No. 708,539. Patented Sept. 9, 1902.

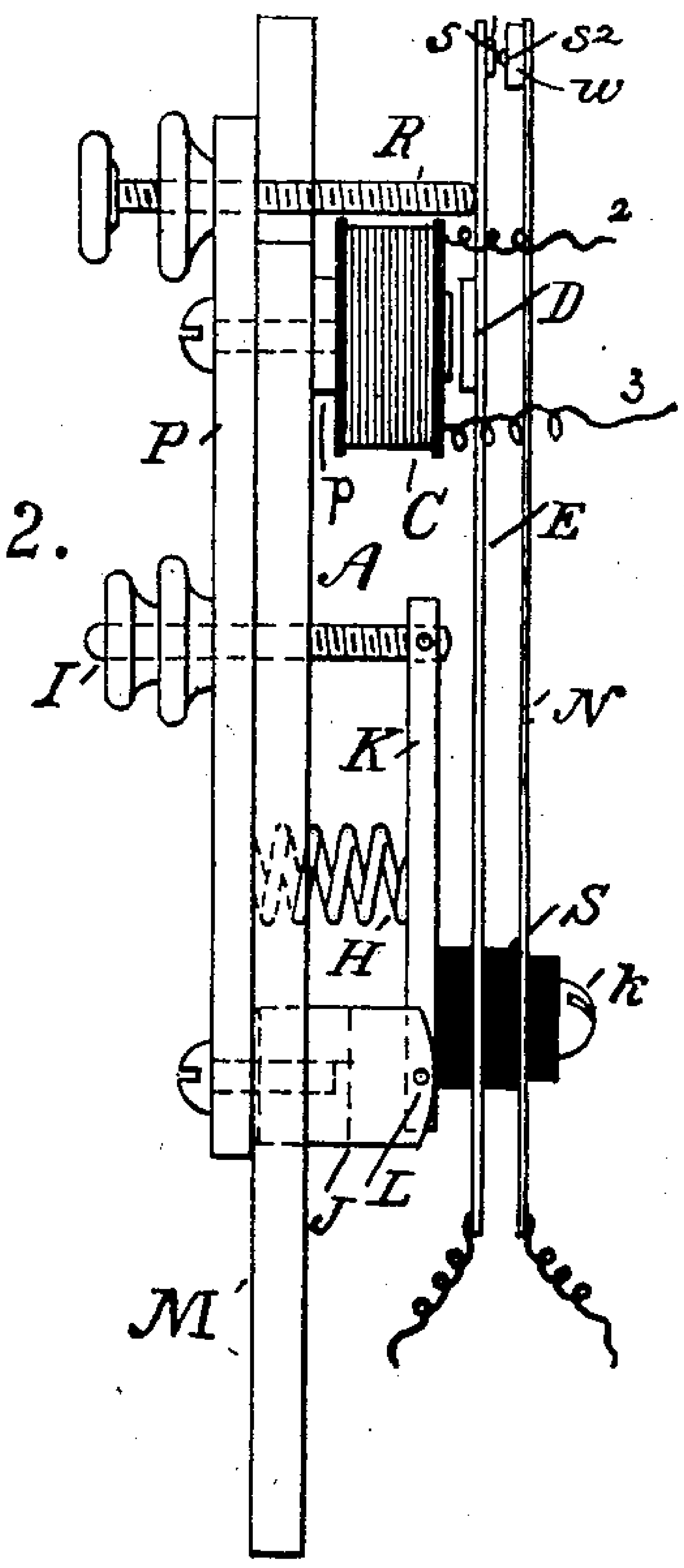
J. M. FELL.

VIBRATORY CURRENT RELAY.

(Application filed Sept. 16, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 2.



