No. 748,107. PATENTED DEC. 29, 1903.

A. SAUVEUR & J. WHITING.

APPARATUS FOR DETECTING THE TEMPERATURE OF METALS.

APPLICATION FILED JUNE 10, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

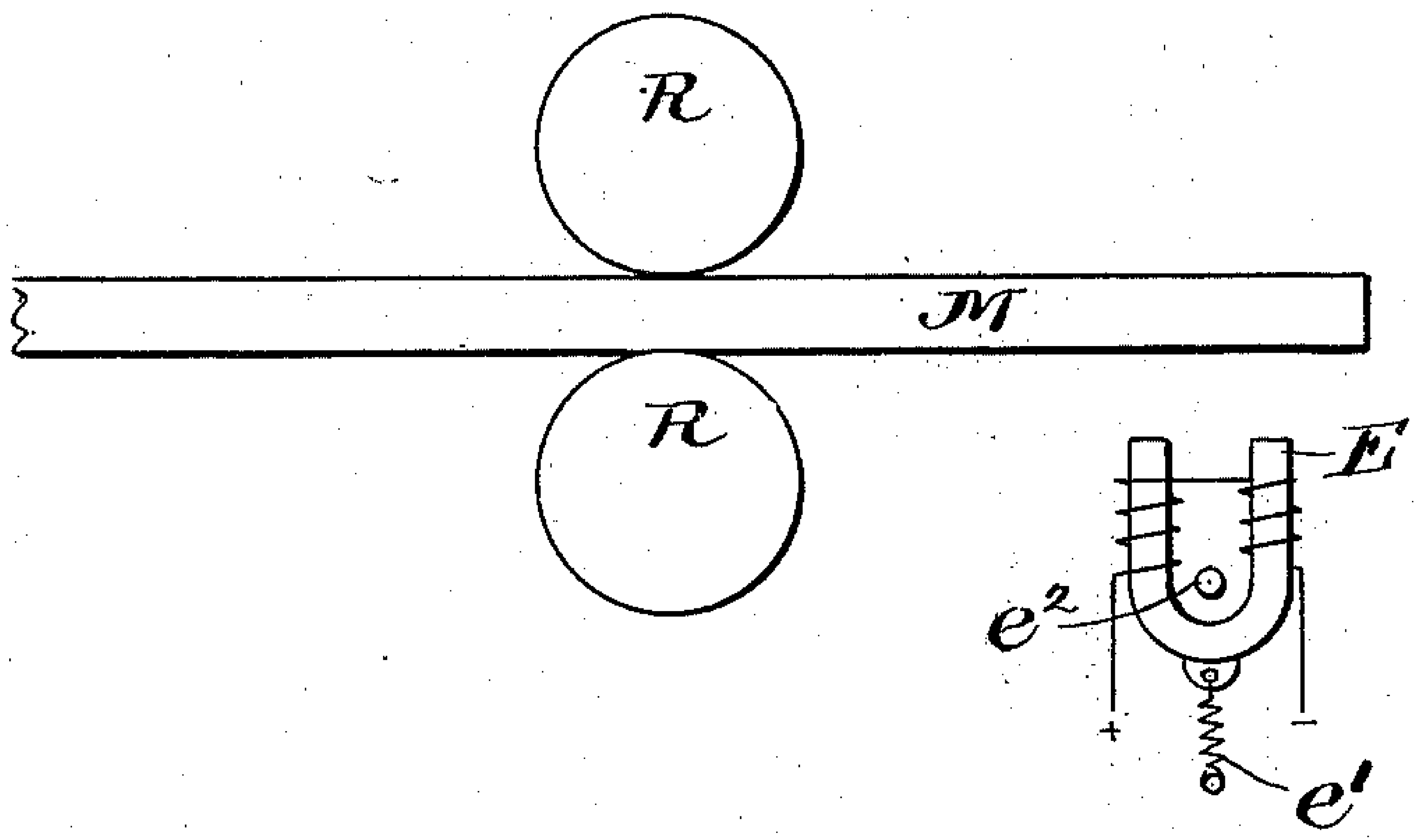


Fig. 2.

