F. E. A. MATHELOT & H. G. GENTILHOMME.

SYNCHRONIZING DEVICE.

APPLICATION FILED APR. 23, 1908.

993,610. **Patented May 30, 1911.**

2 SHEETS—SHEET 1.

Fig. 1

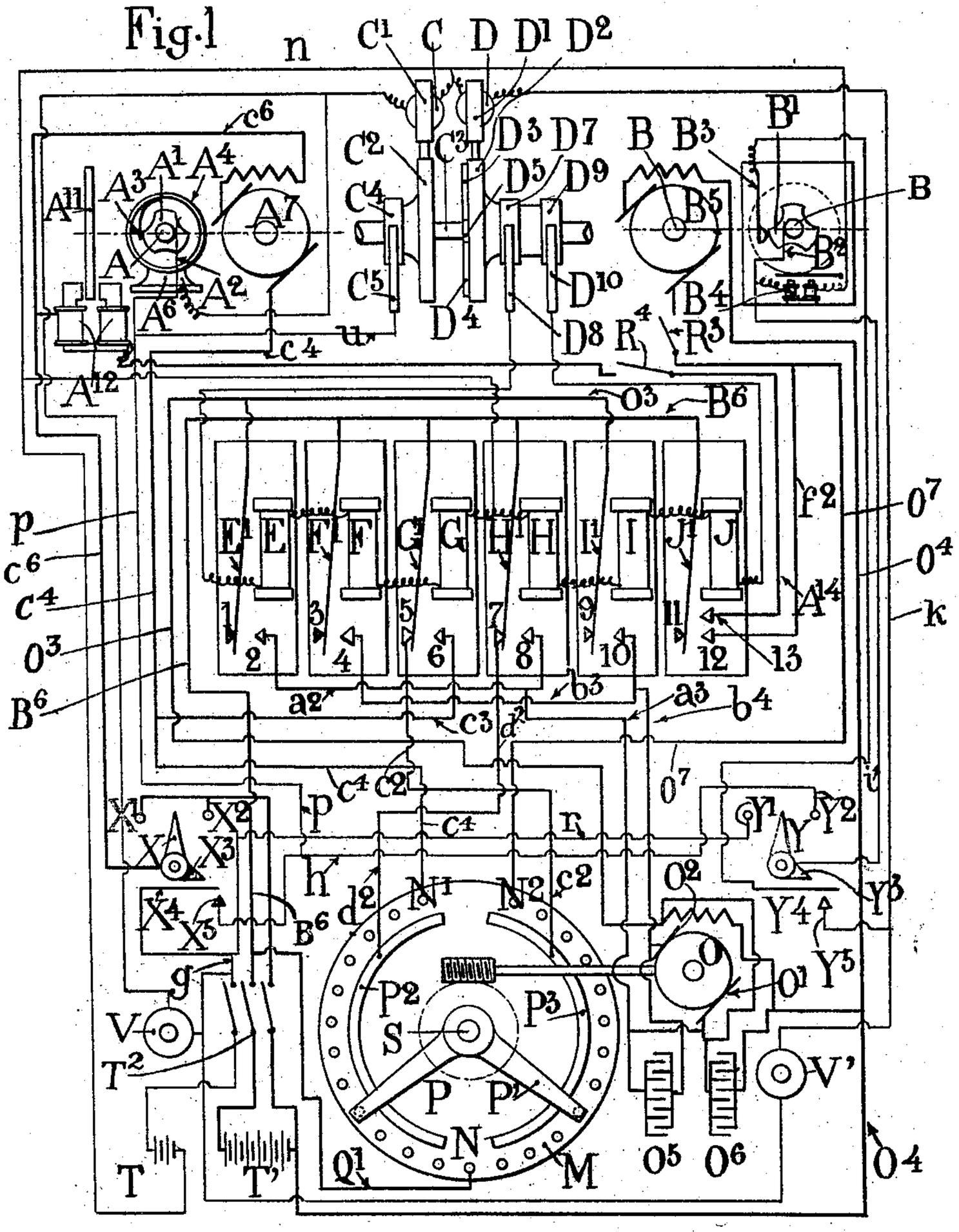


Fig. 2

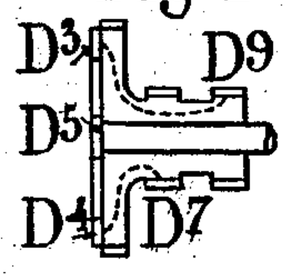


Fig. 3

Fig. 4

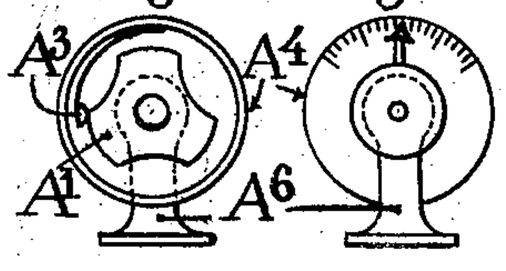
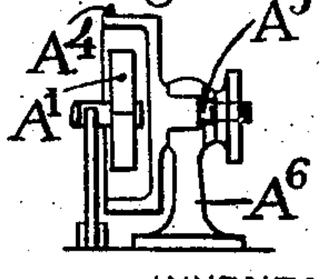


Fig. 5

Fig. 6.



