E. P. BATZEL.

MULTIPLE TELEGRAPH SYSTEM.

APPLICATION FILED MAR. 3, 1909.

960,482.

Patented June 7, 1910.

3 SHEETS—SHEET 1.

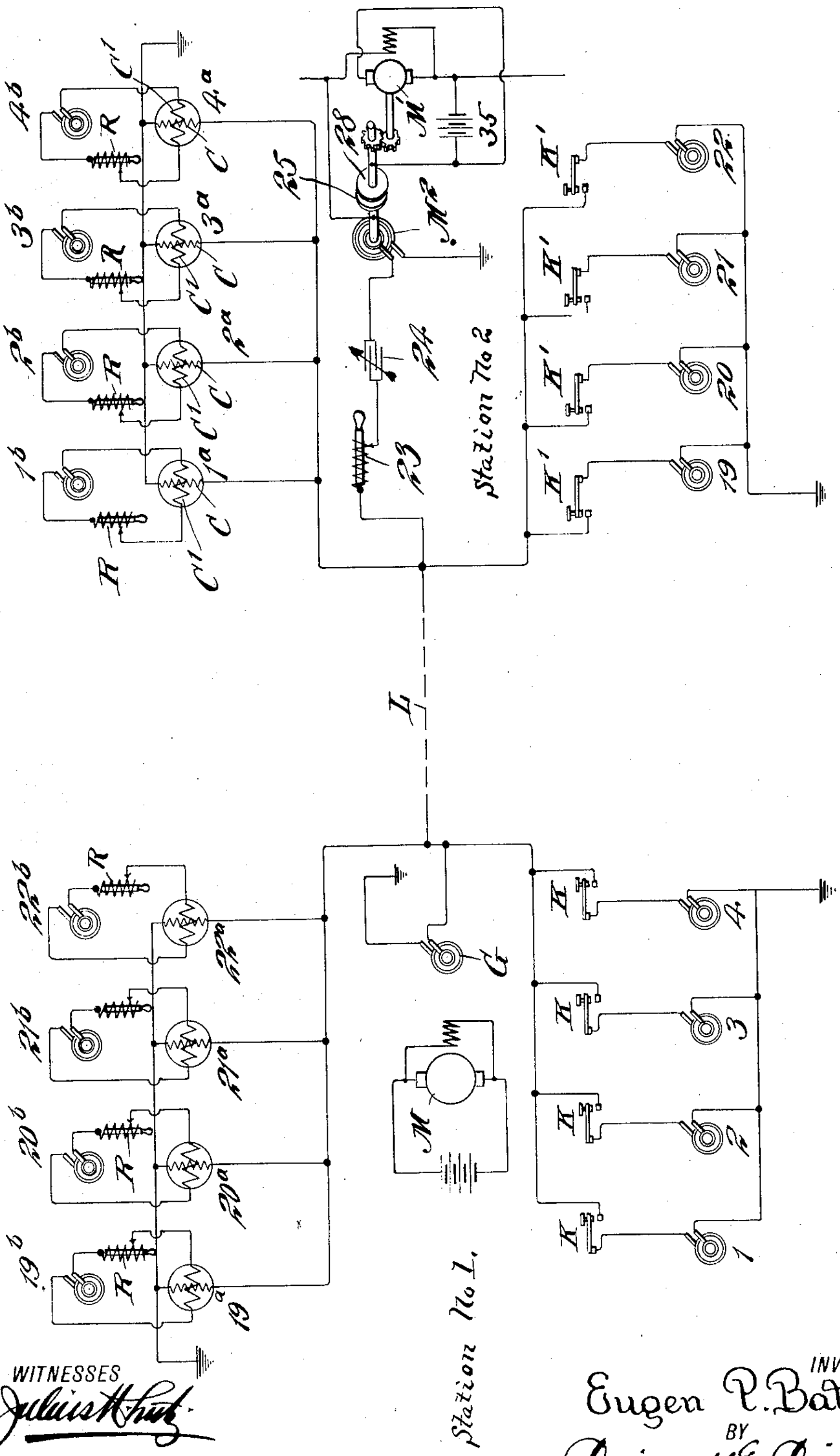

Fig. 1.

