J. H. HALL.

PROGRESSIVE CUT-OUT MECHANISM.

APPLICATION FILED MAR. 18, 1908.

900,165.

Patented Oct. 6, 1908.

3 SHEETS—SHEET 1.

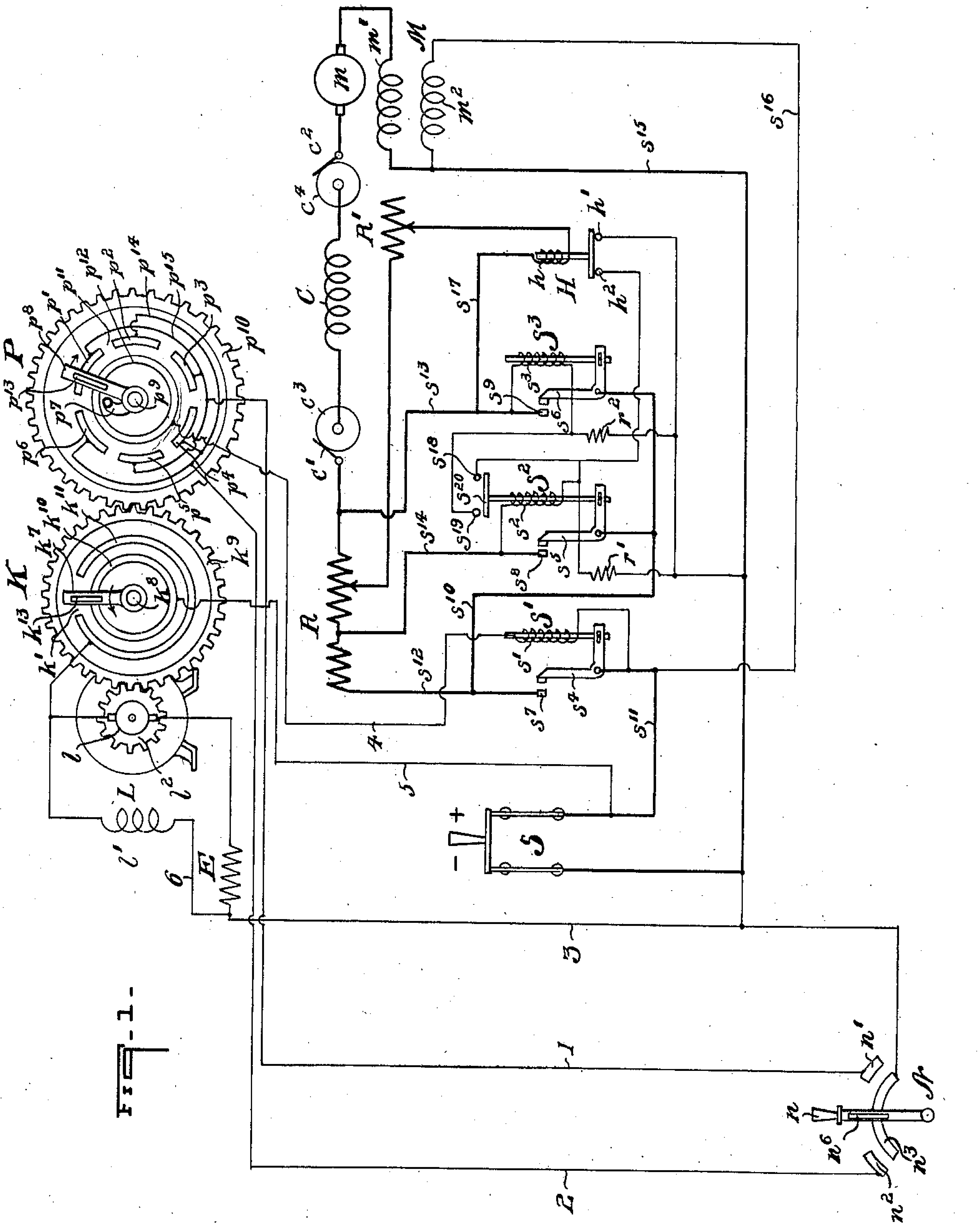

Fig-1-

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3 SHEETS—SHEET 2.

