PATENT SPECIFICATION

Application Date: March 5, 1930. No. 7247/30. **349,977**

Complete Left: Nov. 5, 1930.

Complete Accepted: June 5, 1931.

PROVISIONAL SPECIFICATION.

Improvements in or relating to Radio Beacons.

We, MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, a company organised under the laws of Great Britain, of Marconi House, Strand, London, W.C. 2, and JOHN MAGARRY FURNIVAL, of "Buna," Selcroft Road, Purley, Surrey, and WILLIAM FREDERICK BUBB, of Great Tey, Elmwood Road, Mitcham, Surrey, both British subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to radio beacons, or, as they are sometimes termed, wireless lighthouses, and has for its object to provide a beacon of such nature as to be utilisable for purposes of direction finding by almost any known kind of radio receiver.

The invention is applicable to the general purposes of radio beacons, and will be found particularly advantageous for providing indications of course and bearing for aircraft and other mobile craft which may be equipped with only simple receiving sets.

According to this invention a radio beacon comprises means for emitting signals in two or more fixed directions in such manner that both signals are received with equal strength in a predetermined directional zone or zones, and means for emitting a rotating directional signal of predetermined speed and direction of rotation, said radio beacon transmitting a suitable predetermined signal combination to indicate the moment when it is passing through a known bearing.

Preferably the beacon is provided with means for emitting at regular intervals a non-directional identification sign.

Preferably also a common aerial system is employed for emitting all three forms of course or bearing indicating radiations.

The means for emitting signals in fixed directions, so as to give, what may be termed, an "equi-signal" course indication emission, may consist of means for emitting alternately two fields of equal strength, said fields being such as to give the customary "figure-of-eight" polar diagrams having their axes in fixed predetermined angular relationship. In this way zones of radiation are obtained such that at any point along these zones signals transmitted in either field will be received with equal intensity. In one method a letter of the Morse alphabet is repeatedly transmitted in each field, the letters being so chosen and the transmission so timed that the dots and dashes of one signal coincide with the short and long spaces in the other signal. For example, the two signals may be constituted by the Morse letters A and N. The resultant received signal obtained along any of the equi-signal zones will therefore be a continuous dash. One or more of these zones are arranged to fall along a predetermined course or courses, and may be utilised therefore by craft carrying a suitable receiving apparatus to give an indication of the craft's adherence to or deviation from an equi-signal course.

The means for giving the rotating beacon effect may comprise means for emitting a field giving the usual cardioid or figure-of-eight polar diagram, means for rotating said field at a predetermined uniform speed and direction, and means for transmitting a predetermined signal so as to indicate the moment at which the axis of said field passes through a known direction, e.g. north and south.

It will be seen that by means of such a rotating beacon, the bearing of a receiver in relation to the transmitter can be calculated from the period of time elapsing between the moment at which this predetermined signal is received and the moment at which the line of minimum field strength passes across the receiver.

The invention is illustrated in the accompanying schematic drawing, which shows one form of transmitting station in accordance therewith.

Referring to the drawing, the station comprises a pair of loop aerials 1, 1*a*, arranged at right angles to one another in the usual way, and connected through the customary condensers 1^1. $1a^1$. to coils 2, which energise said loops and form the rotatable secondary coils of a radiogoniometer. In the figure. the rotatable portion of the radiogoniometer is schematically illustrated by an enclosing rectangle, shown in dotted lines, the rotating shaft

[*Price* 1/-]

being indicated by a dotted straight line drawn through the middle of one short side of the rectangle. The stator coils of the radiogoniometer are illustrated at 3 and 3*a*, and, as will be seen, they are fed with radio frequency energy from the plate circuits of a pair of thermionic magnifiers 4, 4*a*, whose grid circuits are controlled by magnetically operated keying relays 5, 5*a*. The lead K is connected to the oscillator (not shown) in the usual way. The relays 5, 5*a*, have their windings included in the circuits of magnetically operated two-pole change-over switches 19, 20. The switch 19, when energised, open-circuits one end of the winding of the keying relay 5, and connects the winding of the relay 5*a* so as to be under the control of a cam and contact device 16. When de-energised, the said change-over switch 19 connects the windings of relays 5 and 5*a* to the contacts of the second change-over switch 20. This change-over switch, when energised, places the windings of both relays 5 and 5*a* in parallel under the control of a " call sign " code wheel 8. When the switch 20 is de-energised, the winding of relay 5 is put under the control of a Morse signal wheel 7 (adapted, for example, to transmit the letter N in Morse code), while the winding of relay 5*a*, is put under the control of a second Morse code wheel 6 (adapted, for example, to transmit the Morse letter A). In these circumstances, an equi-signal transmission, as will be described later, will be obtained. The wheels 6, 7 and 8 are mounted on a common shaft and driven from a motor M.

9 is a worm wheel driven at constant speed by the motor M1, and adapted to make, for example, one revolution per minute. The wheel 9 carries a striker pin, as shown, which pin co-operates with the teeth of a twenty-tooth star wheel 10 so that said star wheel will complete one revolution in twenty minutes. On the shaft of the star wheel are mounted a " call-sign " cam 11, whose contacts, when closed, serve to energise the winding of the change-over switch 20, and a clutch cam 12 whose contacts, when closed, are adapted to energise the winding of a magnetic clutch 13 interposed on the shaft, shown in dotted lines, and leading from the worm wheel 9 to the rotatable portion of the radiogoniometer. On this shaft, and upon the side of the clutch adjacent the rotatable portion of the radiogoniometer, are mounted a striker wheel 14, a hold-on cam and contact device 15, and a code wheel and contact device 16, the last mentioned device being adapted to emit a train of signals during figure-of-eight transmissions. The striker wheel 14 co-operates with a ten-tooth star wheel 17, upon whose shaft is mounted a cam and contact device 18 whose contacts when closed energise the winding of the change-over switch 19.

