(No Model.)

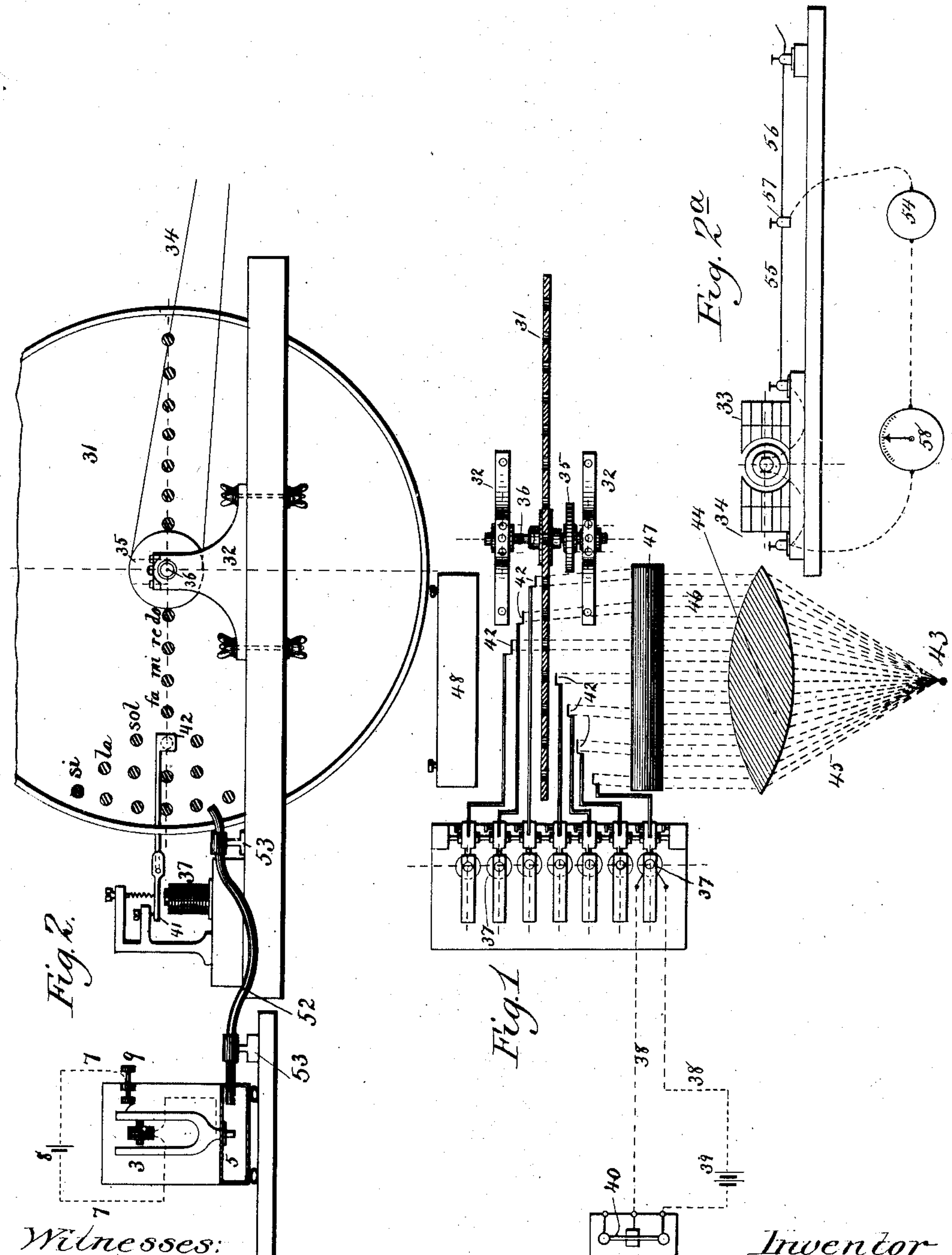
2 Sheets—Sheet 1.

E. J. P. MERCADIER.

MULTIPLE TELEGRAPHY.

No. 420,884.

Patented Feb. 4, 1890.



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(No Model.) 2 Sheets—Sheet 2.

