When the differential regulator is used, one of the ends of the fine coils s^2 s^2 is connected to the insulated binding-post A, while the other end is connected to the insulated binding-post A′, which is connected by conductor 3 to the clamp A of the other regulator, Fig. 5. The coils s' s' are connected up as described with reference to the solenoid-coils of Figs. 1, 2, and 3.

The regulator is operated as follows: It is suspended by a cord from A over the mold, the conductors are properly connected, and the melting rod is put in its place. The operator, taking the regulator in his left hand, turns the hand-wheel *d* with his right until the melting rod touches the mold, whereupon the solenoid draws in the core, causing the arc to be struck, and the rod *s* begins to melt, the drops of molten metal collecting in the mold. While the rod melts the arc becomes so rapidly lengthened that but for the regulator it could not be maintained. As the arc lengthens the current becomes weakened, so that the spring R overcomes the attraction of the solenoid and the end of the tube T with the melting rod *s* descends. At longer or shorter intervals the rod is to be lowered by hand applied to the hand-wheel *d* to turn the spindle V and roller r'', which involves no difficulty, as the regulator corrects manual omissions and the arc is not interrupted. By the employment of the automatic regulator the current can be taken direct from the dynamo-machine without passing through accumulators. In fact, on suddenly closing a circuit of small resistance for a very strong current, which in the preceding case is unavoidable, the difference of potential becomes largely decreased and casting by a current direct from the machine would be impossible because the electric arc would cease immediately on beginning, as it would on any alteration of current strength by the falling of a drop of the molten metal or the like; but the automatic regulator diminishes the length of the arc at the proper time before its extinction. The electrical casting can be carried out in any of the following ways:

First, with a simple regulator. One pole *a* of the source of electricity is connected to the regulator. The other pole *k* is connected to the mold D when it is a conductor, or with the molten article, Fig. 4, or with a carbon or metal rod *t*, which is carried to the handle *m*, Figs. 8 and 8ª, and introduced into the mold.

Second, with the differential regulator. One pole *a* is connected to the binding-screw A of the one regulator, and the other pole *k* with the like binding-screw of the other regulator, and, besides, the binding-screw A′ for the fine coils of each regulator is connected to the binding-screw A of the other regulator through a conductor 3, Fig. 9. In this way it becomes possible with the regulators to melt with two arcs, Fig. 9, or, according to circumstances, with one arc, Fig. 10, the other acting as conductor. The melting rod of the one regulator is connected to the positive pole and the rod of the other to the negative pole. According as the one or the other arrangement is employed or both are adopted various optical phenomena and chemical results are obtained. In any case when a tolerably large rod of metal is melted small pieces of metal may be thrown into the fluid bath, which substantially promotes the operation and lessens the heat. In melting it is especially necessary to know the difference of potential, and it is also useful to have exact information as to the length of current. These may be ascertained by means of any known ammeters and voltmeters.

According to the above-described process very large pieces cannot be cast, but two pieces of metal may be united by casting metal into a space between them; but the most important and extensive application of the process consists in the improvement of cast and wrought pieces by melting into blow-holes of pig-iron and copper, into cracks, sand-blows, &c., in steel articles and vents in iron pieces, and the melting into defective parts of such articles, for which it is useful and often necessary first to heat the piece that is to receive the molten metal. When the part in which the metal is to be poured forms the mold, one obtains the metal in pure, sound, and soft condition. In this case the metal which fills the mold plays the same part as the plug of a furnace tap-hole.

A further condition of a good casting is that it should not be done in layers but in continuous mass, the whole size of the mold. Should the melting rod of the regulator not be enough to completely fill the space, it might be lengthened without interrupting the casting process, for instance, by screwing on an additional length, as shown at *y*, Fig. 1. In most cases, however, there is time to remove the part that may be burned and to substitute a new rod. The casting to fill blow-holes in iron castings involves the greatest difficulties on account of certain peculiarities which require attention. In the first place it is to be noted that not all kinds of pig-iron are suitable for melting rods. A proper choice has to be made. The rod must certainly be connected to the positive pole, but nevertheless it happens that after the casting and the piece have been annealed and when the casting is generally soft at the border of the melted metal with the metal into which it is poured there is a certain hardening, the iron being white and hard. If in such cases the piece has to be worked by tools, a further operation has to be done immediately after the casting and while the iron is still fluid, namely, to slacken the clamp W, Figs. 1, 2, and 3, and to move the tube T so that the carbon in the clamp Z is turned down, so as to form between it and the fluid iron an arc which is for some time maintained. No hardening will then be noticed and the pig-iron will be softer and richer in graphite than if the heating by the electric arc had been longer continued. This results from the fact that the fluid iron becomes enriched by obtaining graphite from the carbon rod. As is well known, more carbon passes from the positive pole to the negative than from the negative to the positive, and this is probably the reason for the enrichment of the iron with carbon when the carbon is connected to the positive pole. When the contrary connection is made, very white hard iron is the result. The above does not apply when iron articles are cast in molds that are not metallic. When such molds are employed any pig-iron can be used, and even wrought-iron can be cast, provided that the mold is of coke, so that the iron can become converted into pig by absorbing carbon from the mold. Other but less important applications of electrical casting might be mentioned.

The process might with advantage be used in the following cases:

First. Casting objects of moderate size in the usual way of any desired metal which can be rendered fluid by the process. The regulator has to act as the one electrode. The crucible or the rod placed in it or the metal that collects in it has to serve as the other electrode. This operation can also be used in special cases, as, for instance, when an article has to be hurriedly cast and there is no furnace available or when on account of the smallness of the article it is not worth while to heat up a furnace.

Second. Casting metals, alloys, and substances which, though conductors, are highly refractory and cannot without great difficulty be melted by usual methods.

Third. Casting simultaneously several metals or alloys in certain proportions, for which purpose, instead of a single rod in the regulator, rods of the several substances are placed so as to melt together and fill the mold.

Fourth. Casting when alterations in the chemical conditions and physical properties of the cast metal are desired. Experiments show that (*a*) brass, after electrical casting, becomes materially altered chemically in consequence of the burning out of the zinc, and probably also in its physical properties, color, strength, &c. (*b*) Iron and steel after being run through a carbon tube are converted into pig-iron when cast in a coke-mold, this iron being so rich in graphite that it almost has the appearance of graphite and seems, moreover, to contain small portions of diamond, for, notwithstanding its general softness, some portions of its surface cut glass. (*c*) When a thin layer of the white hard pig-iron has been melted and heated, as above described, by the carbon electrode connected to the positive pole, it changes into a fine soft gray iron to the depth to which the melting extended in the casting operation. This alteration is a source of great advantage to electrical casting because this process renders it possible: (*a*) to cast parts of machines from any kind of iron, even unsuitable kinds, such as scrap, the surface of the casting being softened by the process, and (*b*) to improve castings which have accidental hardening at the junctions.

I claim as my invention—

The method of casting metals, consisting in the formation of an electric arc between a metallic rod, which procures the metal to be melted and forms at the same time one of the electrodes of the arc, and the contents of the mold (the metallic object in the mold), which forms the other electrode of the arc, and in continuously regulating the electric arc formed, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

NICHOLAS SLAWIANOFF.

Witnesses:

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J. FLIERLING.