The operation of the device is as follows :—

Suppose the apparatus to be in the position shown in figure 1. In this position the contact at 11 has just closed, energising the winding at 20, so that relays 5, 5*a* are being " keyed " under the control of the call-sign wheel 8. The contacts of the clutch cam 12 and the hold-on cam 15 have just been opened, with the result that the clutch 13 is de-energised, and the rotatable portion of the radiogoniometer, together with members 14, 15, 16, 17 and 18, are stationary. The contact at 18 is open and the winding of the switch 19 de-energised.

It will thus be seen that both magnifiers 4 and 4*a* are simultaneously energising the loops 1 and 1*a*, and an approximately non-direction call-sign is therefore being transmitted under the control of the call-sign wheel 8. After five minutes the cam 11 will have been rotated to open its contacts, and in consequence, to de-energise the switch 20. As a result, the relays 5, 5*a* are put under the control of the signal-wheels 7 and 6 respectively, said wheels being so disposed as to transmit the Morse letters A and N in such timed relationship as to give stationary equi-signal zones from the aerials 1, 1*a*. At the end of a further five minutes, cam 12 closes its contacts, thus energising the winding of the clutch 13 and occasioning rotation of the shaft carrying the members 2, 14, 15 and 16. As soon as rotation of this shaft commences, the cam 15 closes its contact which serves to hold-on the winding of the clutch 13. The equi-signal zones are now rotated through space at one revolution per minute (this being the speed of the worm wheel 9) by virtue of the movement of the coils 2 with respect to the coils 3 and 3*a*. During this period, the striker on the member 14 rotates the wheel 17 which in turn rotates the cam 18 through 180°. At the end of a further five minutes, the contacts at 18 are closed, and the winding of switch 19 energised. This de-energises relay 5, and thus cuts off the input to the magnifier 4 at the same time connecting the relay 5*a* associated with the magnifier 4*a* so that it is under the control of the code wheel and contact device 16. This code wheel revolves with the rotatable portion of the radiogoniometer and transmits a predetermined train of signals, each time the " phantom loop " emitted by the aerial

system passes through a predetermined bearing. During the last or tenth revolution of the radiogoniometer shaft, the clutch contacts at 12 open, and on the completion of that revolution, the hold-on contacts at 15 also open, thus de-energising the clutch winding and causing the radiogoniometer to remain stationary at its initial position. At the same time the contacts at 18 are opened, and those at 11 are closed.

The apparatus has thus reached the same setting as it had at the beginning of the twenty minutes above described, and proceeds to repeat the cycle of operations.

Another method of transmitting a non-directional signal is to arrange for the relays to connect the loops together and to earth through a suitable coil.

Means for providing the whole sequence of four distinctive types of transmission i.e. non-directive, fixed, equi-signal, rotating equi-signal-rotating figure of eight diagrams have been described but by a suitable adjustment of cams and contacts any alteration desired may be made to this sequence in order to provide for the requirements of the particular service on which such a beacon can be employed.

Dated this 5th day of March, 1930.

CARPMAELS & RANSFORD,
Agents for the Applicants,
24, Southampton Buildings, London,
W.C. 2.

COMPLETE SPECIFICATION.

Improvements in or relating to Radio Beacons.

We, MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, a company organised under the laws of Great Britain, of Marconi House, Strand, London, W.C. 2, and JOHN MAGARRY FURNIVAL, of "Buna," Selcroft Road, Purley, Surrey, and WILLIAM FREDERICK BUBB, of Great Tey, Elmwood Road, Mitcham, Surrey, both British subjects, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to radio beacons, or, as they are sometimes termed, wireless lighthouses, and has for its object to provide a beacon of such nature as to be utilisable for purposes of direction finding by almost any known kind of radio receiver.

The invention is applicable to the general purposes of radio beacons, and will be found particularly advantageous for providing indications of course and bearing for aircraft and other mobile craft which may be equipped with only simple receiving sets.

According to this invention a radio beacon installation comprises a pair of mutually perpendicular fixed frames, means for energising said frames simultaneously to emit a call sign, means for energising said frames to emit stationary equi-signal zones, means for energising said frames to emit rotating equi-signal zones means for energising said frames to emit a rotating "phantom loop" and a predetermined train of signals each time said loop passes through a predetermined bearing and means for cyclically and successively rendering said various energising means operative for predetermined periods.

The means for emitting signals in fixed directions, so as to give, what may be termed, an "equi-signal" course indication emission, may consist of means for emitting alternately two fields of equal strength, said fields being such as to give the customary "figure-of-eight" polar diagrams having their axes in fixed predetermined angular relationship.

In this way zones of radiation are obtained such that at any point along these zones signals transmitted in either field will be received with equal intensity. In one method a letter of the Morse alphabet is repeatedly transmitted in each field, the letters being so chosen and the transmission so timed that the dots and dashes of one signal coincide with the short and long spaces in the other signal. For example, the two signals may be constituted by the Morse letters A and N. The resultant received signal obtained along any of the equi-signal zones will therefore be a continuous dash. One or more of these zones are arranged to fall along a predetermined course or courses, and may be utilised therefore by craft carrying a suitable receiving apparatus to give an indication of the craft's adherence to or deviation from an equi-signal course.

