(No Model.) 5 Sheets—Sheet 1.

G. D. BURTON & E. E. ANGELL.

ELECTRICAL METAL WORKING.

No. 505,263. Patented Sept. 19, 1893.

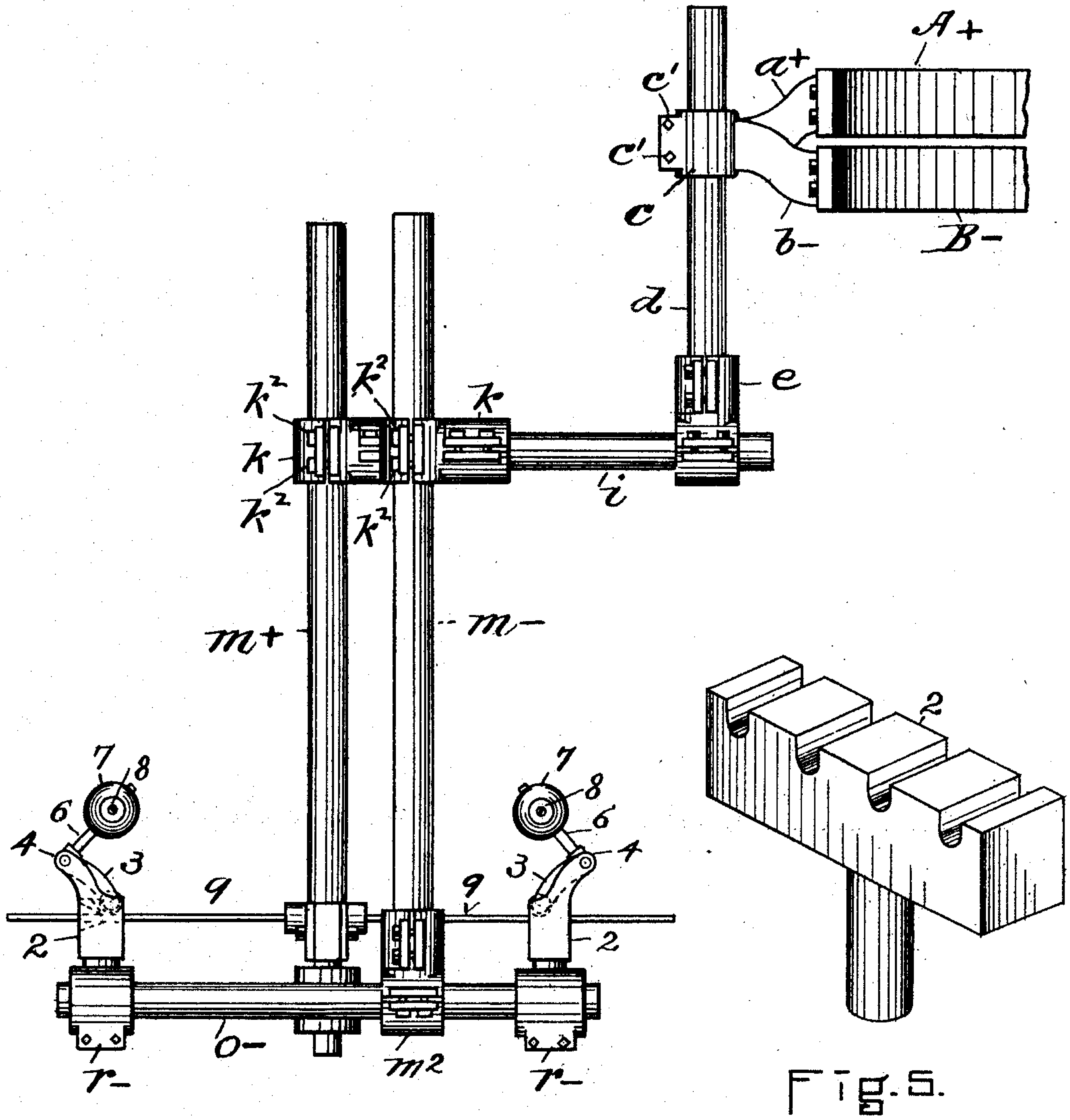

Fig. 1.

Fig. 5.

