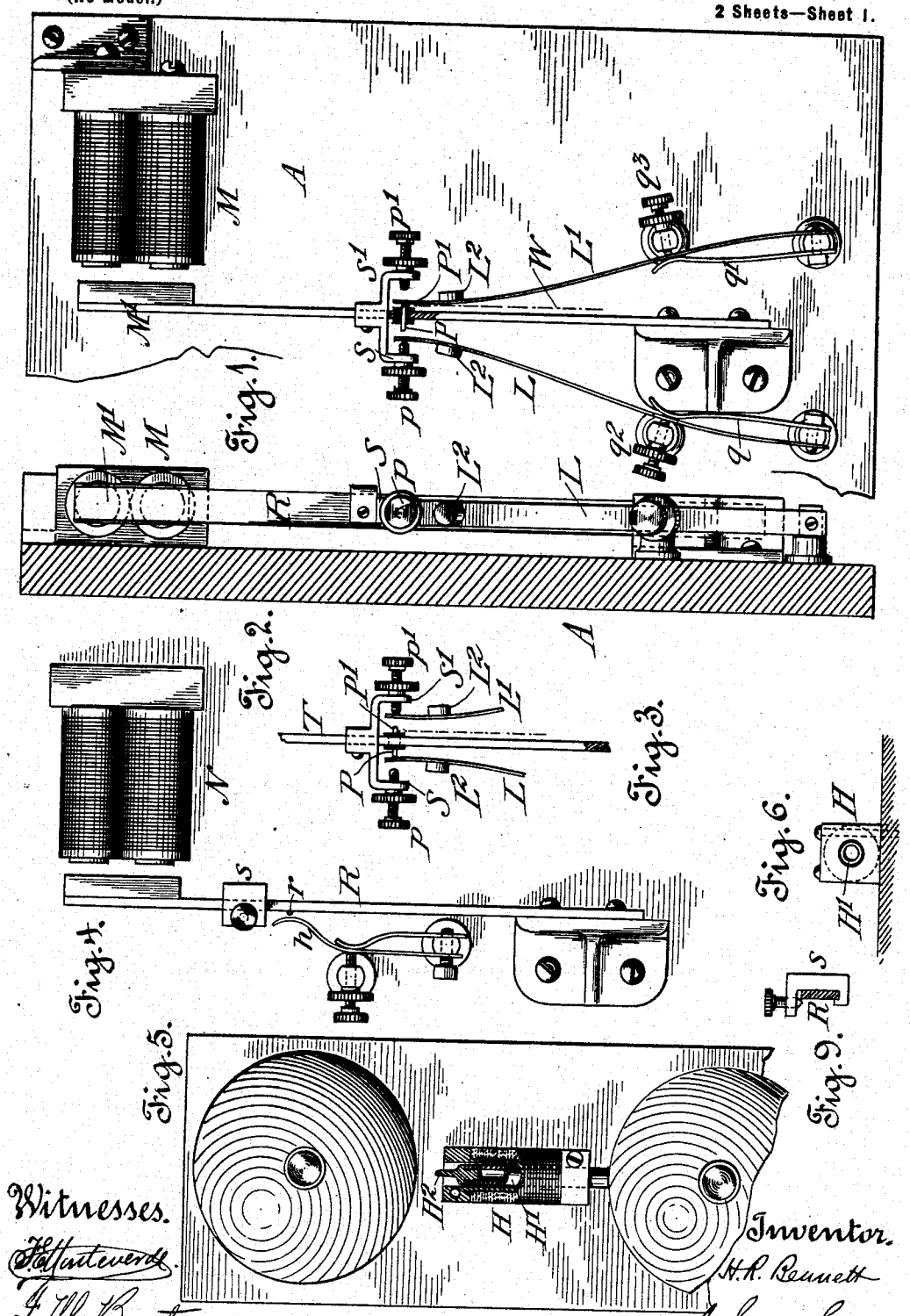
No. 673,376. Patented May 7, 1901.

H. R. BENNETT.

ELECTRICAL SIGNALING SYSTEM.

(Application filed Aug. 9, 1900.)

