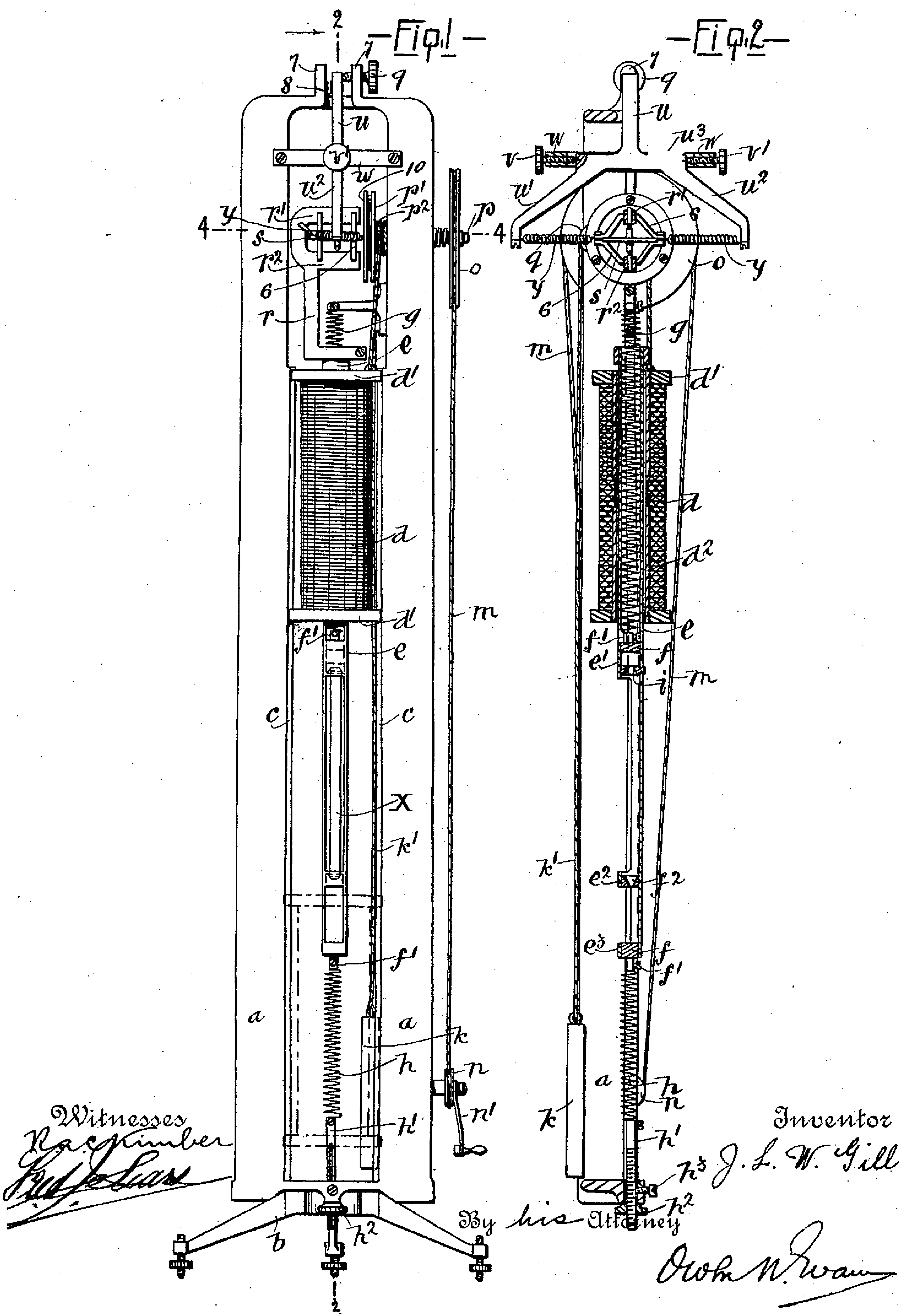
No. 615,695. Patented Dec. 13, 1898.

J. L. W. GILL.

HYSTERESIS METER.

(Application filed Mar. 25, 1898.)

(No Model.) 3 Sheets—Sheet 1.