WITNESSES

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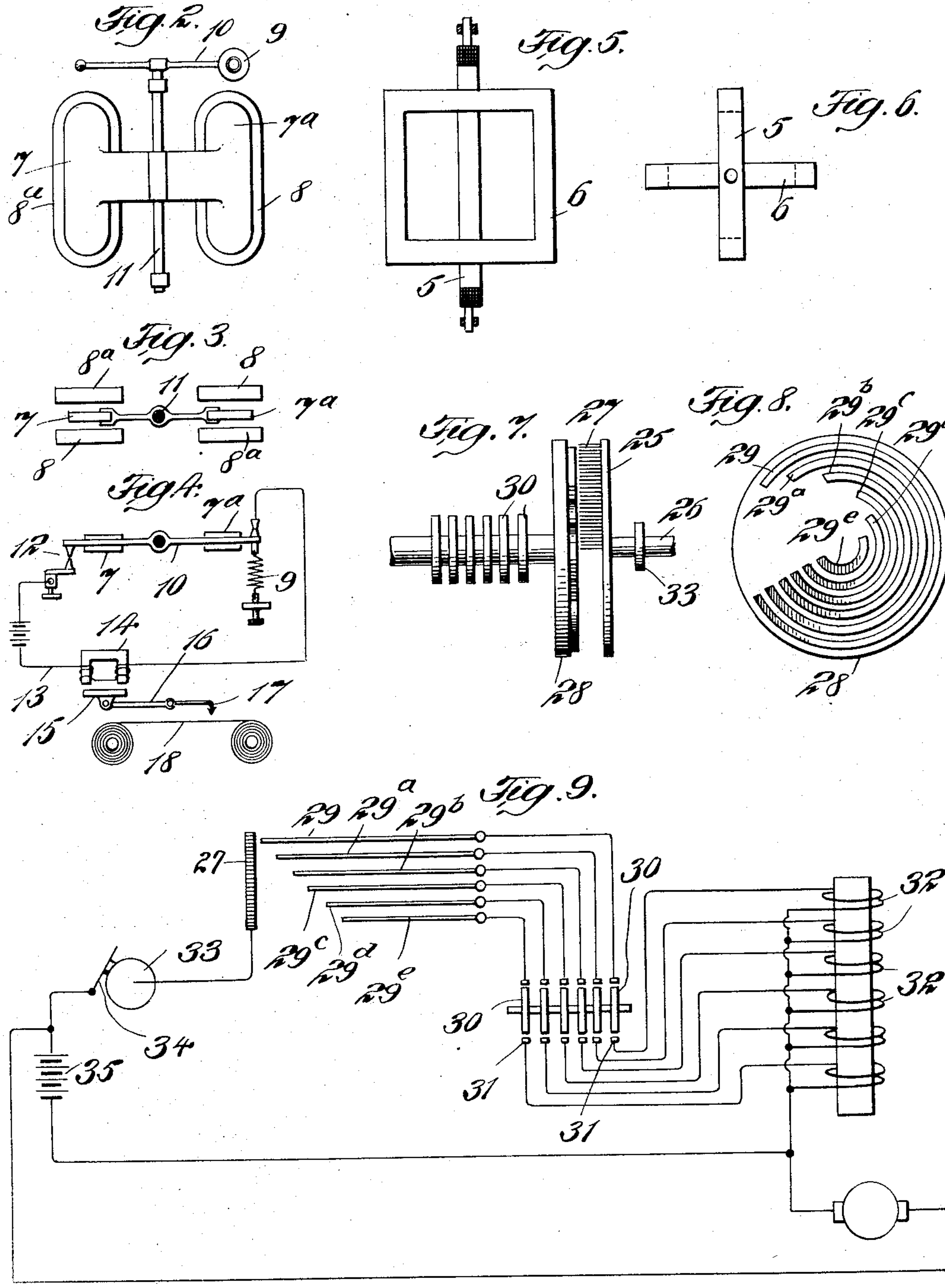