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2 SHEETS—SHEET 2.

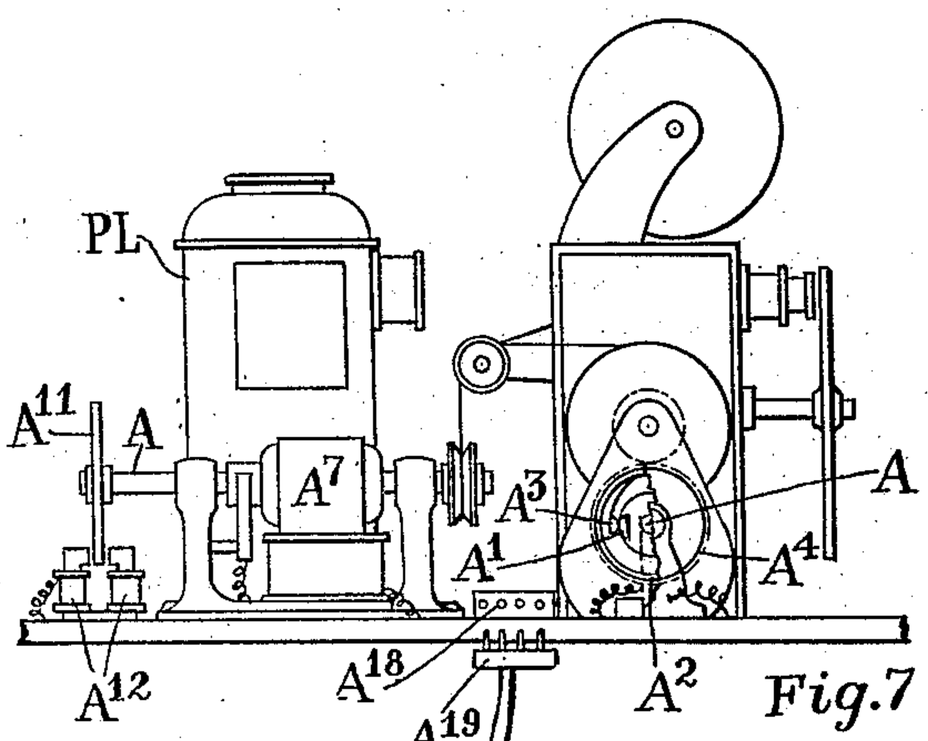

Fig. 7

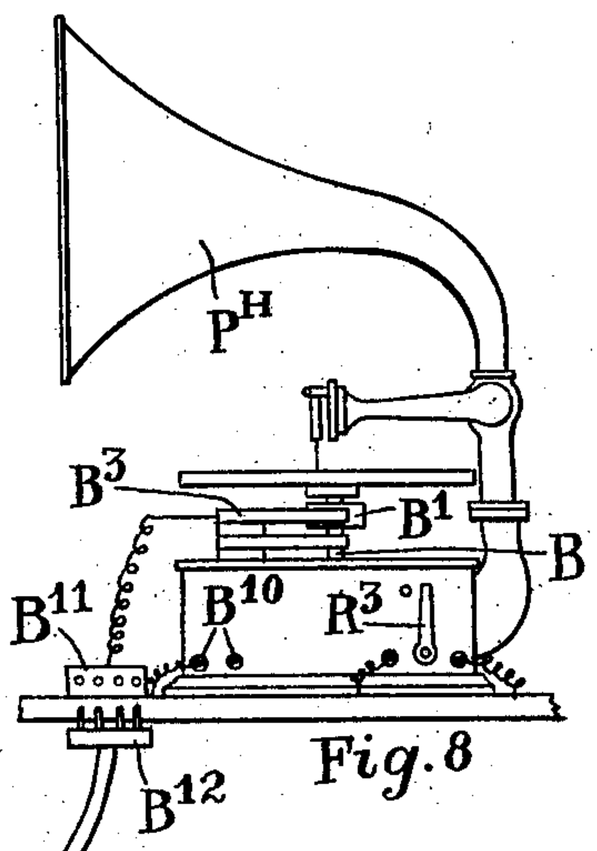

Fig. 8

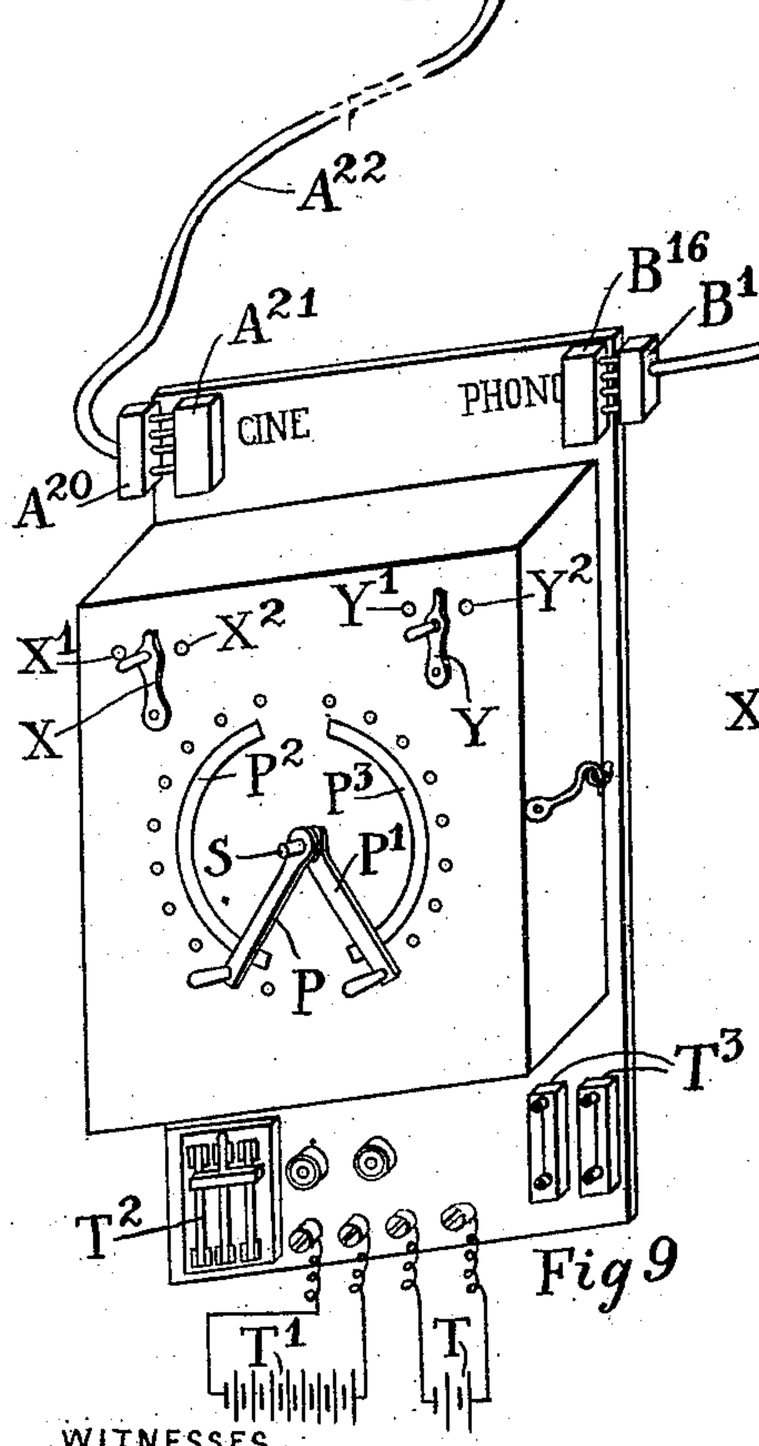

Fig 9

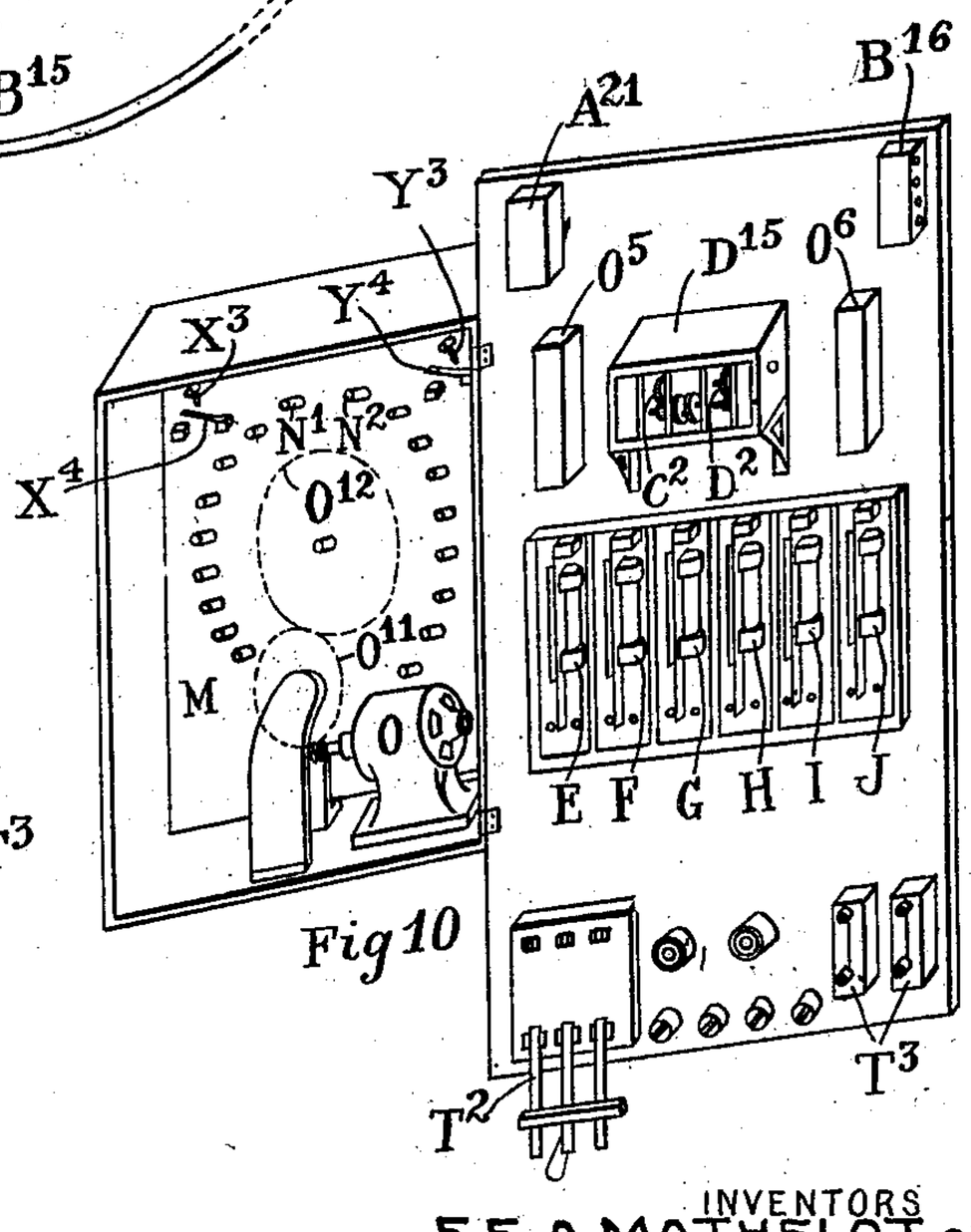

Fig 10

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SYNCHRONIZING DEVICE.

993,610. Specification of Letters Patent. Patented May 30, 1911.

Application filed April 23, 1908. Serial No. 428,720.

To all whom it may concern:

Be it known that we, FERNAND EMILE AUGUSTE MATHELOT and HENRI GEORGES GENTILHOMME, both citizen of the French Republic, and residents of Paris, France, have invented certain new and useful Improvements in Synchronizing Devices, of which the following is a specification.

This invention relates to a device adapted to secure synchronism of movement between two moving apparatus of any kind, but it is specially adapted to secure synchronism of movement between a phonograph and a kinematograph.

In the annexed drawing, Figure 1 is a schematic view of the entire apparatus; Fig. 2 is a longitudinal section of the wheel D^2 and the collecting rings D^7 and D^9 showing the connection between sector D^3 and collecting ring D^9 and between sector D^4 and collecting ring D^7; Fig. 3 is a front view of wheel D^2 and its two sectors D^3 and D^4; Fig. 4 is a front view of the disconnecting box, Fig. 5 is a rear view of Fig. 4, and Fig. 6 is an elevation in vertical section of this