A. HERRING.

Ascertaining the Density and Tensile Strength of Iron and Steel by Magnetism.

No. 213,197. Patented Mar. 11, 1879.

Fig 1.

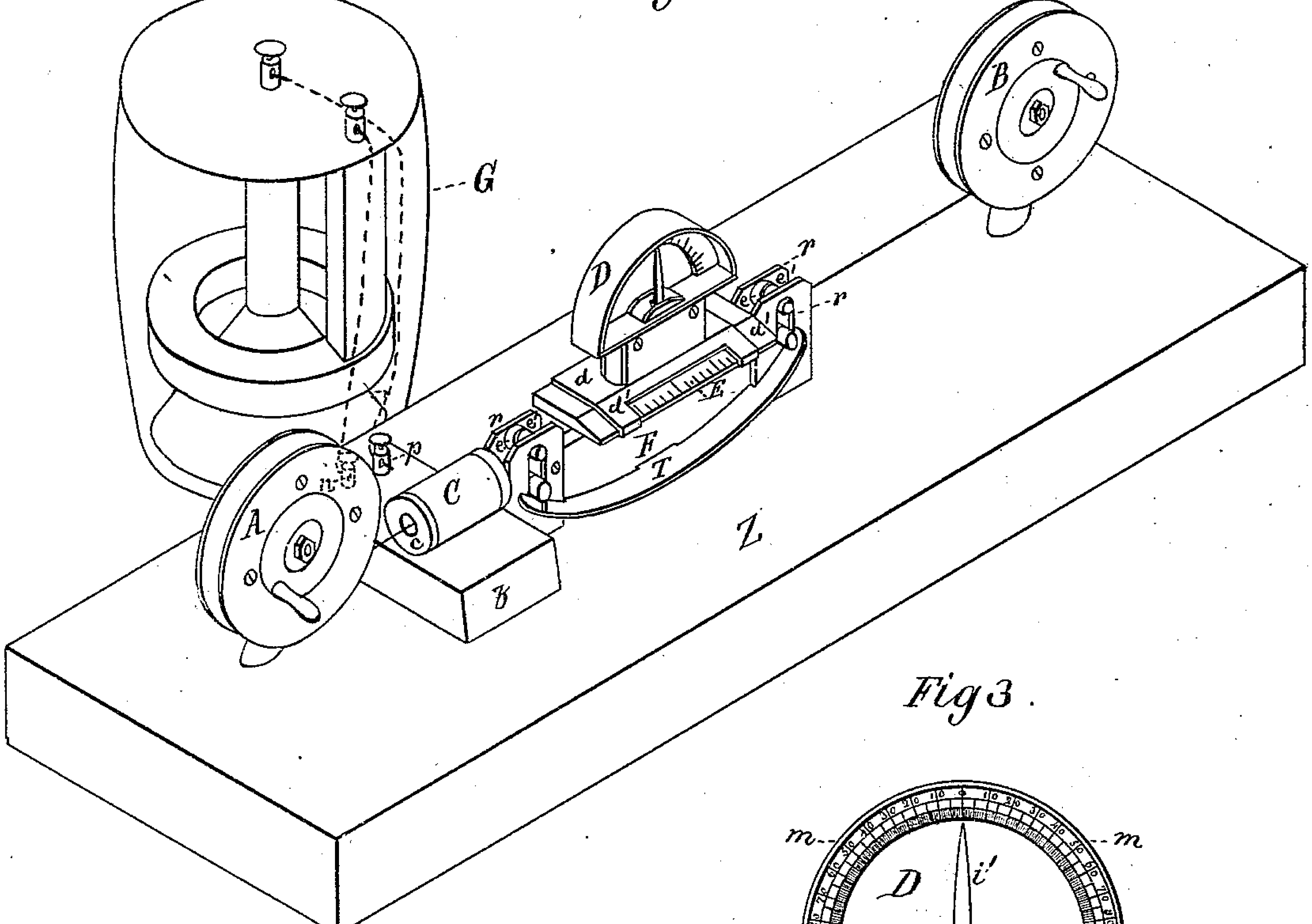


Fig 3.