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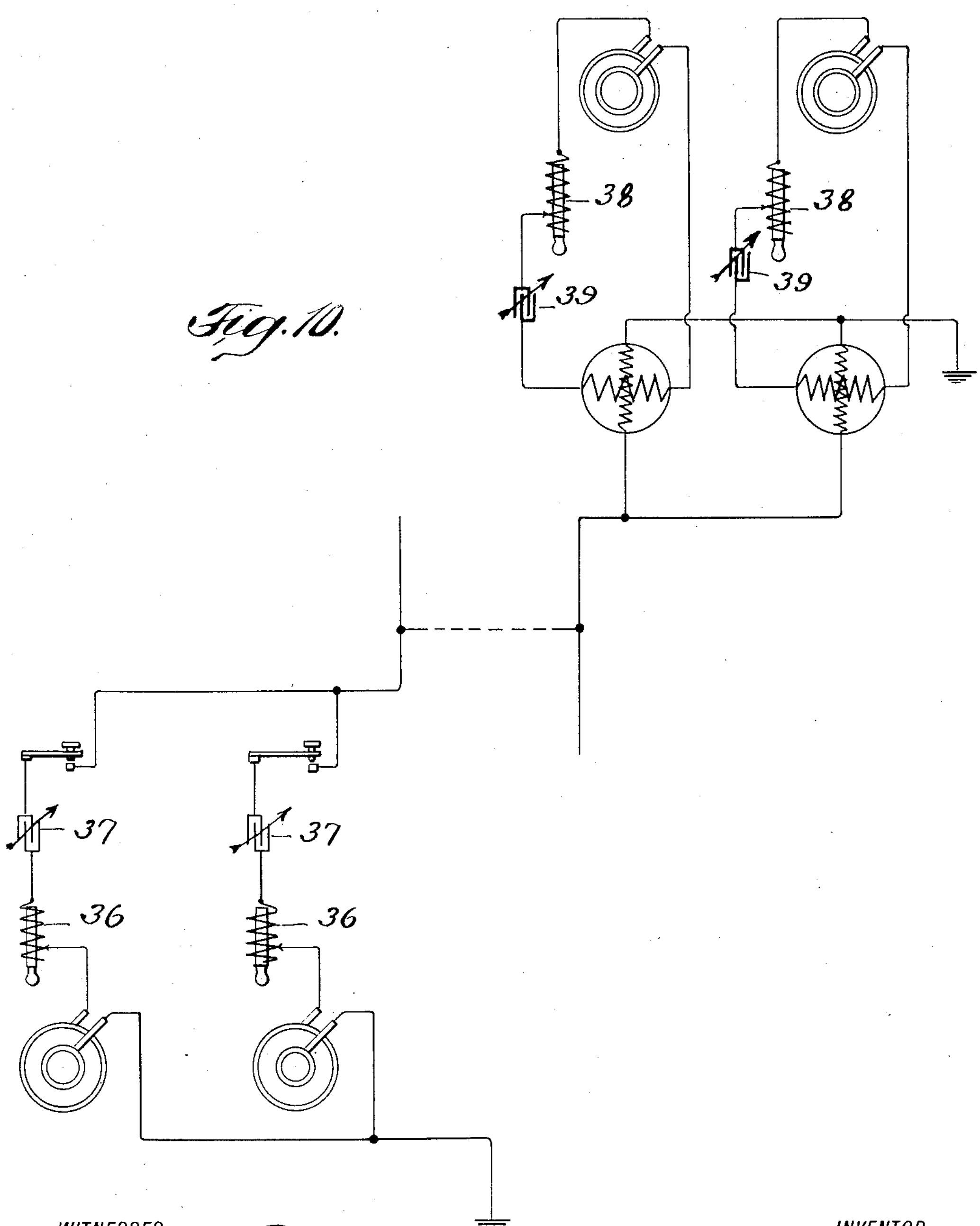

Fig. 10.

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MULTIPLE-TELEGRAPH SYSTEM.

960,482. Specification of Letters Patent. Patented June 7, 1910.

Application filed March 3, 1909. Serial No. 481,031.

To all whom it may concern:

Be it known that I, EUGEN P. BATZEL, a subject of the Czar of Russia, and resident of the city of Buffalo, county of Erie, and State of New York, have invented certain new and useful Improvements in Multiple-Telegraph Systems, of which the following is a specification, reference being had therein to the accompanying drawings, in which—

Figure 1 is a diagrammatic view of my apparatus; Fig. 2 a side elevation of the receiving wattoscope relay; Fig. 3 a plan view thereof; Fig. 4 a diagrammatic view of the relay circuit and the signal recording means; Fig. 5 a diagrammatic view of the coils of a wattoscope; Fig. 6 a diagrammatic plan view of the device shown in Fig. 5; Fig. 7 a detail side elevation of the synchronizing motor controller; Fig. 8 a face view of the contact disk of the synchronizing controller; Fig. 9 a diagrammatic view of the circuits in the synchronizing controller; and Fig. 10 a diagrammatic view of a slightly different form of the apparatus.

My invention is based upon the well known principle that electric currents of different frequency or periodic intensities may be passed over a conductor or circuit independently of each other. This principle has already been employed in multiple telegraph systems but not in the manner in which I have adapted it to my system.

My invention may be briefly and generally described as follows:—

Each station is equipped with one or more single-phase alternating current generators, one generator being supplied for each transmitting key or device. The transmitting generators are preferably driven mechanically by gear transmission and each generates a current of different periodic intensity from the currents developed by all of the other generators so that the currents from all of said generators may pass over the line without interfering with each other. As many generators may be employed as may be desired, each being supplied with its signal-transmitting device. The transmitting generators at one station will, of course, develop currents having periodicity of alternations different from those developed by the transmitting station at the other end of the line so that messages may be sent from both ends of the line simultaneously and without interference. The receiving apparatus at each end of the line consists of a series of wattmeters or wattoscopes, one for each transmitting generator at the other end of the line. For each wattoscope is provided an alternating current generator, each of said generators working in harmony with and developing a current corresponding in periods of intensity, or alternation, with one of the transmitting generators at the other end of the line. Through the tension coil of each wattmeter is passed current from one transmitting generator at the other end of the line and through the current coil is passed a corresponding current from the local or receiving generator. These corresponding currents passing through the coils of the wattmeter, cause a displacement of the movable coil thereof. The movable coil of each wattmeter acts as the armature of a relay to close a local circuit in which is placed a suitable receiving apparatus. It is to be noted that the transmitting generators at each end of the line operate synchronously and in harmony with the local or receiving generators at the other end of the line, suitable synchronizing apparatus being employed.