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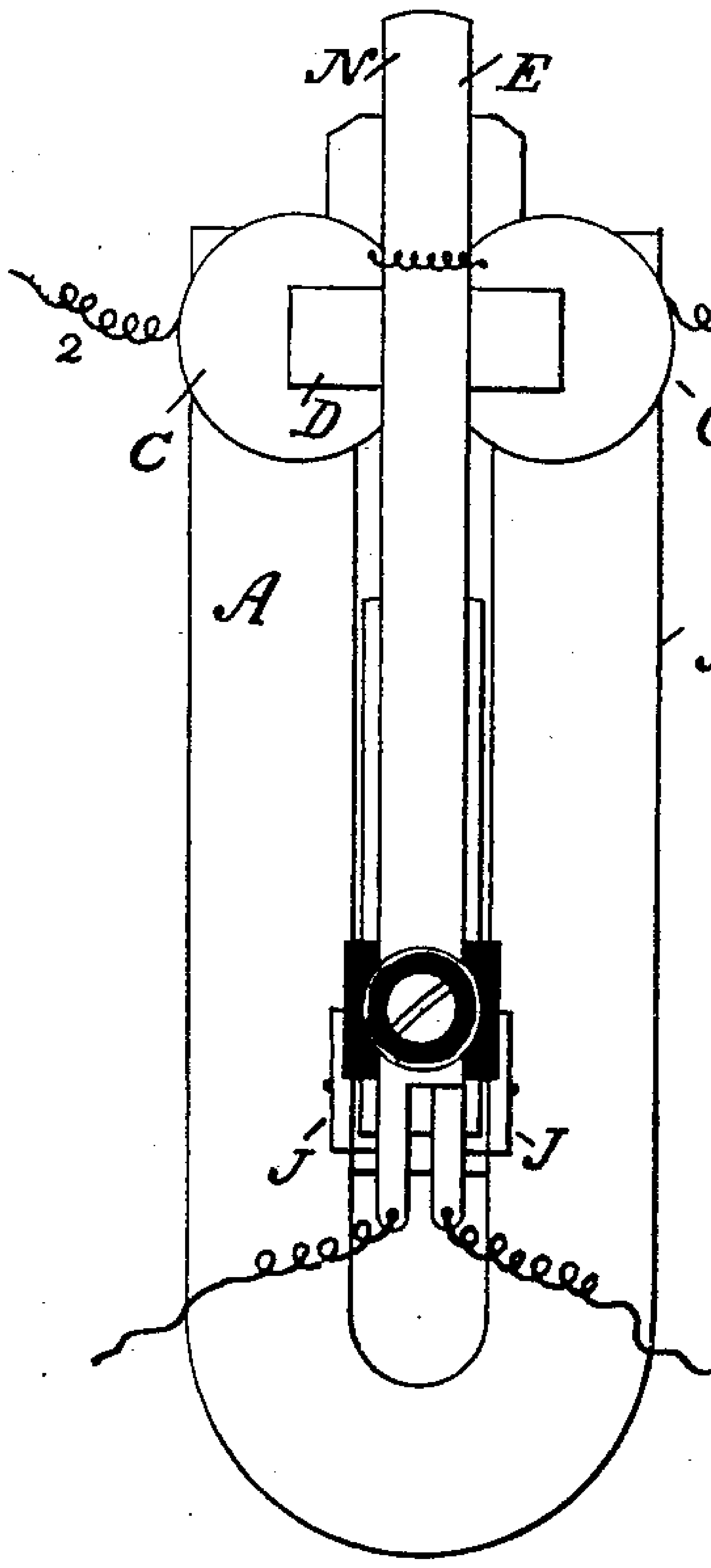
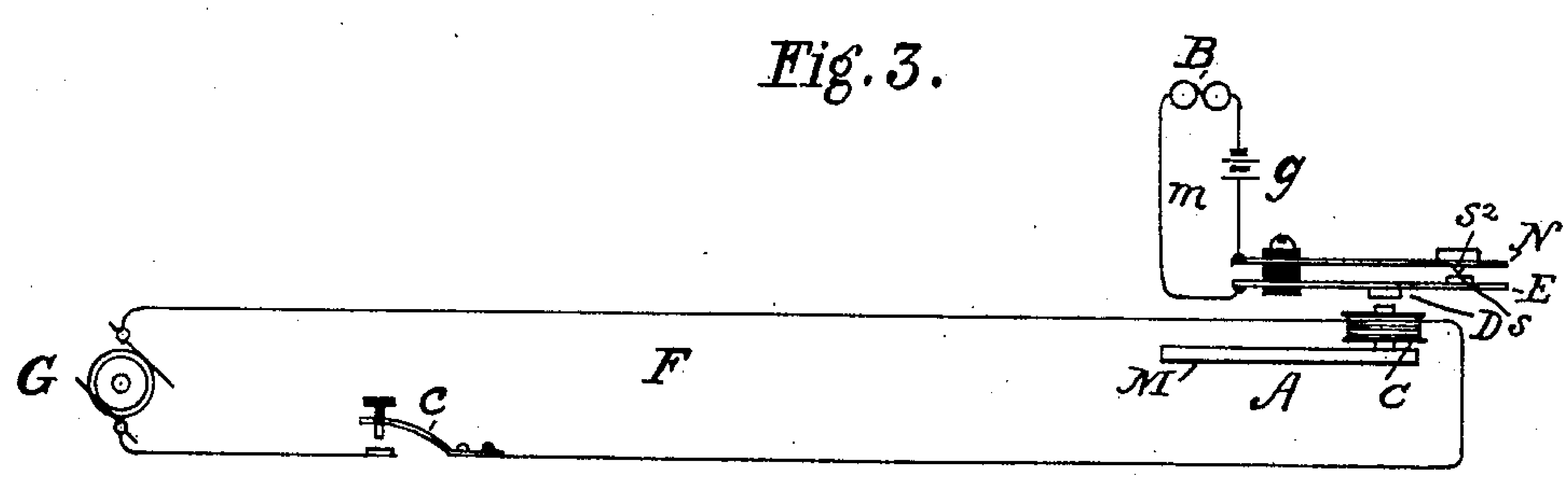


