R. H. MANSON.

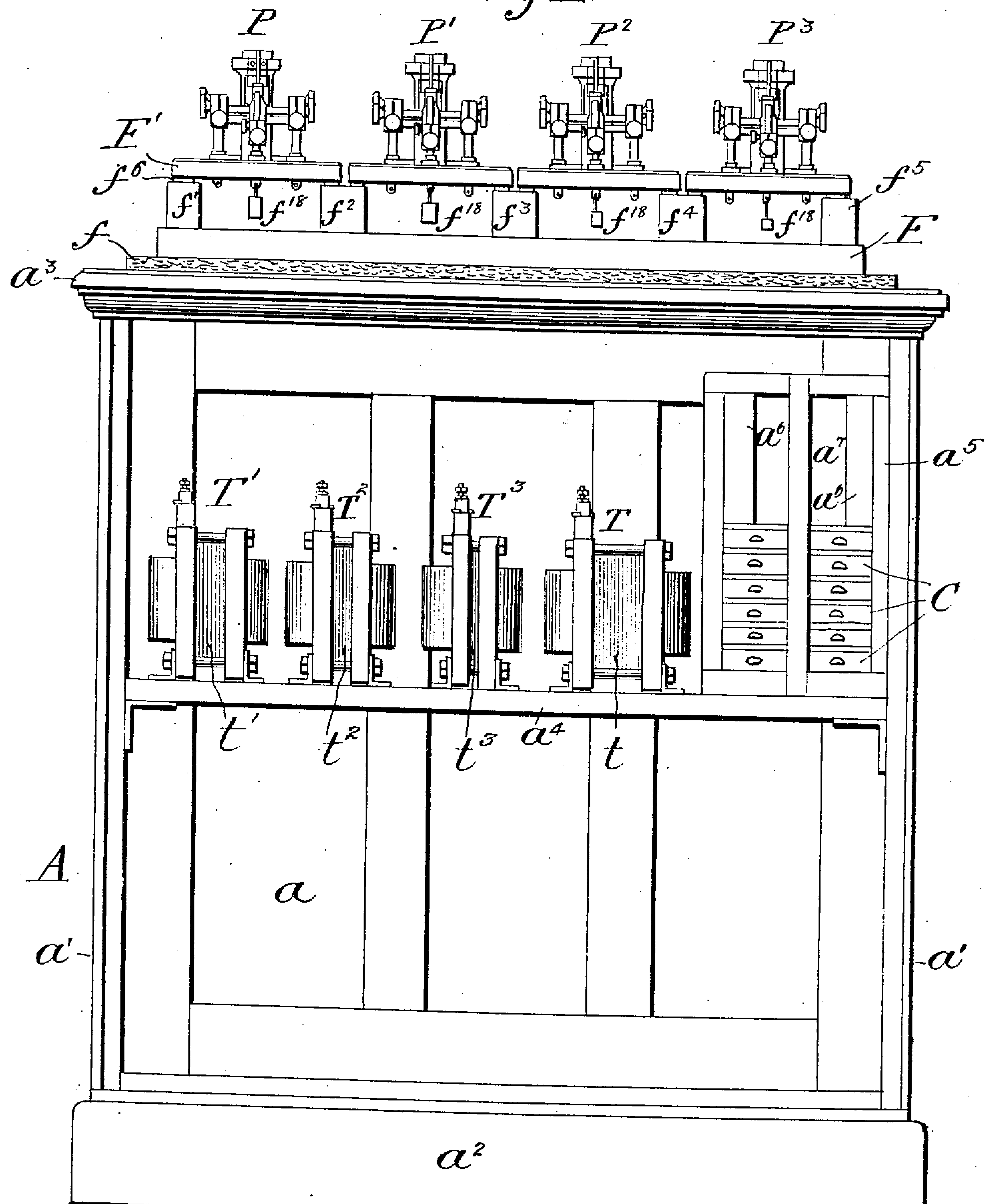
ELECTRICAL SIGNALING SYSTEM.

APPLICATION FILED APR. 18, 1907.

922,436. Patented May 18, 1909.

4 SHEETS—SHEET 1.

Fig. 1.



Inventor

Witnesses

D.W. Edelin.