From the foregoing it will be noted that each wattmeter will be influenced by currents from the transmitting generator having a periodic intensity corresponding to the periods of alternation of the receiving generator connected to said wattmeter, and that said wattmeter will not be affected by current from any of the other transmitting generators connected to the line. As is well known, in order to displace the movable coil of a wattmeter it is necessary that the current or currents passing through the current coil and the tension coil must be of the same periodic intensity. It is, therefore, evident that by providing what I have termed receiving generators developing currents corresponding in such intensity with the transmitting generators at the other end of the line each wattmeter will be affected by the current of only one of the transmitting generators. It is, therefore, evident that as many transmitting devices may be employed as desirable, it being only necessary that the periods of alternation be varied in each transmitting generator and correspondingly varied in the receiving generators.

I may employ any suitable synchronizing apparatus for securing the synchronous operation of the motors for driving all of the transmitting and receiving generators at both ends of the line. I have shown and described one method of accomplishing this end, but I desire it understood that I do not wish to be limited to the method shown and described.

Referring to Fig. 1 which is a diagrammatic view of the apparatus, station No. 1 is provided with four single-phase alternating current generators, 1, 2, 3 and 4, which I shall term transmitting generators. These machines furnish current with the most sinusoid tension curve at different periods. Each of these generators is designed to develop a current having a different periodic intensity from the currents of all the other transmitting generators. Each generator is connected to the line L through a single transmitting device such as a telegraph key K. One pole of each of said generators is connected to the line as described, the other poles thereof being connected to the ground as indicated in the drawings. Station No. 2 is provided with four-receiving wattoscopes 1^a, 2^a, 3^a and 4^a. The high tension coil C of these wattoscopes is connected to the line and to ground. The low tension current coil C′ of each of these wattoscopes is connected in circuit with a single-phase alternating current generator, said generators being designated 1^b, 2^b, 3^b and 4^b. The receiving generator 1^b is operated synchronously with the transmitting generator 1; receiving generator 2^b rotates synchronously with transmitting generator 2 and so on throughout the series, the corresponding receiving and transmitting generators developing currents of equal periodic intensity so that when said corresponding currents pass through the connected wattmeter or wattoscope the movable coil thereof will be displaced to operate the individual receiving apparatus connected therewith.

One of the coils of each wattoscope is movable and its movement is obtained through the dynamic influence of one of said coils on the other. This dynamic influence, which is the general principle upon which my system is based, exists only when currents of the same number of periods flow through both coils and when said currents are not displaced in time on a quarter of their periods. When the electrical impulse which has caused a displacement of a coil in a wattoscope is interrupted, by means of the transmitting key, the coil is returned to its original position by suitable means. These wattoscopes may be constructed like the ordinary wattmeters with two perpendicular coils, one of which is adapted to swing on an axis, as indicated in Figs. 5 and 6, in which 5 is the movable coil and 6 the stationary coil. It is desirable, however, that the movable coil be made very small and light so that it may have a rapid movement, and will respond quickly to the influence of the adjoining coils. I prefer to construct the wattoscope with flat coils placed near to and parallel with one another, as the dynamic influence of such coils on each other will be greater. This construction is illustrated in Figs. 2, 3 and 4 of the drawings, in which 7 and 7^a designate the movable coils and 8 and 8^a the stationary coils. The stationary coils may be made like the flat coils of an ordinary transformer. The direction of windings in the movable coils 7 and 7^a is the same as in the immovable coils 8, but the direction of winding in the immovable coils 8 and 8^a is reversed as to each other, that is to say, if the windings in 8 go up from the left side the winding in 8^a must go up from the right side. The purpose of this is to have the currents in both of these coils moving in the reverse directions, or in opposite directions, at all times. If the coils 7, 7^a and 8, 8^a use currents of the same number of periods each of the coils 8 will attract the adjoining coils 7, 7^a and each of the coils 8^a will repel the adjoining coils 7, 7^a. When the current in coils 7 and 7^a is interrupted a spring 9 will return the coil to its normal position. This spring is connected to one end of a cross-arm 10 carried on one end of the shaft 11 of the movable coil, and is adjustable. It will be understood, of course, that any suitable means may be employed for returning the movable coil to its normal position. It will, therefore, be seen, that the displacement of the movable coil, in the matter of time, will correspond to the length of impulses of current sent over the line by the transmitting key.

The wattoscopes are constructed to act as relays so that my system may be adapted for use with any receiving apparatus employing relays. The end of the cross arm 10 opposite the spring 9 is provided with a contact point which is arranged to engage a similar point 12 to complete the relay circuit 13 in which is provided a magnet 14. This magnet is arranged to attract an armature 15 carried by a pivoted arm 16, the end 17 of which is arranged to engage a moving paper 18 to mark thereon, thereby indicating the signals.

In the circuit of each receiving generator is arranged a variable self-inductance or throttle coil R by means of which current from the receiving generator may be brought as nearly as possible in phase with the current from the corresponding transmitting generator, so that the currents passing through the coils of the wattoscope will be equal in phase and in periods of alternation.

The self-induction of each throttle coil can be varied, which permits a change, within determined limits, in the difference in time between the current and tension in its circuit. This is done to bring the current in the current coil of the wattoscope as nearly as possible in phase with the current passing through the tension coil. When this condition is secured the dynamic influence of both coils is the greatest.