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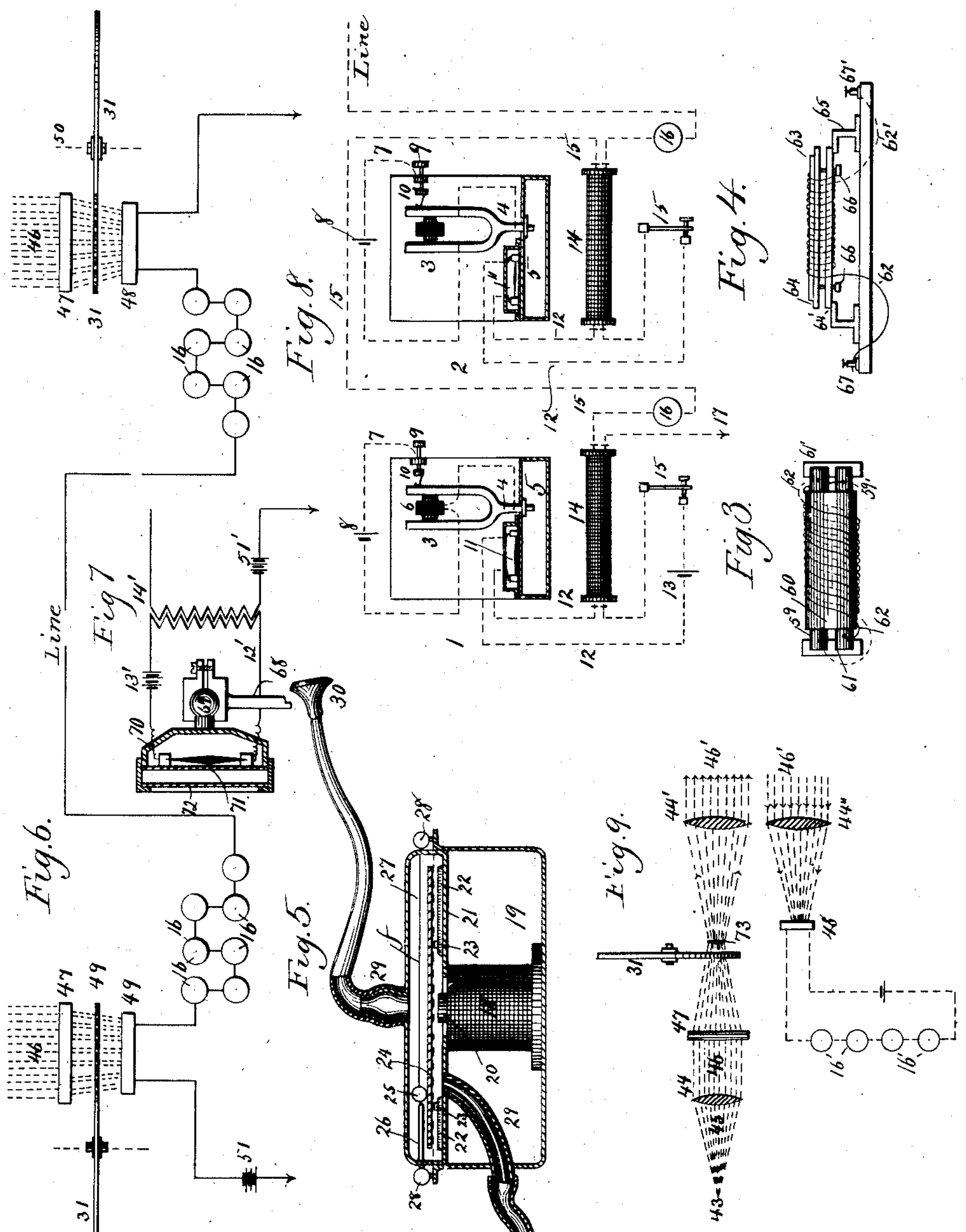

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UNITED STATES PATENT OFFICE.

ERNEST JULES PIERRE MERCADIER, OF PARIS, FRANCE.

MULTIPLE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 420,884, dated February 4, 1890.

Application filed August 16, 1888. Serial No. 282,948. (No model.) Patented in France May 30, 1888, No. 190,909; in England July 17, 1888, No. 10,363; in Germany August 16, 1888, No. 49,213, and in Belgium August 28, 1888, No. 83,056.