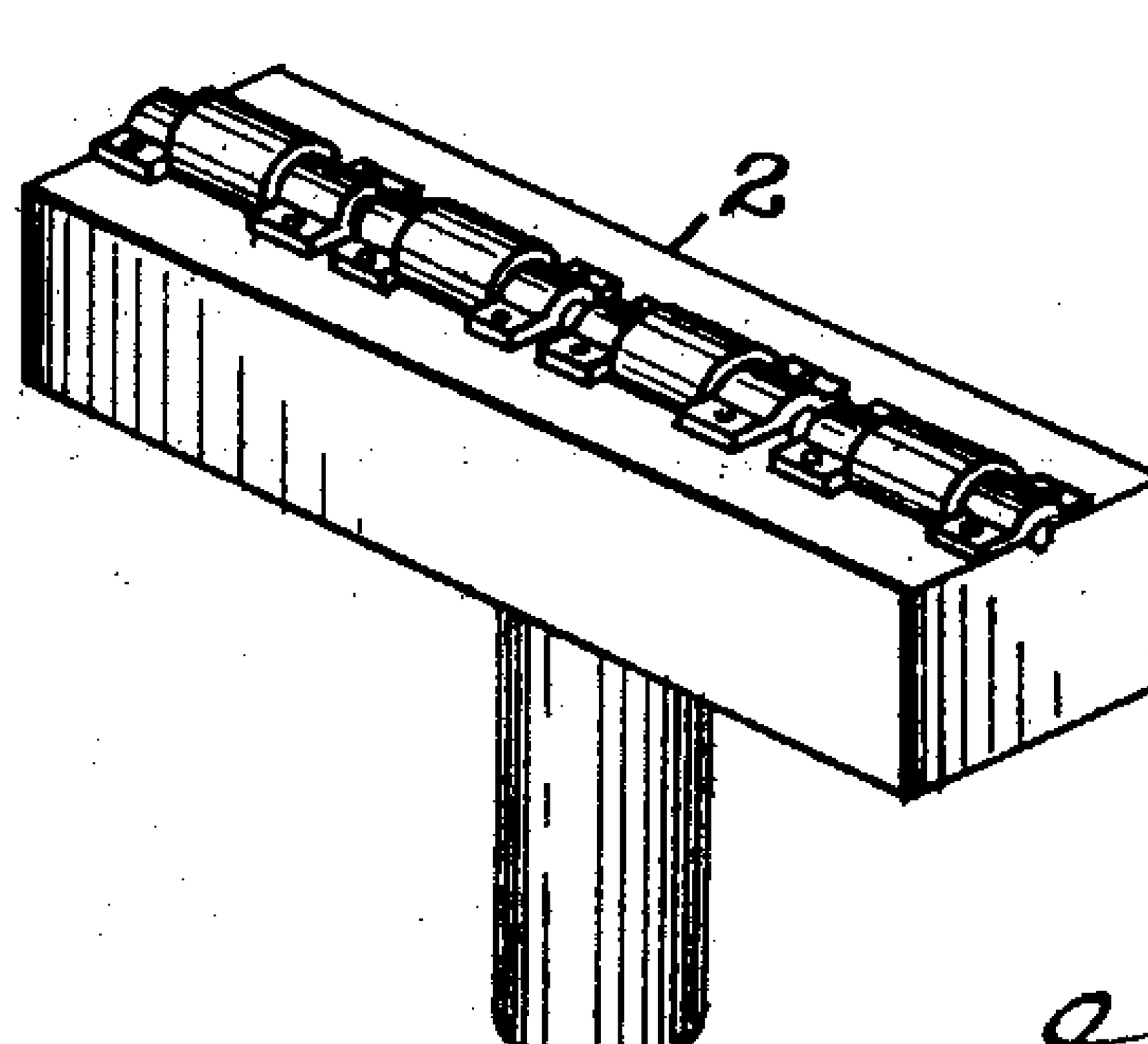

Fig. 6.

WITNESSES:

[signature]

A. G. Barnes,

INVENTORS:

Geo. D. Burton

E. E. Angell,

By F. C. Jones

Attorney

(No Model.)

5 Sheets—Sheet 2.

G. D. BURTON & E. E. ANGELL.

ELECTRICAL METAL WORKING.

No. 505,263. Patented Sept. 19, 1893.

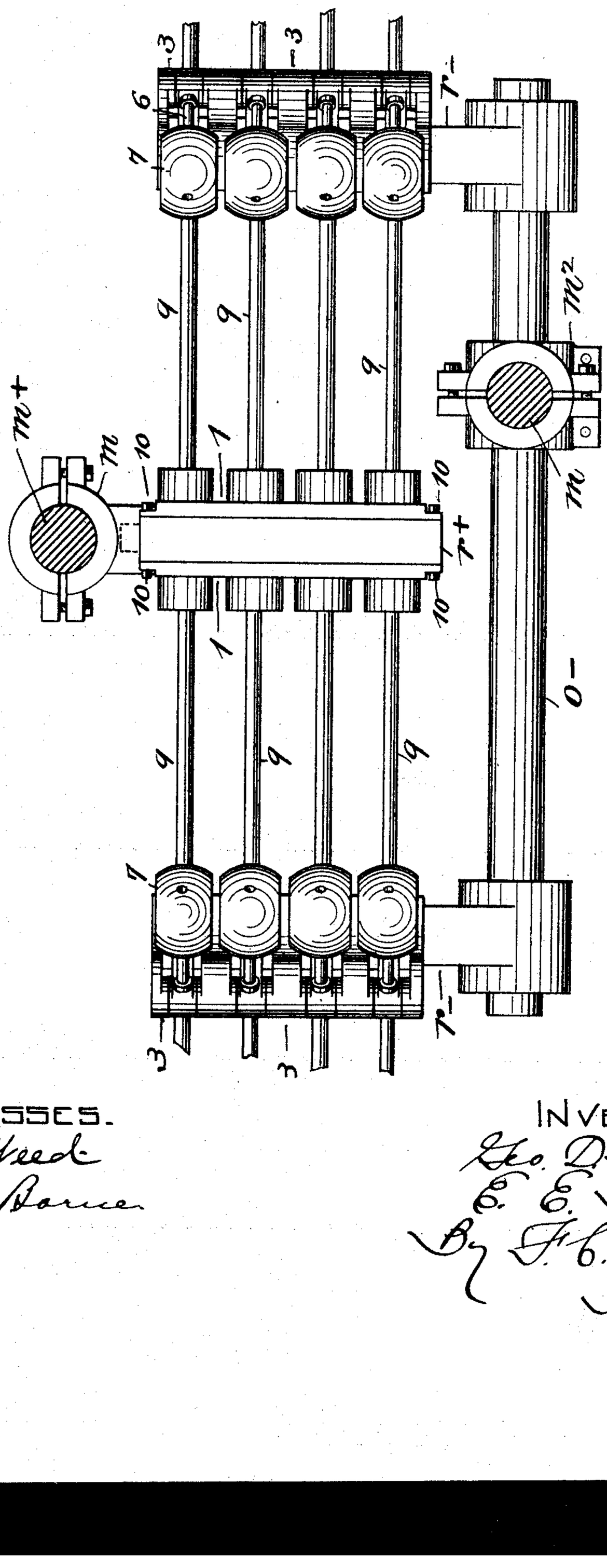

Fig. 2.

WITNESSES.

C. Allred

N. J. Bonner

INVENTORS:

Geo. D. Burton,

E. E. Angell,

By F. G. Jones,

Attorney.

(No Model.) 5 Sheets—Sheet 3.