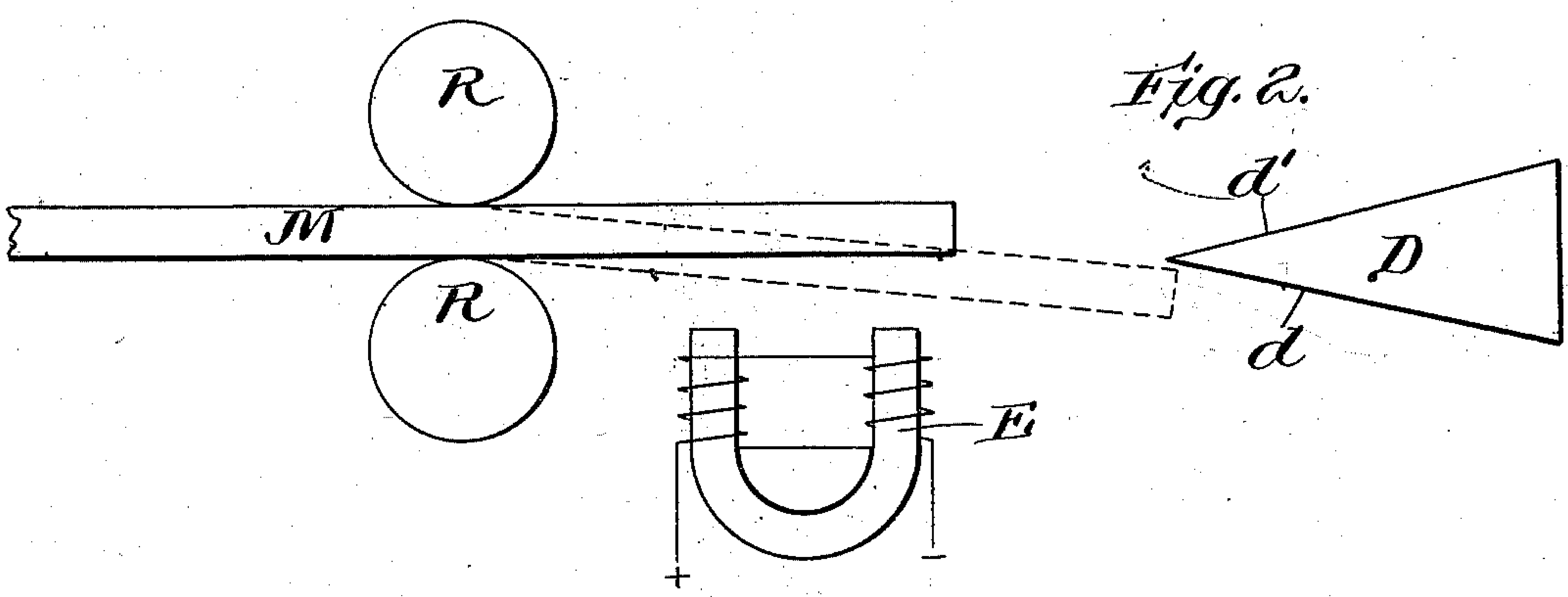
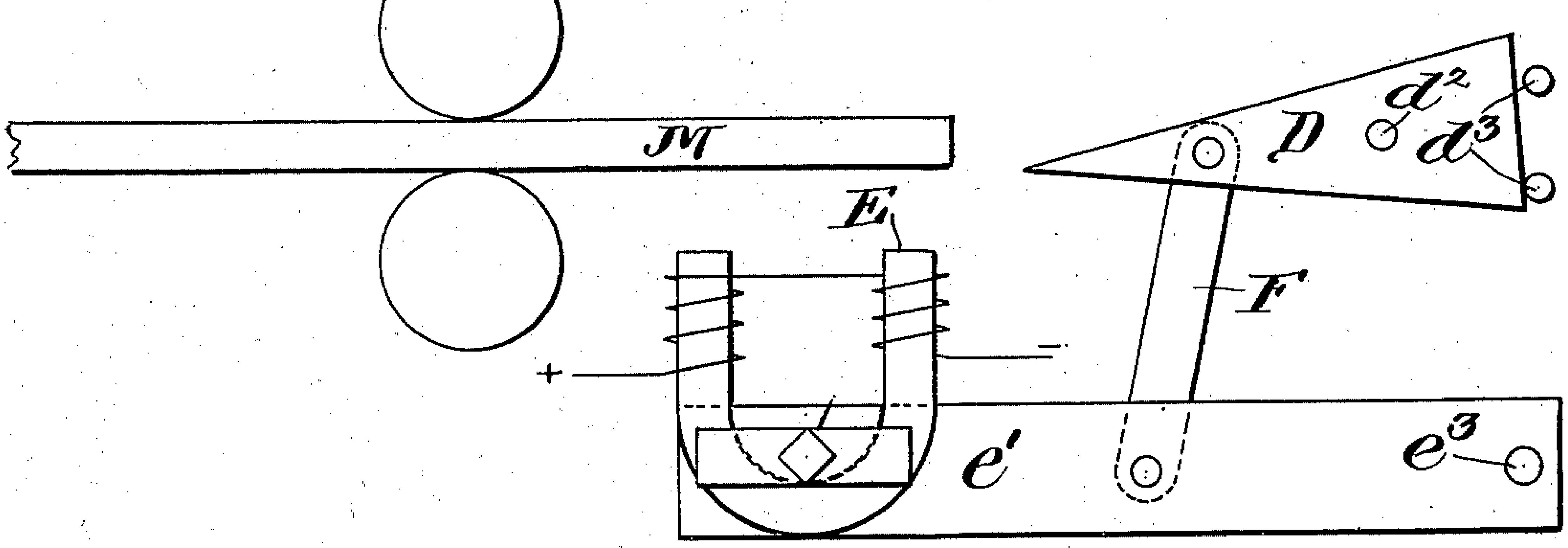


Fig. 3.



Witnesses:

Arthur F. Randall

Joseph T. Brennan

Inventors

Albert Sauveur,

Jasper Whiting,

by Roberts & Mitchell,

Attorneys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 748,107. PATENTED DEC. 29, 1903.

A. SAUVEUR & J. WHITING.

APPARATUS FOR DETECTING THE TEMPERATURE OF METALS.

APPLICATION FILED JUNE 10, 1903.

NO MODEL. 4 SHEETS—SHEET 2.