box. Fig. 7 is a view of the kinematograph in elevation with its driving mechanism; Fig. 8 an elevation of the phonograph; Fig. 9 a front view of the box containing the synchronizing apparatus, with means for connecting it to the kinematograph and the phonograph, and Fig. 10 is an elevation of the box shown in Fig. 9 opened.

A represents the shaft of the kinematograph and B the shaft of the phonograph.

A′ is a cam with teeth rigidly mounted on the shaft of the kinematograph; this cam is shown as provided with three teeth and may be electrically connected with the system, but in order to secure the passage of the current, we prefer to admit this current through a brush A^2, arranged against the end of shaft A of the kinematograph.

A^3 is a contact against which strike the teeth of the cam A′, and is mounted in a drum A^4 provided with a shaft A^5 (Fig. 6), which serves to fix the drum in the suitable position in the bearing A^6. This drum A^4 is shown in section in Fig. 6, and this drum is provided at its rear with a scale so as to readily control the displacement of said drum.

A^7 is a motor driving the kinematograph by any suitable transmission of movement.

B′ is a cam rigidly mounted upon the shaft of the phonograph. Both the cams A′ and B′ have the same number of teeth if the phonograph and the kinematograph rotate at the same speed, but if the phonograph and the kinematograph rotate at a different speed the number of teeth of each of these cams will