To all whom it may concern:

Be it known that I, ERNEST JULES PIERRE MERCADIER, electrical engineer, a citizen of the Republic of France, residing at Paris, France, have invented certain new and useful Improvements in and relating to Multiple Telegraphy, of which the following is a specification.

My invention has reference to a system of multiple telegraphy for which I have obtained Letters Patent in France, No. 190,909, on May 30, 1888; in Belgium, No. 83,056, on August 28, 1888; in Great Britain, No. 10,363, on July 17, 1888, and in Germany, No. 49,213, on August 16, 1888.

The fundamental feature of my invention is based upon the fact that if upon a continuous current in a line a particular set of rhythmical undulations is superimposed the latter may be made to actuate a suitable receiving-instrument constructed to respond to that particular rhythm of current-undulations, and to no other, and that if at the same time electrical undulations of different rhythms are superimposed upon the continuous current, receiving-instruments constructed to respond each to one of those added rhythmical undulations may be used for the reception of messages spelled out by the added undulations.

Prior to my invention it has been attempted to superimpose upon a continuous current in a line electrical pulsations of different rhythms and to receive the messages spelled out by each set of impulses by suitable receiving-instruments, each constructed to respond to one particular rhythm of pulsations only. For practical purposes this old system could not be used with advantage, for the reason that the pulsations composing the sets of different rhythms would frequently blend, constituting a separate and distinct set of pulsations having a rhythm different from either of the sets designed to go to the line, so that the receiving-instruments for which the two sets were respectively designed would not respond, while another receiving-instrument, which perchance was constructed to respond to the new rhythm accidentally formed, would receive the message. The message would therefore either not be received at all or would be received at a station where it was not designed to go in a mutilated and unintelligible form. It has also been suggested that if in place of sharply-defined electrical pulsations electrical undulations in which the current gradually increases and equally gradually decreases are used no blending of the sets of different rhythms takes place and no confusion in the reception of the messages occurs. The production of rhythmical electrical undulations superimposed upon a continuous constant current can be effected in a variety of ways. The simplest mode for producing such undulations is to vary the resistance of a charged electric circuit by variations of contact or pressure by and in accordance with rhythmical mechanical vibrations, and this mode, which, for the sake of clearness of exposition, I have fully described, but to which I make no claim herein, I shall hereinafter call the "microphonic mode of multiple telegraphy."

Another mode of producing the electrical undulations for my system of multiple telegraphy, and the one which I prefer, consists in varying the resistance of an electric circuit by rhythmical pulsations of radiant energy, and this method I shall hereinafter call the "radiophonic mode of multiple telegraphy."

By the term "radiant energy," which I largely employ in this specification, I understand those forms of energy which are currently understood to be propagated by ethereal vibrations from their source in radial lines in all directions, and which are all comprised or found in a ray of ordinary light. I therefore do not wish to be understood to embrace by that term either electrical or magnetic energy, the propagation of which is not at present understood.

It will be understood that according to the particular kinds of radiant energy the radiophonic mode of operation will be either photophonic or thermophonic, and the latter mode may be practiced in two ways: first, by causing heat-rays to act directly upon a substance whose electrical resistance is varied by the same, or to cause, primarily, mechanical vibrations by the rhythmical impact of heat-rays, and then to vary the electrical resistances by and in accordance with such mechanical vibrations. The thermophonic mode of multiple telegraphy will accordingly be either purely thermophonic or thermo-microphonic. All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, in which I have shown suitable apparatus for practicing my invention in its different modes, without, however, confining myself to the use of the identical instrumentalities shown and described.

I have illustrated in Figure 1 a plan view, partly in section, of a radiophonic transmitter, with the circuit-connections shown in diagram; in Figs. 2 and 2ª, a side elevation of the same, showing also an auxiliary apparatus used as an acoustic speed-gage or tachometer; in Fig. 3, a side elevation of a preferred form of selenium or other cell sensitive to radiant energy; in Fig. 4, a modified form of the same, also in side elevation; in Fig. 5, a cross-section of a monotelephonic receiver; in Fig. 6, a diagrammatic view of two stations equipped for practicing my process of multiple telegraphy by the radiophonic mode, some of the details being omitted for the sake of clearness; in Fig. 7, a vertical sectional view of a transmitter adapted to operate by what I have called the "thermo-microphonic" mode; in Fig. 8, a diagrammatic view of the equipment of a station for the transmission and reception of signals by the microphonic mode, and in Fig. 9 a diagrammatic view of a system arranged for the transmission of signals photophonically.