G. D. BURTON & E. E. ANGELL.

ELECTRICAL METAL WORKING.

No. 505,263. Patented Sept. 19, 1893.

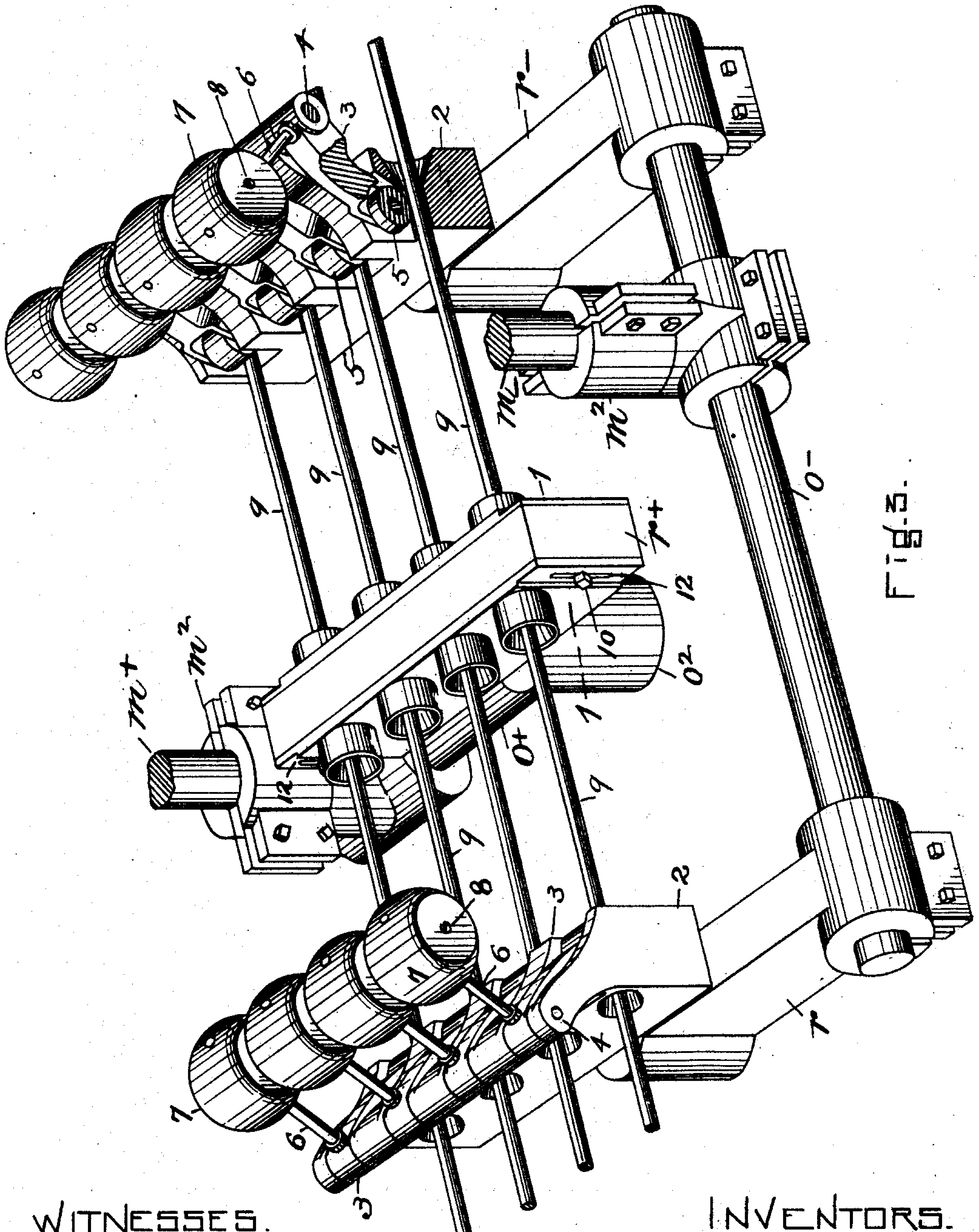

Fig. 3.

WITNESSES.

INVENTORS.

Geo. D. Burton

E. E. Angell.

By F. C. Somes

Attorney.

(No Model.)

5 Sheets—Sheet 4.

G. D. BURTON & E. E. ANGELL.

ELECTRICAL METAL WORKING.

No. 505,263. Patented Sept. 19, 1893.