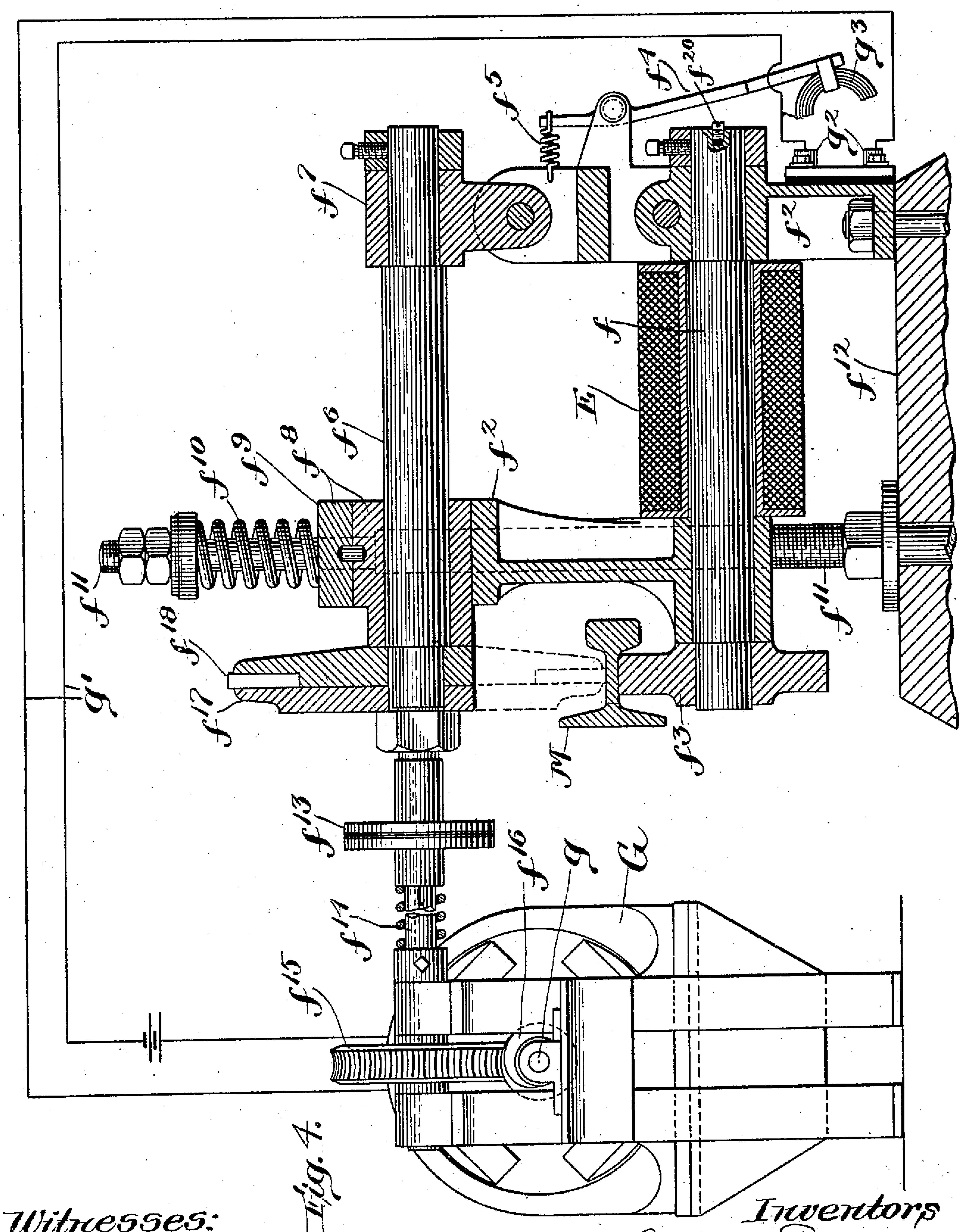


Fig. 4.

Witnesses:

Arthur T. Randall.

Joseph T. Brennan

Inventors

Albert Sauveur,

Jasper Whiting.

by Roberts + Mitchell,

Attorneys.