Like numerals of reference indicate like parts all throughout the drawings.

Referring now more particularly to Fig. 8, there are shown two station apparatus 1 2 of a series of seven or twelve such apparatus, which are supposed to be located at each station. They are all constructed alike, each consisting of a tuning-fork rheotome mounted upon a resonating-box, a microphone also mounted upon a box, an induction-coil, a telephonic receiver, and a key. Each tuning-fork 3 is tuned to a certain definite pitch corresponding to a tone of a diatonic or chromatic scale, so that when there are seven station apparatus a diatonic musical scale will be represented by the seven tuning-forks, and if twelve station apparatus be used a chromatic scale will be represented.

Each tuning-fork is mounted with its stem 4, as usual, upon a resonator 5, and between the prongs of the tuning-fork is mounted an electro-magnet 6, included in a local circuit 7, charged by a battery 8. One terminal of this circuit is formed by the adjustable contact-screw 9 and the other by an elastically-mounted platinum disk 10, carried by one of the prongs of the tuning-fork. This construction is well known in the art, and it causes the tuning-fork to vibrate continuously in accordance with its inherent rate of vibration, and being mounted upon the resonator 5, the latter, re-enforcing the sound of the tuning-fork, vibrates in unison therewith.

The microphone 11, of any ordinary or preferred construction, is mounted upon the top plate of the resonator and is vibrated by the same, producing as many electrical undulations in the circuit 12, in which it is included, as there are vibrations in the tuning-fork.

The microphone-circuit 12 is a local circuit, and is charged by a battery 13, and in the same circuit is included the primary coil of an inductorium 14 and a key 15, which, for convenience of operation, will be constructed like a Morse key.

It will now be understood that if the tuning-fork rheotome is at work and the circuit 12 is closed by the key 15 electrical undulations of the same rhythm as that of the tuning-fork will be produced in the microphone-circuit and alternating electrical undulations of the same rhythm will be produced by induction in the secondary of the inductorium, in the exterior circuit 16 of which is placed a peculiar telephone-receiver constructed to respond to electrical undulations of the rhythm of the tuning-fork, and to no other, and which, for this reason, I call a "monotelephone," the construction of which will hereinafter more fully appear.

I have so far described one station apparatus shown in Fig. 8; but the same description applies to all the station apparatus, which only differ from each other in the pitch of their tuning-forks and in the adjustment of their monotelephones, it being understood that each monotelephone responds only to electrical undulations of the rhythm of its corresponding tuning-fork.

As stated above, at the station represented in Fig. 8 there are supposed to be either seven or twelve station apparatus of the kind described, each representing one tone of a diatonic or chromatic scale and the secondaries of the induction-coils with the monotelephones all in series, as shown, one end of which circuit may be grounded at 17, while the other is connected with the line which passes to a distant station, and is there connected with a series of station apparatus identical in all respects with the apparatus at the home station.

The operation of the system thus far described will now be easily understood. In the normal condition of both stations the tuning-fork rheotomes are all at work and the keys 15 are all open. The monotelephone-receivers, therefore, will not be affected. If now at the one station one of the keys is closed and opened successively in the manner of working Morse keys, a series of electrical undulations having the rhythm of the particular tuning-fork with which said key is associated will pass over the line and a series of sounds of different durations and of a pitch equal to that of the tuning-fork will be heard in the home receiver associated with that particular key, and will be heard in no other receiver at the home station. The series of electrical undulations thus produced will also actuate the monotelephone of the same pitch at the distant station, but will actuate no other telephone at that station. Thus by operating one of the keys at one station in accordance with the Morse or any other code signals of such code will be heard and may be received and interpreted at the distant station, and the signals transmitted will only be received by the receiver for which they are intended. Thus if the station apparatus are constructed and adjusted with their tuning-forks and monotelephones tuned seriatim to the diatonic scale—do, re, mi, fa, sol, &c.—and if the key of the apparatus "do" at one station is actuated, the monotelephone "do" at the distant station will respond, and no other. If, however, two or more keys at one station are operated at the same time, the electrical undulations upon the line will have the characteristics of the rhythms of all the transmitters called into action, or, in other words, there will be electrical undulations of the rhythms of all the transmitters which are in operation at the same time upon the line, and each monotelephone at the distant station responding to one particular rhythm only will be affected by the characteristic of the electrical undulations due to such rhythm, and by no other, so that seven or twelve messages can be transmitted at the same time over a single line, and can be received at the distant station without confusion.