FIG. 2.

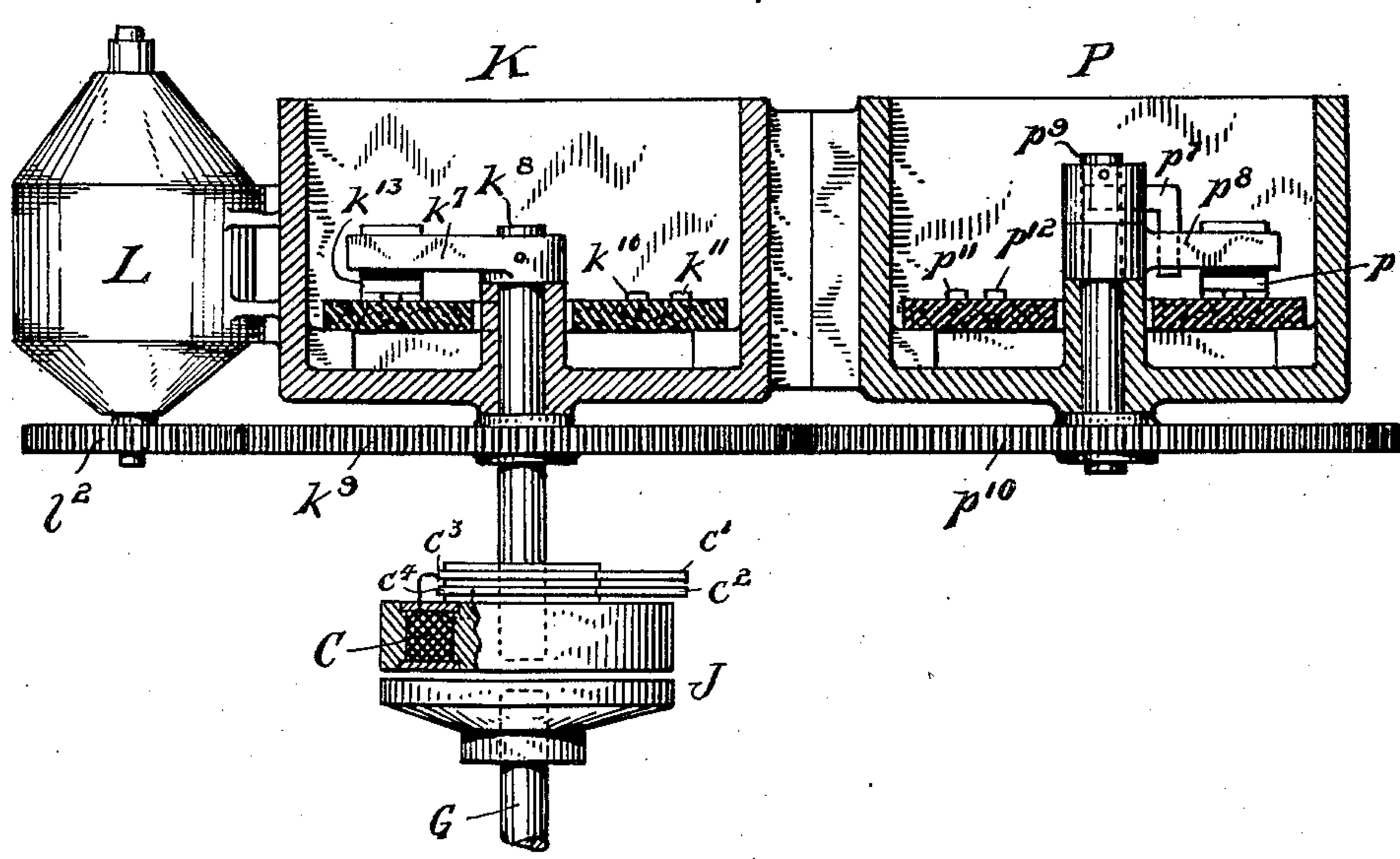