(No Model.) 2 Sheets—Sheet 1.



Witnesses.

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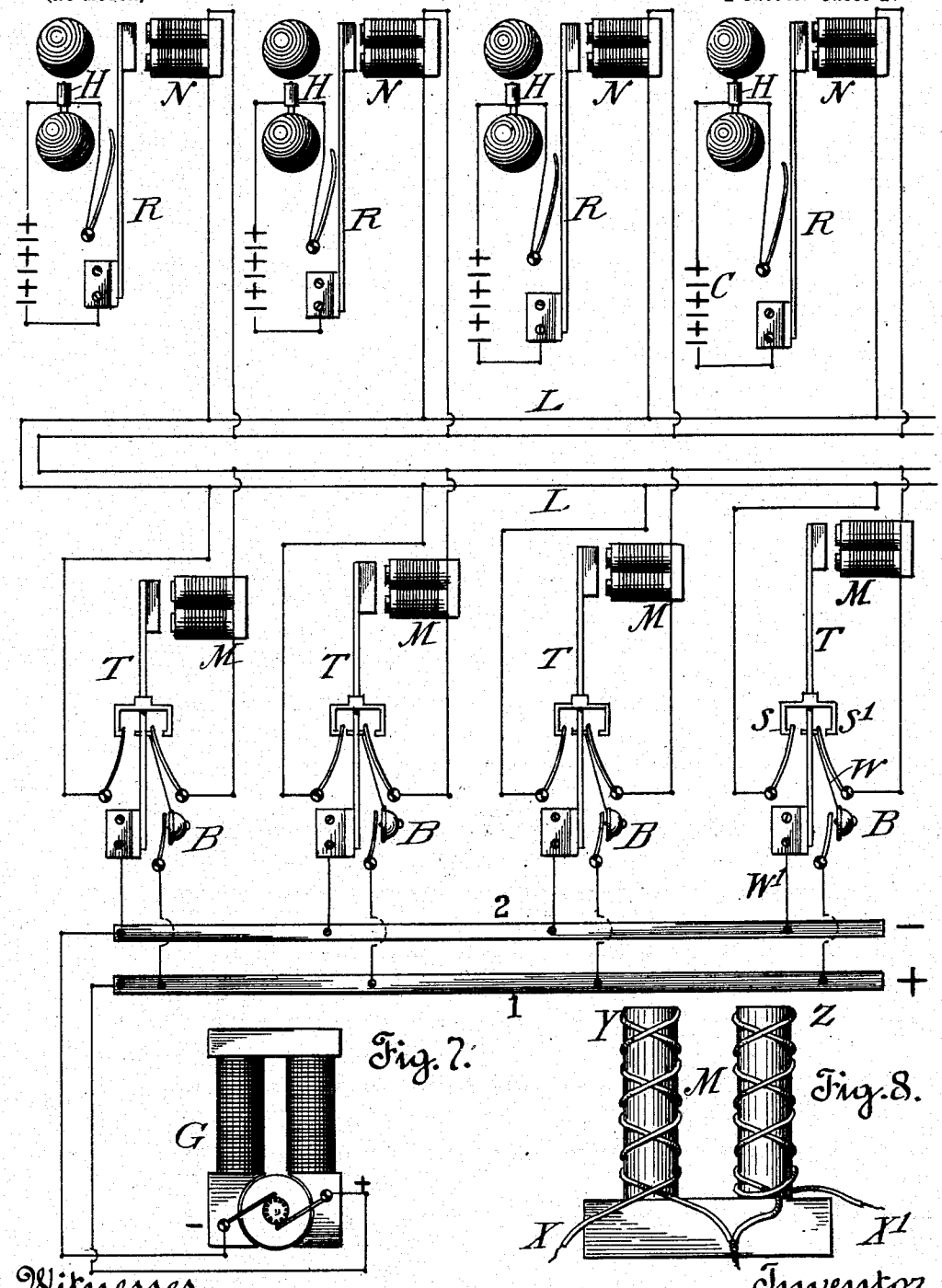

Fig. 7.

Fig. 8.

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UNITED STATES PATENT OFFICE.