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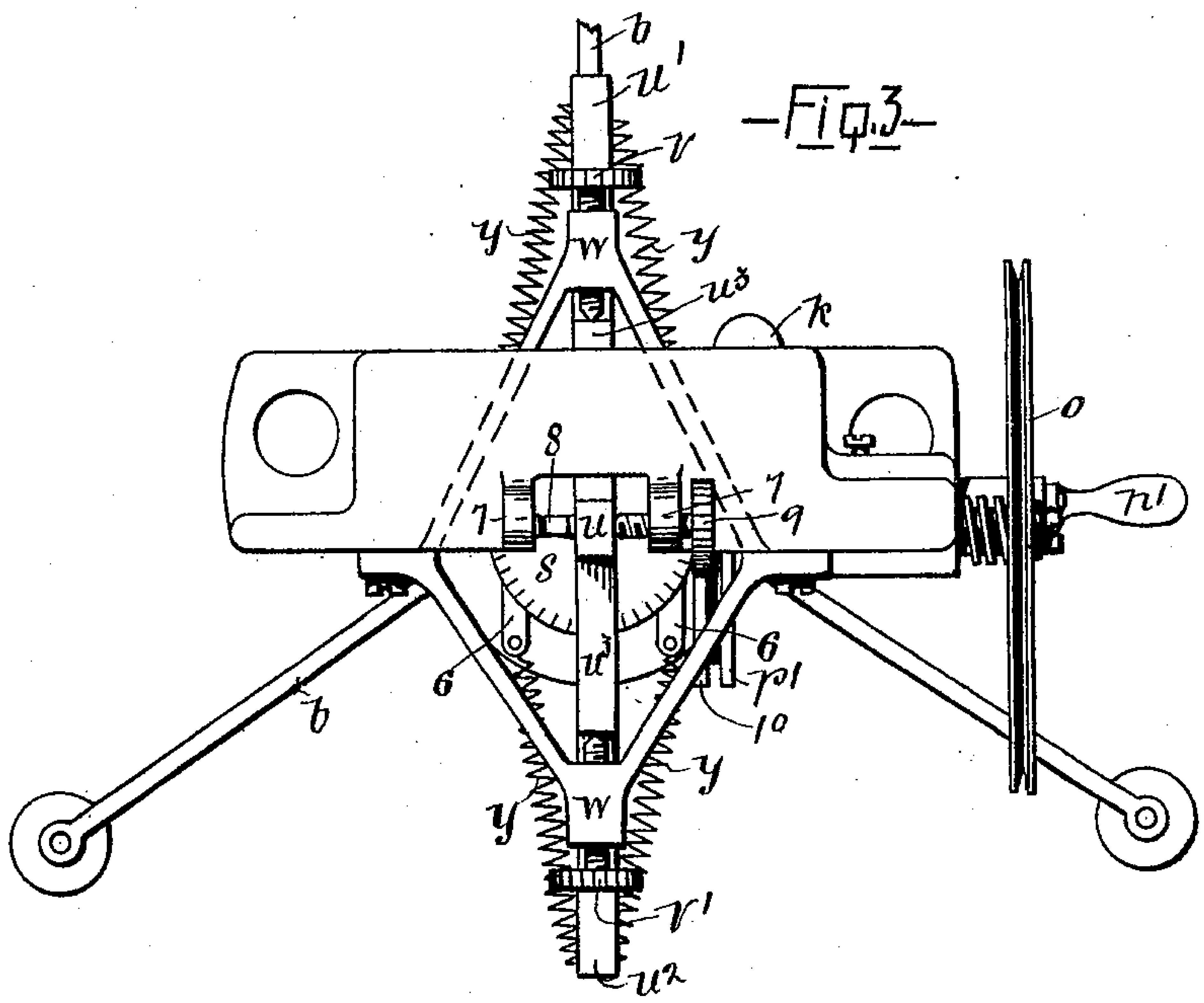
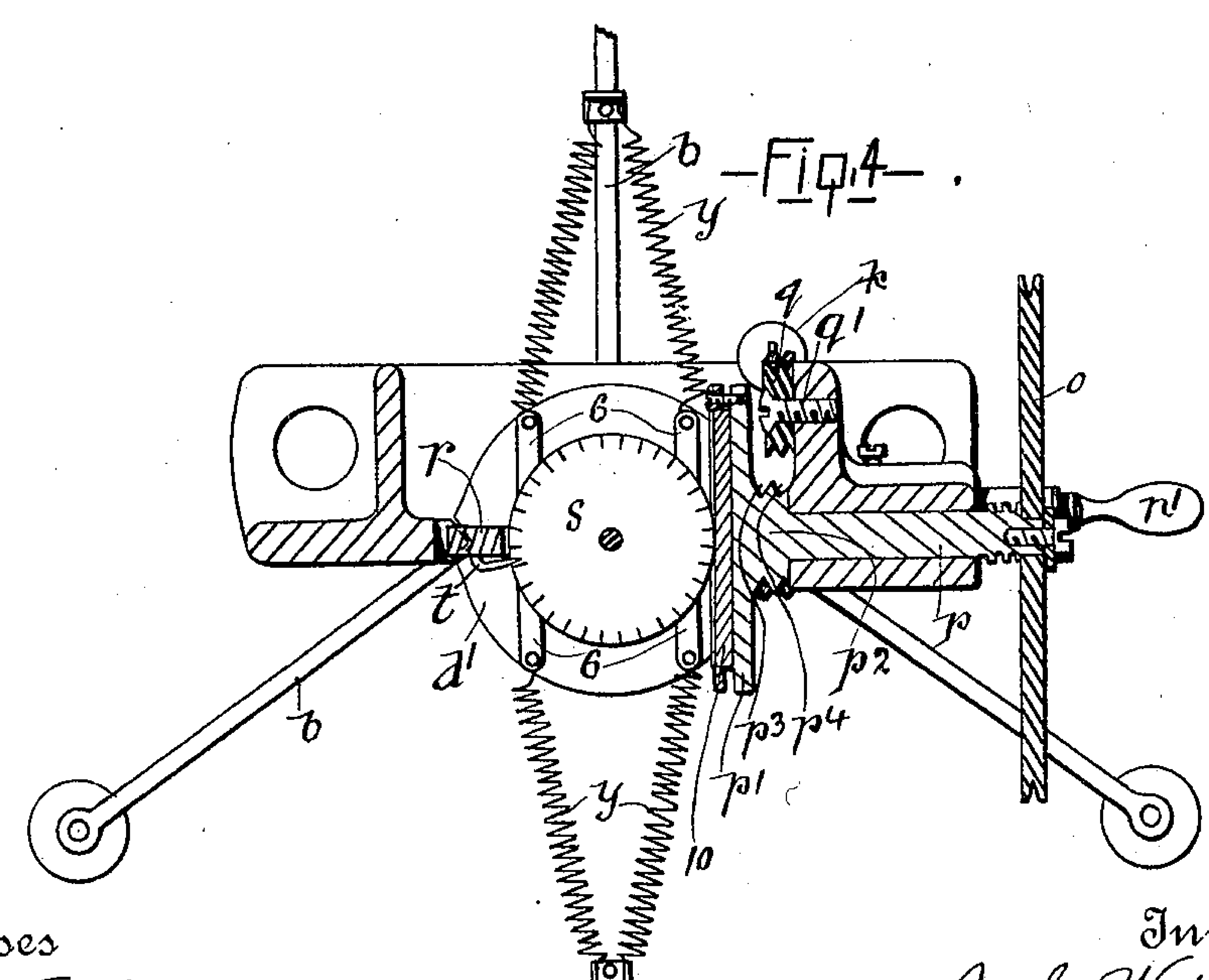