It will be readily understood that assuming the transmitting and receiving generators to be operating synchronously and corresponding generators developing currents equal in periodic intensity, any signals transmitted by the transmitting devices will be properly indicated by the receiving wattoscopes, and that said signals will be received by the local receiving devices. Station No. 2 is similarly equipped with four transmitting single-phase alternating generators, which I call transmitting generators, 19, 20, 21 and 22. One pole of each of these generators is connected to ground, the other poles being connected to the line through signal transmitting devices, such as the telegraph keys K′. Station No. 1 is provided with four receiving wattoscopes 19^a, 20^a, 21^a and 22^a, corresponding with the transmitting generators at station No. 2. To each of these receiving-wattoscopes is connected a single-phase alternating current generator, said generators being designated 19^b, 20^b, 21^b and 22^b. Generator 19^b operates synchronously with generator 19 at the transmitting station No. 2 and produces a current of corresponding periodic intensity; generator 20^b similarly corresponds with the transmitting generator 20 and so on throughout the series. The current or volume coil of lower resistance of each wattoscope is in circuit with the adjoining receiving generator, while the high tension coil of the wattoscope is connected to the line and to ground. It will, therefore, be seen that any signal sent through the transmitting device connected with generator No. 19 will affect the wattoscope No. 19^a, and that said signal will be recorded by the receiving apparatus actuated by the movable coil of said wattoscope. It will, therefore, be seen that by my simple arrangement of transmitting and receiving generators, and wattoscopes, I secure an exceedingly simple, positively-acting multiple telegraph, which is not dependent on harmonic vibrations or apparatus actuated by said vibrations, as is the case with many multiple telegraph systems in which alternating currents of different periodic intensities are employed.

In order to secure synchronous operation of each pair of transmitting and receiving generators, I employ two direct current shunt wound motors M and M′, the motor M being at station No. 1 and M′ at station No. 2. Motor M is to be connected by gear transmission (not shown) to operate the transmitting and receiving generators at station No. 1; and motor M′ is to be similarly connected with and operates the transmitting and receiving generators at station No. 2. To synchronously operate the said motors at the different stations I employ a single-phase alternating current generator G at station No. 1 and operate it from the direct current motor M. At station No. 2 is placed an alternating current motor M^2 connected to the line and to ground, said alternating current motor being driven principally by the current from the alternating generator G at station No. 1. The manner in which the motor M^2 receives the greater portion of its current from the alternating current generator G instead of from the other generators connected to the line, that is to say, the manner of separating this current from the currents of the other generators connected to the line is through a well known principle. In order to make use of this well known principle I make the number of periods of the alternating current generator G much lower than that of the transmitting and receiving generators. I then connect the alternating current motor M^2 through an adjustable coil 23 of large self-induction, and through a variable condenser 24, both of which are adjusted so that

$$WL = \frac{1}{wc}$$

(L=self-induction; C=capacity; W=number of periods) is nearly *nil* for the number of periods of alternations of the generator G, so that the current from the generator will easily pass through to the alternating current motor M, but the currents from the other generators will not be permitted to pass said coil and condenser except in very small amounts, not sufficient to disturb the synchronic rotation of both the alternating generator and the alternating motor. Such an arrangement for operating the motor M^2 is necessary because the motor must be built very light and the comparatively high currents from the transmitting and receiving generators would disturb its synchronous rotation with respect to the alternating generator G at station 1.

The alternating current motor M^2 drives a specially constructed contact brush which is shown in Figs. 1 and 7. This brush consists of a disk 25, or it may be a bar, mounted on the end of the shaft 26 of the alternating current motor M^2. This disk carries a brush contact 27 arranged in a line radial with respect to the shaft, the brush extending in a direction parallel with the shaft, as shown clearly in Fig. 7. Arranged close to the contact brush, and driven from the direct current motor M′ is a contact plate or disk 28. This disk will be rotated at the same speed with the contact brush when the direct current motors M and M′ have the same speeds.

As shown in Fig. 8 the contact plate or disk 28 is provided with a series of parallel, concentric contact pieces 29, 29^a, 29^b, 29^c and 29^d, in its face adjoining the brush 27, all of which are of different lengths. The disk 28 is formed of suitable insulating material. Circuit wires are connected to each of the contact strips, as shown clearly in Fig. 9 and to contact rings 30 carried by the shaft of the direct current motor, as shown in Fig. 9. Bearing on each of said contact rings is a contact brush 31, each of said brushes being connected with a corresponding magnetic (field) coil 32 of the direct current motor M′. Said motor M′ is a shunt wound motor and its speed may be varied by varying the number of magnetic (field) coils through which current passes. The brush 27 is electrically connected to a ring 33 on brush shaft 26 and engaging said contact ring is a brush 34, said brush being in circuit with the battery 35 of the motor M′, the coils 32 being also in circuit with said battery and parallel to the armature of motor M′, as shown in Figs. 1 and 9.