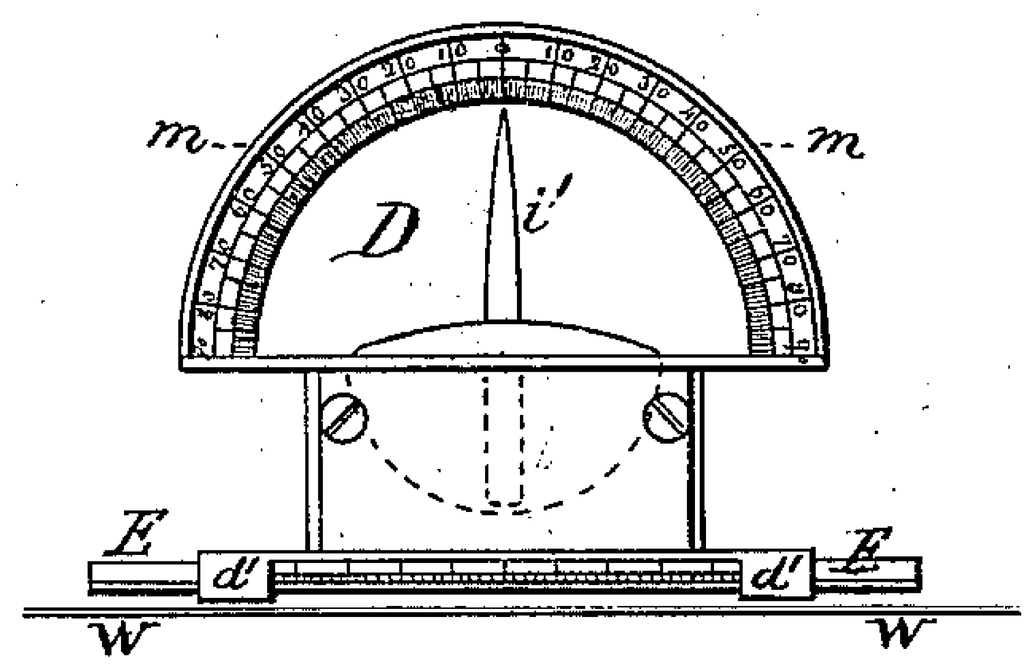
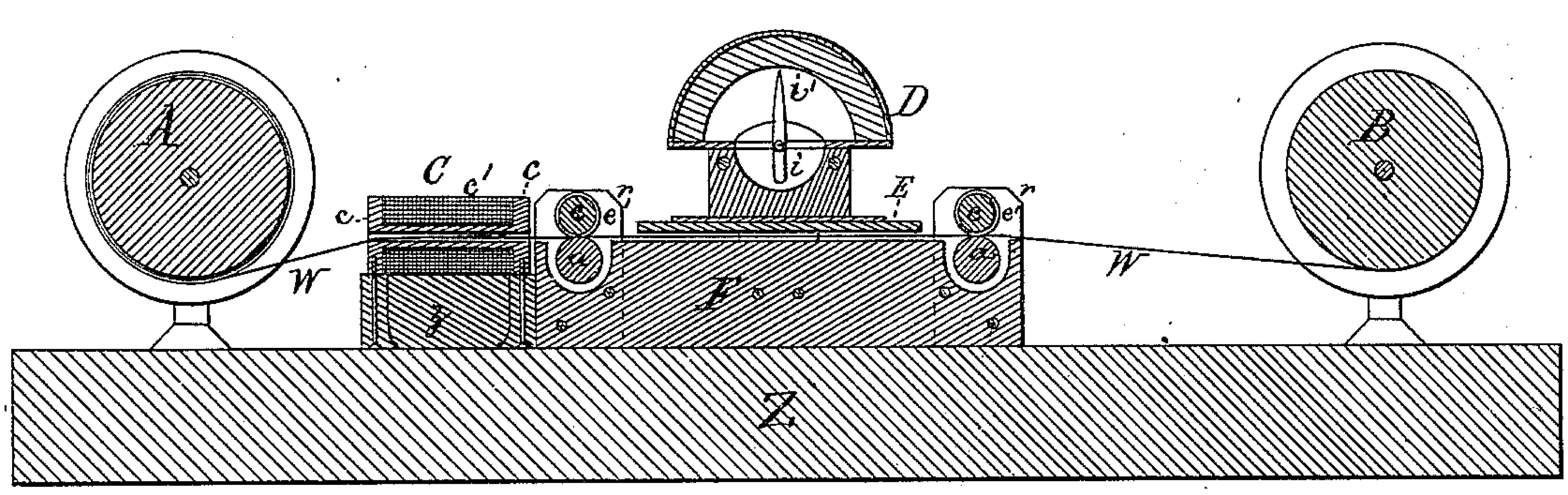