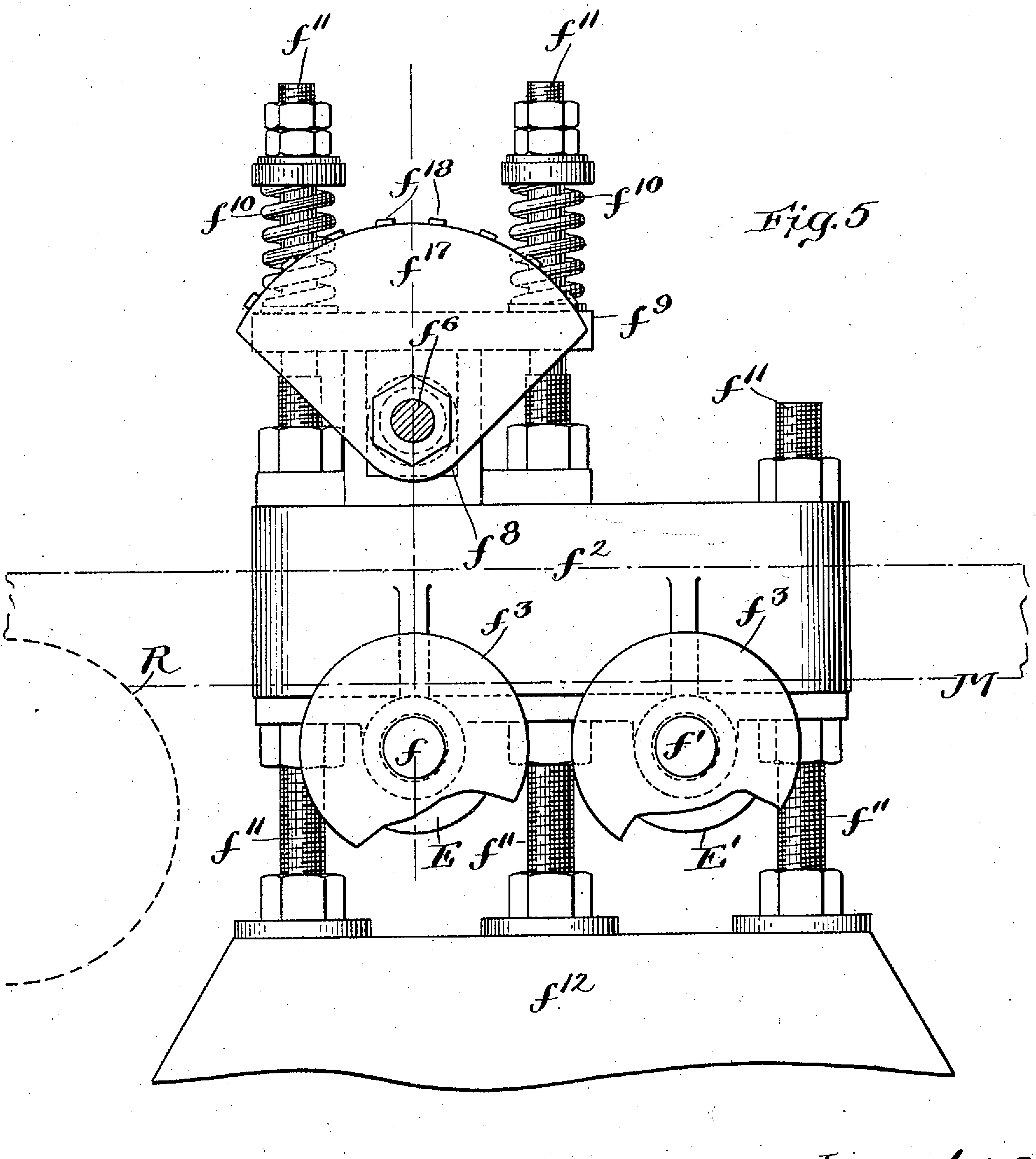
No. 748,107. PATENTED DEC. 29, 1903.

A. SAUVEUR & J. WHITING.

APPARATUS FOR DETECTING THE TEMPERATURE OF METALS.

APPLICATION FILED JUNE 10, 1903.

NO MODEL. 4 SHEETS—SHEET 3.



Witnesses:
Arthur F. Randall,
Joseph T. Brennan.

Inventors:
Albert Sauveur,
Jasper Whiting,
by Roberts & Mitchell,
Attorneys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 748,107. PATENTED DEC. 29, 1903.

A. SAUVEUR & J. WHITING.

APPARATUS FOR DETECTING THE TEMPERATURE OF METALS.

APPLICATION FILED JUNE 10, 1903.

NO MODEL. 4 SHEETS—SHEET 4.