be in the same proportion as the speed of the two devices. The cam B′ may also be electrically connected with the system, but I prefer to admit the current through a brush B^2, in contact with the end of the shaft B of the phonograph.

B^3 is a contact against which the cam B′ strikes three times in each revolution.

PL is the projection lantern. p^H the phonograph.

B^{10} are two terminals of the electromagnet B^4.

B^{11} is a junction box, or socket, in which terminate all the wires of the phonograph p^H, and with this socket engage, by means of terminal plugs B^{12}, the wires of the 4 wire cable B^{14}, ending at its outer end in the 4 plug holder B^{15}, engaging the junction box B^{16} attached to the synchronizing device.

A^{18} is a junction box having four sockets in which terminate all the wires leading to the electrically controlled parts of the kinematograph. Into this socket fit the four plugs forming the cable A^{22}, the other end of which terminates in four plugs engaging four corresponding holes in the junction box A^{21}, also attached to the synchronizing device.

D^{15} is a closed box provided with a window allowing the mechanism to be seen. Within this box are contained a clock mechanism, the electromagnets C D with their armatures C′ D′, (said electromagnets and their armatures being clearly shown in the diagrammatic sketch Fig. 1), and the wheels C^2 and D^2, which rotate in proportion as the electromagnets C D receive current.