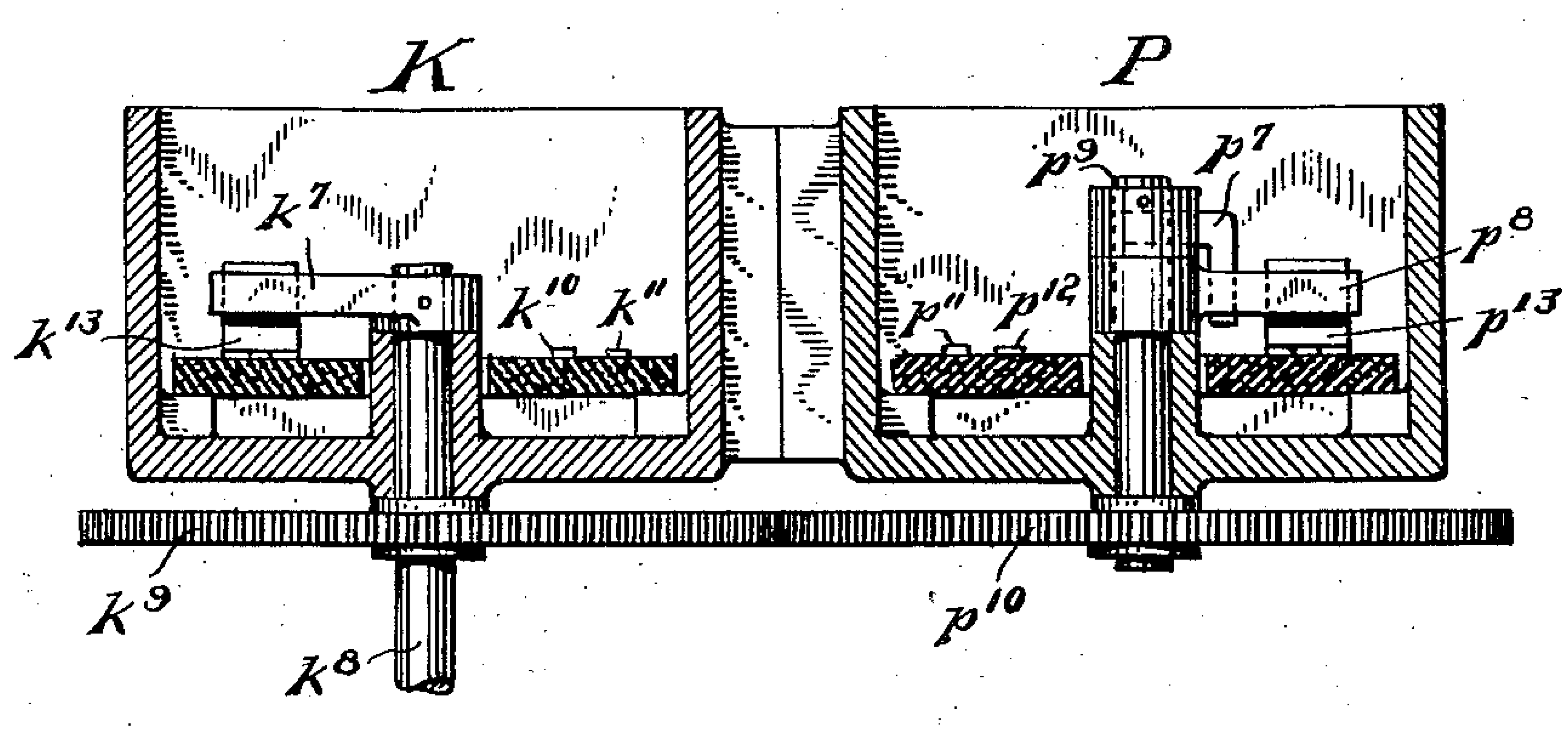