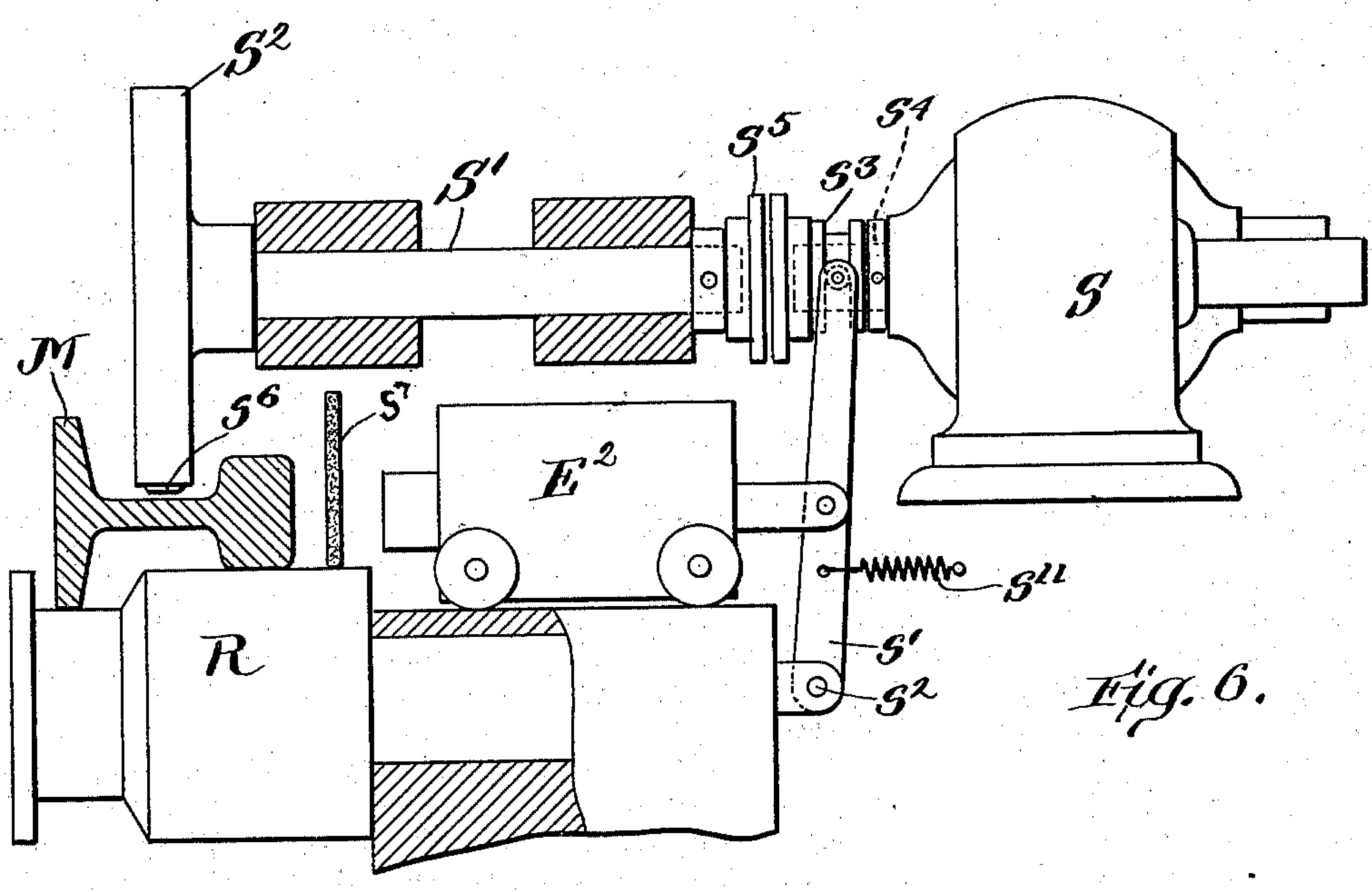


Fig. 6.

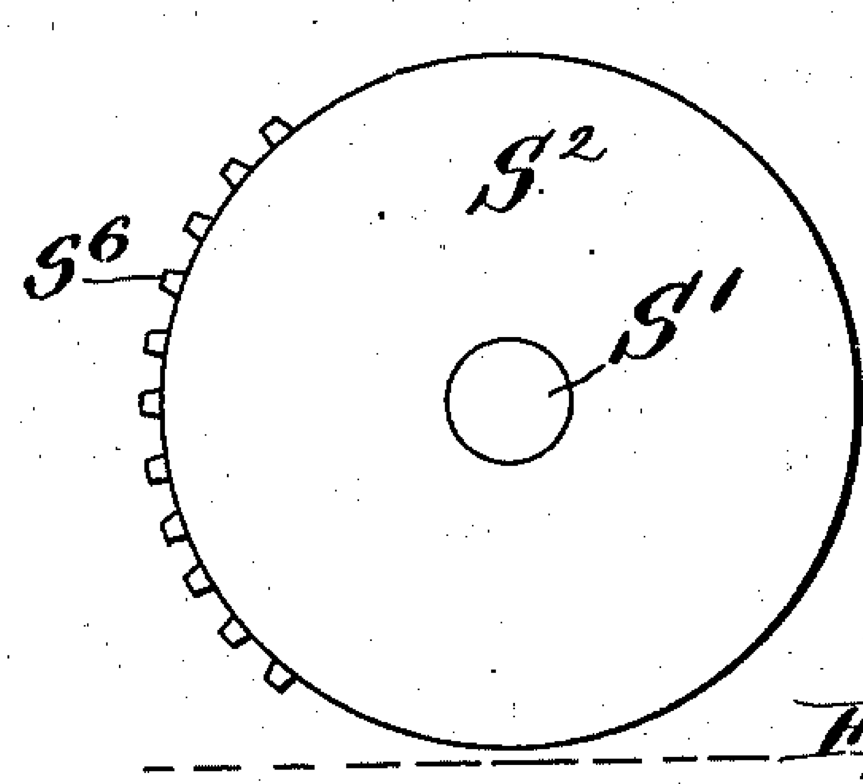


Fig. 7.

Witnesses:
Arthur F. Randall,
Joseph T. Brennan.

Inventors
Albert Sauveur,
Jasper Whiting,
by Roberts & Mitchell,
Attorneys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 748,107. Patented December 29, 1903.

UNITED STATES PATENT OFFICE.

ALBERT SAUVEUR, OF CAMBRIDGE, AND JASPER WHITING, OF LEXINGTON, MASSACHUSETTS.

APPARATUS FOR DETECTING THE TEMPERATURE OF METALS.

SPECIFICATION forming part of Letters Patent No. 748,107, dated December 29, 1903.

Application filed June 10, 1903. Serial No. 160,864. (No model.)

To all whom it may concern:

Be it known that we, ALBERT SAUVEUR, a resident of Cambridge, and JASPER WHITING, a resident of Lexington, in the county of Middlesex and State of Massachusetts, citizens of the United States, have invented new and useful Improvements in Apparatus for Detecting the Temperature of Metals, of which the following is a specification.