-Fig. 3-



-Fig. 4-

Witnesses

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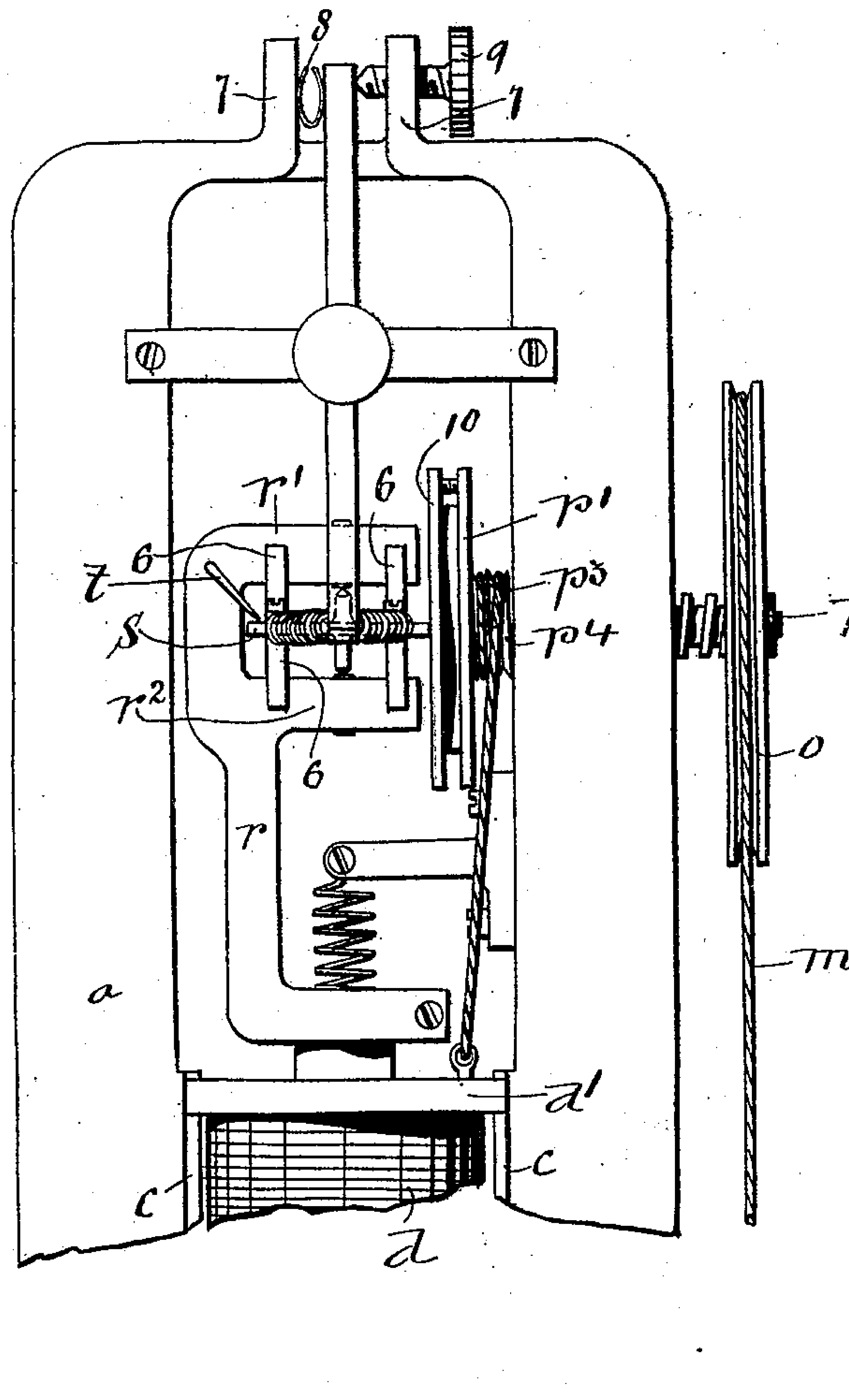
-Fig 5-



Witnesses

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UNITED STATES PATENT OFFICE.

JAMES LESTER W. GILL, OF MONTREAL, CANADA.

HYSTERESIS-METER.

SPECIFICATION forming part of Letters Patent No. 615,695, dated December 13, 1898.

Application filed March 25, 1898. Serial No. 675,125. (No model.)

To all whom it may concern:

Be it known that I, JAMES LESTER WILLIS GILL, of the city of Montreal, Province of Quebec, Canada, have invented certain new and useful Improvements in Hysteresis-Meters; and I do hereby declare that the following is a full, clear, and exact description of the same.

This invention relates to instruments for measuring hysteresis in iron, its use being of great practical advantage in determining the hysteresis loss in iron, and more particularly that intended for use in electrical transformers.

The invention consists, broadly speaking, of a solenoid arranged vertically and so as to have a vertical motion along the sample of iron being tested and which in its movement it encircles and a carrier for the sample of iron yieldingly supported in such a manner that the force of attraction of the solenoid will act to move the specimen and with it the carrier, the work done being shown by integrator mechanism operated by such carrier.

The invention also comprises various features of specific construction, all of which are hereinafter fully described and claimed; but for full comprehension of the invention reference must be had to the annexed drawings, forming a part of this specification, in which like symbols indicate corresponding parts, and wherein—

Figure 1 is a front elevation of the meter or instrument, showing a specimen of iron in the carrier and the solenoid in its uppermost position. Fig. 2 is a vertical section of same on line 2 2, Fig. 1, the solenoid being shown as raised to its uppermost position. Fig. 3 is an enlarged plan view of the instrument; Fig. 4, a horizontal section of same on line 4 4, Fig. 1; and Fig. 5 is an enlarged front elevation of the integrator and upper portion of the instrument.