O^5 and O^6 are two condensers.

On the cover of the box is seen the motor O which works the axle S (Fig. 1) by means of gears O^{11} and O^{12}, and on this axle S are mounted the hands P P′.

T^2 is a three pole interrupter.

The phonograph may be driven by a motor B^5 with which it may be connected in any suitable manner. If the phonograph is driven by a clock spring, said phonograph must be provided with a brake, the action of which ceases as soon as the current passes

into the magnet B^4 of this brake, so that the phonograph may be started exactly at the right moment.

C is an electro-magnet receiving the current from the brush A^3; the armature C′ of his magnet causes the toothed wheel C^2 to move one tooth at each contact. D is an electro-magnet receiving its current from the brush B^3, the armature D′ of said magnet moves the toothed wheed D^2 for one tooth at each contact. These wheels C^2 and D^2 may be ordinary gear wheels with normal teeth against which act the ends of the armatures C′ and D′ of the magnets C and D, but I prefer to construct these wheels in the form of escapement wheels in clocks, the lever driving the wheels is then to be actuated by the armatures C′ and D′. The wheel D^2 is provided at its left side surface with two sections D^3 and D^4, insulated from the system, and from each other by insulating pieces D^5 and D^6 (Figs. 2 and 3). The sector D^3 is electrically connected by a wire or otherwise to the collecting ring D^9 against which rests the brush D^8. The wheel C^2 is provided with an elastic brush C^3 pressed continually against the sectors D^3 and D^4 or against the insulating pieces D^5 and D^6. This brush C^3 is connected to the collecting ring C^4 against which rests the brush C^5, which receives the current through wire *u* connecting with wire *p*.

E, F and G are three electro-magnets all of them traversed by the current taken up by the brush D^{10}.

H, I and J are three electro-magnets all of them traversed by the current taken up by the brush D^8.

The magnet E has an armature E′, vibrating between two contacts 1 and 2, and the magnet F has an armature F′ vibrating between two contacts 3 and 4. The magnet G has an armature G′ vibrating between two contacts 5 and 6, contact 5 is connected by a wire c^2 to a sector P^3 and the contact 6 is directly connected to the motor A^7 by the wires c^3 and c^4. The magnet H has an armature H′ vibrating between two contacts 7 and 8; the contact 7 is connected by wire d^2 to another sector P^2, and the contact 8 is connected to contact 2 by a wire a^2, and a wire a^3 connects these two contacts to the brush O′ of a motor O. The magnet I has an armature I′ vibrating between two contacts 9 and 10, the contact 10 is connected by wire b^3 to the contact 4 and a wire b^4 connects these two contacts to the second brush O^2 of the motor O. The magnet J has an armature J′ vibrating between the two contacts 11 and 12; the contact 12 is connected by wire f^2 to the motor B^5.

The contacts 1, 3, 9 and 11 are insulated contacts serving as resting points for the armatures of their respective magnets.

The armatures F′, G′, H′, J′ are electrically connected with the wire B^6 conveying the high tension current; and the armatures E′ and I′ are electrically connected with wire O^3 leading to the field of motor O.

M is a resistance divided into two portions, N N′ and N N^2, which is traversed by the current passing in the wire Q′ leading from the source of electricity T. A hand P slides on the sector P^2 making also contact with the contacts of the resistance N N′, and a hand P′ slides on sector P^3 making also contact with the contacts of the resistance N N^2. These two hands P, P′ are insulated from each other and are snugly fitted upon a shaft S in the center of the resistance M. These two hands P, P′ being snugly fitted upon shaft S can be changed in position at will, and if left in a certain position when the shaft S rotates actuated by motor O, the two hands will rotate with said shaft thereby maintaining their relative position which has been given by hand. This shaft S can be rotated in one or the other direction by means of motor O which is set in operation in one or the other direction when one of the wheels C^2 or D^2 goes faster or slower than the other. In the drawing the shaft S is connected to motor O by wheel and worm gear, but any suitable manner of transmission may be used.

The brushes of motor O are connected to a condenser O^5, while the ends of the wire of the field of said motor are connected to another condenser O^6. These two condensers are devised to prevent sparking of the motor O when the current is interrupted.

V and V′ are two push buttons similar to the contacts of electro bells. If the push-button V is pushed down the current is sent directly to the magnet C, and as long as this button is kept down, the armature C′ will be attracted and can not vibrate when the cam A′ sends a current into contact A^3, and the wheel C^2 will remain in rest, while wheel D^2 can continue to rotate owing to the vibration of armature D′; in the same way if the button V′ is pushed down, the current is sent directly to the magnet D and its armature D′ remains attracted so long as said button V′ is pushed down, and the wheel D^2 will thus remain in rest while wheel C^2 can continue to rotate with each vibration of armature C′.