Our invention relates to the manufacture of articles of metal which is normally magnetic, and especially to the manufacture of forged and rolled steel articles—such as, for instance, rolled-steel rails, plates, and structural beams. The manufacture of most articles of this general character involves the manipulation of an original mass or ingot at a high temperature, shaping it while plastic into its finished form through the mechanical operation of rolls, presses, hammers, and kindred metal-working machinery. When the steel is finished by the machinery employed, it is then allowed to cool and is ready for application to its intended use. The quality of the finished article depends on the temperature which it possesses at the time the final finishing manipulation is impressed upon it. If the finishing temperature is above a certain point, the metal on cooling afterward crystallizes, has too coarse a structure, and is therefore at least relatively defective as compared with metal articles finished below the aforesaid temperature. The more the finishing heat of the metal is in excess of this critical temperature the more pronounced will be the defective structure of the finished article. The coarse crystalline structure due to finishing at temperatures in excess of the critical temperature degrades the ductility of the metal and wearing power and otherwise injures its quality, and for this reason it is of great importance so to order the work of shaping the heated metal that its finishing temperature shall be at or below the critical temperature.

Manufacturers and consumers alike realize the importance of finishing the forging or rolling of steel implements at the proper temperature, but they lack a suitable means of detecting whether or not the steel implement is at this temperature when work ceases, the pyrometric devices in use for other purposes being unsatisfactory.

It is the object of our invention to provide adequate automatic devices whereby the excess over critical temperature in the metal article emerging from the finishing machinery is detected and whereby also metal pieces finished at too high a temperature are automatically selected and distinguished from pieces finished at the proper temperature.

If a piece of steel be heated to a high temperature and allowed to cool undisturbedly, it will be found by careful observation that the metal cools at first more and more slowly, as is the case with all cooling substances. When a certain temperature is reached, which in commercial steel is not far from 675° centigrade, a sudden retardation in the rate of cooling occurs and for a certain length of time the metal ceases to cool. Indeed, its temperature may actually increase, the metal becomes visibly hotter, it recalesces. Then after a while the metal resumes its normal rate of cooling, which is continued until the atmospheric temperature is reached. This point where the normal rate of cooling is interrupted is generally called the "critical point" or the "critical thermal point" or the "point of recalesence." When a piece of steel is allowed to cool from a high temperature, it crystallizes until the critical point is reached; but below the critical point there is no further growth of crystallization. It follows from the above facts that in order to avoid the development and persistence of the coarse crystalline structure in steel it should be manipulated until in the course of cooling the critical point is reached and has been passed. Thus, as stated above, the finishing temperature should never exceed the critical temperature.

Steel is magnetic at temperatures below the critical point, but at temperatures above the critical point is non-magnetic, and will therefore be not attracted by a magnet, and we avail ourselves of this peculiar characteristic of steel and of other normally magnetic metals in carrying into effect our invention, which we now proceed to describe.

In the drawings hereto annexed, Figures 1, 2, and 3 illustrate conventionally the arrangement of coöperative elements which characterize our invention. Fig. 1 shows a simple means for merely indicating with respect to the critical point the temperature of an article of magnetic metal as it is being finished; and Figs. 2 and 3 illustrate modes by which the temperature is not only indicated in the above respect, but the article being finished is further automatically classified and segregated with its fellows. Figs. 4, 5, 6, and 7 illustrate in detail apparatuses embodying our invention wherein the piece of metal M, which is, for instance, a steel rail, is shown as emerging from between finishing-rollers, and in these forms of apparatus automatic marking devices are substituted for segregating devices, such as are indicated in Figs. 2 and 3.

For the finishing-rollers herein shown there may be substituted any forging mechanism to give the final shape to the metal article.

A magnet E, preferably an electromagnet, is placed in the neighborhood of the finishing instruments, such as rolls R, so that the metal M as it emerges from the rolls passes through the field of the magnet E. The magnet in Fig. 1 is shown as secured by a spring e', which restrains the magnet from movement in the direction of the rail or other article M. A pin e^2 confines the movement of the magnet in the said direction. If the rails or other articles M emerging from between the rolls R are being finished below the critical temperature, as they pass through the magnetic field the magnet is responsively excited, exerts a mechanical pull upon the spring e', and moves toward the pin e^2, and so long as the magnet moves in this manner whenever a rail or other article emerges from the rolls the observing workman may be confident that the rails, &c., are being finished at a safe temperature; but if, on the contrary, the magnet E fails to respond and remains inert as the piece M passes it this is a sure indication that the critical temperature has not been passed in the cooling of the article itself and that it will if allowed to cool further in a quiet state preserve or even further develop the coarse and crystalline structure which will eventually render it defective and unsafe.

The apparatus illustrated in Fig. 1 constitutes merely an indicator of the quality of metal M passing from the finishing-rolls, and with such an apparatus it is left to the workman in charge to determine voluntarily what shall be done with a defective piece of metal when he observes its presence by the aid of the magnetic indicator. In practice the mere movement of the magnet itself would hardly be employed as the indicating means, but rather some form of visible or audible indicator will be arranged to operate under control of the magnet, so that the behavior of the magnet itself will determine the action of the indicator.

We avail ourselves still further of the capacity of our detecting-magnet to develop motive power in order to determine automatically and selectively the course of the metal M as it passes from the finishing machinery. In Figs. 2 and 3 we have illustrated in an elementary and conventional form this feature of our invention. If the size and character of the metal piece M is such that a magnet—say an electromagnet of reasonable power—is capable of deflecting it, we place opposite to the finishing machinery, such as the finishing-rolls R, a deflector D, which is shown in Fig. 2 as a fixed wedge with its point presented to the metal emerging from the rolls. When such metal is finished at the proper temperature, it is consequently magnetic on emerging from between the rolls and passes into the field of the magnet E, which in this case is fixed, and the metal is attracted and drawn toward the magnet to an extent sufficient to cause the metal M to pass on the side d of the deflector D. This condition is shown in dotted lines in Fig. 2. If, however, the metal is finished at too high a temperature and is non-magnetic, it passes straight from the rollers R and is deflected from the side d' of the deflector.