James H. Mann

Ray H. Manson

By Edward E. Clement

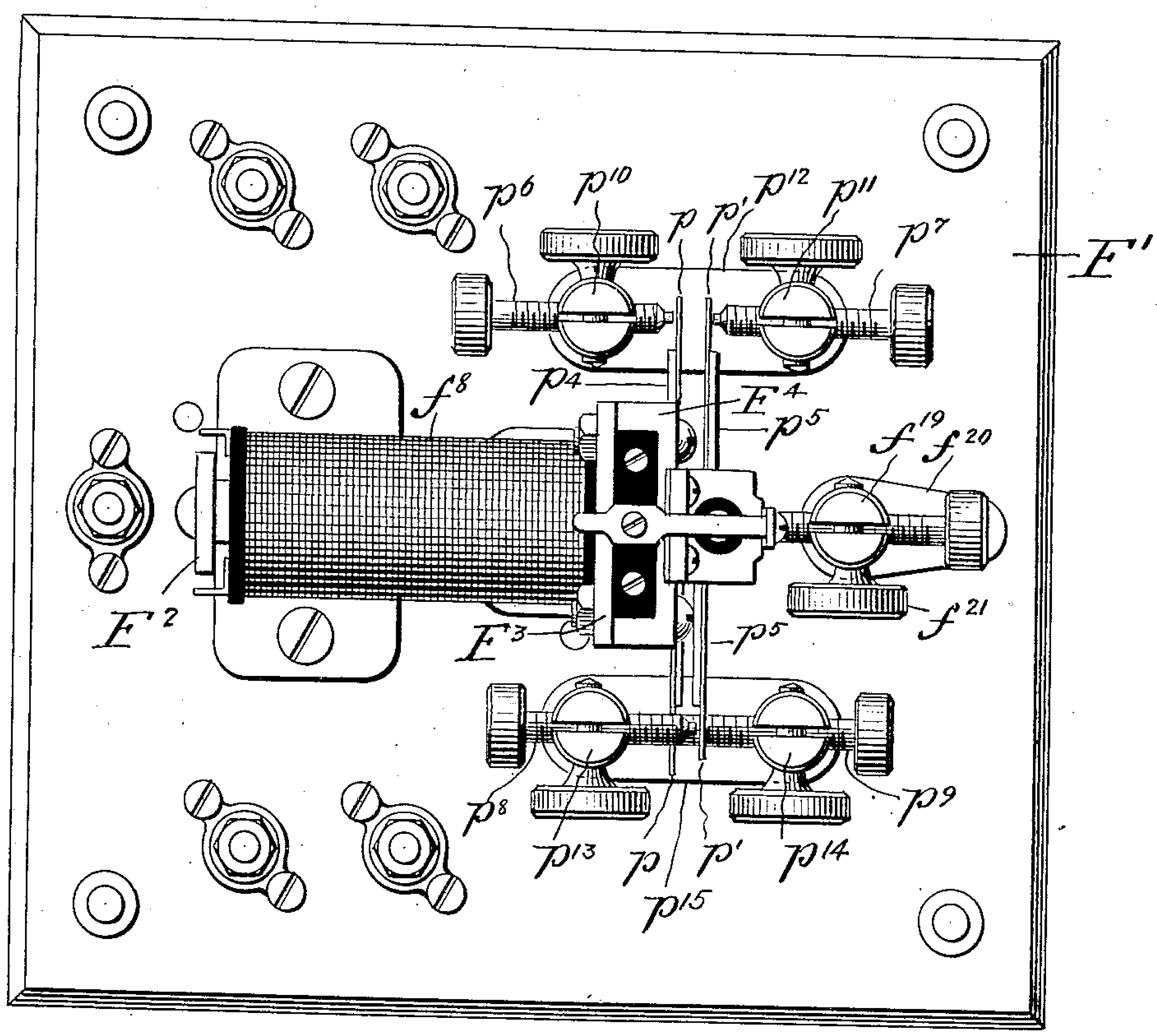
Attorney

R. H. MANSON.
ELECTRICAL SIGNALING SYSTEM.
APPLICATION FILED APR. 18, 1907.

922,436. Patented May 18, 1909.

4 SHEETS—SHEET 2.

Fig. 2.



Witnesses
W. W. Edelin.
James H. Marr

Inventor
Ray H. Manson
By Edward E. Clement
Attorney

R. H. MANSON.

ELECTRICAL SIGNALING SYSTEM.

APPLICATION FILED APR. 18, 1907.

922,436.

Patented May 18, 1909.

4 SHEETS—SHEET 3.

Fig. 3.