Fig. 3.



WITNESSES:

John E. Burch

INVENTOR.

John M. Fell

by Philipp Mauro

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

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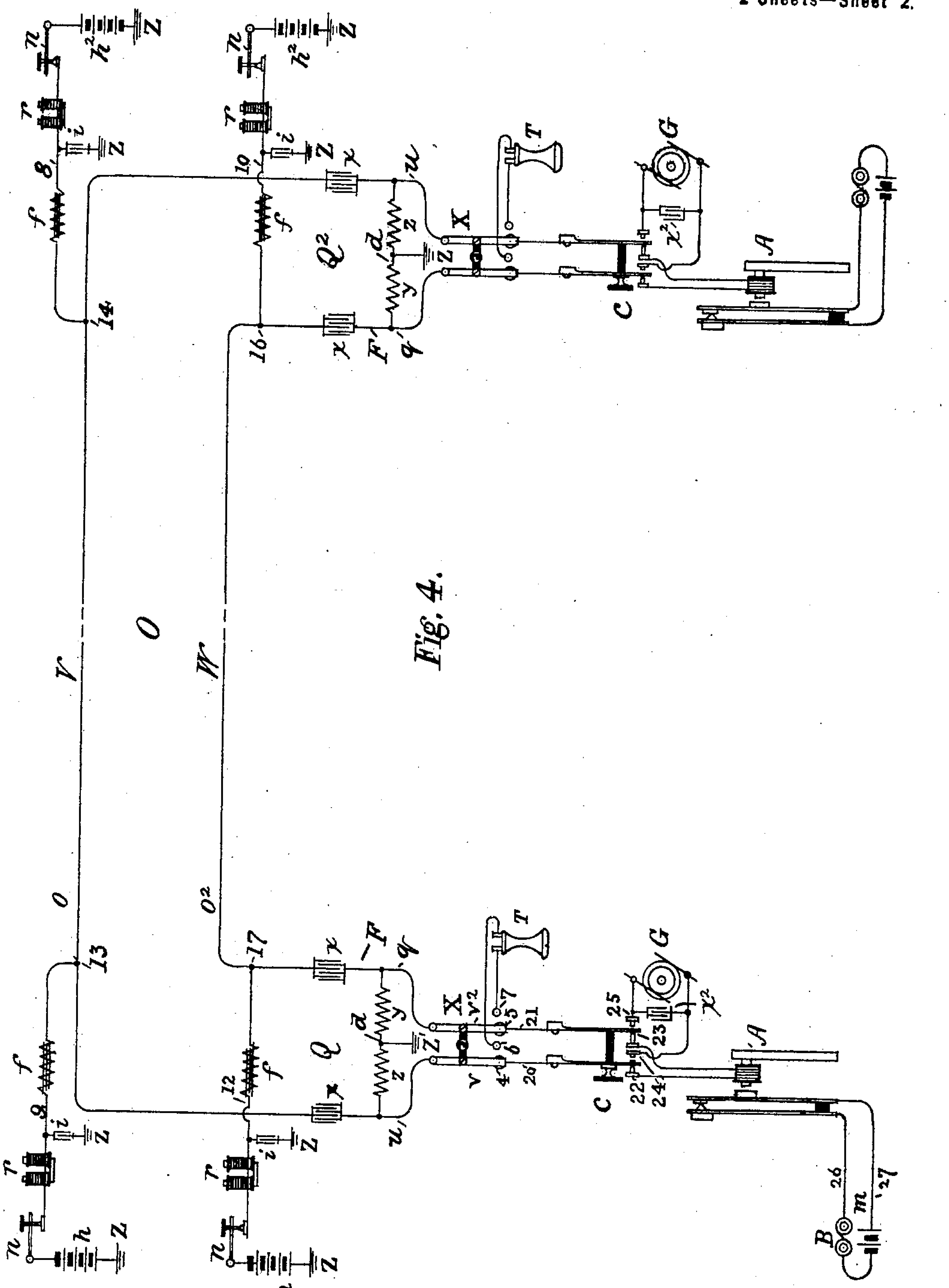