The frame *a* of the instrument rises from a tripod-stand *b* and presents two vertical guiding edges *c c*, facing a central vertical opening in the frame, in which the solenoid and carrier are located, the solenoid *d* having collars *d'* at either end, notched to fit and travel along the guides *c*.

The carrier is shown as formed from a length of tubing *e*, of such a diameter as to freely pass through the tubular core d^2 of the solenoid and having side portions of its lower half cut away, so as to leave small annular sections *e'* e^2 e^3, of which *e'* and e^3 receive plugs *f f*, formed with recesses and set-screws *f'*, by which the lower end of a suspending-spring *g* is thus attached through the plug in section *e'* to the carrier about midway of its length and the upper end of a steadying-spring *h* attached through the plug in section e^3 to the lower end of the carrier, the opposite ends of such springs being attached, respectively, to the upper and lower portions of the frame. The annular section e^2 of the carrier is partially plugged, as at f^2, to form a seat for the lower end of the specimen X, the upper end thereof being held by a slidable cap *i* on the carrier.

To allow of adjusting the tension of the carrier-springs *g* and *h*, the lower end of the latter is connected to the frame through a screw-threaded rod *h'*, passing freely through the bottom of the frame and carrying an adjusting screw-nut h^2, a set-screw h^3 serving to hold the rod in place when adjusted.

The solenoid *d*, which is energized from any convenient source, has a balance-weight *k* attached to its upper end by a cord *k'*, forming part of its operating mechanism, as will now be described, the balance-weight allowing the solenoid to remain in any desired position. If desired, any other magnetic equivalent for the solenoid may be used.

The solenoid is operated or moved up and down by means of a driving-cord *m*, taking over the small and large pulleys *n o*, the former mounted loosely on a stud near the base of the frame and provided with a suitable crank-handle *n'* and the one *o* rigidly set upon a horizontal shaft *p*, rotating in a bearing in the right-hand leg of the frame, near the upper end thereof. The inner end of the shaft *p* terminates in a disk *p'*, and immediately behind the disk the shaft is enlarged, as at p^2, and the periphery of the enlargement formed with two annular pulley-grooves p^3 p^4. The cord *k'*, connecting the solenoid and balance-weight, as before mentioned, passes twice around the shaft *p*, the grooves p^3 p^4 receiving it, and a grooved guide-pulley

q, mounted on a stud q', taking into the projecting vertical web at the back of the frame and set at a slight angle to enable the guide-pulley to accommodate the double turn of the cord. The rotation of the shaft p by the crank and driving pulleys operates the solenoid-carrying cord k' and through it moves the solenoid up and down, the disk p' on the end of the shaft serving to operate the integrator mechanism, now to be explained.

An arm or bracket r, projecting upward from the top of the carrier, has two horizontal fingers r' r^2, pointing toward the disk p' on the shaft p, and between these fingers is delicately carried a graduated disk s to revolve in a horizontal plane and with its periphery always in contact with the disk p' on the shaft p. The extent of rotation of the disk s is shown by a pointer t, carried by the bracket r.

As it is essential and very desirable that the graduated disk s should always be held against the disk p' with a uniform pressure and also that as little resistance as possible be offered to the movement of the carrier and graduated disk, I prefer to use the following means for steadying and adjusting such disk and its carrying parts at the upper end of the carrier and for insuring the uniform pressure of the disk as mentioned.

An adjustable three-armed frame having a vertical arm u and two inclined arms u' u^2, with horizontal middle section u^3, is pivotally supported by adjusting-screws v v', working through bridge-pieces w w, projecting across the back and front of the main frame, and such screws have pointed ends fitting recesses in the faces of shoulders formed by each end of the middle section u^3.

The depending ends of the inclined arms u' u^2 are connected with the fingers r' r^2 of the arm r, projecting up from the carrier through springs y y y y, having their ends attached to the inclined arms and to annular brackets 6 6 6 6, projecting two on each side from the fingers r' r^2. The free end of the vertical arm u is located in a space between two upwardly-projecting lugs 7 7 at the top of the main frame, and between one lug and one side of the arm an expansible spring 8 is placed, while an adjusting-screw 9 passes through the other lug and bears against the opposite side of the arm. It will thus be seen that by adjusting the end of the arm u the three-armed frame can be rocked on its supporting-screws v v' and the inclined arms thus caused to move the graduated disk and its carrying parts toward or away from the operating-disk p' and that such graduated disk can be moved laterally of the disk p' for centralizing purposes by adjusting the supporting-screws v v'.