FIG. 4.



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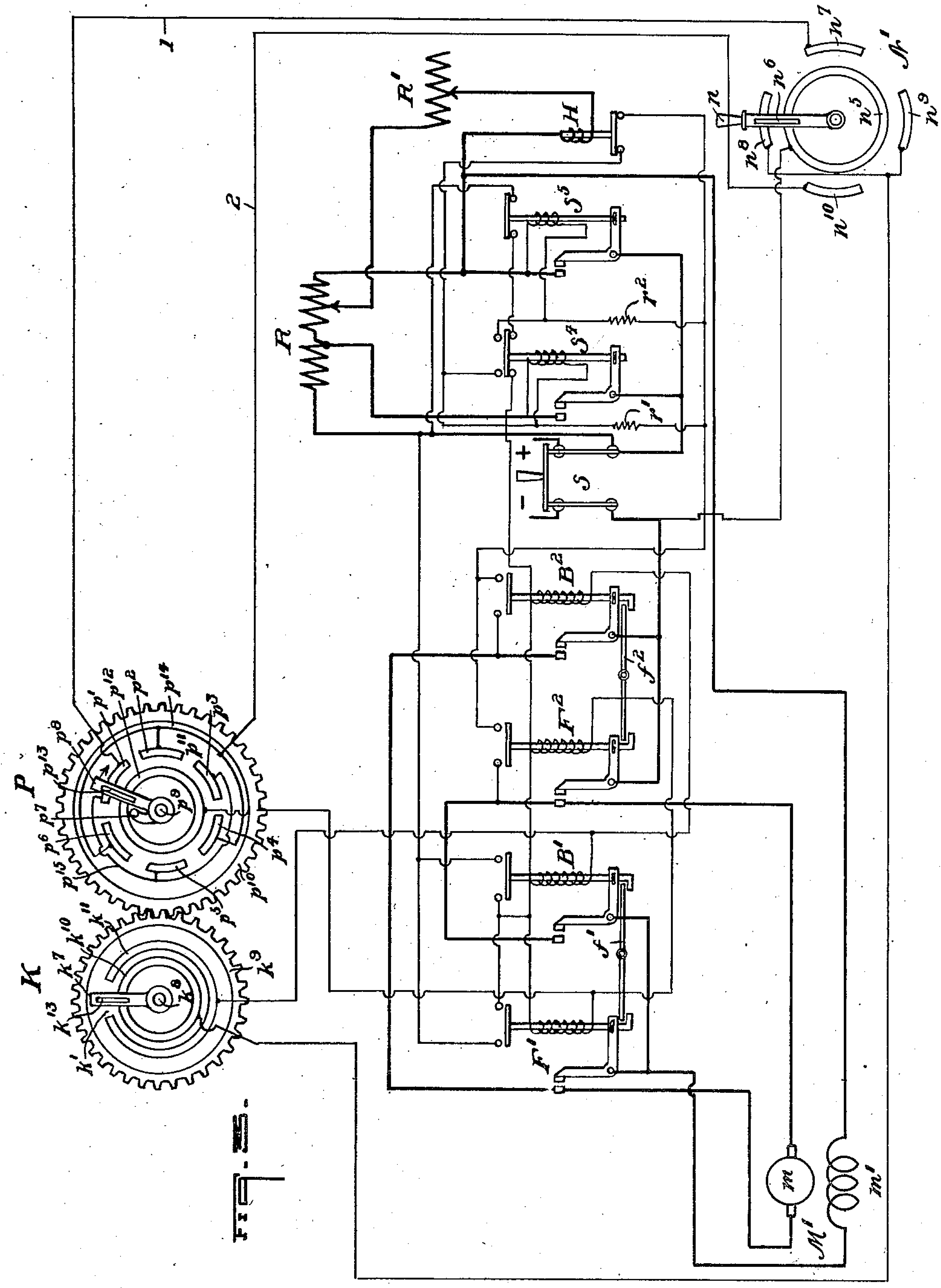

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PROGRESSIVE CUT-OUT MECHANISM.

No. 900,165. Specification of Letters Patent. Patented Oct. 6, 1908.

Application filed March 18, 1908. Serial No. 421,939.

To all whom it may concern:

Be it known that I, JAY H. HALL, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented or discovered new and useful Improvements in Progressive Cut-Out Mechanism, of which the following is a specification.