Traveling chains, aprons, or tables, such as are usually provided for the conveyance of metal articles and which it is not necessary to show in these conventional figures, may be employed to convey the metal M through the field of the magnet E by and beyond the deflector. These conveying devices, as will now be obvious to persons skilled in the art, may be easily arranged and employed to carry the pieces which have been inspected and approved, so to speak, by our automatic selecting apparatus into one place, while the rejected pieces are automatically conveyed to another. Not only will the operation of such an apparatus serve to distinguish accurately between good and bad products, but, further, will afford a check upon the work of the person superintending the rolling or other metal-working operation to enable his superiors to criticise him intelligently if the percentage of defective products is unusually large. When, however, the size and character of the metal piece M is such as to preclude its being deflected, as shown in Fig. 2, by the influence of the magnet E, we employ the arrangement elementarily and conventionally shown in Fig. 3 to accomplish the above automatic selection. The magnet E is in such case mounted so as to be moved in response to the pull exerted when magnetic metal passes into its field, and this movement is communicated by a suitable mechanism to a movable deflector. In Fig. 3 such an arrangement is shown, where the magnet E is mounted upon an arm e', pivoted at e^3. An arm or link F connects the arm e' with the deflector D, which is a wedge-shaped piece, pivoted at d^2. Stops d^3 limit the oscillating movement of the deflector D and likewise the movement of the magnet E and its carriage e'. The presence in the magnetic field of the metal article M will cause the deflector to be moved to one side or the other, according to the magnetic or non-magnetic condition of the metal M. The weight of the magnet operating on the above-described mechanical train may be utilized to hold the selective mechanism in one position in which the piece of metal M, finished at too high a temperature, will be deflected and passed to the place set apart for rejected product; but when the magnet E is excited by the presence of a magnetic piece of metal M the magnet E will be lifted and the deflector D will be moved to deflect the metal piece in another direction, when by proper conveying apparatus it will be taken to the place appointed for approved product.

In Figs. 4 and 5 the metal mass M being operated upon is also shown as a railroad-rail, and the rolls of the mechanism for operating on the rail M are indicated at R. In this case the thermal condition of the metal mass as it emerges from the finishing-rolls R is manifested by the action of two magnets E and E'.

The cores $f f'$ of magnets E and E' are steel shafts journaled in bearings on a frame f^2 of brass, and each shaft or core $f f'$ carries a roller f^3, over which the rail M passes as it leaves the rolls R. Adjacent the opposite ends of shafts $f f'$ is arranged an armature or keeper f^4, pivoted to frame f^2 and normally held away from the ends of shafts $f f'$ by a spring f^5. Above the shaft or core f of magnet E is arranged a third shaft f^6, journaled at one end in a pivoted block f^7 and at its opposite end in a block f^8, mounted in vertical ways on frame f^2. Upon block f^8 rests a bar f^9, and above bar f^9 is arranged a pair of powerful springs f^{10}, each mounted on an anchor-bolt f^{11}, extending upwardly through frame f^2 from the bed f^{12} under the machine.

Shaft f^6 carries one member of a friction-clutch f^{13}, the other member of said clutch being splined to a shaft f^{14}, journaled in bearings on a suitable support. Shaft f^{14} also carries a worm-gear f^{15}, engaged by a worm f^{16} on the armature-shaft g of a motor G. Fixed to the end of shaft f^6 is a die or marker f^{17}, herein shown as a segment of a wheel made in two parts, clamped together with a peripherial series of characters f^{18} between them. The motor G is in a circuit g', terminating in two electrodes g^2, arranged to coöperate with a bridge-piece g^3, carried by armature f^4. When a rail which is cold enough to be magnetic passes over the two rollers f^3, it bridges the air-gap between the rollers, and thereby allows the magnetic flux which is passing through the steel shafts $f f'$ to be increased many times, and the two magnets then constitute a horseshoe-magnet of much more power than the combined power of magnets E and E' before they are joined in this manner by the rail M. Normally the combined power of the two magnets exerted on armature f^4 while disconnected is less than that of spring f^5, so that armature f^4 normally occupies the position shown in Fig. 4 with circuit g' open; but the combined power of magnets E and E' when united by a rail M to form a horseshoe-magnet is greater than that of spring f^5, and therefore armature f^4 is then operated by the two magnets and bridge-piece f^{17} is caused to close circuit g'. When circuit g' is thus closed, motor G is started, and acting through worm f^{16} and gear f^{15} turns shaft f^{14}, and said shaft, acting through clutch f^{13}, rotates shaft f^6. The resulting movement of die-wheel f^{17} brings the first character f^{18} against the rail M, after which the movement of the rail past the die-wheel f^{17} rotates the latter positively until the last character f^{15} passes out of engagement with the rail. The purpose of the friction-clutch f^{13} is to provide for differences in the relative speeds of motor G and rail M and to permit the rotation of shaft f^6 to come wholly under the control of rail M after the die has been brought into engagement with rail M through the medium of clutch f^{13}. As soon as the rail M leaves the two rollers f^3 spring f^5 returns armature f^4 to normal position, thus opening circuit g' and stopping motor G.

