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Following this line of thought, Herr P. Nipkow has constructed an "electric telescope," which he claims fulfils the much desired object, and which he describes in the *Elektrotechnische Zeitschrift.* His apparatus, a most ingenious combination, consists in (1) means for maintaining synchronism of the mechanisms, and in (2) means for transforming intermittent light into intermittent electric currents, and in the retransformation of the latter into light.

He accomplishes his first object by means of the "phonic wheel" employed by Messrs. Delaney and Calahan in their synchronous multiplex telegraph system, the latest improvements in which we give in this issue. We need, therefore, not enter into the details here, which are shown in Fig. 1. Coming to the second requisite, however, the transformation of intermittent light into intermittent currents and their retransformation, Herr Nipkow, while acknowledging the adaptability of selenium for the purpose, has been able to dispense with it entirely by using a lamp-black drum designed by himself. This drum *M*, Fig. 2, is an ordinary box, one end being closed by a glass plate and the other by a diaphragm, the interior being filled with wire gauze covered with lamp-black.

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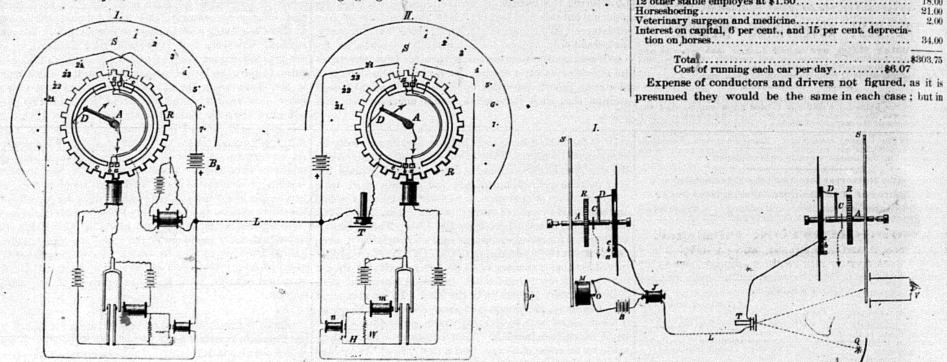

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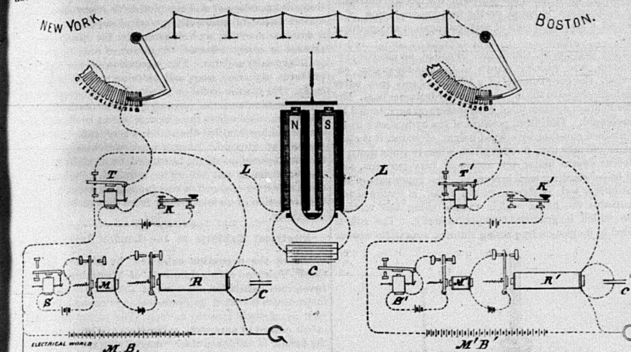

FIG. 1.—IMPROVEMENTS IN SYNCHRONOUS MULTIPLEX TELEGRAPHY.

Without here entering again into an extended description, we propose to show in what the modified system consists. It may be well to premise, however, that the general method employed consists in giving each operator the use of a line alternately during very short intervals of time, so that practically each has an independent line to himself. This is accomplished by causing an arm to travel over a series of contacts arranged in a circle. The stations at the end of the line are both provided with this apparatus, so that if both are kept in synchronous revolution, two corresponding segments connected to an operating circuit will establish communication. Similarly, two other segments will serve as another circuit, and so on, the number being only limited by practical considerations. In practice, a number of these segments at each end of the line are joined together so as to form one circuit and so that the arm traveling over them leaves such a small interval of time between the successive contacts as to give practically a continuous circuit.

This is clearly shown in Fig. 1. which represents the latest improved disposition of the apparatus. The system is worked as a sextuplex, there being alternate series of six segments each. The same numbers of each series are connected together as illustrated in Fig. 1, where the No. 5 of each is so shown. From the figure it will be seen that if the arms at each station are kept in perfect unison, the operators connected with the No. 5's will have a line as well as those connected with the other segments, 1, 2, 3, 4 and 6.

The dial and segments are shown enlarged in Fig. 2. For the sake of clearness the 1's alone are shown connected, it being understood, of course, that the others are similarly joined. There are 12 series of 6 segments each, making 72 for the operating circuits, but there are 12 others, of which 6 are dead or unconnected, which are shown cross-sectioned in Figs. 2 and 3; and to these are added 6 for correcting and synchronizing the motions of the wheels at each station, making in all 84 segments. The correcting segments are marked *C* and *B* respectively in Figs. 2 and 3, and their function will be described presently.