Fig 2.



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2 Sheets—Sheet 2.

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Fig 4.

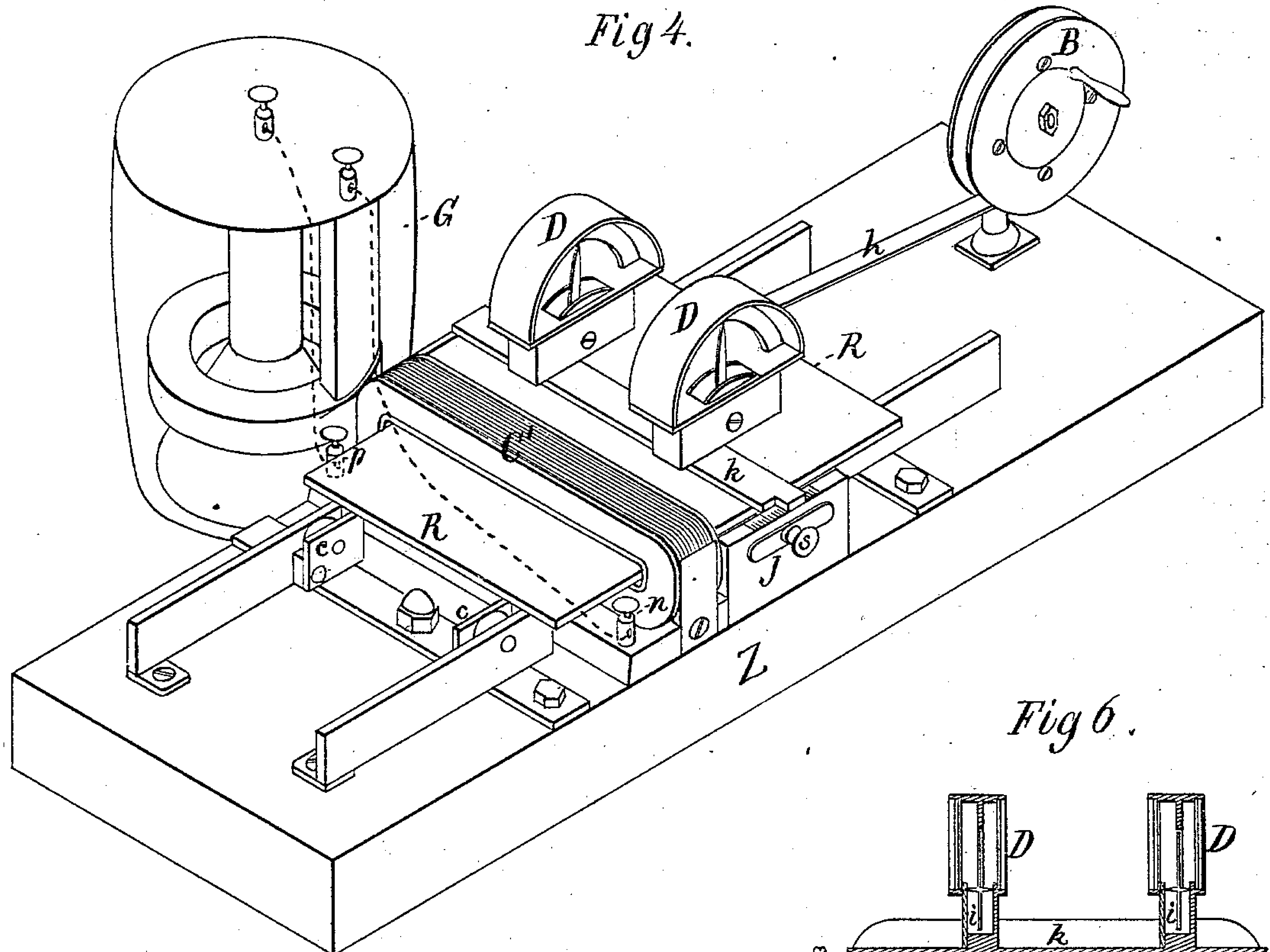


Fig 6.

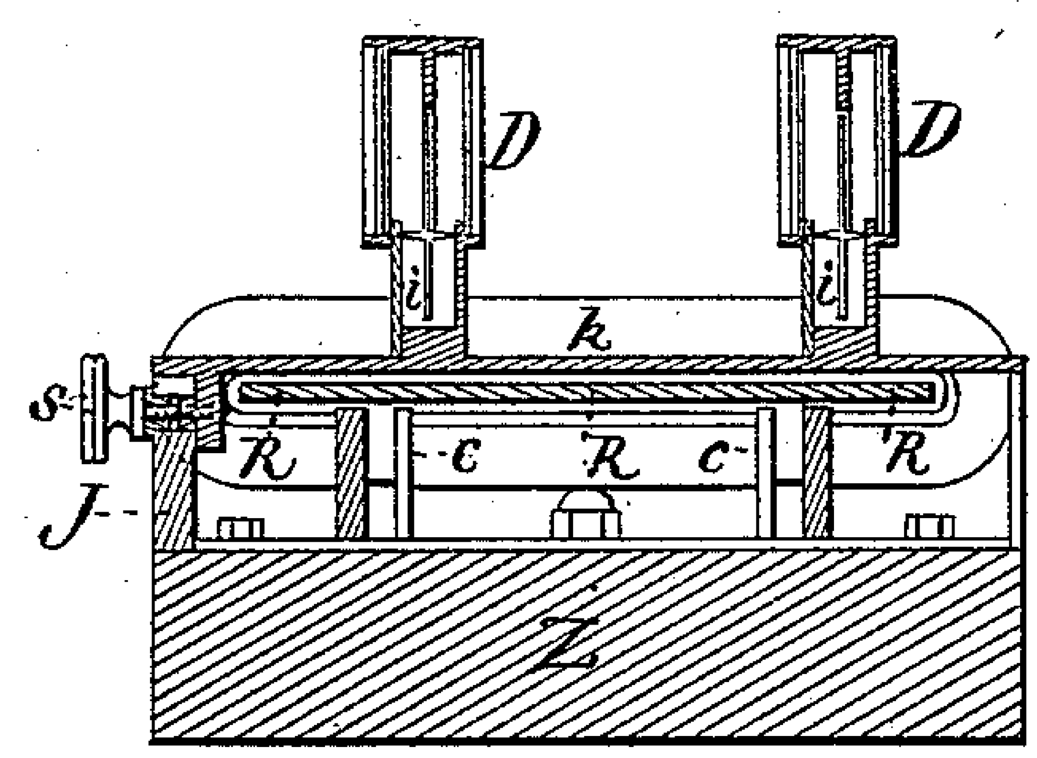
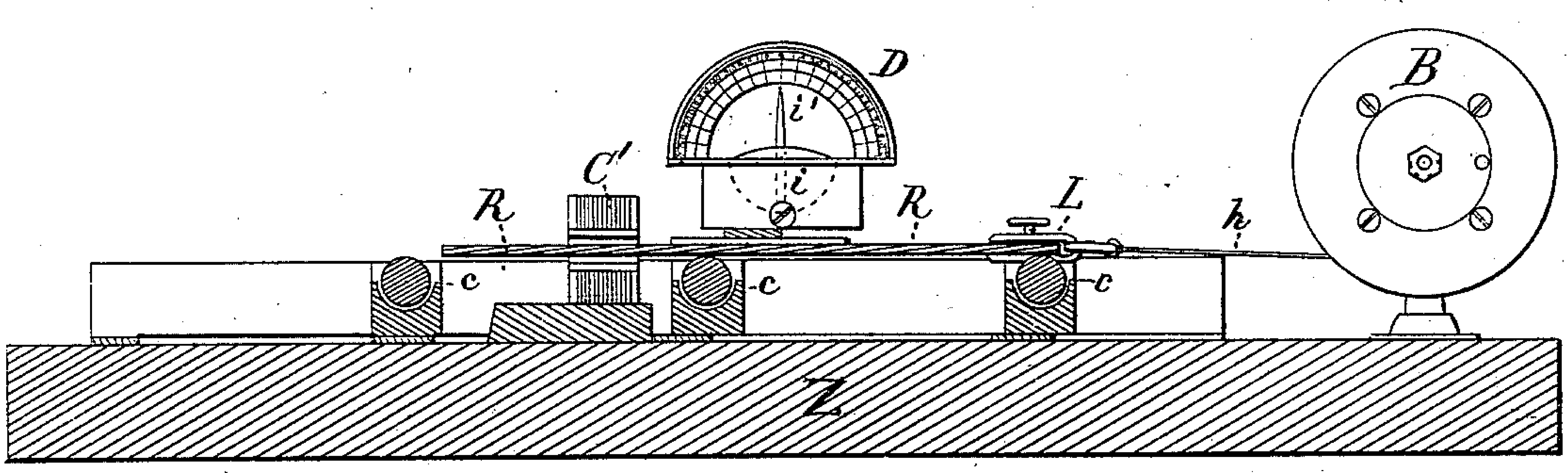