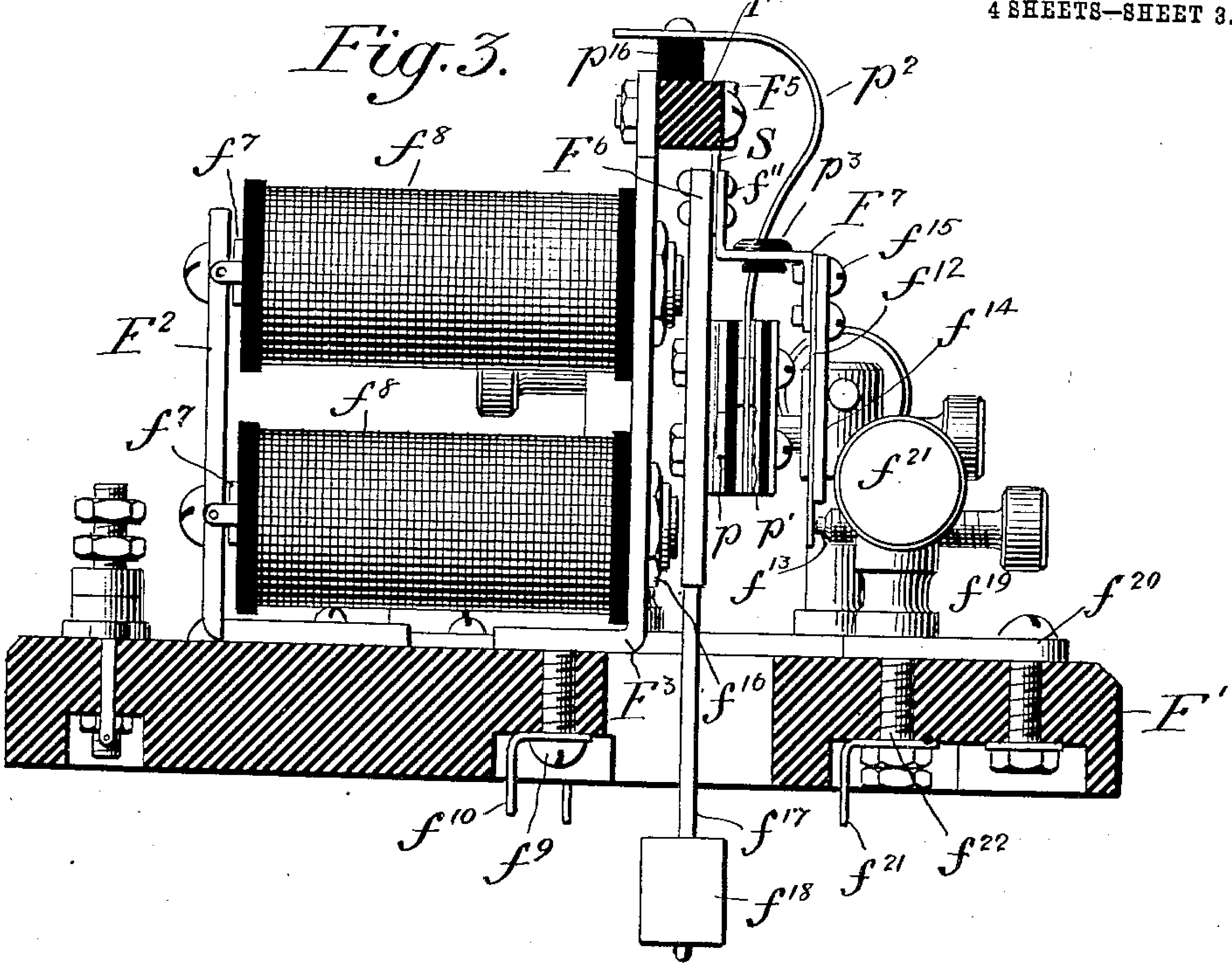
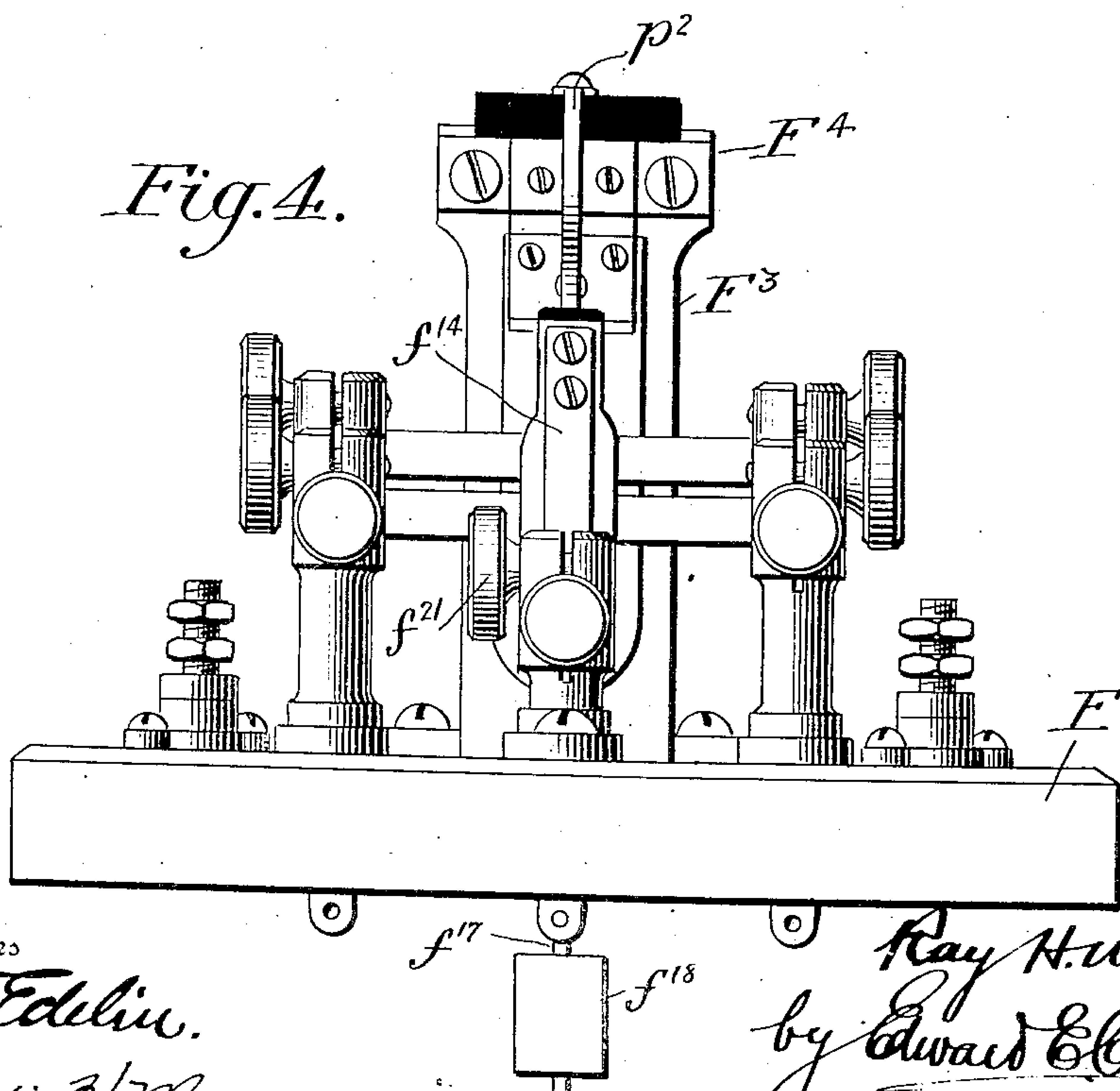


Fig. 4.



Witnesses

D. W. Edelin.

James H. Mann

Inventor

Ray H. Manson

by Edward E. Clement

Attorney

R. H. MANSON.

ELECTRICAL SIGNALING SYSTEM.

APPLICATION FILED APR. 18, 1907.

922,436.

Patented May 18, 1909.