The means for giving the rotating beacon effect may comprise means for emitting a field giving the usual cardioid or figure-of-eight polar diagram, means for rotating said field at a predetermined uniform speed and direction, and means for transmitting a predetermined signal so as to indicate the moment at which the axis of said field passes through a

known direction, e.g. north and south.

It will be seen that by means of such a rotating beacon the bearing of a receiver in relation to the transmitter can be calculated from the period of time elapsing between the moment at which this predetermined signal is received and the moment at which the line of minimum field strength passes across the receiver.

The invention is illustrated in the schematic drawing accompanying the provisional specification, and also in figures 1—4 of the drawings accompanying the present specification.

Referring to the drawing accompanying the provisional specification which shows one form of transmitting station in accordance with the invention the station comprises a pair of loop aerials 1, 1*a*, arranged at right angles to one another in the usual way, and connected through the customary condensers 1^1, $1a^1$, to coils 2, which energise said loops and form the rotatable secondary coils of a radiogoniometer. In the figure, the rotatable portion of the radiogoniometer is schematically illustrated by an enclosing rectangle, shown in dotted lines, the rotating shaft being indicated by a dotted straight line drawn through the middle of one short side of the rectangle. The stator coils of the radiogoniometer are illustrated at 3 and 3*a*, and, as will be seen, they are fed with radio frequency energy from the plate circuits of a pair of thermionic magnifiers 4, 4*a*, whose grid circuits are controlled by magnetically operated keying relays 5, 5*a*. The lead K is connected to the oscillator (not shown) in the usual way. The relays 5, 5*a*, have their windings included in the circuits of magnetically operated two-pole change-over switches 19, 20. The switch 19, when energised, open-circuits one end of the winding of the keying relay 5, and connects the winding of the relay 5*a* so as to be under the control of a cam and contact device 16. When de-energised, the said change-over switch 19 connects the windings of relays 5 and 5*a* to the contacts of the second change-over switch 20. This change-over switch, when energised, places the windings of both relays 5 and 5*a* in parallel under the control of a "call sign" code wheel 8. When the switch 20 is de-energised, the winding of relay 5 is put under the control of a Morse signal wheel 7 (adapted, for example, to transmit the letter N in Morse code), while the winding of relay 5*a*, is put under the control of a second Morse code wheel 6 (adapted, for example, to transmit the Morse letter A). In these circumstances, an equi-signal transmission, as will be described later, will be obtained. The wheels 6, 7 and 8 are mounted on a common shaft and driven from a motor M.

9 is a worm wheel driven at constant speed by the motor M1, and adapted to make, for example, one revolution per minute. The wheel 9 carries a striker pin, as shown, which pin co-operates with the teeth of a twenty-tooth star wheel 10 so that said star wheel will complete one revolution in twenty minutes. On the shaft of the star wheel are mounted a "call-sign" cam 11, whose contacts, when closed, serve to energise the winding of the change-over switch 20, and a clutch cam 12 whose contacts, when closed, are adapted to energise the winding of a magnetic clutch 13 interposed on the shaft, shown in dotted lines, and leading from the worm wheel 9 to the rotatable portion of the radiogoniometer. On this shaft, and upon the side of the clutch adjacent the rotatable portion of the radiogoniometer, are mounted a striker wheel 14, a hold-on cam and contact device 15, and a code wheel and contact device 16, the last mentioned device being adapted to emit a train of signals during figure-of-eight transmissions. The striker wheel 14 co-operates with a ten-tooth star wheel 17, upon whose shaft is mounted a cam and contact device 18 whose contacts when closed energise the winding of the change-over switch 19.

The operation of the device is as follows:—

Suppose the apparatus to be in the position shown in the drawing accompanying the provision specification. In this position the contact at 11 has just closed, energising the winding at 20, so that relays 5, 5*a* are being "keyed" under the control of the call-sign wheel 8. The contacts of the clutch cam 12 and the hold-on cam 15 have just been opened, with the result that the clutch 13 is de-energised, and the rotatable portion of the radiogoniometer, together with members 14, 15, 16, 17 and 18, are stationary. The contact at 18 is open and the winding of the switch 19 de-energised.

It will thus be seen that both magnifiers 4 and 4*a* are simultaneously energising the loops 1 and 1*a*, and an approximately non-directional call-sign is therefore being transmitted under the control of the call-sign wheel 8. After five minutes the cam 11 will have been rotated to open its contacts, and in consequence, to de-energise the switch 20. As a result, the relays 5, 5*a* are put under the control of the signal-wheels 7 and 6 respectively, said wheels being so disposed as to transmit the Morse letters A and N in such timed relationship as to give stationary equi-signal zones

from the aerials 1, 1*a*. At the end of a further five minutes, cam 12 closes its contacts, thus energising the winding of the clutch 13 and occasioning rotation of the shaft carrying the members 2, 14, 15 and 16. As soon as rotation of this shaft commences, the cam 15 closes its contact which serves to hold-on the winding of the clutch 13. The equi-signal zones are now rotated through space at one revolution per minute (this being the speed of the worm wheel 9) by virtue of the movement of the coils 2 with respect to the coils 3 and 3*a*. During this period, the striker on the member 14 rotates the wheel 17 which in turn rotates the cam 18 through 180°. At the end of a further five minutes, the contacts at 18 are closed, and the winding of switch 19 energised. This de-energises relay 5, and thus cuts off the input to the magnifier 4 at the same time connecting the relay 5*a* associated with the magnifier 4*a* so that it is under the control of the code wheel and contact device 16. This code wheel revolves with the rotatable portion of the radiogoniometer and transmits a predetermined train of signals, each time the "phantom loop" emitted by the aerial system passes through a predetermined bearing. During the last or tenth revolution of the radiogoniometer shaft, the clutch contacts at 12 open, and on the completion of that revolution, the hold-on contacts at 15 also open, thus de-energising the clutch winding and causing the radiogoniometer to remain stationary at its initial position. At the same time the contacts at 18 are opened, and those at 11 are closed.