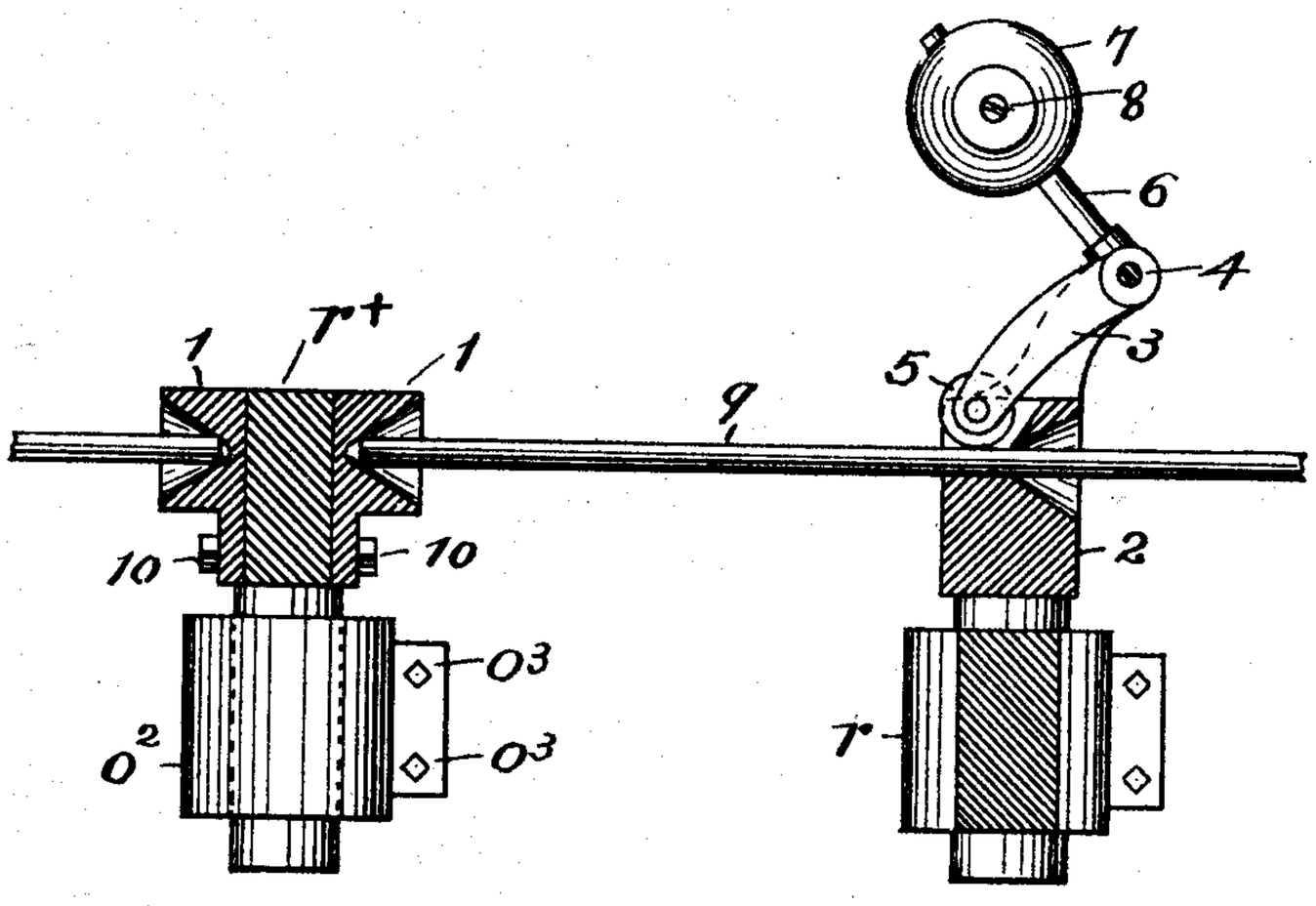

Fig. 4.

WITNESSES.

C. Allred
H. G. Barnes.

INVENTORS:

Geo. D. Burton
E. E. Angell
By F. B. Somes
Attorney.

(No Model.)

5 Sheets—Sheet 5.

G. D. BURTON & E. E. ANGELL.

ELECTRICAL METAL WORKING.

No. 505,263. Patented Sept. 19, 1893.