At both stations, which we will call New York and Boston respectively, there are placed two identical sets of apparatus as shown in Fig. 3. The latter indicates, in a very clear manner, the method of synchronizing the rotation of the wheels. Taking the New York end, it will be seen that the iron cog-wheel *A* rotates before electro-magnet *D*, the circuit of which is continuously broken so as to attract the successive teeth of the wheel, and allow them to pass after reaching the median line. The circuit is broken by the reed *E*, which is kept in vibration in the same manner as a vibrating bell by the electro-magnet *F* and battery *B'*, the contact being broken at the point *H*. On the opposite side of the same point is situated the break contact of the motor wheels, above described; it will also be noted that high resistances are shunted around these two points to prevent sparking. The end of the reed *E* vibrates between the extended poles of an electro-magnet *M* with extended pole-pieces, and the battery circuit of which is normally open at *K*, being maintained so by the electro-magnet *M'*, the battery circuit of which is normally closed at *L*, the back stop of the relay *R*.

Returning now to the segment wheel, we come to the method employed of maintaining the synchronism of the wheels. It will be noted in Fig. 3 that the two wheels are revolved in positions differing one-sixth of a revolution. In each wheel there are three segments, marked *B* and *B'*, which are connected together and to batteries *B''* and *B'''* respectively. There are also three segments in each, marked *C* and *C'*, connected with the relays *R* and *R'* respectively, as shown. Besides these six segments there are placed six "dead" ones, as they are called, since they are not connected to the circuit in any way. Now, as long as the wheels revolve uniformly, as indicated in their positions in Fig. 3, the circuit will be broken at that point in the revolution, as the arm in Boston is upon a dead segment, and hence no correcting impulse will be sent over the line. But if the Boston wheel should increase its speed so as to touch *C'*, while New York is still at *B*, a circuit would be formed and the following would take place: The New York battery *B''* would send an impulse through *B* and the arm *N* over the line to the Boston segment *C'*, and thence through the relay *R'*. The latter would attract its armature, open the circuit of *M'''*, and allow the spring to withdraw its armature *K'*, and thus energize the electro-magnet *M'*. The end of the reed *E* at Boston now vibrates in a magnetic field, which acts as a drag upon it and diminishes its rate. This changes the impulses in the motor magnet *D'*, which, reacting upon the wheel, changes its speed correspondingly until the arm *N'* is brought back to its correct position. When this occurs, the relay *R'* is no longer energized, its armature falls back, and everything returns to its normal state. Should the New York wheel increase its speed, the same action would take place at the end of the line, the impulse then being sent over by the Boston battery *B'''*. The drawing is so clear that we need not enter more in detail. It will be seen that six correcting impulses can be sent at each revolution of the wheel, so that a deviation in position between the two wheels of only a few thousandths of an inch (the distance between a live and dead segment), will be quickly rectified.

The arrangement of the operator's table is shown in Fig. 1, which also shows two stations connected, Boston sending and New York receiving. The system is worked on open circuit and several interesting devices are employed. By pressing his key *K'*, the operator closes the circuit of his transmitter *T'* and sends the current from his main battery *M' B'* over the line. It passes through the transmitter lever *T* at New York, and thence to the relay *R* to ground. The relay being energized, it opens the circuit of the electro-magnet *M*, and closes that of the sounder *S*; thus the dots and dashes transmitted at Boston are received by the sounder at New York. It will be noted that when the keys at the stations are on their back-stops, as shown at New York *K*, they open the transmitter circuit, so that the line current goes to the relay.

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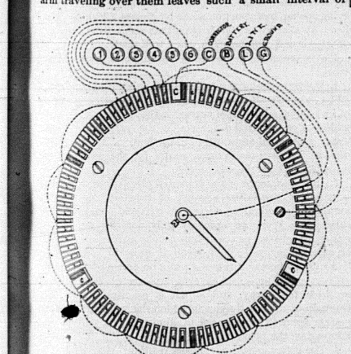