Fig. 4.

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UNITED STATES PATENT OFFICE.

JOHN M. FELL, OF ARLINGTON, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

VIBRATORY-CURRENT RELAY.

SPECIFICATION forming part of Letters Patent No. 708,539, dated September 9, 1902.

Application filed September 16, 1901. Serial No. 75,491. (No model.)

To all whom it may concern:

Be it known that I, JOHN M. FELL, residing at Arlington, in the county of Hudson and State of New Jersey, have invented certain Improvements in Vibratory-Current Relays, of which the following is a specification.

In the practical operation of systems for the simultaneous transmission of telegraphic and telephonic signals over the same circuit-conductors it has been found difficult to provide for the telephonic part of the system suitable appliances for sending and receiving call-signals which, while being perfectly efficient in the exercise of their own functions, do not interfere with the normal operation of and are not themselves subject to interference or disturbance by the normal operation of other parts of the system. It is required in the operation of telephone call-signal apparatus for such a composite system that the electrical currents employed in its operation shall not in any way interfere with or disturb the instruments of the telegraphic part of the system or create inductive disturbance in neighboring telephone-circuits. Moreover, such apparatus must not itself be liable to disturbance by any electrostatic discharges or induced electrical currents which, owing to the operation of the telegraphic part of the system, may appear in the telephonic circuits.

The object of this invention is to provide simple, convenient, and effectual means satisfactorily meeting the said requirements for signaling between the stations of the telephonic circuits of such systems; and the invention consists in a call-signal-receiving relay which is readily responsive to alternating currents of electricity developed by any suitable source and of such potential and frequency as not to interfere in any way with the telegraphic instruments of the system or to inductively disturb other telephone-circuits, which relay when operated by said alternating currents is adapted to act upon and control a local circuit by opening or by increasing the resistance in the same in such a way as to operate any ordinary or usual audible or visible signal. The relay has a permanent magnet, with electromagnetic helices surrounding its poles or pole-pieces and arranged for connection in the main circuit, and an armature carried by a spring-bar, secured at one end in a fixed support and resting near its other end against a stop, (preferably adjustable,) which serves to regulate the position of the armature in relation to the magnet-poles, preventing it from touching them and also acting to establish a nodal point in the said spring-bar. A second but lighter spring-bar, of length similar to that of the first, also has one end attached to the said fixed support and extends parallel with and near to the first-mentioned spring throughout its length, being weighted at its outer or free end. The two springs are insulated from one another at their point of support, and the two local relay contact-points are carried at their outer ends, respectively, each being secured to the inner or proximate surface of its own spring. These points may be regarded as constituting terminals of the local signal-circuit to be controlled by the relay and are normally in contact with each other. The common fixed support of the two springs has preferably an adjustable mounting, whereby the relation of the retractive force of the armature-spring to the attractive force of the armature may be adjusted, and the said fixed support and its mounting are conveniently secured to the permanent magnet, making a condensed and compact device.