The apparatus has thus reached the same setting as it had at the beginning of the twenty minutes above described, and proceeds to repeat the cycle of operations.

The various positions of the cams 12, 11, and 18 at the commencement of each five minute period are shown in the accompanying figure 1. In this figure 1200, 1205, 1210 and 1215 indicate the positions of cam 12 at the beginning of the first, second, third and fourth five minute periods. Similarly 1100, 1105, 1110 and 1115 indicate the positions of the cam 11 at these times and 1800, 1805 1810 and 1815 indicate the positions of cam 18 at these times. Cams 12 and 11 rotate 90° in five minutes while cam 18 rotates 180° in five minutes.

The mechanical arrangements for driving the cams, radiogoniometer, etc., are shown in the accompanying Figures 2, 3, 4, the two latter figures being end views taken at right angles to figure 2 and at either end thereof. In figure 2 P is a pointer.

Another method of transmitting a non-directional signal is to arrange for the relays to connect the loops together and to earth through a suitable coil.

Means for providing the whole sequence of four distinctive types of transmission i.e. non-directive, fixed, equi-signal, rotating equi-signal-rotating figure of eight diagrams have been described but by a suitable adjustment of cams and contacts any alteration desired may be made to this sequence in order to provide for the requirements of the particular service on which such a beacon can be employed.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A radio beacon installation comprising a pair of mutually perpendicular fixed frames, means for energising said frames simultaneously to emit a call sign, means for energising said frames to emit stationary equi-signal zones, means for energising said frames to emit rotating equi-signal zones, means for energising said frames to emit a rotating "phantom loop" and a predetermined train of signals each time said loop passes through a predetermined bearing and means for cyclically and successively rendering said various energising means operative for predetermined periods substantially as described.

2. An installation as claimed in claim 1 and comprising a pair of mutually perpendicular fixed frames a radiogoniometer associated therewith, a clutch for putting the rotatable member of said radiogoniometer in driving connection with an electric motor or other source of power, a call sign code wheel and a pair of Morse signal wheels, a second motor or other source of power for driving these three wheels, a pair of keying relays associated each with one of the fixed frames, a code wheel and contact device adapted to be driven from said first mentioned motor or other device through said clutch, a pair of change over switches for associating said keying relays to be controlled by the different signalling devices at different times and a plurality of cam switch devices driven by said first mentioned motor or other device for closing the clutch and actuating the change-over switches so that the required signals are emitted during predetermined periods and in a pre-determined succession, substantially as described.

3. Radio beacon installations substantially as herein described and illustrated in the accompanying drawings.

Dated the 5th day of November, 1930.