4 SHEETS—SHEET 4.

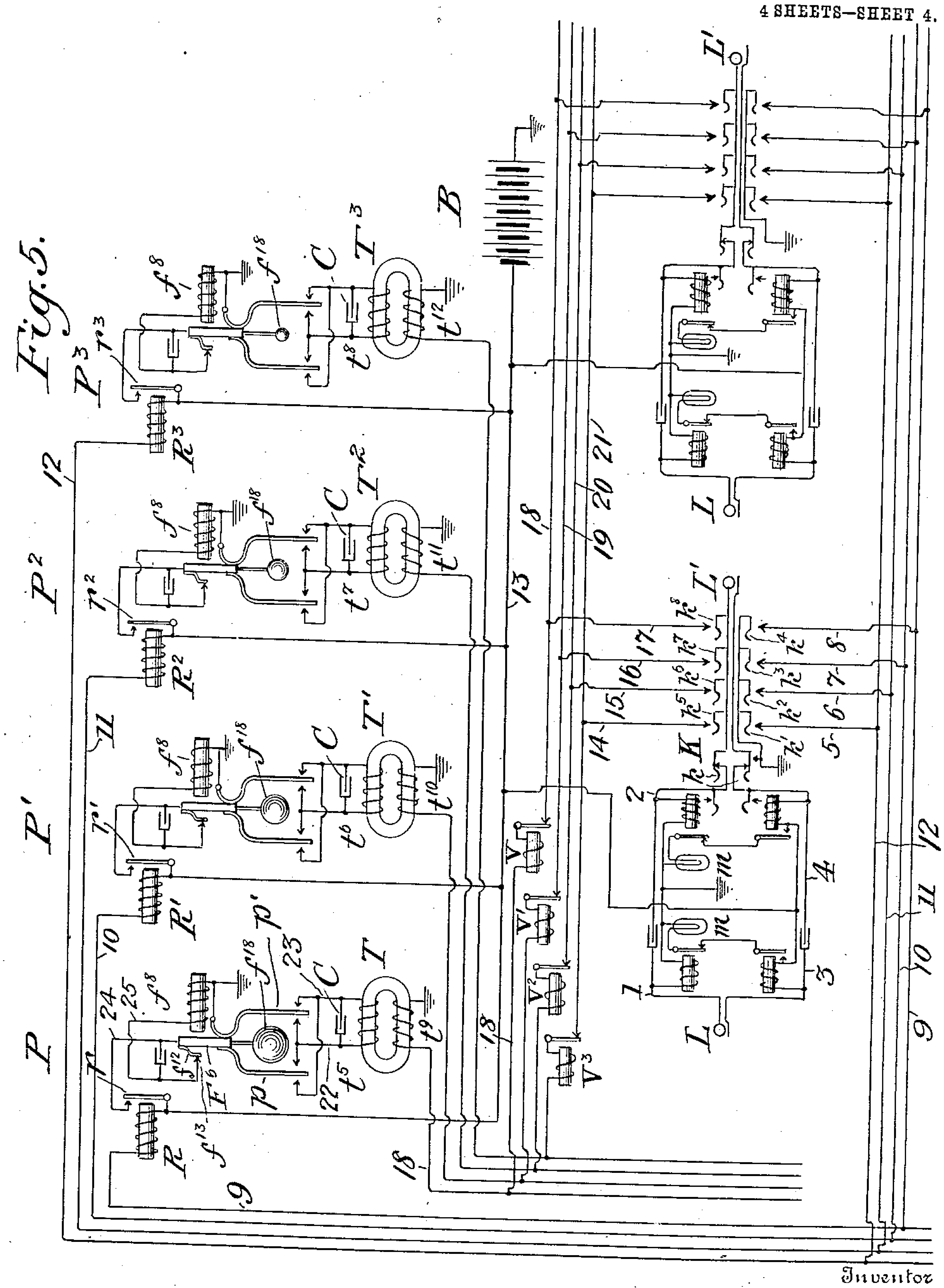


Fig. 5.

Witnesses

D. W. Edelin.

James H. Marr

Inventor

Roy H. Manson

By Edward E. Clement

Attorney

UNITED STATES PATENT OFFICE.

RAY H. MANSON, OF ELYRIA, OHIO, ASSIGNOR TO THE DEAN ELECTRIC COMPANY, OF ELYRIA, OHIO, A CORPORATION OF OHIO.

ELECTRICAL SIGNALING SYSTEM.

No. 922,436. Specification of Letters Patent. Patented May 18, 1909.

Original application filed January 16, 1906, Serial No. 296,309. Divided and this application filed April 18, 1907. Serial No. 369,020.

To all whom it may concern:

Be it known that I, RAY H. MANSON, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Electrical Signaling Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to electrical signaling systems, and has for its object the improvement of such systems and the apparatus used therein.

It is especially designed for use in systems wherein a plurality of signals are to be manifested, or a plurality of signal devices are to be actuated over the same circuit; and in the form which I shall hereinafter describe it finds a wide sphere of usefulness in the telephone field. I contemplate applying it, however, to many other classes of systems, which need no special mention since the methods of application will be sufficiently apparent after reading the description, to those skilled in the electrical arts.

For purposes of selective signaling, and as the basis for the present invention, I employ periodic currents of different frequencies, and the principal merit of my design resides in the efficiency, economy and precision of production and application of such currents. At the present time standard practice, and particularly telephone engineering practice, is such as to render line construction, as well as central office equipment, very expensive; and in order to insure the largest possible returns from the heavy investments thus required, it is customary to serve a plurality of stations over the same circuit wherever possible. In order to render this class of service satisfactory it is demanded that each station may call and may itself initiate calls, without disturbing or alarming the other stations on the same circuit. This may be accomplished in a variety of ways, but where the number of stations is comparatively small, the best way is by means of harmonic signaling, in which the receiving devices at the several stations are arranged so that each will respond only to a definite and predetermined kind of current. Such systems have been designed and extensively used in telephone work, having four distinctive currents generated at the central office, and all the substation ringers tuned to respond to one or another of these currents, only. The necessary equipment, however, has heretofore been expensive both in first cost and in its subsequent maintenance and operation. Many small exchanges have thus been prevented from instaling standard party-line equipments, because of their prohibitive cost. Such equipments have heretofore included special generators, having four different windings or four different armatures, each adapted to produce current of a particular frequency; and since the frequency of a periodic current varies with the speed of the machine generating it, these machines have not only been fitted with devices for maintaining their speed constant, but it has been necessary to keep them running all the time, for the obvious reason that they could not be started and brought up to full speed so as to deliver the proper current for each call to be made. As the machines have usually been run by means of electric motors, and as the idle or friction load in running is considerable, the total current consumption has been a factor to consider, even in large exchanges.