The ordinary magneto-telephone receiver constructed with a diaphragm having its edge or edges clamped has the peculiarity that it will respond to all rates of vibration, and this it must do in order to adapt it to the reception of articulate speech or other complex sounds. Obviously a telephone of this character cannot be used in my system of multiple telegraphy, for if it were used it would take up and reproduce the messages from all station apparatus, whatever the rhythm of the same might be, and no single message could be distinguished from the other. For this reason I have constructed and use in my system telephone-receivers responding each to one rhythm only, and these telephones I call "monotelephones," one form of which I have illustrated in Fig. 5.

An electro-magnet 18, having a coil of rather high resistance, is mounted in a suitable casing 19, with its free active pole 20 slightly projecting through a partition 21. Upon this partition are mounted three guides 22 22 22, arranged radially on the partition, if the same is circular, and by preference the guides are equally spaced, so that the sectors into which the circle is thus divided are equal. Upon each guide is mounted a stud 23, adjustable upon the guide, and if these studs are each adjusted at the same distance from the center of the partition they mark the corners of an equilateral triangle inscribed in a circle whose radius is equal to that distance. A diaphragm 24, of magnetic material, preferably iron, is loosely placed upon the supporting-studs 23, so that the center of the diaphragm coincides with the center of the partition 21. Now it is a well-known fact that if a circular resonant disk is set into vibration by a tone which is the first harmonic of its fundamental tone a concentric nodal line will be formed on the disk, the radius of which nodal line is a trifle less than two-thirds of the radius of the disk.

In my monotelephone I adjust the supporting-studs 23 so that when the diaphragm is placed upon them they correspond to the nodal line of the first harmonic of the diaphragm, and a diaphragm thus supported will perceptibly respond to a rhythm due to that first harmonic, and to no other. I am thus enabled to make a telephone responding to one particular sound only, and telephones of this or similar construction must be used in my system of multiple telegraphy.

The nodal line of the first harmonic of the diaphragm cannot be determined with absolute accuracy, and therefore, as a rule, the first adjustment of the studs 23 will not be perfect, and in order to compensate for this defect I use an adjusting-weight 25, which may be a short heavy cylinder of brass resting upon the diaphragm and connected on one side with a rubber or other elastic cord 26 and on the other with a thin wire or cord 27, both of which are fixed at their other ends to winding-pegs 28, and by turning the latter one way or the other the adjusting-weight 25 may be brought to any desired position upon the diaphragm, and by a proper adjustment of the same the defect of adjustment of the supporting-studs 23 may be neutralized and the diaphragm tuned to respond powerfully to the first harmonic of its fundamental note. In fact, the pitch of the diaphragm may be varied within a major second by proper adjustment of the weight 25, although such violent adjustments are not necessary in practice. Sound-conveying tubes 29 29, terminating in ear-pieces 30, are arranged to convey the sound from both sides of the diaphragm to the listener, who will preferably use both ear-pieces.

If in place of a circular diaphragm one of rectangular form is used, the supporting-studs 23 will be so adjusted that two of them will be on one of the two nodal lines of the fundamental sound of the diaphragm, which are at about twenty-two one-hundredths of the whole length, measured from either end, and the other supporting-stud will be on the other of said nodal lines. A telephone thus constructed will respond to the rhythm of its fundamental tone only. Monotelephones differently constructed may be used in my system, and I am therefore not confined to those herein described.