In order to provide a uniform distribution of the material charged into a blast furnace, the furnace top is sometimes so made that it can be revolved through a larger or smaller angle after each skip-load has been deposited upon the usual bell in the top. Such an angle of revolution can be selected that the successive charges may be discharged into the furnace at any desired number of degrees from adjacent charges. If the skip always dumps the material into the top at the zero point, the top may be revolved 85° and the material dropped into the furnace. The next skip-load is, after having been deposited in the bell, revolved 170° and dropped; the third is revolved 255° and dropped; the fourth is revolved 340° and dropped; and the fifth is revolved 425° and dropped. The latter will be 65° from the zero point. If this cycle is continued, each load being dropped 85° beyond the previous one there will be 72 skip-loads charged before the top will again stop at the zero position and begin to repeat the cycle. As each charge is deposited at 5° less than a quarter revolution, it is seen that there will be a space of 5° between the adjacent charges. If each angle of movement is 87° instead of 85°, the charges will be spaced 3° apart and there will be 120 movements or steps before a cycle is completed. Similarly, if the angle of movement is 89°, the charges will be spaced 1° apart and there will be 360 movements or steps before completing a cycle.

My invention is a device which will automatically stop a revolving mechanism so that any desired angle may be included between two successive stops.

I shall describe the device as used in connection with an electric controller operating a motor which drives the revolving mechanism of a blast furnace top. Its uses are not limited to a blast furnace top only but it may be applied to any mechanism moving through any given cycle.

Figure 1 is a diagrammatical representation of one form of my invention for use with a non-reversing motor; Fig. 2, a vertical section through the cut-out mechanism for use with the invention shown in Fig. 1; Fig. 3, a diagram of a second form of my invention for use with a reversing motor; and Fig. 4, a vertical section of the cut-out mechanism for use with the invention shown in Fig. 3.

Referring first to Figs. 1 and 2, S′, S^2, and S^3 represent a set of magnetically operated starting or acceleration switches, having the respective windings s', s^2, and s^3 for actuating the respective switch arms s^4, s^5, and s^6, arranged to engage with the fixed contacts s^7, s^8, and s^9, respectively. The fixed contact s^7 is connected by the wire s^{10} to the movable contacts s^5 and s^6. The movable contact s^4 is connected to the positive side of the main switch S by the wire s^{11}, and the fixed contacts s^7 and s^9 are connected by the wires s^{12} and s^{13} to opposite ends of the starting resistance R, its middle point being connected by the wire s^{14} to the fixed contact s^8.

M is a motor having its armature m in series with the series field winding m' connected to the negative side of the main switch S by the wire s^{15}. I also provide the shunt winding m^2 bridged across the mains between the wire s^{15} and the wire s^{11} by means of the wire s^{16}. The remaining end of the armature winding is connected to the negative end of the resistance R through the winding C of the magnetic clutch J, the ends of the winding C being joined by the brushes c' and c^2 to the rings c^3 and c^4 on the hub of the clutch (Fig. 2).

I provide the throttle H, actuated by the winding h, bridged by the wire s^{17} on the wire s^{13} and the variable resistance R′, which has one end connected to the resistance R by a movable connection, these features being shown and described in A. C. Eastwood's patent, No. 867,810, granted October 8, 1907. The auxiliary contact h' of the throttle H is connected through the resistances r' and r^2 to the lower ends of the windings s^2 and s^3 and also to the wire s^{15}. The lower end of the winding s^2 is also connected to the auxiliary contact h^2 and the auxiliary contact s^{18}, while the lower end of the winding s^3 is connected to the auxiliary contact s^{19}, the contacts s^{18} and s^{19} being closed by the auxiliary switch s^{20}, when the switch S^2 is closed. The upper ends of the windings s^2 and s^3 are connected respectively, to the wires s^{14} and s^{13}.

K and P represent sections of my cut-out mechanism, the parts of the section K being represented by the small letter k with exponents, and the parts of the section P by the small letter p with exponents.

k^8 represents a shaft connected to that portion of the magnetic clutch J which contains the coil C and the rings c^3 and c^4. The top of the shaft k^8 has pinned thereon the arm k^7 which carries the brush k^{13} arranged to contact with the two concentric contacts k^{10} and k^{11}, the former being a complete ring and the latter being broken or interrupted at the point k'.