Fig 5.



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UNITED STATES PATENT OFFICE.

ANAXAMANDER HERRING, OF COHOES, NEW YORK.

IMPROVEMENT IN ASCERTAINING THE DENSITY AND TENSILE STRENGTH OF IRON AND STEEL BY MAGNETISM.

Specification forming part of Letters Patent No. **213,197**, dated March 11, 1879; application filed July 15, 1878.

To all whom it may concern:

Be it known that I, ANAXAMANDER HERRING, of Cohoes, in the county of Albany, in the State of New York, have invented a new and useful Machine or Apparatus for Ascertaining the Density and Tensile Strength of Iron and Steel; and do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the accompanying drawings, making a part of this specification, and to the letters and figures marked thereon.

Figure 1 of the drawings is a perspective view of my said machine or apparatus. Fig. 2 is a vertical longitudinal section of the machine or apparatus shown in Fig. 1, and Fig. 3 is a detail view of a magnetometer employed in connection with my said machine or apparatus.

The object of my invention is to estimate the density and tensile strength of iron and steel by its known magnetic intensity, and to attain this result without injury to the material under examination.

In connection with said machine or apparatus, my process consists, first, in magnetizing the steel or iron to be tested; and, second, in measuring the magnetic intensity of all parts of it in such a manner as to compare it with iron and steel of known strength and density.

In the drawings, by Figs. 1, 2, and 3 I have represented an apparatus adapted for testing the density and tensile strength of steel wire, in which a foundation, as at Z, constitutes a support for the main portion of my apparatus, which is represented in connection with a cell, G, of what is known as "Wilson's battery."

The essential parts of said apparatus consist of drums or reels A and B, a helix, C, a magnetometer, D, mounted and movable upon a scale, E, a frame, F, and said battery G.

The helix C rests upon a projecting portion, *z*, of the foundation Z, and is in the form of a spool, the body portion *c* of which is made of hard rubber with an aperture through it from end to end. Upon this spool insulated copper wire *c'* is wound in superposed layers, the ends of which wire are connected to the binding-screws *n* and *p*.