When a rail M passes over rollers f^3 at a temperature above the critical point, and therefore too high to be magnetic, of course armature f^4 is not operated, and therefore that rail passes through the machine without being marked, and the idleness of the mechanism expresses or indicates to the workman that that particular rail was improperly finished, while the absence of the mark is another indication of its quality by which it can be distinguished from other marked rails. An advantage incident to this form of our invention resides in the fact that the properly-finished rails, even though mixed with other rails finished at improper temperature, can at any time be distinguished from the others by the mark left by the die f^{17}.

In the end of each shaft f and f' adjacent armature f^4 is mounted an adjustable brass plug or screw f^{20}, and the function of these plugs f^{20} is to prevent armature f^4 sticking to shafts $f f'$ after the rail M has passed away from rollers f^3. This they accomplish by maintaining a small air-space between the ends of said shafts and armature f^4. The plugs f^{20} also serve to reduce friction and wear between shafts $f f'$ and armature f^4.

In Fig. 6 the thermal condition of the metal mass M as it emerges from the finishing-rolls R' is manifested by the action of a single magnet E^2, which is movably mounted on rolls and at its rear end is pivotally connected with a shipper-lever s', pivoted at s^2 to a fixed support, and is normally retracted by the spring S^{11}, secured to the lever s' and a fixed point. The other end of lever s' engages one member s^3 of a friction-clutch. This clutch member s^3 is splined to the armature-shaft s^4 of a constantly-operated motor S. When a rail M at a temperature below the critical point traverses the field of magnet E^2 and said magnet moves toward the rail, the clutch member s^3 on the rotating armature-shaft s^4 frictionally engages and rotates the other member of the clutch, (represented at s^5.) This member s^5 of the clutch is fixed on the end of a shaft S′, which at its other end carries a die S^2, herein shown as a wheel, whose periphery is provided with suitable projecting characters s^6. Normally the characters s^6 stand out of the path of the rail M, but when clutch member s^3 is caused to engage and turn the clutch member s^5, fast on shaft S′, the resulting movement of the die-wheel S^2 brings the first character s^6 against the rail, after which the movement of the rail past die-wheel S^2 rotates the latter positively until the last character s^6 passes out of engagement with the rail. The passage of the characters s^6 between the rail M and shaft S′ causes the die to leave a mark upon the rail which indicates, as in Figs. 4 and 5, that the rail was properly finished. After the rail finished at proper temperature passes out of the field of magnet E^2 a spring s^{11} returns said magnet and connected parts to normal position, as shown in the drawings. Of course when a rail passes through the field of magnet E^2 at a temperature above the critical point said magnet will not move, and the idleness of the mechanism expresses or indicates to the workman that that particular article is improperly finished.

Between magnet E and the path of the rail M is interposed a wall S^7, of asbestos or the like, the purpose of which is to shield the magnet E from the heat of the rails M.

What we claim is—

1. The combination, with mechanism for working hot metal, of a magnet, and means to indicate the response or non-response of the metal to the magnetic influence.

2. The combination of a magnet; means for conveying metallic masses to the field of the magnet, and devices controlled by the magnet to indicate selectively, the quality of the metallic masses.

3. In an apparatus for detecting the temperature of metals, the combination of a magnet, means for conveying metallic masses to the field of the magnet, and devices controlled by the behavior of the magnet with relation to metal in its field, to indicate the response or non-response of the magnet to the metal.

4. In an apparatus for detecting the temperature of heated metals, the combination of a magnet, means for conveying metallic masses to the field of the magnet, and devices controlled by the behavior of the magnet when the metal is in its field, to differentiate according to their magnetic or non-magnetic character when in the magnetic field, the metallic masses aforesaid.

5. In an apparatus for detecting the temperature of heated metals, the combination of a magnet, means for conveying heated metallic masses to the field of the magnet, and marking devices controlled by the behavior of the magnet when the metal is in its field, to mark selectively, according to their magnetic or non-magnetic character when in the magnetic field, the metallic masses aforesaid.

6. In combination, a magnet past which heated articles are conveyed; a marker adapted to operate on said articles, and means controlled by the magnet for operating the marker.

7. In combination, a magnet past which heated articles are conveyed; a marker adapted to operate on said articles; a motor for actuating the marker, and means operated by the magnet for controlling the action of the motor.

8. In combination, a pair of magnets past which heated articles are conveyed adapted to be connected by said articles; a marker for operating on said articles; an armature operated by said magnets, means opposed to the magnets for yieldingly holding said armature in normal position, and means controlled by the armature for operating the marker.

9. In combination, a pair of magnets past which heated articles are conveyed, adapted to be connected by said articles; an armature operated by said magnets; means opposed to the magnets for yieldingly holding said armature in normal position; a marker adapted to operate on said articles; a motor for operating the marker, and means operated by the armature for controlling the action of the motor.

10. In combination, a pair of magnets past which heated articles are conveyed, adapted to be connected by said articles, an armature operated by said magnets; means opposed to the magnets for yieldingly holding said armature in normal position, a marker adapted to operate on said articles; a motor for operating the marker and a normally open switch in the circuit of said motor operated by the armature.

Signed by us at Boston, Massachusetts, this 28th day of May, 1903.

ALBERT SAUVEUR.
JASPER WHITING.

Witnesses:
ARTHUR F. RANDALL,
JOSEPH T. BRENNAN.