HARRY R. BENNETT, OF SAN FRANCISCO, CALIFORNIA.

ELECTRICAL SIGNALING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 673,376, dated May 7, 1901.

Application filed August 9, 1900. Serial No. 26,411. (No model.)

To all whom it may concern:

Be it known that I, HARRY R. BENNETT, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Electrical Signaling Systems, of which the following is a specification.

My invention relates to the electrical transmission of signals, and is particularly adapted to the calling devices on party-line telephone systems.

My object is to produce electrical signals with certainty and in relation to telephone systems to supply a practical and effective signal-selector for party-lines by means of which any signal-bell on a party-line of telephones can be rung without affecting or operating the other bells on that line. I send from the central station an electrical impulse or impulses which will traverse every telephone in the circuit, but will be received and do work only at one designated instrument.

My apparatus comprises a number of vibrating transmitting devices and an equal number of vibrating receiving devices, one of which receiving devices is capable of vibrating in synchronism with one of said transmitting devices while out of synchronism with all the others. Electrical impulses will be generated by vibrations of the transmitter and will be received and will operate at the single receiving instrument whose vibrations are synchronous therewith.

The invention can be applied to any ordinary party-line installation, since a single wire with the customary ground-return is all that is required.

A practical embodiment of my invention is shown in the accompanying drawings, in which—

Figure 1 is a front elevation of one of the vibrating transmitting devices at a central station and shows the pole-changing switch in normal position or at rest. Fig. 2 is a side elevation of the same. Fig. 3 is an elevation of the pole-changing switch similar to Fig. 1, but showing it in its second or reversed position. Fig. 4 is an elevation of the receiving device. Fig. 5 is an elevation of the bell and the intermediate solenoid whose core acts as a bell striker or hammer. Fig. 6 is an end elevation of the said solenoid. Fig. 7 is a diagram of the whole system. Fig. 8 is a detail view of one of the polarized magnets. Fig. 9 is a detail view of an adjustable slide for regulating the frequency of vibration of the receiving-vibrator.

Referring first to Fig. 7 for a general understanding of the whole system, the central-station apparatus is shown at the lower part of the figure and the party-line stations at the upper part. The central-station generator G is in normal open circuit through the bus-bars 1 2 with the vibrating transmitters T, of which four are shown and each of which is provided with a circuit-closing button B. The line is shown at L and the four corresponding vibrating receivers at R. Each transmitting-vibrator is an elastic arm fixed at one end and carrying at the free end an armature for a polarized magnet M. The several transmitting-vibrators are of different lengths, as shown, and the receiving-vibrators are also of different lengths relatively to one another, although each one corresponds in length to one of the transmitting-vibrators. These variations in length account for different periods of vibration and make it possible to synchronize the vibrations of a particular pair of transmitters and receivers. For greater accuracy in this respect the receiving-vibrators are provided with adjustable slides *s*, by the movement of which along the arm the period of vibration can be regulated if not normally exact. The receiving-vibrators are preferably in local relay-circuit with the bell-striker through the telephone-battery cells C at each station. Referring now to Figs. 1 and 2 in connection with Fig. 7, each transmitting-vibrator carries a pole-changing switch S S′ and an insulated double platinum contact P P′. The latter is connected by a wire W to the button B, through which button and the corresponding transmitter the circuit can be closed at will. The contact P P′ is located between the arms of the switch, which are preferably provided with adjusting screw-contacts *p p′*. This pole-changing switch and the platinum contact on the vibrator coöperate with two other elastic arms L L′, which I term "lagging vibrators," because their period of vibration is longer than that of arm T, which makes them lag or follow the said contacts as