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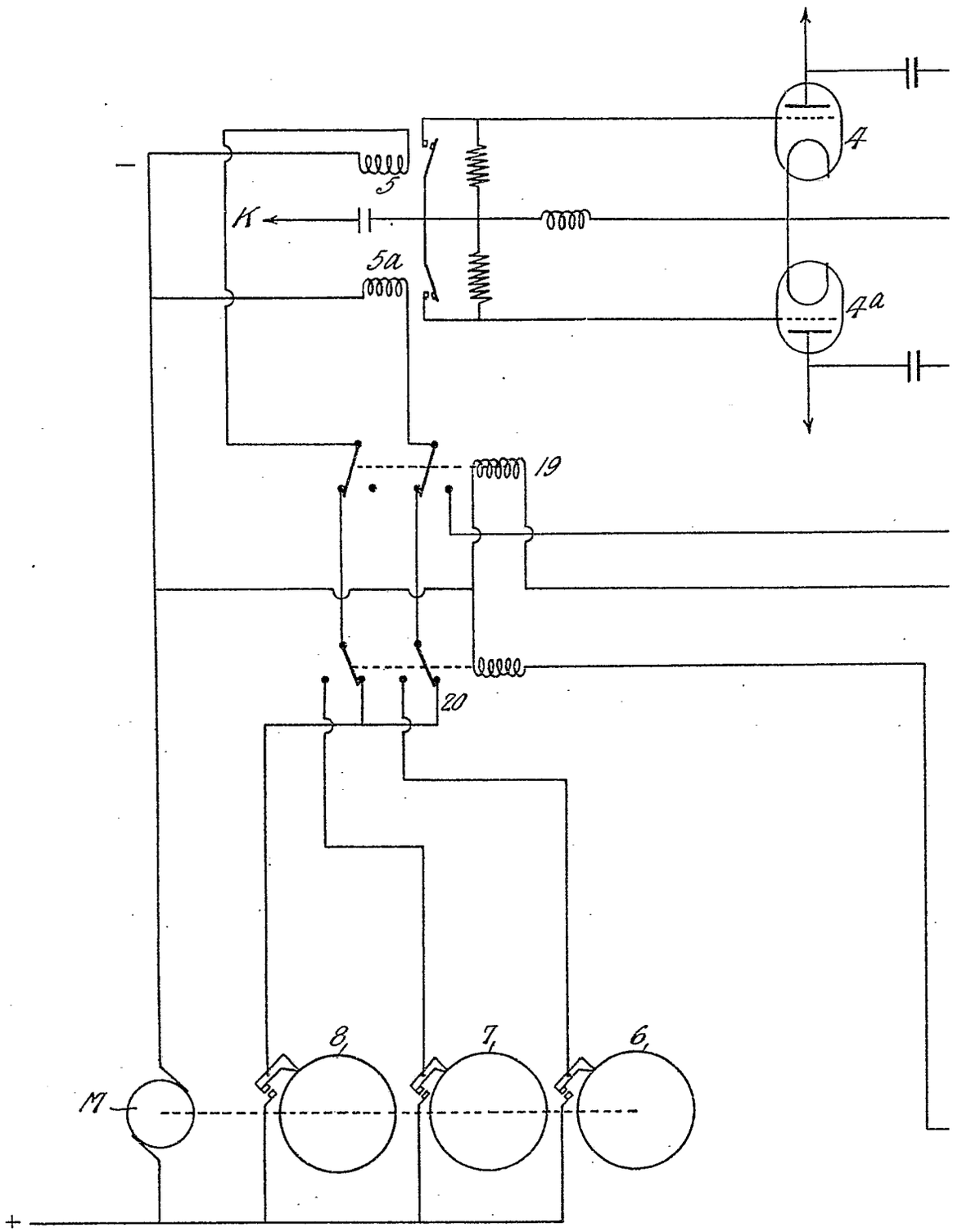
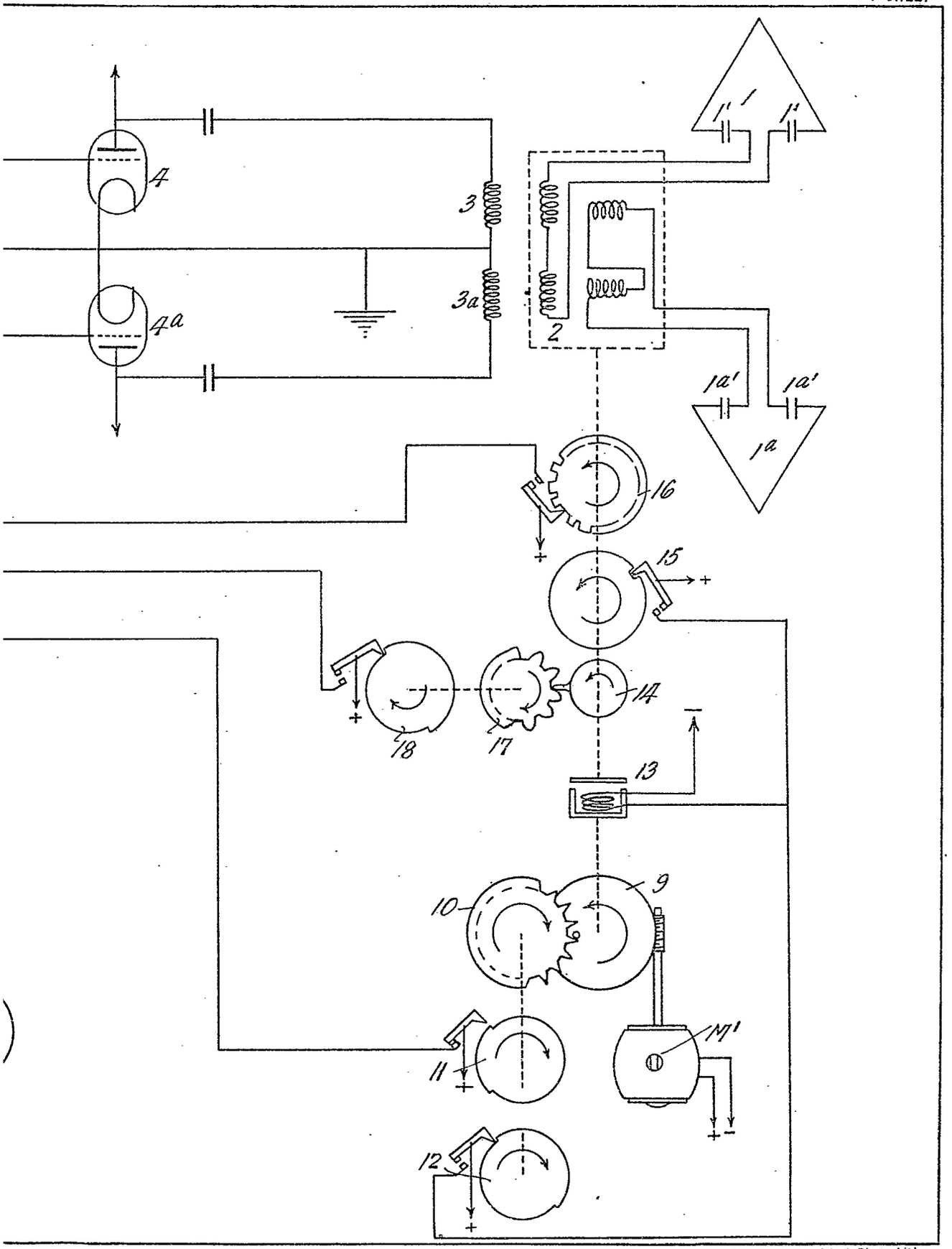
Agents for the Applicants,
24, Southampton Buildings, London,
W.C. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1931

[This Drawing is a reproduction of the Original on a reduced scale.]