In the drawings which illustrate this specification, Figure 1 is a plan view of the relay which constitutes my present invention. Fig. 2 is a side elevation thereof. Fig. 3 is a diagram of a simple circuit containing the said relay and a suitable source of current therefor. Fig. 4 is a diagram illustrating the use of the relay in an improved system of composite telegraphy and telephony.

Referring in the first instance to Figs. 1 and 2, M is a U-shaped permanent magnet having polar projections *p*, fitted with electromagnetic coils or helices C, which by their terminal wires 2 3 may be connected in an electric circuit. The said polar projections may either be of steel and in one piece with the magnet or soft-iron pole-pieces made separately and secured to the magnet-poles in any usual manner. D is the armature, attached to the vibratory spring or spring-bar E and held thereby in front of the pole-pieces, the said spring being at one end secured to the supporting-block S. The spring E, as shown, extends a short distance beyond the attachment of the armature and at a point substantially midway between its end and the center of said armature rests against the end of the stop-pin R, which is adjustably carried by the magnet or by a base-plate P, secured thereto. The armature D is normally under the attractive influence of the magnet pole-pieces *p*, but is prevented from coming into contact with them by the said stop R. The supporting-block S may consist of plates of non-conducting material held together by a screw *k*. It is advantageous to make the said supporting-block adjustable, and for this purpose it is mounted upon the link-piece K, which is pivoted at L in the pedestal J, and at the other end is provided with the adjusting-screw I, a compression-spring H being arranged to press against the inferior surface of said link-piece. The said pedestal and compression-spring may both be attached to the base-plate P, while the adjusting-screw I may pass through a hole in the said plate. By means of the adjusting-screw I and by reason of the pressure of the spring H the link-piece K, and with it the block S, may be slightly turned on the pivot L, thus varying the tension of the armature-spring E with respect to the pull of the permanent magnet M, or, as it may be stated, thus adjusting the force of the spring against the force of the magnet, so as to make the armature D more or less sensitive to variations in the pull of the magnet arising from the action of electrical currents flowing through the electromagnetic coils C. A comparatively light spring-bar N also has one end attached to the supporting-block S. It extends parallel to the armature-spring E to the end thereof, and its inertia is increased by providing it with a weight *w* at its outer end. The springs E and N carry the local-circuit relay-points *s* and s^2, respectively, on their proximate surfaces, and these points, constituting the separable terminals of the local circuit which is to be controlled by the relay, are normally held by the pressure of the lighter spring in contact with each other. When alternating currents of appropriate frequency traverse the electromagnetic coils C, they produce variations of the magnetic field which act upon the armature D, throwing it and the spring E, to which it is attached, into vibration. By reason of the stop R the spring-bar E vibrates with a node at the point where the said stop impinges upon the said spring, the vibrations of that part of the spring which is beyond the stop R toward the outer end being the reverse of those between R and the supporting-block S. Good results have been obtained by placing the stop R about half an inch from the center line of the coils C, with a spring extending about the same distance beyond the said stop, the contact-point *s* being placed quite near to the end of said spring, as shown. The fundamental periodicity of vibration of the spring N is very much lower than that of the spring E, partly because it is lighter than the said spring E and partly because such weight as it has is unequally distributed, being massed at *w*. Thus the two springs are of diverse inertia, and when therefore the armature and the spring E, to which it is attached, are vibrated by the changes in the field of the magnet M and the relay-point *s* pulled away from the point s^2 the lighter spring N cannot promptly follow the vibrations of the said armature-spring, so that the contact between the said points is broken or becomes so delicate that its resistance is greatly raised, with the consequence that the local circuit, normally closed through said points, is opened or substantially opened, causing the operation of any suitable signal device included in such local circuit. It is not essential that the separable relay-points shall be placed near the end of the springs E and N, respectively; but I have found that when thus placed beyond the nodal point their separation is more effectual and satisfactory in operation than when placed on the other side of said nodal point, even though the length of the spring N between the point of support and the point of contact remains the same. The amplitude of vibration of the point *s* may to a certain extent be regulated by varying the distance between the stop R and the said point *s*. The vibrational amplitude of the armature-carrying spring-bar E is greatest when the alternating current producing the vibrations has a periodicity corresponding exactly with the fundamental periodicity of vibration of the said spring as mounted in the instrument—that is to say, when the frequency of the current alternation and the spring are harmonic. The instrument, however, is perfectly operative under practical conditions wherein the current frequency may have a considerable range either above or below the determined periodicity of the relay-spring, so that absolute correspondence is not essential to satisfactory operation. Main-line alternating currents of required potential and frequency may readily be developed by any convenient and suitable source or apparatus, such as a vibrating circuit-breaker and induction-coil or an alternating-current magneto-electric generator associated or not with an induction-coil, as may under the conditions of any particular installation be preferred.