The magnetometer D consists of a magnetized needle or bar of steel, *i*, the negative end of which has been lengthened by the addition of a piece of aluminum, *i'*, in order that the operator during the act of "testing" may read on an enlarged semicircle, *m*, as shown clearly in Fig. 3. The magnetometer D is seated upon a thin metal plate, *d*. This plate has its rear portion or edge bent over and under the rear edge of the scale E, while front portions, as at *d'*, are in like manner fitted to or clasped upon the front edge of said scale, thus retaining the magnetomer in position upon the scale, and also allowing it to be moved longitudinally thereon. A portion of the plate *d* is cut away between the lapped parts *d'*, so that the scale E is exposed to view; and as the magnetometer is moved upon the scale toward or from the helix the inner edge of the parts *d'* serve to register with the divisions marked off upon the scale, and thus indicate the exact distance from the helix which the magnetometer is to occupy at the commencement of a "test," and which position throughout the test it must maintain. In other words, the magnetometer is so mounted upon the scale E as to allow it to be moved toward or from the helix C, and admit of its being fixed at any desired distance from the helix to suit the different sizes of wire to be tested.

The frame F is constructed at each end with a set of slotted posts, *r r*, and between these posts are two upper rollers, *e e*, having a groove, *e'*, central of their length to receive and guide the wire *w* while being tested, and also two fellow ungrooved lower rollers, *a a*. The axles of each of these rollers play loosely (up and down) in the vertical slot of the posts *r*. The axles of the lower rollers extend some distance outside of said posts, so as to engage, as indicated in Fig. 1, with a spring, T, attached to the frame F, as shown, so that the force exerted upward by the spring will press the wire *w* firmly against the rollers *e e* in their grooves *e'*, thus keeping the wire at a fixed distance from, but near to, the needle *i* while being wound from the reel A to the reel B.

Operation: To practically test steel wire which is from four to five millimeters in thickness, the apparatus should have the following proportions: Drum A should be of such dimensions as to receive the coils as they come from the manufacturers. Drum B should be about two meters in diameter. The helix C should be composed of about two hectometers of No. 14 insulated copper wire, wound in superposed layers upon a spool, the center of which should be made of a non-conducting substance (such as rubber, paper, or hard wood,) with a hole six millimeters in diameter through the length of it. The scale E should be two decimeters in length, and divided into millimeters. The guide-rollers *e e* and *a a* in frame F should be about three decimeters apart. The spring T should be sufficiently stiff to keep the wire *w* firmly to its place in the grooves *e'* of the rollers *e*. Any form of galvanic battery may be used; but the Wilson battery, owing to its constancy, I believe is best adapted to the purpose. Three cells of this battery should be coupled together and connected to the helix C by the binding-screws *p n*. The arc of the magnetometer should be a semicircle of a ten-centimeter circle. The arc should be divided, as indicated in Fig. 3, into degrees, or one hundred and eighty equal divisions, with zero at the top, and numbering right and left to ninety. The needle of the magnetometer should be formed of two pieces: first, a steel bar or needle, four centimeters in length, with a pivot in the center; second, an aluminum point, riveted to the negative end of the steel needle, making the length of the needle seven centimeters. In this manner we bring the axis of the needle near the iron to be tested, which insures the greatest deflection from any change in the magnetic intensity of the iron, and gives an extended arc, *m*, on which we are the better able to read the changes of the needle.

To adjust the apparatus for use, the battery C being in operation, a piece of soft-iron wire, perfectly made, five millimeters in thickness and one meter in length, and of known tensile strength, is placed in the helix C and drawn through until the center of the length of the wire rests within the helix. The magnetometer D is then moved along the scale E until the negative end *i'* of the needle points to zero. This will take place when the magnetometer has been moved toward or from the helix, as the case may be, until the positive end of the needle is directly over the point of greatest magnetic intensity developed in the wire. The soft-iron wire is then removed, and the magnetometer remains throughout the test in its position on the scale E which it now occupies.