A handle X can be turned on either of the contacts X′ or X^2, both connected to the return wire to the source of high tension current T′. The shaft of this handle X is electrically connected to the return wire of the motor A^7, and on said shaft is fixed an insulated cam X^3 which may also be constructed of non-conductive material. When the handle X is pushed on the contact X^2, said cam X^3 pushes a pedal X^4 upon the contact X^5; said pedal X^4 being connected

by a wire *g* to the positive pole of a battery of low intensity T. Another handle Y, connected by wire *i* to the brush B^2, can be shifted over the contacts Y′ or Y^2, the contact Y^2 is connected by wire *h* to contact X^5 and the contact Y′ is connected by wire *r* to the feed wire *g*. Upon the shaft of this handle Y is fixed an insulated cam Y^3, which when the handle Y is placed over the contact Y^2 can lower a pedal Y^4 upon a contact Y^5 connected by wire *k* to the magnet D.

A″ is a disk of red copper fixed on the shaft of motor A^7, this disk is placed between the poles of a magnet A^{12} and this constitutes a brake when the current passes into magnet A^{12}.

Operation: All parts constituting the synchronization apparatus, *i. e.* the magnets C, D and their parts, the relays E, F, G, H, I and J and their parts are actuated by a low tension current emanating from a source of energy T while the motors A^7, B^5 and O are actuated by a high tension current coming from a source of energy T′. These two currents can be made and broken by a three polar interrupter T^2. The handle X being pushed to the right upon contact X^2, cam X^3 will push down pedal X^4 on contact X^5, and the handle Y being pushed to the right upon contact Y^2, the cam Y^3 will push down pedal Y^4 upon contact Y^5. The low tension current arriving through wire *g* passes through pedal X^4 and contact X^5 and through wire *h* to contact Y^2, then passes through handle Y and through wire *i* to the brush B^2, then through cam B′ which each time it touches brush B^3 sends the current into magnet D which then vibrates armature D′, advancing the wheel D^2 one tooth. The current leaving the magnet D returns through wire *n* to the source of energy T. A derivative current is taken up by wire *p* ending at brush A^2 from wire *h*, the current passes to cam A′ and each time said cam touches brush A^3 a current is sent to magnet C which then actuates its armature C′ which in turn advances wheel C^2 one tooth. The current leaving magnet C returns through wire *n* to the source of energy T. It will thus be seen that if the phonograph and kinematograph rotate at the same speed, the magnets will receive in a given time the same number of impulses and consequently the wheels C^2 and D^2 will rotate at exactly the same speed, and if brush C^3 rests at the start on one of the insulating parts D^5 or D^6 no current will pass to the collecting rings D^7 and D^9 until one of the wheels C^2 or D^2 runs ahead of the other or lags behind. The high tension current emanating from source T′ passes through interrupter T^2 and through wire B^6 to the armature F′, G′, H′, J′, but no current being sent through magnets E, F, G, H, I and J, the armatures of these magnets will remain in position shown in Fig. 1 of the drawing. Armature G′ then transmits the high tension current to sector P^3 by the way of contact 5 and wire *c*. Hand P′ slides on sector P^3 and at the same time on the contacts of resistance N—N^2, consequently the current coming through sector P^3 will pass through that part of the resistance comprised between hand P′ and the exit N^2. From N^2 the current passes directly to motor B^5 through wire O^7, and the current leaving the motor returns to the source of energy through wire O^4. The speed of motor B^5 can thus be regulated by placing the hand P′ in the suitable position. Armature H′ transmits the high tension current to sector P^2 through contact 7 and wire d^2. Hand P slides on sector P^2 and at the same time on the contacts of resistance N—N′. The current arriving through sector P^2 and leaving at N′ will thus pass through the resistance part between hand P and the exit N′. From N′ the current passes directly to motor A^7 through wire c^6. The current leaving motor A^7 passes through wire c^5 to handle X whence it passes through contact X^2 to the return wire to battery T′. It will thus be seen that at the start the speed of motor A^7 can be regulated by placing hand P in the suitable position.

The phonograph and the kinematograph being started, let us assume that the synchronism is perfect but that the views of the kinematograph do not correspond with the words reproduced by the phonograph and that there be a rather considerable difference; now if the kinematograph is fast, the button V is pushed down in order to send a continuous current into magnet C so as to stop wheel C^2 as above explained; if on the other hand the phonograph is fast, the button V′ is pushed down so as to stop wheel D^2. By thus stopping one of the wheels D^2 or C^2 one of the motors is speeded up and the other one slowed down, as will be hereinafter explained. When the phonograph and the kinematograph are nearly regulated as to the coincidence of the words with the pictures, it would be difficult to regulate the same completely by merely actuating the push buttons V or V′. Said buttons are therefore released and the regulation is completed by means of the device A^4. The drum A^4 is turned in its bearing A^6 in one direction or the other, until there is complete accordance of the pictures and words. It will be understood that if the box A^4 is shifted in one or the other direction the teeth of the cam will strike against contact A^3, a little sooner or later than this contact would have been made in the original position of the drum, and consequently an advance or retardation is obtained as slight as may be desired for the sending of the current into the magnets C or D and conse-