In Fig. 3 such a relay as has been described is shown joined up in a typical circuit with an alternating-current generator and arranged to control a local circuit including a signaling instrument. F is the main circuit, and *m* the local circuit. G is the alternating-current generator, *g* the local-circuit battery, and B the signaling instrument, which may be a closed-circuit annunciator, an electromagnetic bell, or a visual indicator. A is the relay, comprising, as herein described, the magnet M, with its coils C, the armature D, the springs E and N, and the contact-points $s\ s^2$, carried by said springs. The main circuit is controlled by a transmitting-key *c*. The main circuit F contains the generator G and the magnet-coils C, and the local circuit *m* includes the battery *g* and the signal instrument B and passes through the relay-points $s\ s^2$. When the main circuit is closed by the key *c*, the currents developed by the generator G flow through said circuit and traverse the magnet-coils C, thus varying the magnetic condition of the magnet-poles. The attraction exercised by these on the armature D is correspondingly varied and the said armature caused to vibrate. The relay-points $s\ s^2$ being separated or the contact resistance between them being increased, as described, the local circuit *m* is opened or its current greatly weakened to a point where it is practically of zero value, and the signaling instrument is caused to manifest its signal.

In Fig. 4 is illustrated the application of the relay described herein to a composite system of simultaneous telegraphic and telephonic transmission over the same conductors for use as a call-signal-receiving apparatus, particularly associated with the telephone-circuit of said system, together with means for developing and transmitting alternating currents appropriate for the operation of said relay. The composite system above referred to and about to be described is not a part of the invention claimed herein, but forms the subject-matter of divisional application, filed January 8, 1901, Serial No. 88,883. V and W represent the two main conductors of a metallic telephone-circuit O, extending between two stations Q and Q^2, and severally constitute the main conductors of two independent ground-return telegraphic circuits *o* o^2 in a manner well understood to those skilled in the art. The said two telegraphic circuits are both provided at each end with grounded instrument branches or extension-conductors 8 9 and 10 12, respectively, each containing a source of current *h*, a sending-key *n*, a receiving instrument *r*, and an electromagnetic resistance or impedance coil *f*. The said impedance-coils act to smooth the telegraphic currents, so that they will not be liable to disturb the telephonic part of the system, and they also tend to prevent the telephonic currents from being short-circuited to earth at Z through the neighboring telegraphic branches. Associated with each telegraphic extension there is also a branch to earth through a condenser *i*. The several earth connections of the system are all indicated by the same reference-letter Z. The telephone-loops F at the stations Q Q^2, respectively, are joined to the main conductors at the points 13 17 and 14 16 outside of the impedance-coils *f*, so that the said impedance-coils shall be always interposed between the telegraphic and telephonic instruments. Condensers *x* are placed at both ends of each line conductor between said conductor and the corresponding conductor of the telephone-loop, and a bridge *d*, containing resistance-coils *y* and *z*, with a ground connection between them, unites the two loop-conductors *u* and *q* between the said condensers and the telephone instruments. Each terminal telephone-loop may be completed through the call-signal-receiving relay A, the call-signal-transmitting appliances G, or the speaking-telephone apparatus T alternatively, and a switch X and key *c* control these connections. The switch X is a two-bar switch and has two positions. When the line is at rest, the two switch-bars $v\ v^2$ are in connection with the contact-buttons 4 and 5, respectively, and the telephone-circuit continues by conductors 20 and 21 to the signaling-key *c* and associated apparatus; but by turning the said switch to its second position, where its bars are brought into connection with the contact-buttons 6 and 7, the key and signal apparatus are disconnected from the loop, which is then switched to a connection with the telephone apparatus T. The signaling-key *c* establishes normal connection through its back or resting contact-stops 22 and 23 with the relay A, controlling the local circuit *m* and the signal-receiving instrument B, included therein, but when depressed acts to cut off the said relay and to connect the loop-conductors with the terminals of the alternating-current generator G, which terminals are brought to the front contact-stops 24 and 25 of the said key. A condenser x^2 is preferably bridged between the conductors of the generator G to aid in graduating or rounding off the call-current. With this arrangement, though my call-relay is in normal connection with the working circuit and though the induced currents or electrostatic discharges which are due to the operation of the telegraphic circuits pass through its electromagnetic coils, the said relay is not operated or disturbed by them, since they are comparatively slow and infrequent, and therefore cannot move the armature D so fast as to cause the separation of the relay-points $s\ s^2$. Alternating currents having a frequency of approximately three hundred periods per second and a potential of twenty volts have been found suitable for the operation of the relay A, and I employ in association with said relay a generator constructed to develop such currents. The said frequency is sufficiently high to be without apparent effect upon the instruments of the telegraphic circuits and can be transmitted to considerable distances without being seriously attenuated by the conditions of the line, while at suitable potentials for signaling an alternating current of this or similar frequency has no objectionable inductive effect on neighboring parallel circuits.