The disk p' is preferably faced with a very smooth quartz disk 10, so as to lessen any chance of interference with the up-and-down movement of the carrier.

The carrier is suspended so that when the solenoid is in its lowest position the specimen is out of the magnetic field, being above the solenoid. As the solenoid is moved up the carrier and specimen pass through it, and when the solenoid is in its highest position the specimen is practically out of the field. If the solenoid be moved once up and down, the field being reversed when the specimen is out of it, the specimen passes through a complete magnetic cycle, provided the specimen has been once through the field and is initially in that particular cyclic state. As the solenoid is moved up the specimen is attracted down, the force of the attraction increasing until it reaches a maximum, when about one-half of the specimen is inside the solenoid. Up to this point work is being done by the magnetic force. The attracting force becomes a maximum when the specimen is about one-half out of the solenoid on the lower side and becomes zero when the solenoid is in its highest position. The maximum force in the second half of the motion is greater than the maximum force in the first half. The work done in the second half of the motion is also greater than that done in the first half, the difference being the work expended in taking the specimen through half a cycle. When the field is reversed and the solenoid moved down, the action is similar to that which takes place when the solenoid is moved up, and the resultant work done will be the same, provided the specimen is homogeneous.

The integrating mechanism ascertains the result of the work done. Since the motion of the quartz disk is proportional to the motion of the solenoid and the displacement of the graduated disk is proportional to the attracting force of the solenoid, it follows that the speed of motion is proportional to the work being done at any instant. The total amount of rotation is therefore proportional to the total work done. Consequently all that is necessary to test a specimen with the instrument is to place the specimen in the carrier, move the solenoid up and down to get the specimen in a cyclic state, then take it through a cycle and observe the amount of rotation communicated to the graduated disk. This is a direct measure of the work expended.

The constant of the instrument is determined by placing a known weight in the carrier and observing the amount of rotation communicated to the graduated disk when the solenoid is moved through a known distance. The specimen may be taken through a number of cycles and the readings allowed to accumulate. The average of a number of cycles is thus obtained.

What I claim is as follows:

1. A meter or instrument for measuring hysteresis in iron comprising a solenoid adapted to have a motion along the sample of iron being tested with means for operating such solenoid, the specimen of iron being support-

ed so that the force of attraction of the solenoid will proportionally move the specimen, and means for indicating the work done, substantially as described.

2. A meter or instrument for measuring hysteresis in iron comprising a solenoid adapted to have a motion along the sample of iron being tested with means for operating such solenoid, a carrier for the specimen of iron being yieldingly supported in such a manner that the force of attraction of the solenoid will proportionally move the specimen, and with it the carrier, and means for indicating the work done, substantially as described.

3. A meter or instrument for measuring hysteresis in iron comprising a vertically-movable solenoid with means for operating same electrically and mechanically; a carrier, for the sample of iron being tested, extending through the solenoid; yielding supports for such carrier, and integrator mechanism carried in part by said carrier and in part by the mechanically-operating means of the solenoid for indicating the work done, substantially as described.

4. A meter or instrument for measuring hysteresis in iron comprising a vertically-movable solenoid with means for operating same electrically and mechanically; a carrier, for the sample of iron being tested, extending through the solenoid; yielding supports for such carrier; adjustable integrator mechanism carried in part by said carrier and in part by the mechanically-operating means of the solenoid for indicating the work done; and means for adjusting said integrator mechanism, substantially as described.

5. In a hysteresis-meter, the combination with the main frame, the carrier for the specimen and its yielding supports, and a shaft forming part of the solenoid-operating mechanism, of a disk on the end of said shaft rotatable in a vertical plane; an arm extending from the carrier; an index-disk mounted in said arm so as to rotate in a horizontal plane with its periphery bearing against the vertical disk; and an indicating-pointer carried by said arm, substantially as and for the purpose set forth.

6. In a hysteresis-meter, the combination with the main frame, the carrier for the specimen and its yielding supports, and a shaft forming part of the solenoid-operating mechanism, of a disk on the end of said shaft rotatable in a vertical plane; an arm extending from the carrier; an index-disk mounted in said arm so as to rotate in a horizontal plane with its periphery bearing against the vertical disk, an indicating-pointer carried by said arm; an adjustable frame flexibly connected with said carrier-arm, and means for adjusting said frame, substantially as and for the purpose set forth.

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

J. LESTER W. GILL.

Witnesses:
WILL. P. MCFEAT,
FRED. J. SEARS.