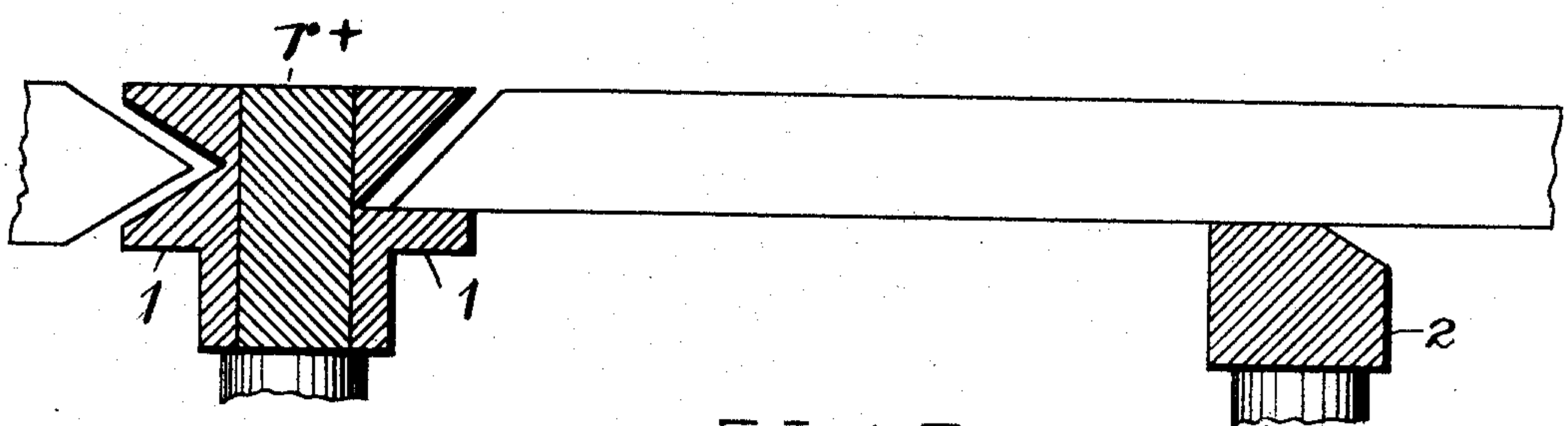

Fig-7-

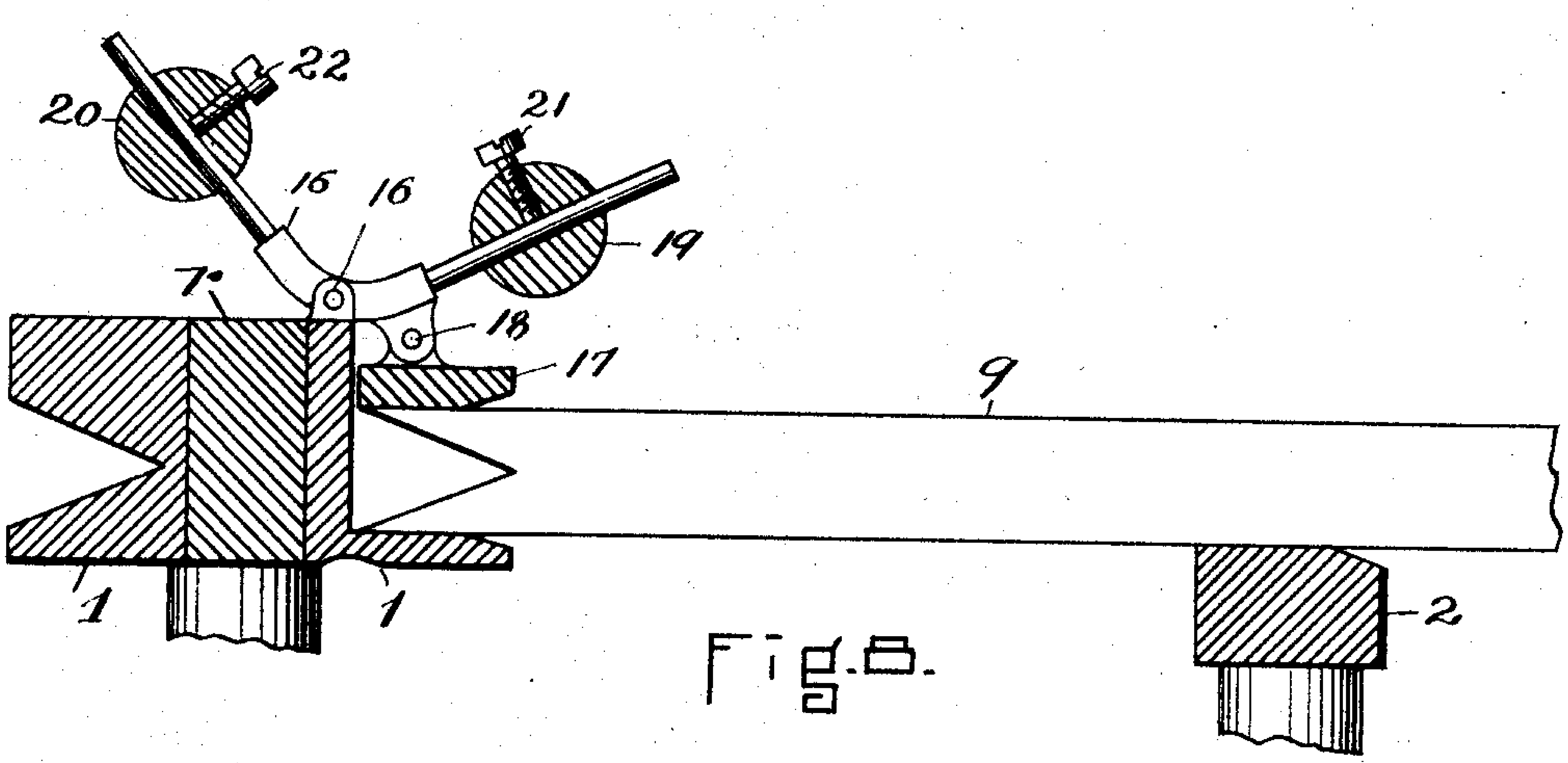

Fig-8-

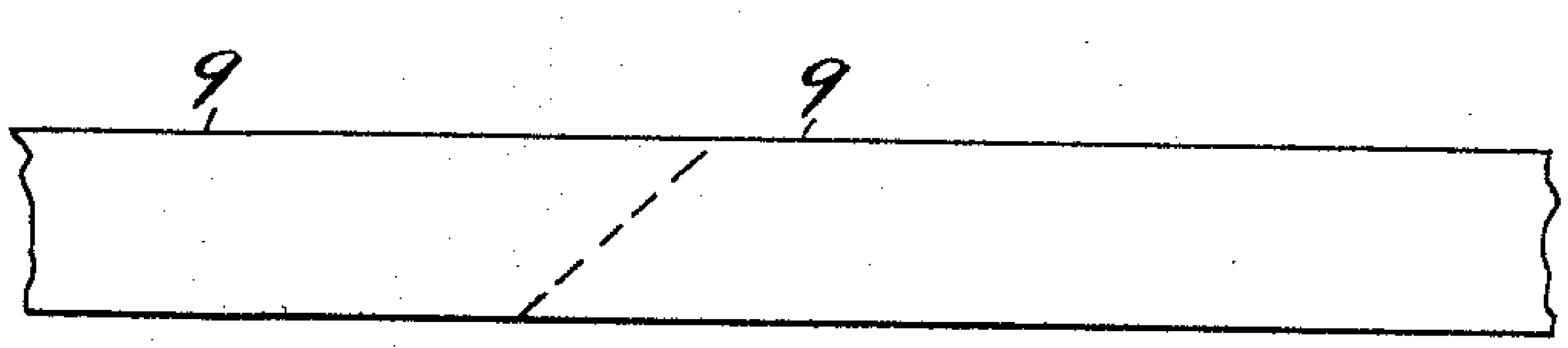

Fig-9-

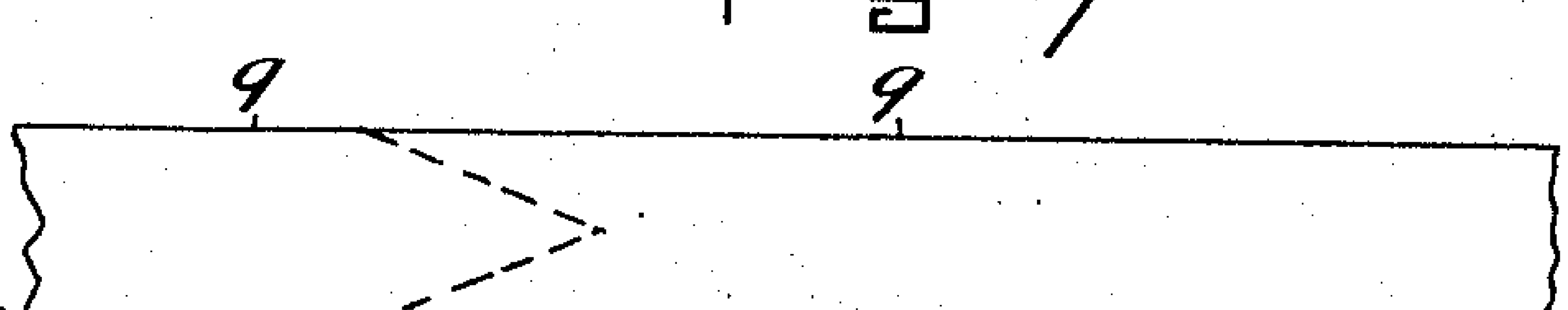

Fig-10-

WITNESSES-

C. A. Reed.
A. J. Barnes,

INVENTORS

Geo D. Burton
E. E. Angell,
By [signature]
Attorney

UNITED STATES PATENT OFFICE.

GEORGE D. BURTON, OF BOSTON, AND EDWIN E. ANGELL, OF SOMERVILLE, MASSACHUSETTS, ASSIGNORS TO THE ELECTRICAL FORGING COMPANY, OF MAINE.

ELECTRICAL METAL-WORKING.

SPECIFICATION forming part of Letters Patent No. 505,263, dated September 19, 1893.

Application filed February 27, 1892. Serial No. 423,089. (No model.)

To all whom it may concern:

Be it known that we, GEORGE D. BURTON, of Boston, in the county of Suffolk, and EDWIN E. ANGELL, of Somerville, in the county of Middlesex, State of Massachusetts, have invented a new and useful Improvement in Processes of Forging and Welding Metals by the Aid of Electricity and Apparatus Therefor, of which the following is a specification.

Our invention relates to a new and useful method of forging and welding metals by the aid of the electric current and to the apparatus therefor, substantially as hereinafter described and claimed.

In the drawings:—Figure 1 is a side elevation of one form of our apparatus embodying our improvements. Fig. 2 is a top plan view of a portion of the same, partly in section. Fig. 3 is a perspective view of the same. Fig. 4 is an enlarged view of a pair of the electrodes of Fig. 3, shown in vertical section. Figs. 5 and 6 are modifications of one of the electrodes. Fig. 7 is another form of electrode, also in vertical section. Fig. 8 is another form of the same with a graduating pressure apparatus attached thereto. Fig. 9 is an illustration of one form of welding iron bars together by our method, and Fig. 10 shows another form.

In the electrical heating of metals preparatory to forging and welding them, several difficulties arise from the nature of the electric current, and the laws governing its passage through the metal to be heated. Thus while with the electric current which we employ it is comparatively easy to heat a metal bar of equal area in cross section in all its parts to an even working heat, of the degree desired for welding, tempering or forging, it has been found difficult to do so when the bar is larger in one part, than in another through which the current passes. In such cases the smaller part of the bar in cross section heated first and the larger part, owing to its affording an easier passage for the electric current, either failed to heat under the direct action thereof, or else heated so much more slowly than the smaller part, that it could not be brought up to an even heat with the latter. It is also well known that when the electrodes are made large