Should there be any variation in the speed of the alternating current motor M^2 and direct current motor M′, there will be a differential movement of the brush 27 and contact plate 28. This differential movement will vary the position of the contact brush 27 on the contact strips 29, 29^a, 29^b, 29^c and 29^d, and the speed of the direct current motor M′ will be thereby varied. It is well known that the speed of a direct current, shunt-wound motor may be varied by varying the number of magnetic (field) coils through which current is passed. By a differential rotation of the contact disk and the contact brush so as to reduce the number of magnetic (field) coils in circuit with the battery 35 the speed of the motor will be increased and by increasing the number of coils in circuit with said battery the speed of the motor will be reduced. It will, therefore, be seen that if said motors normally operate synchronously they may be automatically brought back to said uniform speed should one or the other vary from the normal. It is also possible to use in my system transmitting generators in pairs having the same number of periods but having their currents displaced in time, one from the other, on a quarter of their periods. It is well known that such currents are wattless with respect to each other and that, therefore, they will not affect the movable coil of a wattmeter. By providing at the receiving station two alternating generators in pairs having their number of periods corresponding to the periods of the alternators at the transmitting station and having their currents displaced in time on a quarter of their periods, the wattoscopes at the receiving end of the line will be affected only by corresponding currents. Fig. 10 is a diagrammatic view of an apparatus of this form. In this form of the apparatus the general arrangement of the apparatus as heretofore described may remain the same, it being only necessary to provide means to regulate the displacement in time between each of the transmitted currents, as this displacement must be just a quarter of their periods. As the relative positions of the armatures and poles of all of the generators are invariable, the relative positions in time between their tension curves will also be invariable. The regulating of the displacement between the two currents can only be done by changing their displacement relative to their own tension. The displacement in time between an alternating current and its tension, as is known, depends on the self-induction and capacity of the line, and, therefore, can be changed if a variable self-induction and capacity is provided in the line.

Referring to Fig. 10, 36 designates a throttle coil of large self-inductance and having a movable core by which its self-inductance may be varied. 37 designates a condenser of variable capacity. This may be accomplished by varying the distance between its sheets or by varying the area of its surface. The throttle coil and condenser are placed in circuit with the generators between the generator and the transmitting key, as illustrated in Fig. 10. By properly adjusting the throttle coil and the condenser the currents may be displaced in time, one from the other on a quarter of their periods. It will, of course, be understood that in the circuits of the receiving generators corresponding throttle coils and condensers must be employed as indicated at 38 and 39 in Fig. 10, to displace the currents to correspond with the displacement at the transmitting end of the line. The displaced currents corresponding in number of their periods will each affect the movable coil of one wattoscope.

In one of the known arrangements for multiple telegraph based on the use of currents of different number of periods for each current, telephones or tuning forks, constructed to admit a predetermined number of vibrations in a second, are used in receivers. These vibrations are produced by the transmitted currents passing through an electromagnet placed opposite the telephone diaphragm, or opposite the tuning fork. If a telephone is used the telegraphic signals are audible. The tuning fork receivers are sometimes employed as signal recording means. It has been found, however, that recording by means of tuning forks is very unsatisfactory as the recorded signals are not clear and definite. In both of these arrangements the receivers require a certain time before they are brought into full vibration, making their operation slow. Moreover, such apparatus does not give clear signs or signals because besides their main vibrations they have what are called the higher harmonic vibrations. These higher harmonic vibrations can be produced by any of the transmitted currents and any of the receivers may be affected by them so that the main vibrations are interfered with and disturbed by these higher harmonics. The same indistinctness occurs also from these higher harmonics in each electric current when its tension curve is not sinusoid.

In my system I employ as receivers the wattoscope-relays, and provide means whereby the transmitted signs are written. I also use currents of the most sinusoid tension curve. These currents have the higher harmonics to a very small degree as compared with their main vibrations and as some friction must be overcome in shifting the movable coils of the wattoscopes the minor vibrations or higher harmonics will not affect them. By this means the signals received are clear and distinct. I, as before stated, form the movable coils of the wattoscope as light as possible. It will, therefore, be seen that I provide an apparatus capable of more rapid transmission than the ordinary apparatus, and which can be adapted for use with all machine telegraph systems using receiving relays. My system can be readily adapted for use with all telegraph systems now in use employing receiving relays and may be installed at a comparatively low cost.

The number of periods between each transmitting generator may be kept very low as compared with other alternating systems of telegraphic transmission. The differences between the periods need not be over five or ten periods per second, if currents of a comparatively low number of periods are used.

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

1. A multiple telegraph apparatus comprising means for developing alternating currents of different intensities, means for transmitting said currents over the lines means for generating alternating currents of corresponding intensities to the currents sent over the line from the transmitting station, and signal receiving means actuated by alternating currents of corresponding periods of intensity or alternation from the transmitting station and from the receiving station.