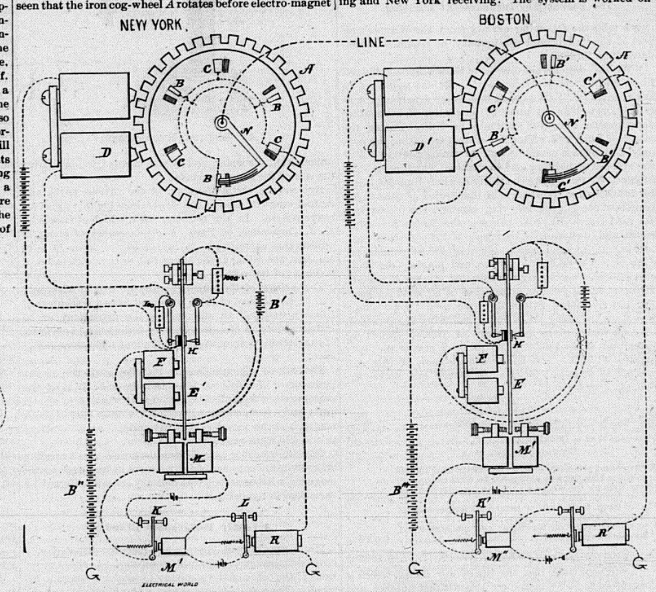

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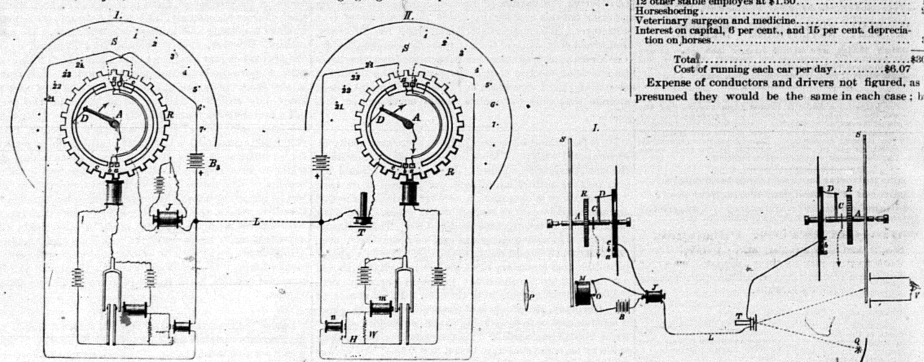

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Without here entering again into an extended description, we propose to show in what the modified system consists. It may be well to premise, however, that the general method employed consists in giving each operator the use of a line alternately during very short intervals of time, so that practically each has an independent line to himself. This is accomplished by causing an arm to travel over a series of contacts arranged in a circle. The stations at the end of the line are both provided with this apparatus, so that if both are kept in synchronous revolution, two corresponding segments connected to an operating circuit will establish communication. Similarly, two other segments will serve as another circuit, and so on, the number being only limited by practical considerations. In practice, a number of these segments at each end of the line are joined together so as to form one circuit and so that the arm traveling over them leaves such a small interval of time between the successive contacts as to give practically a continuous circuit.

This is clearly shown in Fig. 1, which represents the latest improved disposition of the apparatus. The system is worked as a sextuplex, there being alternate series of six segments each. The same numbers of each series are connected together as illustrated in Fig. 1, where the No. 5 of each is so shown. From the figure it will be seen that if the arms at each station are kept in perfect unison, the operators connected with the No. 5's will have a line as well as those connected with the other segments, 1, 2, 3, 4 and 6.

The dial and segments are shown enlarged in Fig. 2. For the sake of clearness the 1's alone are shown connected, it being understood, of course, that the others are similarly joined. There are 12 series of 6 segments each, making 72 for the operating circuits, but there are 12 others, of which 6 are dead or unconnected, which are shown cross-sectioned in Figs. 2 and 3; and to these are added 6 for correcting and synchronizing the motions of the wheels at each station, making in all 84 segments. The correcting segments are marked *C* and *B* respectively in Figs. 2 and 3, and their function will be described presently.

At both stations, which we will call New York and Boston respectively, there are placed two identical sets of apparatus as shown in Fig. 3. The latter indicates, in a very clear manner, the method of synchronizing the rotation of the wheels. Taking the New York end, it will be seen that the iron cog-wheel *A* rotates before electro-magnet *D*, the circuit of which is continuously broken so as to attract the successive teeth of the wheel, and allow them to pass after reaching the median line. The circuit is broken by the reed *E*, which is kept in vibration in the same manner as a vibrating bell by the electro-magnet *F* and battery *B'*, the contact being broken at the point *H*. On the opposite side of the same point is situated the break contact of the motor wheels, above described; it will also be noted that high resistances are shunted around these two points to prevent sparking. The end of the reed *E* vibrates between the extended poles of an electro-magnet *M* with extended pole-pieces, and the battery circuit of which is normally open at *K*, being maintained so by the electro-magnet *M'*, the battery circuit of which is normally closed at *L*, the back stop of the relay *R*.