In place of the soft-iron wire a piece of steel wire of like dimensions and known strength, and perfectly made, is now in like manner placed in the helix. If the steel is of greater tensile strength than the iron, the pointer *i'* of the magnetometer will fall to the right of zero. Take a note of the point on the scale of the arc *m* at which the pointer comes to rest; remove the steel wire; fix the coil of wire to be tested on the reel A; pass one end of the wire through the helix C and between the rollers *a a* and *e e* in the groove *e'* of the rollers *e*, and then attach the end of the wire to the reel B. Now, turn the reel B, and while the wire is wound from the reel A to the reel B note the position of the pointer *i'* upon the scale of the magnetometer and calculate the strength of the wire from the ratio found between the two test-pieces. For instance, if the breaking-strain of the soft-iron wire which fixed the needle at zero is two thousand pounds, and the steel wire which fixed the needle, say, at forty-five degrees breaks at four thousand eight hundred pounds, the increase in pounds per degree is sixty-two pounds, and the ratio found, which is thirty, will serve to calculate the strength of any portion of the wire being tested, unless the pointer *i'* passes zero to the left, which indicates an actual flaw in the wire, and the greater the deflection of the pointer to the left of zero the greater the flaw.

In testing large shafting, bars of metal, heavy ordnance, pieces of machinery, and small articles, such as pieces of fire-arms, sabers, bayonets, &c., the apparatus will of course be adapted in intensity to the size, weight, and shape of the piece under examination.

Figs. 4, 5, and 6 represent, in the main, the same apparatus shown in Figs. 1, 2, and 3, constructed and arranged for testing plates of iron and steel. By this construction and arrangement we are able to test rapidly and give the density and tensile strength of every square inch of the largest-sized boiler or armor plates. In said Figs. 4 and 5, the helix C is flattened or elongated, so as to admit the metal plate R to be passed through it, as indicated in perspective view in Fig. 4 and in Fig. 5, which latter view is a longitudinal vertical section of Fig. 4. This helix is composed of superposed coils of insulated copper wire the ends of which connect with binding-screws *n* and *p*. The magnetometers D D are mounted on a movable bar, *k*, that they may be the better moved to and fro in front of the helix, and fixed at any desired distance from it by means of the set-screw *s* to the scale J. B in said Figs. 4 and 5 is a drum with a band, *h*, and clamp L, for drawing the plate R through the helix C while being tested. In said figures, R indicates a plate of iron or steel in position in the act of being tested, said plate resting upon trunnions *c c*, over which it is drawn by the drum B.

To test a plate the helix and battery G should be suited in size and power to the thickness of the iron or steel to be tested. The movable bar *k* should reach from side to side of the plate, and have fixed to it a number of magnetometers about two decimeters apart. These magnetometers should be of the same construction as that described for testing wire. Connect the poles of the battery with the helix C by means of the binding-screws *n* and *p*, so as to magnetize the plate with the negative pole to the right of the helix; pass the end of the plate through the helix and fasten with the clamp L, and while an assistant draws it steadily through the helix note the changes of the needle *i* in the several magnetometers.

Having previously ascertained the magnetic intensity of a cubic centimeter of iron and steel of known density and tensile strength, we are enabled to calculate the strength of any part of the plate by a comparison of its magnetic intensity.

I claim—

1. The herein-described method of ascertaining the density or tensile strength of metals, consisting in subjecting the iron to be tested to the magnetic effect of an electric current, and comparing its magnetic condition while under the influence of the current with the magnetic condition of pieces of metal of known density or tensile strength when subjected to the magnetizing effect of an electric current of the same intensity.

2. The herein-described method of ascertaining the density or tensile strength of metals, consisting in magnetizing the iron whose density or tensile strength is to be ascertained, and comparing its magnetic condition with that of a magnetized piece of metal of known density or tensile strength.

3. In an apparatus adapted for ascertaining the density and tensile strength of metal, the combination of a galvanic battery, a helix, and a magnetometer, substantially as described.

4. A magnetic indicator or magnetometer which is adjustable toward or from a magnetizing helix, or its equivalent, and an iron or steel bar, whereby the point of greatest magnetic intensity of the iron or steel can be ascertained, substantially as and for the purpose described.

5. A tubular helix, C, in combination with a battery, G, a magnetic indicator or magnetometer, D, and reels A B, substantially as and for the purpose described.

6. The combination of the reels A B, rollers *e e a a*, helix C, a magnetic indicator, and a battery, substantially as and for the purpose described.

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