Instead of producing electrical undulations on the line by the reaction of a tuning-fork upon a microphone, I preferably produce them by the action of radiant energy upon a selenium cell or other device sensitive thereto, and one apparatus for producing electrical undulations in this manner is illustrated in Figs. 1, 2, and 3. Referring to these figures of drawings, there is shown a rotary disk 31, of some opaque material, or it may be made of glass and rendered opaque by pasting over it a sheet of card-board or paper. This disk is mounted in suitable bearings 32, and is driven at a great and uniform speed by an electric motor 33, (see Fig. 2,) connected by a belt 34 with a pulley 35 upon the shaft 36 of the disk. In the disk 31 are formed a series of concentric holes, which from the center toward the periphery are marked in the drawings seriatim by the musical notations do, re, mi, fa, sol, la, si, and the numbers of holes in the circular series are related to each other as the numbers of vibrations which form the tones do, re, mi, fa, sol, la, si, or they may be equal to these numbers, so that when the wheel is rotated as many holes of each series will pass a given point in one second as there are vibrations per second in the notes represented by the respective series, provided, of course, that the wheel is rotated with the proper speed.

Parallel with the axis of the disk or wheel is arranged a series of electro-magnets 37, each included in an open circuit 38, charged by a battery 39 and opened or closed by a Morse key 40. In operative relation to each magnet is arranged a pivoted armature 41, to the rear end of which, which extends parallel with the disk 31, is secured a shutter 42, which is large enough to cover one of the holes in the disk. The rear arms of these armatures are of different lengths and so arranged that the holes of one series will pass in succession behind one shutter, the holes of the next series behind another shutter, and so forth, so that there will be a shutter for each series of holes and an electro-magnet for actuating each shutter. The extended armature-levers are all parallel to the plane of one radius of the wheel, and the shutters extend downwardly, crossing the plane of such radius, so that when the armatures are in their retracted position the shutters carried by their extended arms will obstruct those holes of all the series which are in the same radius. If, now, the local circuit of one of the magnets 37 is momentarily closed by the key 40, its armature will be attracted and the shutter carried by the same will be raised to expose the hole which it covers in its normal position. Thus by manipulating the keys of the different electro-magnets any one or all of the holes formerly obstructed by the shutters may be exposed so long as the circuit remains closed. When the circuit is again opened, the armature is withdrawn from the magnet and the shutter returns to its normal position.

Since I have shown seven series of holes in the disk corresponding to the diatonic scale, there must be seven electro-magnets and seven shutters, and by reference to Fig. 1 it will be seen that the electro-magnets and shutters are disposed on each side of the disk, four of them being on one side and three on the other. One extended arm of the armature on each side of the disk is straight and the others are angular in order to bring their shutters as near as possible to the face of the disk. A source 43 of radiant energy—as, for instance, an electric-arc light—is arranged at the focus of a condensing-lens 44, which renders the diverging rays 45 from the former parallel, as shown at 46. These parallel rays are arranged to fall upon a cylindrical lens 47, mounted parallel to the disk 31, and with its axis in the horizontal plane of that radius of the disk which is occupied by the shutters 42 in their normal position. Thus a narrow bundle of rays will fall upon the shutters, which will prevent the passage of radiant energy to the selenium cell 48, arranged on the other side of the disk or wheel, and which is designed to vary the resistance of an electric circuit in accordance with the intensity and frequency of flashes of radiant energy impinging thereon. If, now, one of the shutters 42 be raised by depressing the corresponding key while the disk 31 is rotating at its proper speed, flashes of radiant energy having a certain definite rhythm will fall upon the selenium cell through the apertures thus uncovered, and the resistance of the selenium cell being reduced momentarily by each impact thereon of such radiant energy there will be set up in the electric circuit, including said selenium cell, electrical undulations of a corresponding definite rhythm, and a monotelephone having the pitch corresponding to such rhythm, if included in said circuit, will respond to such undulations. If more than one key is actuated at the same time, several series of electrical undulations will be produced in the line, or, more correctly speaking, there will be electrical undulations having the characteristics of all the undulations produced or tending to be produced by the same selenium cell, so that if there are a number of telephones in the line-circuit those having the pitch corresponding to the rhythms of the several electrical undulations will respond and multiple telegraphy will be carried on radiophonically by the same manipulations which have been described with reference to the microphonic method.

In Fig. 6 I have illustrated diagrammatically the equipment of two stations 49 and 50 for radiophonic multiple telegraphy; but I have omitted, for the sake of clearness and simplicity, the shutters and the operating mechanism for the same. The perforated disks 31 are supposed to be rotated at a proper uniform speed, and the selenium cells 48 48 are in the line-circuit charged by a line-battery 51, and at each station there is a series of monotelephones 16 arranged tandem. In the drawings are shown seven monotelephones at each station, which, therefore, represent the diatonic scale. Seven messages can therefore be sent in either or both directions at the same time.