enough to have a sufficiently wide bearing on the bar of metal, and especially when these wide electrodes are clamped firmly upon the bar, the metal, between the clamping parts upon it of the same electrode, does not materially heat by the action of the current, but that, even when the metal between the electrodes of opposite polarity is raised under the heating action of the current to a glowing white heat, the bar may be grasped in the naked hand at the part clamped in either electrode, and carried about until it has become too hot by its own conductivity to be thus held. This heating by conductivity requires a considerable degree of time. On the other hand it is also well known, that when the bar was thrust endwise against an electrode with an imperfect contact, while the other electrode made a perfect contact as above described, the bar heated at its end and burned off before its heat between the electrodes was raised to the working point desired. Our invention is based upon these known facts, and we so fashion our electrodes, and form them of materials of different conductivity, and so manipulate a bar of varying cross section in its different parts as to give to these the same degree of working heat substantially in the larger as in the smaller parts. We thus avoid the necessity of passing the electric current transversely through the bar in each part separately, by which it was attempted to overcome these difficulties. Another part of our invention is based upon our discovery that we can cause one part of the bar to heat more readily than another, by cleaning off the scale and oxidized surface from that part, as hereinafter described.

A+ and B— are the conductor rings of an electric converter of opposite polarity; this converter and the source of electricity with which it is connected being of the same construction and operation as shown in the application of Burton, Eddy and Briggs, filed September 15, 1891, Serial No. 405,751. From these rings the arms, *a*+ and *b*—, project outward and carry on their ends vertical sleeves, *c*. In the latter sleeves rods, *d*, slide up and down and are secured in place by the clamp screws, *c'*, *c'*, and carry on their lower ends

the horizontal sleeves, *e*, clamped upon them. The sleeves, *e*, in turn carry the horizontal rods, *i*, which have the vertical sleeves, *k*, *k*, attached to their outer ends. Into these are fitted the vertical rods, *m*+ and *m*−, which can be slid up and down and clamped in place in the sleeves by the set screws, k^2, k^2. On the lower ends of the rods, *m*+, *m*−, are attached the sleeves, m^2, m^2, which as shown in Figs. 2 and 3, are some distance apart horizontally. One of the latter sleeves supports the horizontal rod, *o*+, (Fig. 3) while the other supports the horizontal rod *o*−.