2. A multiple system comprising a series of alternating current transmitting generators, a transmitting device connecting each of said generators with the line, a series of alternating current generators at the receiving end of the line, each of said generators developing a current corresponding in its periods of alternation with one of the generators at the transmitting end of the line, a signal-receiving means in circuit with each generator at the receiving end of the line and through which passes the current from the transmitting end of the line, said signal-receiving means being adapted to be operated only by currents corresponding in their periods of alternation and flowing from both a receiving generator and a transmitting generator.

3. A multiple system comprising a series of alternating current transmitting generators, a transmitting device connecting each of said generators with the line, a series of alternating current generators at the receiving end of the line, each of said generators developing a current corresponding in its periods of alternation with one of the generators at the transmitting end of the line, a signal-receiving means in circuit with each generator at the receiving end of the line and through which passes the current from the transmitting end of the line, said signal-receiving means being adapted to be operated only by currents corresponding in their periods of alternation and flowing from both a receiving generator and a transmitting generator, and a variable inductance in circuit with each of the generators at the receiving end of the line.

4. A multiple system comprising a series of alternating current transmitting generators, a transmitting device connecting each of said generators with the line, a series of alternating current generators at the receiving end of the line, each of said generators developing a current corresponding in its periods of alternation with one of the generators at the transmitting end of the line, a signal-receiving means in circuit with each generator at the receiving end of the line and through which passes the current from the transmitting end of the line, said signal-receiving means being adapted to be operated only by currents corresponding in their periods of alternation and flowing from both a receiving generator and a transmitting generator, and means for synchronously operating the alternating generators at the transmitting and receiving ends of the line.

5. A multiple system comprising a series of alternating current transmitting generators, a transmitting device connecting each of said generators with the line, a series of alternating current generators at the receiving end of the line, each of said generators developing a current corresponding in its periods of alternation with one of the generators at the transmitting end of the line, a signal receiving means in circuit with each generator at the receiving end of the line and through which passes the current from

the transmitting end of the line, said signal-receiving means being adapted to be operated only by currents corresponding in their periods of alternation and flowing from both a receiving generator and a transmitting generator, and means for automatically controlling the operation of the generators at both ends of the line to synchronize said generators.

6. A multiple telegraph apparatus comprising a line, means for developing currents of electricity wattless with respect to each other, means for transmitting impulses of said currents over the line, means for receiving said series of electric currents separately and individually to give watt indications, and means whereby said watt indications will reproduce the signals transmitted.

7. A multiple telegraph apparatus comprising means for producing a series of electric currents wattless with respect to each other, means for interrupting each of said currents whereby impulses of said currents may be sent over the line, means at the receiving station to receive the individual currents transmitted over the line, means to cause said currents to give watt indications to thereby open and close a local circuit, whereby impulses of current will be sent through the series of local circuits corresponding to the impulses of wattless currents sent over the line from the transmitting station.

8. A multiple telegraph apparatus comprising a series of single phase alternating current generators at the transmitting station, means for sending impulses of current from each of said generators over the line, a series of wattoscopes at the receiving end of the line and having their tension coils connected to the line, a single phase alternating current generator connected to the current or low tension coil of each of said wattoscopes, the generators at the receiving station being arranged to develop currents corresponding in periodic intensity or alternations to the currents developed in the generators at the transmitting end of the line, and means for automatically maintaining the synchronous rotation of the generators at both ends of the line.

9. A multiple telegraph apparatus comprising a series of single phase alternating current generators at the transmitting station, means for sending impulses of current from each of said generators over the line, a series of wattoscopes at the receiving end of the line and having their tension coils connected to the line, a single phase alternating current generator connected to the current or low tension coil of each of said wattoscopes, the generators at the receiving station being arranged to develop currents corresponding in periodic intensity or alternations to the currents developed in the generators at the transmitting end of the line, and a variable inductance in circuit with each of the generators at the receiving station.

10. A multiple telegraph apparatus comprising a series of single-phase alternating current generators at the transmitting station, means for sending impulses of current from each of said generators over the line, a series of wattoscopes at the receiving end of the line and having their tension coils connected to the line, a single-phase alternating current generator connected to the current or low tension coil of each of said wattoscopes, the generators at the receiving station being arranged to develop currents corresponding in periodic intensity or alternations to the currents developed in the generators at the transmitting end of the line, a direct current motor at each station for driving the alternating generators, an alternating current motor at one end of the line, an alternating current generator at the other end of the line adapted to be driven by the adjacent direct current motor and to develop a current of lower periodic intensity than any of the transmitting or receiving generators, an adjustable condenser and a variable inductance arranged in the line between the alternating current motor and the low period alternating current generator, and means whereby the alternating current motor will control the speed of the adjoining direct current motor to synchronize said direct current motor with the corresponding motor at the other end of the line.

11. A multiple telegraph apparatus comprising a series of single-phase alternating current generators at the transmitting station, means for sending impulses of current from each of said generators over the line, a series of wattoscopes at the receiving end of the line and having their tension coils connected to the line, a single-phase alternating current generator connected to the current or low tension coil of each of said wattoscopes, the generators at the receiving station being arranged to develop currents corresponding in periodic intensity or alternation to the currents developed in the generators at the transmitting end of the line.