It will be understood that in working my system of multiple telegraphy by the radiophonic method the disks 31 must be rotated at a proper speed, and this speed is determined by an apparatus which I have called an "acoustic tachometer," and which is shown in Fig. 2 as an attachment to the transmitting apparatus. It consists of a tuning-fork rheotome constructed substantially like the tuning-fork rheotomes described with reference to Fig. 8, and in addition thereto there is a flexible sound-conveying tube 52 leading from the interior of the resonator 5 to within a very short distance of the face of the disk 31. For convenience' sake this tube is mounted upon standards 53 53. The tuning-fork 3 is accurately tuned to a definite pitch—say to the pitch of the tone "si"—and the length of the sound-conveyer 52 is such that the fundamental note of the column of air within the same and within the resonator, when set into vibration, will also be "si." If, now, the tuning-fork is actuated, air-vibrations of the note "si" will proceed from the open end of the sound-conveyer. If, on the other hand, the open end of the sound-conveyer is brought into close proximity to the face of the disk 31 just opposite one of the holes of the series "si," and if the disk is rotated with such speed that as many holes as there are air-vibrations due to the tone "si" will pass in one second in front of the open end of the sound-conveyer, the column of air within the sound-conveyer will receive a like number of impulses, since the walls of the holes act like so many diminutive fans. It is now clear that if the tuning-fork is at work and the disk rotates at the proper speed, the tones produced in the sound-conveyer by the tuning-fork and by the disk, respectively, will be identical and will re-enforce each other. If, however, the speed of the disk is too high or too low, there will be an interference of sound, which will manifest itself by beats. It is now easy to adjust the speed of the disk so that the beats disappear, and when this is reached we are certain that the disk rotates at the proper speed, and it is only necessary to maintain such speed by any known or improved regulator.

As has heretofore been stated, the disk will preferably be rotated by an electric motor 33, fed by a battery or other source of electricity 54, in the circuit of which is also included a rheostat 55, composed of a platinum or German-silver wire 56 and a movable contact 57, all substantially like the well-known rheocord of Poggendorff. A current-meter 58 is also included in the motor-circuit to indicate variations of current, so that by adjusting the contact 57 the current can be maintained constant and the uniformity of the speed of the disk secured.

I have heretofore referred to the devices for varying the flow of current in the circuit by the action of radiant energy by the term "selenium cell," and I desire it to be understood that by said term I did not and do not mean to confine myself to cells made of selenium to the exclusion of other substances sensitive to radiant energy, for I can use not only selenium, but also an alloy of selenium and tellurium, tellurium alone, also lampblack, sulphide, iodide, bromide, or chloride of silver, sulphide of tin, sulphide of antimony, galena, oxide of copper or of iron, and phosphide of zinc. I shall adhere to the term "selenium cell" as a generic name for all devices adapted to vary the resistance of a circuit by the action thereon of radiant energy, and I will now describe the construction of selenium cells which I use by preference.

One of my new forms of selenium cell is illustrated in Fig. 3. I use two brass plates 59 59′, two centimeters wide and from six to ten centimeters long. They are placed parallel to each other, and are covered with layers of asbestus paper 60, by which they are bound together, and at the same time insulated from each other. They are connected together at their ends by hard-rubber cross-pieces 61 61′. On the asbestus covering are wound in close spirals and parallel to each other two wires 62 62′, of platinum, copper, brass, or other metal, one of said wires 62′ being shown in dotted lines. The two ends of the wire 62 are connected with the plate 59′, and those of the wire 62′ are connected with the plate 59, as shown.

Before applying the hard-rubber cross-pieces the device is heated on a mica plate to such temperature that a pencil of selenium placed thereon will just begin to melt. This temperature is about 210° centigrade or 410° Fahrenheit. The pencil of selenium is then rubbed rapidly over the surface of the device, care being taken to fill the spaces between the two wires 62 62′ and to maintain the temperature. The device is then allowed to cool slowly, so that the selenium surface may preserve a dark-gray color.