quently a retardation or increase of the rotation of wheels C^2 or D^2. The apparatus being thus started and regulated, suppose that the synchronism is broken through any cause whatever, the cams A′ and B′ will evidently cease to transmit to the magnets C and D the same number of impulses in the same time; the wheels will consequently no longer rotate at the same speed and the brush C^3 will come into contact with section D^3 or sector D^4. Let us further suppose that the kinematograph be fast, the brush C^3 will come into contact with sector D^3, the current will pass to brush D^{10} to traverse the group of magnets J, I, and H, which will actuate their armatures J′, I′, and H′; the armature J′ will strike contact 12 and thus send the current through wire f^2 directly to motor B^5 without traversing resistance $N—N^2$ and the current being consequently of greater intensity the speed of the motor will be increased. The armature H′ having released contact 7, the current is no longer sent to sector P^2, but the current coming through wire Q′ to point N is compelled to traverse the entire resistance N—N′, while before the current coming through sector P^2 had only to traverse that part of the resistance comprised between handle P and the point N′; the intensity of the current going to motor A^7 is thus decreased and consequently the speed of said motor is reduced. Armature H′ comes to contact 8 and thus a current is sent through wire a^3 to brush O′ of motor O, this current traverses the armature, passes out through the other brush O^2 and goes through wire b^4 to contact 10 upon which strikes armature I′. The current passes through this armature I′ and passes through wire O^3 to the said field of motor O traverses said field and returns through wire O^4 to the source of energy T′. This motor causes shaft S to rotate which shaft carries along the handles P—P′ to change the resistance N—N′ and $N—N^2$. Wheel D^2 having made up its retardation by the increase of speed of the phonograph, contact C^3 comes back to the insulating part D^5 or D^6, the low tension current is no longer sent to magnets J, I, and H and their armatures reassume the position shown in the drawing, which prevents the current from being any longer sent to motor B^5 or motor O thus leaving the hands P—P′ in the position in which they were brought, the current is again sent to sectors $P^2—P^3$ and the whole operates as originally, with the only exception that the hands P—P′ have modified the resistances traversed by the currents feeding motors A^7 and B^5. If on the contrary the synchronism is broken by an advance of the phonograph, the brush C^3 will come to sector D^4, the current will then pass through brush D^8 to the magnets E, F, and G which will attract their respective armatures E′, F′ and G′. The armature G′ having released contact 5, the current passes no longer to sector P^3, but coming to N will have to traverse the entire resistance $N—N^2$ in order to pass out at N^2, the motor B^5 will consequently receive a weaker current and will rotate at less speed. The armature G′ striking contact 6 the current will be passed directly to motor A^7 through wires c^3 and c^4, this current having no resistance to traverse will be of higher intensity and will cause motor A^7 to rotate at higher speed so as to enable the kinematograph to make up its retardation. The armature F′ striking contact 4 a current will be sent through wire b^3 and wire b^4 to brush O^2 of motor O, this current traverses the armature and passes out through brush O to go through wire a^3 to contact 2, said current will traverse armature E′ and will pass through wire O^3 to the field of motor O, traverse said field and return to the source of energy through wire O^4.

It will be noted that the current sent to motor O through contact 4 has a direction contrary to that of the current sent through contact 8, and that in both cases the current sent into the field of said motor O flows always in the same direction. The motor O will thus rotate in a direction opposite to that above described and will rotate shaft S in opposite direction, thus changing the position of the hands P—P′ on their resistances. When the kinematograph has made up its retardation, brush C^3 has come back to one of the insulating parts D^5 or D^6 of wheel D^2 the current is no longer passed into magnets E, F, G, and their armatures reassume the position shown in the drawing, motor O will not receive any further current and will stop, leaving the hands P—P′ in the position in which they have been brought; motors A^7 and B^5 will take up the current which will pass through the resistances as modified by the position of the hands P—P′.

If for any reason it should be desired to stop the synchronization apparatus but to continue to operate the motors A^7 and B^5 it is only necessary to place the hand X on the contact X′, the cam X^3 will release pedal X^4 which will be raised and will thus break the current at contact X^5, and cams A′ and B′ will not receive any current and the entire synchronizing apparatus will thus be stopped. If the entire apparatus is to be stopped it is only necessary to place hand X between the two contacts X′ and X^2 as shown in the drawing or to open the three pole interrupter T^2.

If the magnet D alone is to be thrown out of operation, it is only necessary to push handle Y between the contacts Y′ and Y^2, as shown in the drawing, the cam Y^3 will then release pedal Y^4 which when raised breaks the current at contact Y^5.

It is often desirable to drive the phonograph by means of a clock spring instead of by a motor; in this case it is only necessary to provide an interrupter R^3 which allows of the breaking of the current passing to the motor B^5 driving the phonograph. The interrupter being open the magnet J is inoperative and also contact 5, sector P^3, hand P′, resistance N—N^2 and contact 12, while the balance of the mechanism heretofore described is operated as described, it being well understood that the shaft of the phonograph is provided with cam B′ which transmits the current to magnet D. The apparatus as described may thus be operated at will either by the motors A^7 and B^5 or by motor A^7 and the phonograph by a spring; but it is also possible to construct the apparatus so that the phonograph can only be operated by a spring. In this case the magnet J, contact 5, sector P^3 and its hand P′ can be dispensed with; the current instead of entering at N could enter at N^2 and the hand P under the impulse of motor O, could then travel over the entire resistance N′ N^2 which should be graduated accordingly. In this case it is necessary to provide an additional magnet B^4 actuating a brake designed to start the phonograph at the moment desired by the operator. This brake holds the disk of the phonograph from rotating so long as the current does not pass into magnet B^4. This electromagnet receives its current by a branch from wire *i* which sends its current to cam B′; the return of this current passing through wire *n*.