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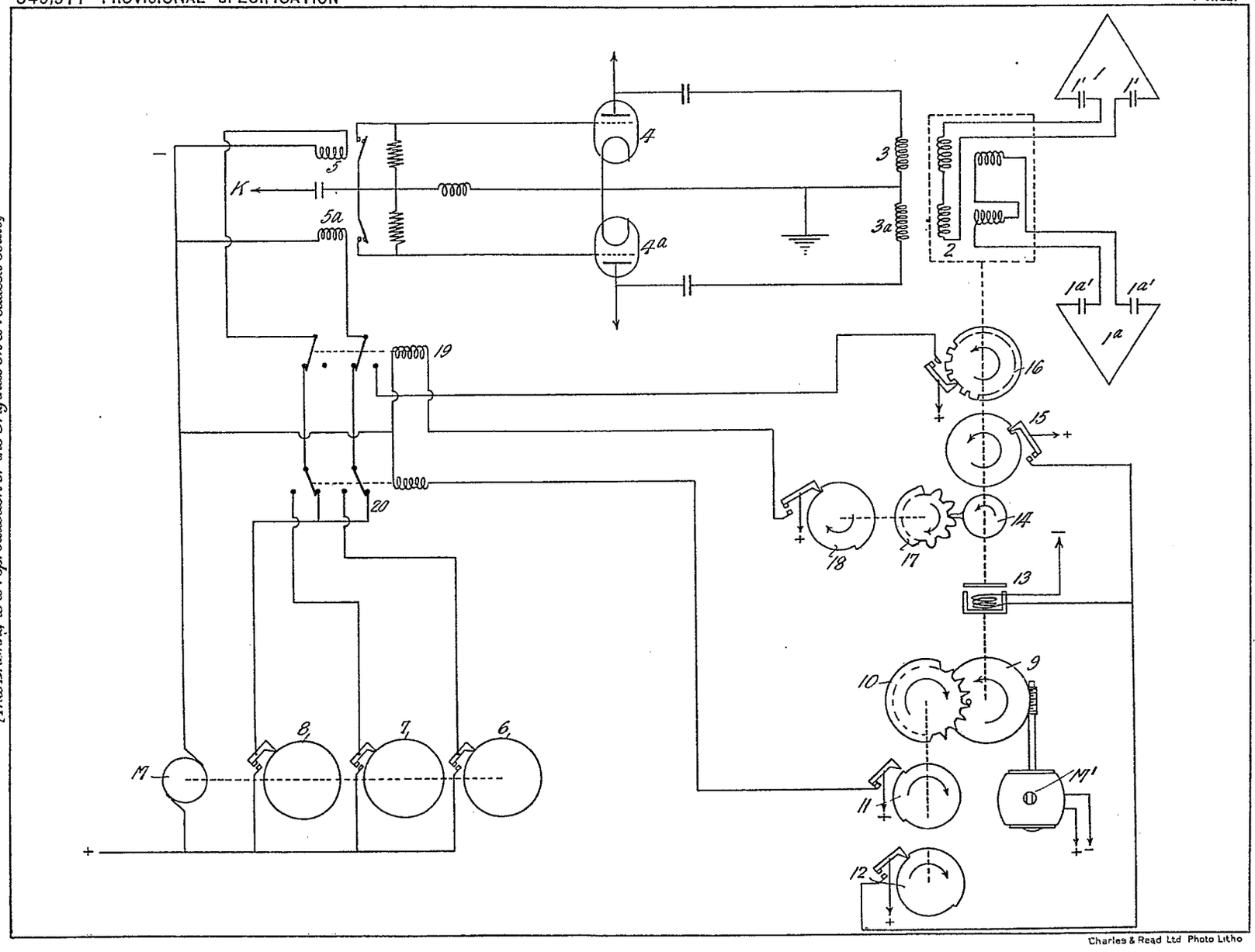

[This Drawing is a reproduction of the Original on a reduced scale.]