According to my present invention I provide a plurality of pole-changers, each with its own motor, preferably governed by an individual relay, the working parts of each pole-changer being tuned so as to have a distinctive period, which determines the frequency of the current output, and which is constant under all circumstances, whether continuously running or freshly started. I associate with these pole-changers an equal number of transformers, each especially adapted to the particular frequency of current with which it is to be used, and also a number of condensers which may likewise be suitably proportioned to the several currents. The motors for the pole-changers, which are conveniently electro-magnetic vibrators, may be run constantly by means of closed circuit primary batteries, such as the well known gravity batteries, and the pole-changing contacts may be supplied from separate open-circuit batteries; but I preferably arrange both the motors and the contacts to be supplied from a common source, and controlled as to their supply by the individual relays. This enables me to connect my entire system to a common source, such as, for example, the main storage battery of an exchange.

Such an arrangement is both economical and efficient, since no current is consumed except when calls are actually being made, but when a machine is operating its source of supply is capable of generating a very large current if required. The storage battery having a very low internal resistance, the current flow through my machines is dependent entirely upon the internal conditions in the machines themselves, and they can thus be designed for any given voltage and current output with the same precision as an ordinary power-driven generator. An incidental advantage in the use of separate motors for these machines lies in this,—that each machine will continue to operate perfectly, even though one or more of the other machines in the same set may be disabled. This is not so with the generating sets heretofore employed, and it has always been considered necessary to have these sets installed in duplicate, since the breaking down of the ringing machine would obviously cripple all the work of an exchange. In the present case it is only necessary to carry a small stock of parts in order to be able to remedy any temporary break-down almost instantly, and I make the units composing each set interchangeable, so that in case of the complete destruction of one unit, another may be substituted, and properly tuned, with little trouble and no delay. Another great advantage in the use of separate motors lies in the possibility thus afforded for wide scope in choice of frequencies to be used. In rotary or other machines heretofore employed, because of the common moving parts, frequencies have had to be taken which were substantially multiples of each other, as 33, 66, 50, and 100 cycles. With separate motors, I am enabled on the contrary, to choose any frequencies I wish; and I find it best to avoid common multiples, because of their well understood liability to interfere.

I mount my pole-changing set, with its transformers and condensers, in a cabinet which forms a complete portable unit in itself, and which preferably has provision also for containing primary or secondary battery cells to run the machines, if desired.

In order to protect my machines, and also the operator's ringing leads, from excessive current due to grounds or short circuits upon the lines, I introduce into each lead a suitable compensating resistance, preferably in the shape of an electro-magnetic vibrator having only a few turns of large wire, so that it will not respond to the ordinary ringing currents, but upon an undue rise in current will commence to vibrate, thereby introducing a resistance proportional to the current flow.

The present application is a division of my earlier application filed January 16, 1906, Serial No. 296,309.

My invention is illustrated, as to one embodiment, in the accompanying drawings, in which—

Figure 1 is a front view of a cabinet with the cover and face panel removed, showing the pole-changing units upon its top, and the transformers and condensers within it; Fig. 2 is a plan view of one of the pole-changing units; Figs. 3 and 4 are, respectively, a side view and a face view of the same unit, the base being shown in Fig. 3 in section; Fig. 5 is a diagram of the circuits of my ringing outfit as applied to a standard common battery manual exchange equipment.

Referring first to Fig. 1, A is a cabinet, which I have shown with a paneled back a, sides a', a base a^2, and a flat top a^3. Within this cabinet and across the two sides a'—a' I mount a shelf a^4, of sufficient weight and strength to carry the transformers T T′ T^2 T^3, and the condensers C. The latter are assembled together for convenience in handling, in a separate box or cabinet a^5, in which the distance pieces a^6 are fitted, and from end to end of which a bar a^7 extends, so that the condensers are securely held against displacement. The front of my cabinet A is closed when it is in use by means of a removable panel or door, not shown. Upon the top a^3 is secured a thick rectangular base of felt or similar sound insulator f. Upon this rests the base F, which is common to all of the pole-changers. Each pole-changer comprises the apparatus shown in Figs. 2, 3 and 4, mounted upon a separate base F′, secured to solid posts f' f^2 f^3 f^4 and f^5. These posts, as well as the common base F, may be of wood or similar material, and are made sufficiently heavy and solid to form a reliable foundation for the support and alinement of the pole-changers. The bases of the latter are raised up on the posts f'—f^2 etc., in order to leave a clear space beneath them for the pendulums or tuning weights. Each base F′ may also be insulated from its supports f'—f^2 etc., as shown at f^6, if desired. It will be observed that the individual bases themselves are heavy and substantial, and as they are of slate or similar material, and all of the parts are insulated, the sound produced by the outfit in ringing is not sufficiently loud to be objectionable, which has been the case heretofore with many pieces of apparatus of this character.

The transformers T T′ T^2 and T^3, in point of their general design form no part of the present invention; but they have one or two special features which I have found necessary in order to adapt them to my purposes. It will be observed that the iron core t of transformer T is much larger than the core t' of the transformer T′, and this in turn is larger than the core t^2 of the transformer T^2, while the core t^3 of transformer T^3 is the smallest of all. There is a corresponding difference in the windings of these transformers. The transformer T is used with currents of the lowest frequency, and in order to produce the necessary efficiency, it is given more iron, and a proportionate winding, so that the self-inductance with its frequency will be small. The transformer T′ is used for the next higher frequency, and has a decreased amount of iron in its magnetic circuit, with a corresponding change in the winding; T^2 is used with the next higher frequency, its iron circuit being therefore further reduced, and its winding changed; and T^3 is used for the highest frequency, having therefore a comparatively small amount of iron in its magnetic circuit, and its winding so proportioned as to produce the necessary low co-efficient of self-induction. It is unnecessary for me to give the formulæ for these transformers, the same being well known to engineers, and I will merely call attention to the characteristic proportions of each transformer, by which, in conjunction with the proper design of the pole-changers and if necessary of the condensers, I maintain approximately uniform conditions for ringing currents of all frequencies.