they vibrate. In order to insure such greater length of vibration, they may be weighted, as indicated at L^2. They are fixed to the support A at their lower ends, and their upper free ends respectively project between contacts S and P and contacts S′ and P′. They are adjusted as to tension by springs q q' and screws q^2 q^3. Figs. 1 and 7 represent them as in normal or rest position and respectively in contact with points S and P′, the circuit being open and no current passing. In this condition the magnetomotive force of the polarized magnet M is derived only from its cores and is only sufficient to partially attract the armature M′ on the vibrator T. When the circuit is closed by button B, the course of the current is through wire W, contact P′, lagging vibrator L′, magnet M, through the line, in shunt through all the receiver-magnets N, back through the line to lagging vibrator L, switch-contact P, vibrating arm T, and a connecting-wire W′ to the other bus-bar 2. The magnetomotive force in the coils of magnet M is added to the normal magnetomotive force of the cores and the armature is pulled sharply toward the magnet, moving the transmitter-rod T, the switch, and both lagging vibrators in the same direction. As the latter have a longer period of vibration, however, they continue their movement after the tension of the transmitter-arm has overcome the magnetomotive force of the magnet. Temporarily, the said tension and the double magnetomotive force are about equal and the transmitter-arm and armature rest, as it were, in suspension, while the lagging vibrators leave the contacts S and P′ and break the circuit. This releases the extra magnetomotive force in the magnets. The tension of transmitter-rod T, resulting from its attraction and the extra magnetomotive force to which it has been exposed, is so great that upon the breaking of the circuit it tends to fly back to its original normal position. Before this can occur, however, the lagging vibrators continue their period, and thus make new contacts at P S′ and reverse the current. This change in the direction of the current through magnet M opposes the magnetomotive force in its helix to the magnetomotive force in its cores, with the effect of neutralizing the entire magnetomotive force and permitting the transmitter-rod to fly back with the increased tension referred to. It consequently retracts beyond former normal position, carrying the lagging vibrators with it. On the cessation of its period or length of vibration the lagging vibrators continue their movement, reëstablish the original contacts, reverse the current, and double the magnetomotive force in the magnet M. Of course such an analysis as above of the movements of these parts conveys no idea of the actual and extreme rapidity of the movement in vibration.

In practice the operation is as follows: When it is desired to call receiving-station No. 1, the button B in transmitter No. 1 is pressed and the current in alternating impulses, as described, divides and flows in shunt through all the receiving-magnets. Since each transmitter-rod has a definite rate or period of vibration and the corresponding receiver-rod is in synchronism with it alone and all other receiver-rods are non-synchronous and have a different rate or period, only the receiver-rod at station No. 1 will take up the current impulses so as to do work. If station No. 2 or 3 or 4 is to be called, the corresponding transmitter is thrown into the circuit and the desired station only responds to the alternating impulses transmitted.

Since the rapidity and delicacy of vibration in the receiving-rods make it inconvenient to cause them to do actual mechanical work, it is preferred to operate the bell-signal by a relay in the local telephone-circuit, which includes the local batteries C and the solenoid H, whose rapidly-vibrating core forms the bell-striker. The vibrating receiver-rod successively makes and breaks contacts at r with a spring h, electrically connected to the solenoid H, Fig. 7. The details of the latter are shown in Figs. 5 and 6. The core H′ is hollow and is provided with a diamagnetic striking projection H^2 at the upper end and acts itself by gravity as the striker at the other, being situated between the two call-bells. As circuit is closed and broken at r the successive attractions and releases of the core produce a rapid vibratory motion between the two bells, which are alternately struck. The construction of the solenoid, its hollow core, and the diamagnetic cap or projection has several peculiar features. Since the core or plunger is designed to vibrate with very great rapidity, it must not be too heavy to respond to the limited electrical impulses, but must be heavy enough to strike the lower bell by gravity with sufficient force. The central passage or bore of the solenoid should be substantially filled by the core in order that the latter may be kept approximately in axial parallelism with the coil and with the proper line of motion, so that the whole force of the blow will be delivered upon the bell without lost motion. Now the central passage should be of comparatively large sectional area, since the strength of a magnet is in inverse proportion to the length of the solenoid and in direct proportion to the sectional area, and in this case the solenoid must be of sufficient length to prevent the lower end of the core from getting too far out of the magnetic field or influence. Hence for both reasons the light hollow core of correspondingly large circumference is employed.