Rod *o*+ supports upon its end the sleeve, o^2, in which the block, *r*+, is supported by a downwardly projecting stem secured by clamp screws, o^3, o^3. (Figs. 1, 3 and 4.) To this block are attached the positive electrodes 1, 1, for heating. The rod, *o*−, supports on its ends the blocks, *r*−, *r*−, each of which has a horizontal sleeve at one end surrounding the rod, and has a vertical sleeve at the other end; these sleeves being split and provided with clamp screws to compress them. In these vertical sleeves are set the negative electrodes, 2, 2, by stems, 3, (Fig. 4) projecting downward through the sleeves. The purpose of the combination of rods and sleeves, as described, is to enable the electrodes to be adjusted up and down to suit the operator, as well as to be adjusted for heating longer or shorter bars of metal, and to be aligned perfectly with each other to suit different classes of work to be heated. The blocks *r*− and electrodes 2, 2, may be made of the same metal as the electrodes 1, 1, in which case copper would be preferable, and the series of rods and sleeves connecting the converter rings, A+ and A−, with these blocks and electrodes are also preferably made of copper. We prefer, however, that the blocks *r*−, *r*−, and electrodes 2, 2, should be made of a different metal from that of the electrodes 1, 1, having less conductivity, for the reasons hereinafter specified, as for instance, iron when the electrodes 1, 1, are of copper. The electrodes 1, 1, may be of several different forms, to suit the shapes of the ends of the various bars to be heated as, for instance, conical as in Fig. 4, or double or single wedge-shaped as in Fig. 7, or with parallel movable jaws as in Fig. 8. The electrodes 2, 2, may also be made either with a presser jaw to increase the contact by pressure as in Figs. 1 to 4 inclusive or with a grooved surface as in Fig. 5, or with rollers for very heavy bars as in Fig. 6, or in the form of a plain block as in Figs. 7 and 8.

The movable jaw, 3, Figs. 1 to 4 inclusive, is pivoted on the axis 4. It may be either plain, or provided with a roller, 5, in its bearing face, under which roller the bar slides when it is inserted in the electrodes to be heated. From opposite the axis, 6, a rod projects out over the jaw on which the movable weight, 7, is mounted, and secured in place by the set screw 8. By adjusting the weight out or in on the rod 6, the pressure of the jaw 3 on the bar being heated may be varied.

The electrodes 1, 1, are made to receive the ends of the bars, and the electrodes 2, 2, to support the middle parts of the bars. The electrodes 1, 1, are secured to the block, *r*+, by set screws, 10, passing through vertical slots, 12, which allows them to be adjusted up and down to correspond with the electrodes 2. Two sets of electrodes are secured on opposite sides of the block, *r*+, which enables two workmen to use the electric forge at once, as one set of electrodes 2 faces each set on the block *r*+. By sliding the rod, *o*−, in the sleeve, *m'*, horizontally, the distance between each set of electrodes 2 and its opposite electrodes 1 may be lengthened or shortened to accommodate different lengths of bars to be heated.

Each workman is supplied with a set of two or more electrodes, 1 and 2, on his side of the block, *r*+, in order that he may have bars being heated, while he is working at the anvil, or by other tools, upon those which have been heated. He is thus always enabled to have a vacant pair of electrodes, into which to thrust the bar, after working and removing the heated part, so as to continue the heating process and work it again. The bars 9, 9, to be heated are thrust through or over the electrodes, 2, and their ends inserted in or upon the electrodes 1, 1.

In Fig. 8 is shown in side view a double weighted lever, carrying a pivoted electrode presser foot, for use in our process of heating the parts of beveled bars to form a lap weld, although it may also be found useful in other classes of metal working. The lever, 15, is hung on the pivot, 16, at its middle portion and carries the presser foot, 17, pivoted at 18 on the ear of the lever. This enables the presser foot to adjust itself to an even bearing on bars of different thicknesses while being heated. On the two arms of the lever are slipped the balls, 19, 20, which can be secured in any particular adjustment by the set screws, 21, 22, so as to provide for the utmost nicety of pressure on the bar, which is of importance when bars of the form shown in this figure are to be heated for lap-welding, as illustrated by the dotted lines on the bar in Fig. 10.

In order to heat bars evenly which are smaller in one part than another, as for example the bevel-ended bars shown in the drawings, clear to their smaller ends for lap-welding, tempering, &c., we have discovered that it is necessary to graduate the amount of bearing surface of the bar at its end upon the electrode 1, either when it is placed upon the electrode, or while the heating progresses, and it is also necessary to proportion the relative freedom of flow of the electric current to the bar at the electrodes 1 and 2. That is to say, if the proportion of contact of the electrode with the bar at the electrode, 2, is greatly in excess of that on its end at the electrode 1,

the bar will burn or melt at its extreme end before heating far enough along its length to make a good lap weld, or temper it well. On the other hand, if the amount of contact with the bar at and near its extreme end on electrode, 1, is in excess of that at electrode 2, it will begin to heat at the latter first. By forming the electrode, 2, of a metal of less conductivity as iron, and the electrode, 1, of a metal of greater conductivity as copper, we are able to balance the conductivity of the two (so to speak) and employ a much less area of contact on the copper than on the iron electrode, which enables the operator to more readily control the heating of the end of the bar to an even heat, without burning or melting the thinner portion of it, while at the same time the iron electrode, 2, has so broad a bearing on the bar, 9, as not to burn or melt it in one place, as might be the case with an electrode of copper having a very narrow bearing on the bar. The copper electrode, 1, should be so formed that when the bar is shoved clear on to it, the bar will begin to heat at that end just outside of the electrode, on account of the excess of contact at its extreme end. The operator watches the heating, and withdraws the bar, 9, just far enough to have the heat run down toward its thin end and raise that to the same working heat as the thicker part of the bar to be worked, and thus accomplishes the new result of raising the thicker and thinner parts of the bar to the same working heat. Two bars of iron or steel being thus simultaneously heated are then taken to the anvil and welded together in the usual way, forming a perfect lap weld, as shown in Fig. 9 or 10, by the dotted lines where the weld takes place.

The use of the presser foot, as shown in Fig. 8, enables the operator to manipulate the bar with two thin ends in the manner above described. In actual practice the pivots and parts of the lever, 15, and foot, 17, will of course be made large enough to freely convey the electric current to the upper member of the bar to be heated, and the lower contact part of the electrode will also be made thinner back of the contact part, so as to equalize the flow of the current to the two parts of the end of the bar.