By leaving a space of about one millimeter between the two wires a selenium cell is obtained which is very sensitive to intense light. The electrical resistance of such a cell gradually rises to about three hundred thousand (300,000) ohms, and then remains constant for several years without losing its sensitiveness. It will be understood that cells may be constructed having a much smaller normal electrical resistance if the two wires are placed closer to each other.

If, in place of selenium, sulphide of silver is used, the cell will assume the shape shown in Fig. 4. The two wires 62 62′ in this case may be made of silver, platinum, aluminium, iron, &c., and they are wound in the same manner as in the construction shown in Fig. 3; but in this case they are placed upon a layer of sulphide of silver spread on an insulating-plate 63 of asbestus, cork, or mica, the upper surface of which is rounded off. The plate 63 itself is mounted upon a plate 64 of hard rubber, which is arranged parallel to another similar plate 64′, fixed upon standards 65. Adjusting-screws 66, passing through the lower hard-rubber plate, bear upon the under side of plate 64, whereby the two plates may be adjusted to and from each other and the pressure of the wires 62 62′ upon the sulphide of silver may be varied, thus varying the normal resistance of the cell. One end of wire 62 is carried to binding-post 67, and one end of the wire 62′ is connected with binding-post 67′.

Instead of varying the resistance of a circuit directly by the impact of radiant energy upon selenium or other similar bodies, this can be done indirectly in the manner which I have called the "thermo-microphonic mode," and in Fig. 7 I have illustrated one apparatus which may be used for this purpose. Upon a standard 68, mounted by a ball-and-socket joint 69, is a microphone-box 70. The diaphragm 71 of this microphone may be made of hard rubber, or it may be made of any other resonant material, upon the upper surface of which is then deposited a thin layer of lamp-black. The microphone proper, which in the drawings is shown of the Hughes form, is mounted upon the rear side of the diaphragm, and a protecting glass plate 72 is placed on the front of the same.

The operation of such an apparatus is based upon principles now well understood in the art. It is known that when heat-rays impinge upon the hard-rubber or lamp-black surface of the diaphragm the same will be set into vibration. Consequently the microphone, which I mount upon the diaphragm, will be actuated, and will produce electrical undulations in the local circuit 12′, which includes a battery 13′ and the primary of an induction-coil 14′. The secondary of said induction-coil, which may or may not include a line-battery 51′, is then connected in the same manner as has been explained with reference to Fig. 8.

In Fig. 9 the arrangement for practicing my system of multiple telegraphy by the photophonic mode is diagrammatically illustrated. The optical system described with reference to Fig. 1 and the perforated disk and shutters with their actuating magnets and keys are used in this case. The focal line of the cylinder-lens 47 is marked in the drawings by the numeral 73, and this line is coincident with the focus of another condensing-lens 44′, from which the rays proceed in a cylindrical parallel bundle 46′ and fall upon a third condensing-lens 44″ at the distant station. These rays are thus concentrated upon the surface of the selenium cell 48, in the circuit of which are placed the monotelephones 16. By thus combining the apparatus described with reference to Figs. 1 and 2 with the additional lenses just described I can practice multiple telegraphy without the use of a line-wire, as will now be readily understood; but,

Having now fully described my invention, I do claim and desire to secure by Letters Patent—

1. In the art of multiple telegraphy, the hereinbefore-described method, which consists in producing electrical undulations bearing the characteristics of two or more sets of as many distinct rhythms by and in accordance with rhythmical impulses of radiant energy, and thereby producing sound-waves in sets of the different rhythms.

2. In the art of multiple telegraphy, the hereinbefore-described method, which consists in producing electrical undulations bearing the characteristics of two or more sets of as many distinct rhythms by and in accordance with rhythmical flashes of light, and thereby producing sound-waves in sets of the different rhythms.

3. In the art of multiple telegraphy, the hereinbefore-described method, which consists in producing simultaneously two or more sets of rhythmical variations of resistance in a charged electric circuit by and in accordance with two or more sets of rhythmical impulses of radiant energy, each set having a different rhythm, and thereby producing sound-waves in sets of the different rhythms.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ERNEST JULES PIERRE MERCADIER.

Witnesses:
R. J. PRESTON,
ALBERT COHEN.