Referring now more particularly to Figs. 2, 3 and 4, wherein one of the pole-changing units is shown on a larger scale, F′, as before noted, is a heavy base of slate or other suitable material, upon which is erected the yoke frame F^2, carrying a pair of magnetic cores f^7, with windings f^8. The forward ends of these magnetic cores pass through and are secured to a second vertical yoke frame F^3, which is itself secured to the base by one or more screw-bolts f^9 passing up from beneath, and carrying tailed washers f^{10}: or other means for attaching circuit wires. It will be noted from the diagram that one side of each pair of contacts is to battery, and I preferably make these battery connections through the frame, thus simplifying the wiring very materially. Upon the upper end of the frame F^3 a heavy transverse block F^4 is secured, upon which the stiff spring S is held by the clamping plate F^5, preferably seated in a depression or cross groove milled out in the heavier block. I make these parts heavy and solid for a double purpose,—first, in order to have the fastenings absolutely secure, and, second, to prevent the communication of vibrations through the parts of the machine. The spring S carries the armature F^6, and the contact member F , which are riveted together at f^{11} through the body of the spring, and upon opposite faces thereof. The contact member is bent out at right angles from the plane of the armature, and upon its outer end, which is again returned at a right angle, I fasten the contact spring f^{12}. In order that this may yield on the back stroke when it touches the twin contact f^{13}, but may be rigid when the armature is drawn forward, I provide a stiff backing member f^{14}, which is held at its upper end to the spring and also upon the contact member F^7 by means of the screws f^{15}. The armature F^6 normally hangs vertically directly in front of the poles of the magnets f^8, which I may make adjustable with regard to the frame F^3 by means of the nuts f^{16}. Attached to the armature and depending therefrom is the rod f^{17}, carrying the tuning weight or pendulum f^{18}. The back contact f^{13} for this vibratory mechanism is preferably the platinum point of a thumb screw having a milled head by means of which it may be adjusted in the post f^{19} secured upon a base piece f^{20}, and provided with a set screw f^{21}, by which the contact screw may be locked. All of the contact posts in my device have split heads and set screws for this same purpose. Circuit connections to the post f^{19} are effected through the tailed washer f^{21} attached beneath the base to the screw bolt f^{22}. The plate f^{20} is employed, with its two screw bolts through the base, in order to prevent any possible turning of the post f^{19}, and consequent disarrangement of the contact f^{13}. The post is rigidly set in the plate by means of solder or a steady pin or a squared shoulder let into the plate. A solid construction is thus attained which will not be disturbed by the continuous vibration of the contacts.

The parts of the apparatus thus described constitute the motor mechanism of the individual or unit pole-changer. The electromagnets f^8 are connected on one side to the posts f^{19}, and on the other side to ground, the armature and frame being to battery when the circuit is closed. In this condition the armature will be vibrated, and by properly adjusting the screw contact f^{13}, this vibration may be rendered uniform and smooth, and its frequency determined to a certainty by means of the pendulum bob or weight f^{18}. The pole-changing means operated by this motor device comprise a pair of transverse springs p—p', the first of which is in metallic contact with the parts of the armature and frame, and so to battery, while the second is to ground through a flexible spring p^2, passing upward through the central opening in the member F^7, and kept from touching the latter by means of an insulating bushing p^3. These springs are stiffened by metallic backing strips p^4—p^5, precisely similar to the strips f^{14}, and for the same purpose, that is, each spring p or p' is quite flexible, but the backing strips are relatively stiff, hence the springs are permitted to give in one direction, but not in the other. It will appear that the opposite ends of the springs must give in opposite directions, hence the strips p^4—p^5 are on the outside faces on one side, and upon the inside faces on the other (see particularly Fig. 2). For convenience of mounting, I assemble the springs p—p' and their associated parts before connecting them to the armature, the alternating strips of metal and insulation being clearly shown in Fig. 3, from which it is sufficiently apparent that these parts may be put together and so held by the screw bolts shown, before they are applied to the armature. The opposite ends of the springs p—p' play between the platinum points of contact screws p^6 p^7 p^8 and p^9. Each of these screws is adjustably mounted in a split head post, with a set screw, similar to the post f^{19} and screws f^{21}. All four contacts may therefore be adjusted with great accuracy, and held positively thereafter. The posts p^{10}—p^{11}, carrying the screws p^6—p^7, are mounted upon opposite ends of a plate p^{12}, and the posts p^{13}—p^{14} are mounted upon a similar plate p^{15}. These two plates are secured to the base by means of screw bolts, in a similar manner to the plate f^{20}. They are connected to suitable terminals mounted on the base, and thence to opposite sides of the primary winding of one of the transformers T. Since the two springs p—p' are connected respectively to battery and to ground, and as the contacts are adjusted so that one of the springs will make on one side and break on the other side, at the same time that the other spring breaks on the first side and makes on the other, and vice versa, it will be apparent that as the armature vibrates the springs back and forth between the contacts, battery and ground will be rapidly, simultaneously and alternately connected to the two plates p^{12}—p^{15}.

For the purpose of securing the springs p^2 in an efficient manner, I mount a rubber block p^{16} on the top of the block F^4, and secure the spring upon the rubber. It is necessary to provide thorough insulation between these springs and the other parts, since the potential difference between them represents the full strength of the battery or other source of supply, and also since a ground upon the live side of the battery would not only produce disastrous results in the individual unit, but would temporarily disarrange other portions of the exchange mechanism.

Having thus described the individual unit I will revert again to Fig. 1. I have referred to the pendulum bob or weight f^{18} as determining the pitch or tune of the individual unit. In Fig. 1 the four units, designated as P P′ P^2 and P^3, are fitted with weights of different sizes and masses. They may also be differently adjusted upon the rods f^{17}. The preferable method by which I effect this tuning is to take the armature with its moving parts assembled upon it, and put it in a standard frame where it is exposed to magnetic effects produced by current of the frequency to which it is intended to respond. A weight exactly corresponding to that which is to be used upon it is then adjusted upon the rod until the proper point is determined at which the greatest efficiency is attained, and a mark is made upon the rod to indicate this point. The test weight is then removed, and the final or working weight is driven upon the rod up to the point marked. This method of tuning and assembling enables me to produce absolutely uniform results, with considerable economy in manufacture.