p^9 is a shaft parallel to the shaft k^8, the two said shafts being connected together by the spur-gears k^9 and p^{10} or by any other suitable transmission mechanism. The shaft has loosely mounted thereon the arm p^8 carrying the insulated brush p^{13}, arranged to connect together the concentric contacts p^{11} and p^{12}, the former being broken into six equal sections p' to p^6, the sections being separated slightly but alternately electrically connected by the wires p^{14} and p^{15} so placed as not to be engaged by the brush p^{13}. The contact p^{12} is a complete ring. The shaft p^9 has the arm p^7 secured thereto by a pin, the arm having thereon a pendent portion arranged behind the arm p^8 to drive the latter from left to right. The armature l, of the motor L is connected to the gear k^9 by the pinion 12 on the said shaft. The upper end of the winding s' is connected by the wire 4 to the contact p^{12} and the positive side of the switch S is connected by the wire 5 to the contacts k^{10}. The wire 3 is connected by the wire 6 through the field winding l' of the motor L to the contact k^{11} and the remaining end of the armature l', the resistance E being between the armature and the junction of the wires 3 and 6'. The long stationary contact strip n^3 of the master controller N is connected to the wire 3, which is connected to the negative side of the switch S. The contact n' of the master controller N is connected by the wire 1 to the wire p^{15}, and the contact n^2 is connected by the wire 2 to the wire p^{14}. The arm or handle n of the controller has the brush n^6 arranged to connect the strip n^3 to the strip n' or n^2.

G is a shaft which carries the second member of the magnetic clutch J and is connected at its lower end to any mechanism which angular or other movement it is desired to control according to the principles hereinbefore stated or according to principles derivable therefrom. I may for the sake of definiteness assume that the shaft G is connected to a furnace top rotatable by the motor M so as to give the shaft and furnace top the same angular movement; that is, the same number of revolutions per minute.

The arrangement of the wiring shown on Fig. 1 is for a non-reversing controller, since each move of the driving motor is always in the same direction. If the arm n be moved to bring the brush n^6 on the contact n', the following circuit will exist: from the positive main through the wire s^{11}, the winding s', the wire 4, the contact p^{12}, the brush p^{13}, the contact p', the wires 15 and 1, the contact n', the brush n^6, and the contact n^3 to the negative main. The energization of the winding s' closes the switch S' and the motor circuit as follows: from the positive main through the wire s^{11}, movable and fixed contacts s^4 and s^7, the wire s^{12}, all of the resistance R, the clutch winding C, the armature m of the motor M, the series field m', and the wire s^{15} to the negative main. This circuit causes the rotation of the motor M and consequently of the shaft G. As the circuit of the clutch winding C is also closed the shaft k^8 will be caused to rotate with the shaft G.

As soon as the speed of the motor is such as to make it safe to cut-out the first section of the resistance R (which will not be until the current through the winding h permits the contacts h' and h^2 to be closed), a circuit is set up from the resistance R through the wire s^{14}, the winding s^2, the contacts h^2 and h', and the wire s^{15} to the negative main. This circuit closes the switch S^2 and causes the first section of the resistance R to be shunted through the wire s^{10}, the contacts s^5 and s^8, and the wire s^{14} to the second section of the said resistance. As the winding s^2 is in the circuit of the contact h' and h^2 as the throttle H may be lifted as soon as the switch S^2 has been closed, the winding s^2 is still kept energized by the small current flowing through the resistance r', which is so adjusted as not to short-circuit the winding s^2 but to permit enough current to flow through it to hold the switch S^2 closed, though never permitting enough current to pass to close the switch when open. The switch S^3 is closed when the motor current is so reduced as to permit the throttle to bridge the contacts h' and h^2 again. The resistance r^2 performs the service for the switch S^3 that the resistance r' serves for the switch S^2.

As the shaft k^8 rotates in the direction of the arrow, the brush k^{13} soon bridges the contacts k^{10} and k^{11}, thus closing the circuit of the field coil l' and armature l through the wires 3 and 5. The motor is arranged to tend to rotate the shaft k^8 oppositely to the direction of the arrow, but is over-powered by the motor M. As the arm k^7 travels, the arm p^7 drives the arm p^8 until the brush p^{13} is brought over the gap between the sections p' and p^2 of the contact p^{11}, at which time the winding s' becomes deënergized and the switch S′ opens. The switches S^2 and S^3 also open their contacts immediately.