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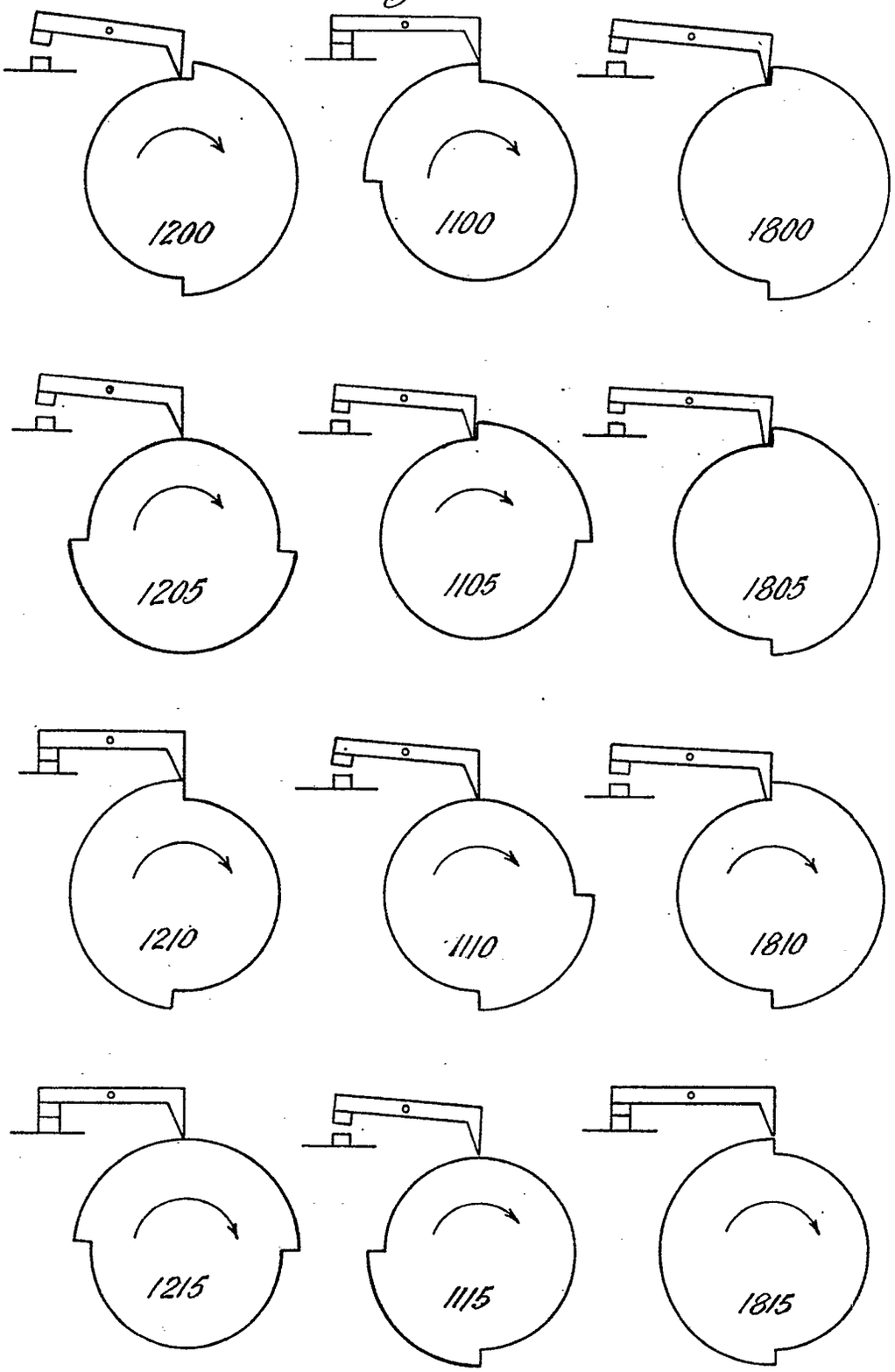
Fig. 1.



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1800

1805

1810

1815

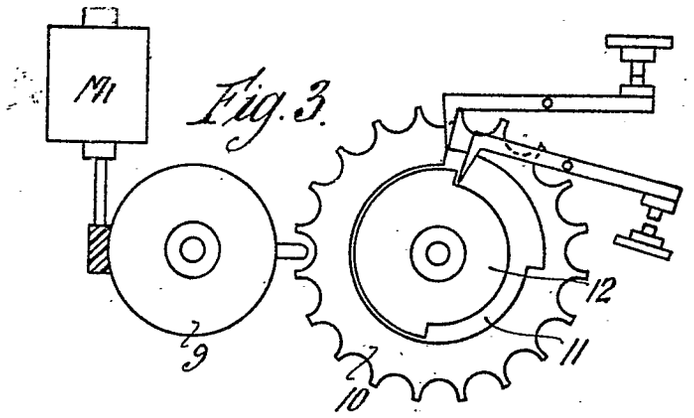

Fig. 3.

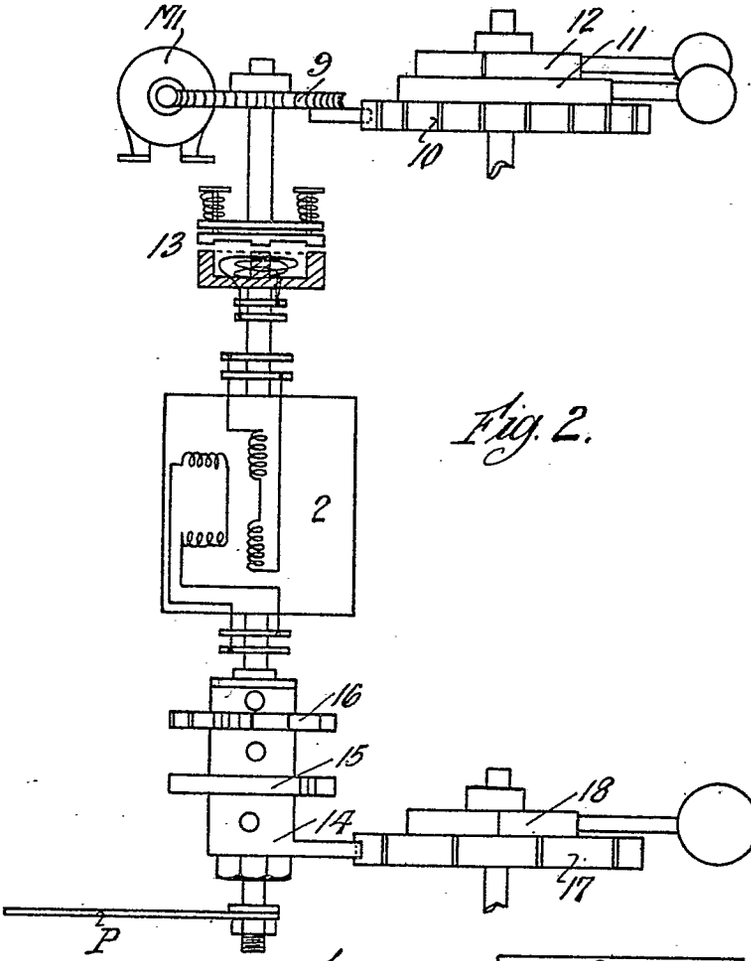

Fig. 2.