Turning now to the circuit shown in Fig. 5, L L′ represent pairs of connecting plugs adapted for use with a manual switchboard of standard design, each pair of plugs being connected by cord conductors 1, 2, 3 and 4, with interposed condensers, and bridged relays controlling supervisory signals m, all of standard type and arrangement. The line jacks and line circuits with which these plugs coöperate are not shown in the diagram, being perfectly familiar to all engineers. They may be of any suitable or desired construction and arrangement, it being presupposed for the purposes of this invention, however, that the line circuits are two-wire or metallic circuits, and each with one or more sub-station ringers connected across its component wires.

My generating set will work upon grounded circuits, and in fact I have shown the secondaries of the transformers all grounded on one side, but, as a general rule, and in accordance with modern practice, these grounds are common, and the current is brought back from the sub-stations to the central office and passes to ground at the ringing keys.

Associated with each plug L′ is a selective ringing key K. It goes without saying that since I can ring any one of four stations on a line, I can ring one, two or three stations on a line, so I will confine myself in this description to the four-party arrangement. In this the key K has four pairs of selective contacts, k', k^2, k^3 and k^4, any one of which can be closed by means of a suitable lever or button, in the usual manner. Associated with these pairs are other pairs k^5—k^6—k^7 and k^8, simultaneously controlled. Associated with all of these selective contacts is a pair of springs k which normally rest upon contacts through which the cord circuit is completed, but are separated therefrom when any one of the selective buttons is in use, so that when any ringing current is put on the plug L′ it will be prevented from flowing back over the cord to the calling subscriber. The contacts k'—k^2—k^3 and k^4 are connected by means of wires 5, 6, 7 and 8 to the leads 12, 11, 10 and 9, which pass to the relays R^3, R^2, R^1 and R of the pole-changers P^3, P^2, P^1 and P, and thence to the battery wire 13 and so to the main battery B and ground. All of the contacts k', k^2, k^3 and k^4 are connected together and to ground, and when the spring k

is actuated it grounds the sleeve of the plug L′, while it opens the cord on the other side. The springs k^5, k^6, k^7 and k^8 are connected by wires 14, 15, 16 and 17 to the leads 21, 20, 19, 18, which pass through contacts of the compensating vibrators V^3, V^2, V^1 and V, to the secondary windings t^{12}, t^{11}, t^{10} and t^9 of the transformers T^3, T^2, T^1 and T, associated with the pole-changers P^3, P^2, P^1 and P. The primary winding of each of these transformers is connected on one side by wire 22 to the inside contacts of the pole-changer, and on the other side by wire 23 to the outside or alternate contacts of the pole-changer. Across these two wires is bridged a condenser C, which takes up the discharges from the coil and prevents sparking at the contacts, besides rendering the effect in the winding more uniform and efficient.

The battery wire 13 is connected to the armatures r r' r^2 and r^3 of the relays R, R′, R^2, R^3, and thence in each case when these relays are energized by the wire 24 to the armature structure F^6 and the contact spring f^{12} secured thereto, also to the pole-changing spring p. The opposite pole-changing spring p' is grounded. The motor magnet f^8 is connected between the ground and the contact f^{13} by wire 25, and across the contacts f^{12} and f^{13} is bridged a condenser C′ for the purpose of taking up the extra current and preventing sparking.

The operation of my system thus described is as follows: The plugs L L′ having been inserted in order to effect a connection, and the operator being apprised of the party wanted on the line with which connection has been made, she presses down the appropriate button which we will assume to be k^8, and at the same time spreads apart the springs k. A circuit is at once established through contacts k^4 as follows: battery B, 13, R, 9, 8, k^4 and ground back to battery. The relay R thereupon becomes energized and pulls up its armature r, closing the operating circuit of the motor magnet f^8 of the number one pole-changer P, as follows: B, 13, r, 24, F^6, f^{12}, f^{13}, 25, f^8, and ground back to battery. The armature F^6 is thereupon pulled up, breaking apart the contacts f^{12}, f^{13}, then released to close said contacts, and so on continuously vibrating at a definite pitch predetermined by the mass and adjustment of the pendulum f^{18}. This vibration of the armature causes the springs p, p' to play back and forth between their contacts, and so to alternately connect battery and ground on each wire 22 and 23, so as to produce rapid reversals of current in the primary winding t^5 of the transformer T. The operation of the key k^8 has connected the secondary of this transformer to the tip of the plug L′ by the following path: t^9, 18, V, 17, k^8 and tip of plug L′. From the tip of the plug this circuit is completed out over the line with which the plug is temporarily associated, through the one or more ringers upon that line, and if the circuit is metallic back to the central office and through the sleeve of the plug to the key k to ground; or if the circuit is a single wire circuit, then to ground at the sub-stations. It happens that the pole-changer P has the heaviest pendulum, and the slowest movement, also that its associated transformer has the most iron and the greatest number of turns in its winding, hence the signal current that is generated in the secondary of the transformer and sent to line, is of a low frequency determined by the adjustment of the constants to which I have referred. These constants in the case of each transformer and its pole-changer are so adjusted, however, that the amount of energy sent to line will be fairly uniform in all cases.

The operation of the other selective keys and of the other pole-changers is substantially the same, except as regards the frequencies. The compensating vibrators V V′, etc., are included to complete the lay-out, and not in themselves as parts of the present invention, although in coöperation with the apparatus described they form a very advantageous means for automatically increasing the resistance of the circuit upon an excessive current flow therein, and, moreover, this increase is practically proportionate to such increase in current.