The diamagnetic cap or striker on the upper end of the hollow core is used to increase the effective or mechanical length of the core without increasing its magnetic length. The magnetomotive force of the coil tends to draw the center of magnetism of the core or plunger toward the center of magnetism of the coil, and the former should be at a dis-

tance below the latter, so that the magnetomotive force shall have a considerable range of "suction" before the centers meet and neutralize the action of the magnetomotive force. If the cap were not employed, the magnetic part of the core would be obliged to come past the upper part of the coil and partly out of the magnetic field, and if the magnetic core were made longer it would raise its own center of magnetism, and so reduce its own effective vibration.

Fig. 8 shows in detail the winding for all the polarized magnets.

In the condition of Fig. 1 the current enters at X and leaves at X', forming a positive pole at Y and a negative pole at Z, in conjunction with the normal polarity of the magnet-cores, the magnetomotive force being doubled. In the reversed condition of Fig. 2 the current enters at X' and leaves at X, forming a positive pole at Z and a negative pole at Y, in opposition to the normal polarity, and the magnetomotive force is accordingly neutralized.

While I have described the use of means for producing an alternating current and prefer to use such a current in most cases, it is evidently practicable to use a direct current if the resistance in the circuit be not too great to render the operation uncertain. The modification required will be easily understood by any one skilled in the art. The electromagnets will not be polarized, and for the pole-changing device carried by the transmitter-armature will be substituted a single contact for such armature, which is made and broken by its vibration.

I do not limit myself to details of construction and arrangement described herein and shown in the drawings, as I desire to avail myself of such modifications and equivalents as fall properly within the spirit of my invention.

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

1. A signal-selecting system for telephones, comprising alarms at subscribers' stations, a number of dissimilarly-vibrating central-station transmitters, a pole-changing switch at each transmitter for causing rapid successive alternations in the current, a number of vibrating receivers at subscribers' stations arranged respectively in synchronism with said transmitters, and means derived from the vibration of any receiver for sounding the alarm at that station.

2. A signal-transmitter comprising a polarized electromagnet, a vibrating armature, and a pole-changing switch operated by the vibration of said armature for causing successive alternating-current impulses.

3. In a signaling system, a source of electrical energy, means for producing rapid successive alternations in the current derived therefrom, and a signaling device together with a polarized electromagnet and a vibrating armature at the receiving-station, said vibrating armature being operated by changes in said electromagnet produced by said alternations, and means for causing the vibrations of said armature to operate the signal means.

4. In an electrical signaling system, a bell in combination with a magnet arranged in proximity thereto, and means for energizing said magnet whereby its armature operates as a bell-striker.

5. In an electrical signaling system, a pair of call-bells, in combination with an intermediately-arranged solenoid and means for causing its core to operate as a double bell-striker.

6. In an electrical signaling system, a pair of call-bells, an intermediately-arranged solenoid, the core or plunger of the same having a diamagnetic extension, and electrical connections for alternately energizing and de-energizing the solenoid, whereby said core operates as a double bell-striker.

7. In a signal-transmitter, a polarized electromagnet, an elastic armature therefor having an ascertained period of vibration, a pole-changing device carried by said armature, and a pair of lagging vibrators having a longer period of vibration and operating in conjunction with said pole-changing device.

8. In a transmitter, a polarized electromagnet, an elastic armature therefor having an ascertained period of vibration, an insulated double contact carried by said armature, a pole-changing switch carried by said armature, a pair of vibrating arms of longer period than the armature, whose free ends are respectively interposed between one arm of said pole-changing switch, and one member of said double contact, an electrical circuit in which said devices are included, and a circuit-controlling button.

9. In a signaling system, a polarized electromagnet, an elastic armature therefor under tension which opposes the pull of said magnet, and which is superior to the attractive power of the core, means for energizing the coil of the magnet so as to overcome said tension, and an automatic circuit-breaker and pole-changer, all constructed and arranged so that when the circuit is closed the magnet is alternately energized to the combined magnetomotive force of its core and its coil, and completely neutralized, whereby the said armature is set in vibration.

In testimony whereof I have affixed my signature, in presence of two witnesses, this 2d day of August, 1900.

HARRY R. BENNETT.

Witnesses:
L. W. SEELY,
F. M. BURT.