Having thus described the invention, I claim—

1. A vibratory-current relay adapted to produce steady makes and breaks in a local circuit, consisting of a permanent magnet with coil-surrounded poles; two insulated spring-bars of diverse weight and rate of vibration mounted by one end in a common support, and together extending over the poles of said magnet to a point beyond them, the lighter of said springs being outermost and weighted at its free end; an armature attached to the heavier spring-bar and supported thereby in front of said magnet-poles; a stop for said heavier bar; and coöperating local-circuit relay-points carried at the free ends of the said spring-bars respectively; the said stop being adapted to maintain the said armature out of contact with said magnet-poles and to establish a nodal point in the said heavier spring-bar, and the said local-circuit points being normally in contact but adapted to separate when the said springs are vibrated by said magnet, substantially as described.

2. In a vibratory-current relay, the combination of a permanent magnet M having electromagnetic coils C surrounding its poles; the vibratory armature-spring E secured at one end to the supporting-block S; the armature D carried thereby; and the node-establishing and armature-regulating front stop R for said armature-spring; with the lighter associate spring N also secured at one end in said supporting-block and weighted at the other; relay-points $s\,s^2$ carried by the springs E and N respectively and held normally in contact with each other by the pressure of said lighter spring; and an adjustable mounting for the common fixed support of said springs E and N; the said two springs being constructed and adjusted to have different rates of vibration, whereby the said normally united points are enabled to separate, or increase their contact resistance during the passage of appropriate alternating currents through the said electromagnetic coils, substantially as specified.

3. In a vibratory-current relay, the combination of the permanent U-magnet having pole-pieces surrounded by electromagnetic main-circuit helices; an armature therefor; a contact-spring carrying said armature supported at one end in an insulating-block adjustably mounted on said magnet near the heel thereof, and extending beyond the point of armature attachment; a stop adjustably secured to said magnet and impinging upon the face of said spring at a point substantially midway between the armature and the end thereof; a lighter contact-spring also supported at one end in said insulating-block and extending parallel with the armature-carrying spring; the said two springs having different rates of vibration, and carrying the separable relay-points of a local circuit, and the said lighter spring being weighted at its free end, and adjusted to exercise a normal pressure upon the armature-carrying spring at the free ends of both, thereby holding the said relay-points normally in contact, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 10th day of September, 1901.

JOHN M. FELL.

Witnesses:

G. B. HAWLEY,

ROBERT E. CHETWOOD, Jr.