From the foregoing description and statement of operation it will now be apparent that I effect the greatest economies, and attain the highest efficiency, combined with perfect precision in operation. There is nothing more accurate and more uniform in its action than a properly tuned reed or pendulum. There is no periodic vibrator which can be brought into full operation with a smaller time-loss, and it is to be particularly noted that this is very important, because if the ordinary rotary generator be started up in making a call, the rate of alternation will be accelerated as the machine speeds up, from zero to maximum, and as a result all the ringers on the line will be operated in succession. In my case action is so quick as to have no effect whatever on any but the one ringer which it is designed to actuate. The very important feature in this circuit is the inclusion of the controlling relays R R′ in circuit with the ringing keys, whereby I am enabled to maintain the operating current in purely local circuits, and prevent any possible trouble in the keys from that source. The ringing currents, of course, pass through the keys, but the relays may be so wound as to take very little current, and also so they will offer very high impedance. Thus it will be seen that the current flow through the operator's key, closing the actuating circuit of the pole changer, is limited by the resistance of the relay coils contained in this circuit, such coils being preferably of high resistance, and this circuit is independent of the circuit through the pole changer and transformer coil, that is, in the pole changer P the actuating key is k^4 which closes a circuit through the coils of the relay R, such circuit being independent of the circuit through the vibrating member f^6 and the transformer winding t^5. The coils of the relay R therefore constitute a means for limiting the current flow through the actuating key independent of the current flow through the pole changer P and winding t^5. The relay coils also maintain a constant current flow through the actuating key for varying currents through the pole changer and transformer winding.

I am aware that it has been proposed before to use vibrating reeds or tongues with pole-changing contacts, for producing alternating current. I believe, however, that I am the first to produce a system such as that I have described, wherein currents of different frequencies, and approximating in character to those of the standard ringing generators, may be produced from pole-changers with precision, and so as to operate with high efficiency. By combining transformers with my pole-changers, as shown, I am enabled not only to approximate the characteristics of ordinary generator current in the ringing leads, but also to raise and regulate the voltage perfectly while working, if desired, on a source of low potential. As I have before pointed out, it is possible to connect this system directly on the main storage battery of any common battery exchange, and this I believe has never been accomplished before, hence I feel entitled to claim the combination I have thus made available, in broad terms.

Many changes may be made in details of construction and in the circuit connections without departing from the spirit of my invention. It is not limited to any particular type of connective or line circuits, nor even to telephone circuits as such; and I desire my claims to be broadly construed so as to cover all non-essential variations.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer and means for limiting the flow of current through such key independent of the current flowing through such pole changer.

2. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer and means for maintaining a constant current flow through such key for varying currents through such pole changer.

3. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer and means for maintaining a comparatively small current flow through such key relative to the current flowing through such pole changer.

4. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer and means for maintaining such key in a local circuit independent of the circuits through such pole changer and transformer.

5. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer, a relay adapted to be operated by the closing of such key and contacts carried by such relay for controlling the operating circuit of such pole changer.

6. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer, means for maintaining such key in a local circuit independent of the circuits through such pole changer and transformer and a second key located in such signaling circuit for controlling the same.

7. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer, means for maintaining such key in a local circuit independent of the circuits through such pole changer and transformer, a second key located in such signaling circuit for controlling the same and means for simultaneously operating such keys.

8. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer, means for maintaining a constant current flow through such key for varying

currents through such pole changer and a second key located in such signaling circuit for controlling the same.

9. In a signaling system, a source of electric energy, a pole changer adapted to be connected thereto, a transformer having one of its windings connected to such pole changer and a second winding connected to signaling leads, a key for actuating such pole changer, means for maintaining a constant current flow through such key for varying currents through such pole changer, a second key located in such signaling circuit for controlling the same and means for simultaneously operating such keys.

10. In a singaling system, a source of electric energy, a plurality of diversely tuned pole changers adapted to be connected thereto, a plurality of transfomers having primary windings connected to such pole changers and secondary windings connected to common signaling leads, tuned signaling devices in circuit with such leads, a key for actuating a desired one of such pole changers and thereby causing current flow of definite frequency in such signaling circuit and the operation of the corresponding signaling device and no other and means for maintaining such key in a local circuit independent of the circuits through such pole changer and transformer.

11. In a signaling system, a source of electric energy, a plurality of diversely tuned pole changers adapted to be connected thereto, a plurality of transformers having primary windings connected to such pole changers and secondary windings connected to common signaling leads, tuned signaling devices in circuit with such leads, a key for actuating a desired one of such pole changers and thereby causing current flow of definite frequency in such signaling circuit and the operation of the corresponding signaling device and no other, means for maintaining such key in a local circuit independent of the circuits through such pole changer and transformer, and a second key located in such signaling circuit for controlling the same.

12. In a signaling system, a source of electric energy, a plurality of diversely tuned pole changers adapted to be connected thereto, a plurality of transformers having primary windings connected to such pole changers and secondary windings connected to common signaling leads, tuned signaling devices in circuit with such leads, a key for actuating a desired one of such pole changers and thereby causing current flow of definite frequency in such signaling circuit and the operation of the corresponding signaling device and no other, a relay adapted to be operated by such key and contacts carried by such relay for controlling the operating circuit of the pole changer.

13. In a signaling system, a source of electric energy, a plurality of diversely tuned pole changers adapted to be connected thereto, a plurality of transformers having primary windings connected to such pole changers and secondary windings connected to common signaling leads, tuned signaling devices in circuit with such leads, a key for actuating a desired one of such pole changers and thereby causing current flow of definite frequency in such signaling circuit and the operation of the corresponding signaling device and no other, a relay adapted to be operated by such key and contacts carried by such relay for controlling the operating circuit of such pole changer, a second key located in such signaling circuit for controlling the same and means for simultaneously operating such keys.

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

RAY H. MANSON.

Witnesses.
S. J. ROBERTS,
S. P. KINGSTON.