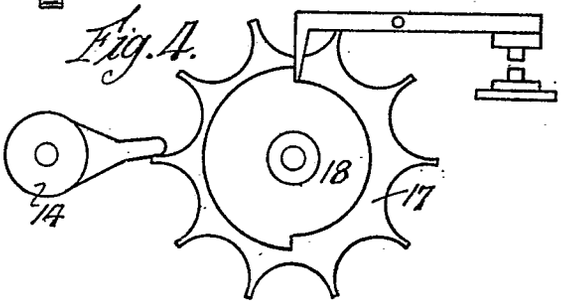

Fig. 4.

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Fig. 1.

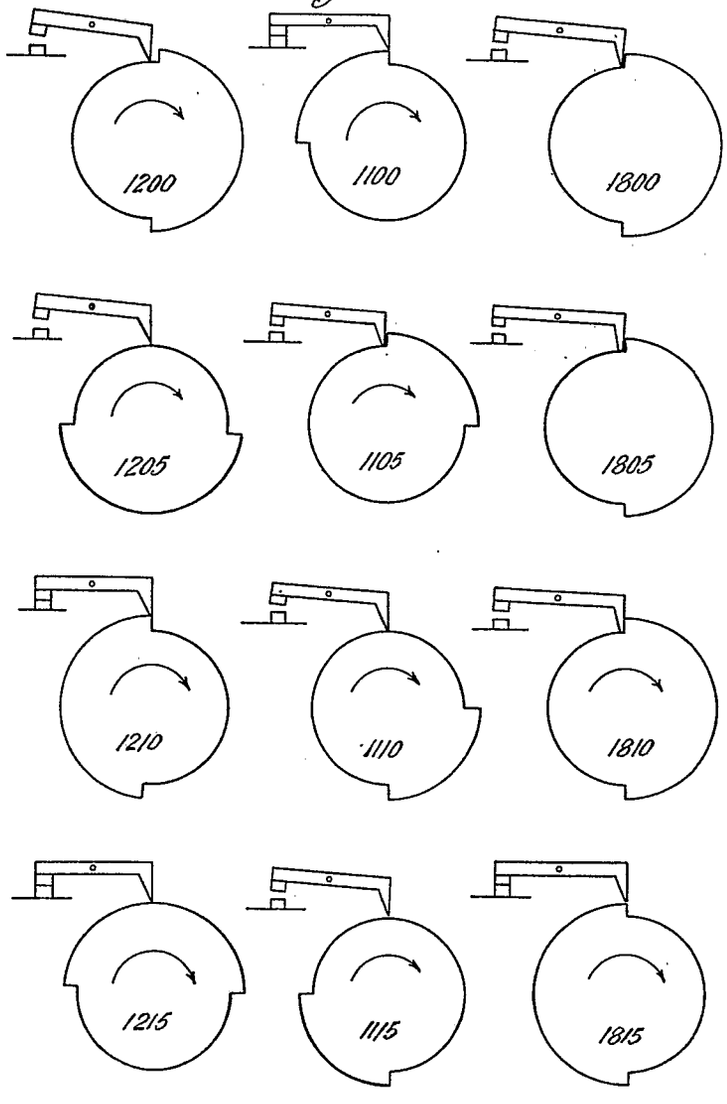
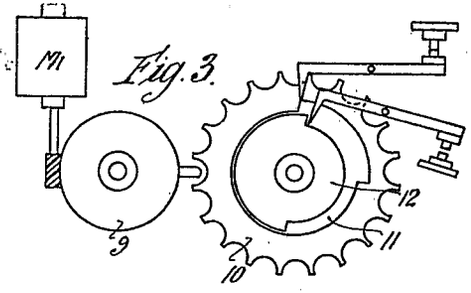
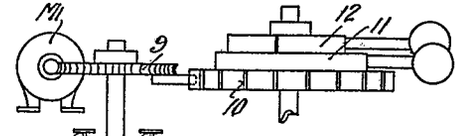


Fig. 3.





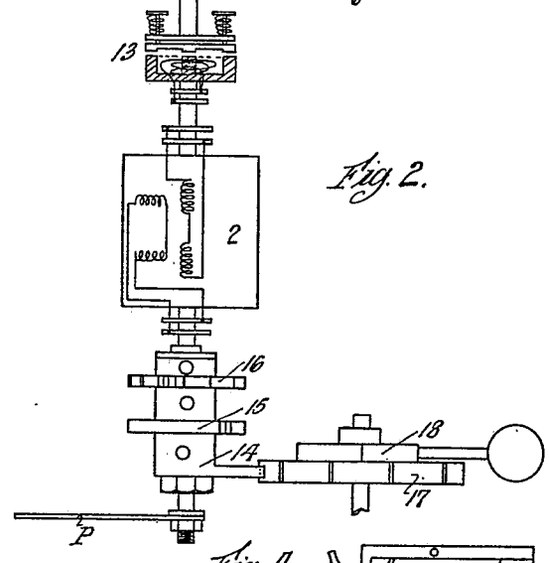
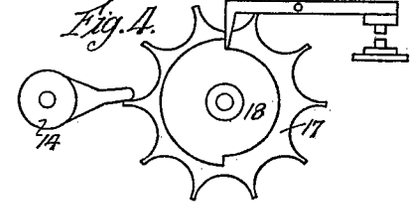


Fig. 2.

Fig. 4.



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