Returning now to the segment wheel, we come to the method employed of maintaining the synchronism of the wheels. It will be noted in Fig. 3 that the two wheels are revolved in positions differing one-sixth of a revolution. In each wheel there are three segments, marked *B* and *B'*, which are connected together and to batteries *B''* and *B'''* respectively. There are also three segments in each, marked *C* and *C'*, connected with the relays *R* and *R'* respectively, as shown. Besides these six segments there are placed six "dead" ones, as they are called, since they are not connected to the circuit in any way. Now, as long as the wheels revolve uniformly, as indicated in their positions in Fig. 3, the circuit will be broken at that point in the revolution, as the arm in Boston is upon a dead segment, and hence no correcting impulse will be sent over the line. But if the Boston wheel should increase its speed so as to touch *C'*, while New York is still at *B*, a circuit would be formed and the following would take place: The New York battery *B''* would send an impulse through *B* and the arm *N* over the line to the Boston segment *C'*, and thence through the relay *R'*. The latter would attract its armature, open the circuit of *M'''*, and allow the spring to withdraw its armature *K'*, and thus energize the electro-magnet *M'*. The end of the reed *E* at Boston now vibrates in a magnetic field, which acts as a drag upon it and diminishes its rate. This changes the impulses in the motor magnet *D'*, which, reacting upon the wheel, changes its speed correspondingly until the arm *N'* is brought back to its correct position. When this occurs, the relay *R'* is no longer energized, its armature falls back, and everything returns to its normal state. Should the New York wheel increase its speed, the same action would take place at the end of the line, the impulse then being sent over by the Boston battery *B''*. The drawing is so clear that we need not enter more in detail. It will be seen that six correcting impulses can be sent at each revolution of the wheel, so that a deviation in position between the two wheels of only a few thousandths of an inch (the distance between a live and dead segment), will be quickly rectified.

The arrangement of the operator's table is shown in Fig. 1, which also shows two stations connected, Boston sending and New York receiving. The system is worked on open circuit and several interesting devices are employed. By pressing his key *K'*, the operator closes the circuit of his transmitter *T'* and sends the current from his main battery *M'B'* over the line. It passes through the transmitter lever *T* at New York, and thence to the relay *R* to ground. The relay being energized, it opens the circuit of the electro-magnet *M*, and closes that of the sounder *S*; thus the dots and dashes transmitted at Boston are received by the sounder at New York. It will be noted that when the keys at the stations are on their back-stops, as shown at New York *K*, they open the transmitter circuit, so that the line current goes to the relay.

We must also draw attention to the device employed for

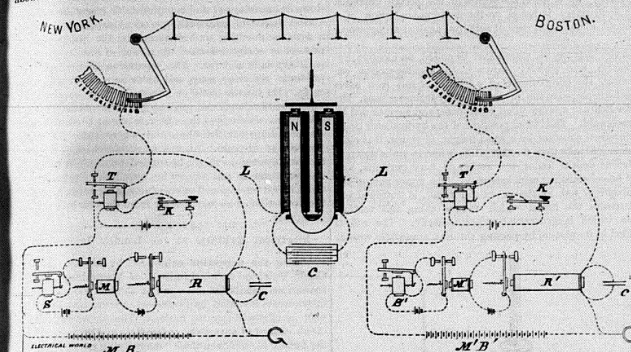
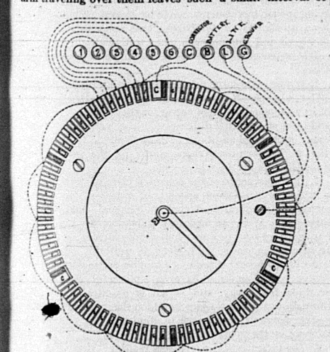
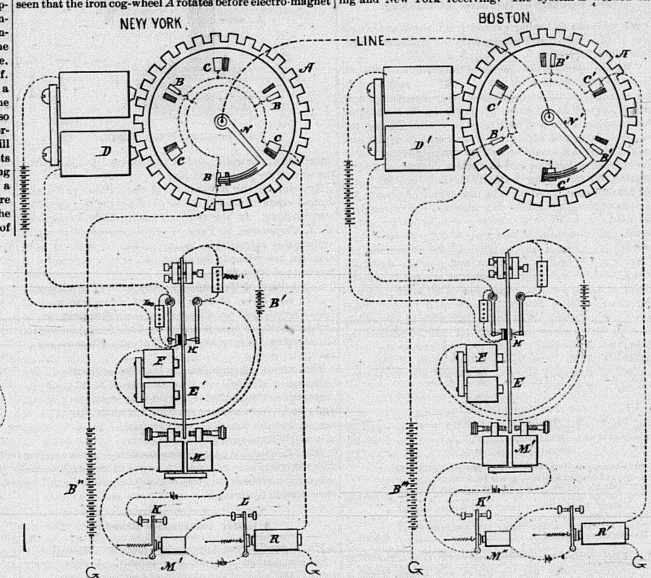


FIG. 1.—IMPROVEMENTS IN SYNCHRONOUS MULTIPLEX TELEGRAPHY.





FIGS. 2 AND 3.—IMPROVEMENTS IN SYNCHRONOUS MULTIPLEX TELEGRAPHY.