In order to have the beveled part of the bar, which is to be lap-welded to the other bar, heat as rapidly as possible and with the least expenditure of the electric current, we have discovered that it is advantageous to remove all rust or scale from that particular surface. We do this either by shearing off the bar on that surface, or by cleaning and even polishing it. When so prepared it will be found that the higher internal heat, which the electric current gives to the interior of the bar, will come out upon the surface more rapidly than in other parts not so treated, and save time and expense in the heating process. In like manner, in tempering steel tools, such as chisels, &c., the manipulation of the bar previously beveled to an edge will enable the operator, as above described, to give a higher temper to the surface which forms the cutting edge, as it is sharpened by grinding, than to the adjacent parts of the metal which are intended to be ground away in the sharpening process, thereby forming a better tool and one more easily sharpened. If it be desired to do so, the operator can so manipulate the bar to be heated that it shall be brought up to the working heat first at the iron electrode, 2, and that heat be made to traverse through the bar to the electrode, 1, before the end of the bar in that electrode has even been raised above a black heat, thereby insuring that the thin beveled end of the bar shall not be injured by premature heating, and this thin end may then be brought up last to the same working heat.

What we claim as new and of our invention is—

1. In an electric metal-heating apparatus, the combination of the pivoted sleeves *k*, *k*, respectively connected to opposite terminals of the converter, the rods *m*+, *m*−, respectively connected thereto, the bar, *o*+, connected to one of said rods and carrying an electrode of one polarity arranged to receive the bar to be heated, and a vertically pivoted block, *r*−, connected to the other of said rods and carrying an electrode of the opposite polarity, arranged to make contact with another part of the metal bar to be heated, all arranged substantially as described, whereby said electrodes may be swung into different positions and brought into proper alignment with each other, substantially as described.

2. In an electric metal-heating apparatus, the combination of two electrodes respectively connected to opposite terminals of the converter by metal bars arranged to slide vertically in holding sleeves, and to adjust said electrodes at different heights to receive the metal bar to be heated, and accommodate the workman using the same, substantially as described.

3. In an electric metal-heating apparatus, the combination of two electrodes respectively connected to opposite terminals of the converter, by metal bars arranged to slide vertically and pivot in holding sleeves and to adjust said electrodes in alignment with each other at different heights and positions, to receive the metal bar to be heated and accommodate the workman substantially as described.

4. In an electric metal-heating apparatus, the combination of an electrode arranged to receive the end of the bar and connected to one terminal of the converter, the electrode, 2, connected to the other terminal and arranged to allow the metal bar to be thrust through it to be placed in the electrodes, and the weighted lever, 3, connected to the latter one and arranged to automatically lift as the

metal bar is thrust under it, and to take a bearing thereon during the heating process, substantially as described.

5. In an electric metal-heating apparatus, the combination of a series of electrodes, arranged to receive the ends of the bar to be heated and connected to one terminal of the converter, and a series of electrodes connected to the other terminal and arranged to allow the metal bars to be thrust through them to be placed in the electrodes, and a series of weighted levers, 3, connected to the latter series of electrodes and respectively arranged to lift as the metal bar is thrust under them, and to take a bearing thereon during the heating process, substantially as described.

6. In an electric metal-heating apparatus, the combination of one electrode connected with one terminal of the source of electric energy and arranged to bear upon one part of the metal to be heated, formed of a metal of one degree of conductivity, with another electrode connected with the opposite terminal of the source of electric energy, and arranged to bear upon another part of the metal to be heated, and formed of a different metal of a substantially greater or less degree of conductivity than the metal of the first electrode, substantially as described.

7. In an electric metal-heating apparatus, the combination of one electrode, 2, connected to one terminal of the converter, the other electrode, 1, connected to the opposite terminal, and the weighted lever, 15, pivoted to the latter electrode carrying the pivoted presser foot, 17, arranged to bear upon the metal bar to be heated, substantially as described.

8. In an electric metal-heating apparatus, the combination of one electrode, 2, connected to one terminal of the converter, the other electrode, 1, connected to the opposite terminal, and the lever, 15, pivoted to the latter electrode, provided with opposite balancing arms and weights, 19 and 20, and with the presser foot, 17, attached thereto and arranged to bear upon the metal bar to be heated, substantially as described.

9. The combination of two outer bars, each carrying a series of electrodes, all connected with one electric pole; and an intermediate bar connected with the opposite pole of the same circuit and provided on its opposite side with two series of adjustable electrodes disposed respectively opposite the electrodes of the outer bars, whereby two workmen can work on opposite sides of the same forge utilizing the same current, substantially as set forth.

10. The method of heating a bar of metal of different sizes in cross-section, which consists in adjusting the bar on electrodes so as to secure a large area of contact until the larger portion is sufficiently heated, and then gradually reducing the contact of the smaller portion, substantially as set forth.

11. The method of heating a bar of metal of different sizes in cross-section, which consists in placing said bar in contact with electrodes of opposite polarity, and holding a smaller cross section largely in contact with one of said electrodes until the larger cross-section is sufficiently heated, and then reducing the electric contact of the smaller cross-section, substantially as set forth.

12. The method of heating a bar having a tapered end, which consists in placing it between electrodes of opposite polarity, and holding its tapered end largely in contact with one of said electrodes until the larger portion of the bar is raised to the desired temperature, and then gradually reducing the area of contact of the tapered end with its electrode, substantially as set forth.

13. The method of heating a metal bar of different areas in cross-section at different parts to a substantially even working heat, which consists in subjecting the bar to the action of an electric heating current and graduating the area of contact surface between the bar and the electrodes during the heating operation.

In testimony whereof we affix our signatures in presence of two witnesses.

GEO. D. BURTON.
EDWN. E. ANGELL.

Witnesses:
CHESTER MARR,
J. W. GAGE.