If it is desired to cut out magnet D although the phonograph operates, it is only necessary to push hand Y into contact Y′, the current can then actuate magnet B^4 which actuating the brake, will allow the disk of the phonograph to rotate, but as cam Y^3 no longer holds down pedal Y^4, magnet D will be cut out. By placing hand Y between contacts Y′ and Y^2 it is possible to cut out magnets D and C.

For certain large kinematographs or if the phonograph is driven by a spring; in order to obtain a quick slowing up of the kinematograph, an electrically operated brake may be used. Such brake is preferably constructed as follows: A red copper disk A^{11} is mounted upon the shaft of motor A^7, said disk being rotated between the two poles of electromagnet A^{12}. This device operates as follows:—As soon as the kinematograph becomes fast, brush C^3 will strike sector D^3 of wheel D^2, and a current will be sent into magnets J, I, and H, armature J′ will strike a special contact 13 and will send the current through wire A^{14} into magnet A^{12}, disk A^{11} will then be submitted to a resistance owing to the actuation of magnet A^{12} and when the synchronism shall be restored, the current will no longer pass into magnets J, I and H the current will also be broken at contact 13, and the disk can freely rotate between the poles of magnets A^{12}. An interrupter R^4 is provided so as to allow the brake to be cut out.

What we claim is:—

1. In a synchronizing device, a pair of wheels mounted opposite each other on separate shafts, one of the wheels having on its opposite face conducting sectors separated from the wheel and from each other by insulating material, the other wheel carrying a flexible brush contacting when the wheels are in unison with the insulation between the sectors, electromagnets actuating the wheels, cams mounted on the driving shafts of the devices to be synchronized and making at predetermined intervals electric contact with the terminals of the electromagnets, in combination with a circuit including a source of electric energy, the flexible brush and the sectors.

2. In a synchronizing device, a pair of wheels mounted opposite each other on separate shafts, one of the wheels having on its opposing face conducting sectors separated from the wheel and from each other by insulating material, the other wheel carrying a flexible brush contacting when the wheels are in unison with the insulation between the sectors, electromagnets controlling the wheels, a low tension electric source actuating the magnets, cams mounted on the driving shafts of the devices to be synchronized and contacting at predetermined intervals with the terminals of the electromagnets, a circuit connecting the flexible brush and the sectors to a series of relays, a high tension circuit including the armatures of these relays, in combination with an adjustable automatically operated resistance, and a motor included in the high tension circuit and operating the resistance.

3. In a synchronizing device, a pair of electrically actuated wheels facing each other and mounted on separate shafts, one of the wheels being provided on its opposing face with conducting sectors separated from the wheel and from each other by insulating material, the other wheel carrying a flexible brush resting when the wheels are in unison on the insulating material between the sectors, a source of electric energy, an electric circuit, a pair of electric motors operating the devices to be synchronized, a drum carrying a contact included in the electric circuit and displaceable about the axis of one of the motors, in combination with a cam mounted on the same axis and impinging at predetermined intervals the contact carried by the drum, as and for the purpose set forth.

4. In a synchronizing device, a pair of wheels electrically operated and mounted facing each other on separate shafts, one

of the wheels being provided with conducting sectors separated from the wheel and from each other by insulating material, the second wheel carrying a flexible brush resting when the wheels are in unison on the insulation between the sectors, a pair of collecting rings mounted on the shaft of the sector wheel, said rings being connected electrically one to each of said sectors, a collecting ring on the brush wheel shaft, an electric circuit including the driving motors, two sets of relays actuated respectively by the sectors according as the sector wheel outstrips or lags behind the brush wheel, a divided resistance included in the relay circuit and carrying two mutually insulated contact arms preadjusted to any desired angle relatively to each other and traversing the two parts of the divided resistance, in combination with a motor controlling the movement of the preadjusted resistance contact arms and thereby the amount of current sent to the driving motors.

5. In a synchronizing device, the combination of a pair of wheels operated step-by-step by means of a pair of electromagnets and mounted on separate shafts facing each other, one of the wheels carrying on its opposing face two conducting sectors separated from the wheel and from each other by insulating material, the other wheel carrying a flexible brush included in the same electric circuit as the sector, two collecting rings on the sector wheel shaft connected electrically each with one of the sectors, a pair of driving motors, a cam mounted on the motor shaft and impinging a contact controlling the step-by-step movement of the wheels, in combination with a series of relays and an electric brake mounted on one of the motor driving shafts and controlling automatically the speed of rotation of the same.

FERNAND EMILE AUGUSTE MATHELOT.
HENRI GEORGES GENTILHOMME.

In presence of—
H. C. COXE,
CHARLES MERVILLE.