12. A multiple telegraph system comprising a line, a series of transmitting generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, means for sending impulses of said currents over the line, a series of receiving generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, the receiving generators at one end of the line developing currents corresponding in intensity with the currents

developed by the transmitting generator at the other end of the line, a series of wattoscopes at each end of the line and having their high tension coils connected to the line and their low tension or current coils connected to the receiving generators, and means whereby the movable coils of the wattoscopes will give watt indications.

13. A multiple telegraph system comprising a line, a series of transmitting generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, means for sending impulses of said currents over the line, a series of receiving generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, the receiving generators at one end of the line developing currents corresponding in intensity with the currents developed by the transmitting generator at the other end of the line, a series of wattoscopes at each end of the line and having their high tension coils connected to the line and their low tension or current coils connected to the receiving generators, a local relay circuit for each wattoscope, means whereby the movable coil of each wattoscope will close said relay circuit, and a signal means in each relay circuit.

14. A multiple telegraph system comprising a line, a series of transmitting generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, means for sending impulses of said currents over the line, a series of receiving generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, the receiving generators at one end of the line developing currents corresponding in intensity with the currents developed by the transmitting generator at the other end of the line, a series of wattoscopes at each end of the line and having their high tension coils connected to the line and their low tension or current coils connected to the receiving generators, means whereby the movable coils of the wattoscopes will give watt indications, and means for automatically synchronizing the receiving and transmitting generators at both ends of the line.

15. A multiple telegraph system comprising a line, a series of transmitting generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, means for sending impulses of said currents over the line, a series of receiving generators at each end of the line adapted to develop single-phase alternating currents of different periodic intensities, the receiving generators at one end of the line developing currents corresponding in intensity with the currents developed by the transmitting generator at the other end of the line, a series of wattoscopes at each end of the line and having their high tension coils connected to the line and their low tension or current coils connected to the receiving generators, a local relay circuit for each wattoscope, means whereby the movable coil of each wattoscope will close said relay circuit, a signal means in each relay circuit, and means for automatically synchronizing the receiving and transmitting generators at both ends of the line.

16. An apparatus for simultaneously transmitting impulses of alternating currents over a line comprising a series of alternating current generators at each end of the line, means for sending impulses of current from each of said generators over the line, a direct current motor at each station for driving the alternating generators, an alternating current motor at one end of the line, an alternating current generator at the other end of the line adapted to be driven by the adjacent direct current motor and to develop a current of lower periodic intensity than any of the transmitting or receiving generators, an adjustable condenser and a variable inductance arranged in the line between the alternating current motor and the low period alternating current generator, and means whereby the alternating current motor will control the speed of the adjoining direct current motor to synchronize said direct current motor with the corresponding motor at the other end of the line.

17. A multiple telegraph apparatus comprising means for developing alternating currents of different intensities, means for transmitting said currents over the line, means for generating alternating currents of corresponding intensities to the currents sent over the line from the transmitting station, signal receiving means actuated by alternating currents of corresponding periods of intensity or alternation from the transmitting station and from the receiving station, and means for varying the phase of the currents from the generators at the receiving end of the line.

18. A signal transmitting apparatus comprising a line, means for developing a plurality of currents at the transmitting end of the line, means for transmitting said currents over the line, means for developing a plurality of currents at the receiving end of the line, a signal receiving means, means whereby said currents from both ends of the line are connected to the signal receiving means, said signal receiving means being actuated by the reciprocal influence of two currents, one from the transmitting and one from the receiving end of the line.

19. A signal transmitting apparatus comprising a line, means for developing a plurality of alternating currents at the trans-

mitting end of the line, means for transmitting said currents over the line, means for developing a plurality of alternating currents at the receiving end of the line, said currents being wattless in respect to all currents except one from the transmitting end of the line, a signal receiving means, means whereby said currents from both ends of the line are connected to the signal receiving means, said signal receiving means being actuated by the two currents from both ends of the line with a watt indication.

20. A signal transmitting apparatus, comprising a line, means for developing a plurality of alternating currents of different periodical intensity at the transmitting end of the line, means for transmitting said currents over the line through signal transmitting apparatus, means for developing a plurality of alternating currents at the receiving end of the line, said currents corresponding in periodical intensity each with one from the transmitting end of the line, a signal receiving means, means whereby said currents from both ends of the line are connected to the signal receiving means, said signal receiving means being actuated by currents of the same periodical intensity.

21. A multiple telegraph apparatus, comprising a line, means for transmitting a plurality of electric currents over the line, said currents being wattless with respect to each other, a series of wattmeters to receive said electric currents, means to supply additional electric currents to said wattmeters to thereby cause the wattmeters to give indications.

This specification signed and witnessed this 26th day of February A. D. 1909.

EUGEN P. BATZEL.

Witnesses:

J. R. O'Toole,

E. L. Watson.