As the clutch winding C has also been deënergized, the shaft p^8 and the gears k^9, p^{10}, and 12 will be no longer driven by the shaft G, but will be driven in the reverse direction by the motor L which is now free to rotate its armature. The motor L operates until it returns the arms k^7 and p^7 to the positions shown in Fig. 1, where the circuits of the field coil l' and the armature l of the motor L are opened, causing the said motor to stop. The torque of the motor L need be only large enough to turn the moving parts of the sections P and K backwardly as just described. The clutch must be of a capacity to drive the sections P and K and rotate the motor L against its torque.

There being six equal gaps in the contact ring p^{11}, they are 60° apart. If the gears p^{10} and k^9 have 85 and 60 teeth, respectively, it is clear that when the arm p^8 moves 60° or to the gap between the sections p' and p^2 of the contact p^{11}, the arm k^7 will move 85°. The inertia of the moving mechanism causes the arm p^8 to drift to the section p^2 of the contact p^{11}, but until the controller arm is brought to the contact n^2, the winding s' cannot be energized, because the contact p^2 is in circuit with the contact n^2 and not with the contact n'. If the brush p^{13} is wide enough to bridge the gap, s' will be deënergized as soon as p^{13} leaves p'. No inertia drift is necessary.

The furnace top, having been revolved 85°, is in position to be discharged by the lowering of the usual bell. A fresh charge having been placed in the furnace top after the bell has been raised, the controller arm n is moved so as to bring the brush n^3 on the contact n^2. The motor M and the cut-out sections K and P will be rotated as before. The motor M will operate till the arm p^7 pushes the arm p^8 to the gap between the sections p^2 and p^3, whereupon the winding s' becomes deënergized, the switches S′ to S^3 open, the motor M stops, the clutch J is deënergized, the arm p^8 drifts on to the section p^3 and the motor L returns the arms k^7 and p^7 to their original positions, leaving the arm p^8 behind. The shaft k^8, and therefore the furnace top, has during this second step of revolution turned 170°. The second charge is at the end of this step dropped into the furnace and a new charge deposited in the furnace top. The controller arm n is again moved onto the contact n', causing a repetition of the two steps above described except that the furnace top will rotate 255° before the arm p^8 comes to the gap between the sections p^3 and p^4 on the contact ring p^{11}. The operations are repeated *ad libitum*, the furnace top or other rotary mechanism rotating 85° further during each step than it rotated during the next preceding step; that is, each successive operation automatically stops the furnace top or its equivalent at a point 85° in advance of the previous step. Seventy-two operations will make a complete cycle and a stop will have been made at each 5° point about the circle. By changing the number of teeth in gear p^{10} to 87, the successive stops will be 87° apart and it will require 120 stops to complete a cycle, a stop being made at each 3° point about the circle. Similarly, if the gear p^{10} has 89 teeth, it will take 360 stops to complete a cycle, a stop being made at each degree point. By properly changing the relative number of teeth in the gears p^{10} and k^9, any desired arrangement of stops may be obtained. The number of gaps in the contact rings p^{11} and k^{11} may be changed to suit various conditions. Gaps in the rings p^{12} and k^{10} may also be made to alter the arrangement of the stops. The motor L is merely a torque device and may be replaced by other means operated by gravity, or a spring, or other force.

Fig. 3 does not differ from Fig. 1 except that the motor L and clutch J have been omitted and the control system has been adapted to a reversing motor. It may be supposed that the motor M drives a revolving ore-bucket whose cycle of motions is as follows: Starting from the zero position, the bucket must move forward 85°, stop, return to the zero position, and stop. In the second forward movement, the bucket must move 170°, stop, return to the zero position, and stop. Similarly each successive forward movement proceeds 85° in advance of the previous movement, to be followed by a return to the zero position.

In Figs. 3 and 4, the cut-out mechanism K and P are the same as in Figs. 1 and 2. F′ and F^2 are a pair of magnetically operated switches for giving a forward rotation of the motor M′ and B′ and B^2 are similar switches for giving said motor a backward rotation. S^4 and S^5 are magnetically operated switches for accelerating the motor in a well-known manner. The pairs of switches F′, B′ and F^2, B^2 are connected by the well-known interlocking bars f' and f^2. H is the throttle or relay for controlling the switches S^4 and S^5.

To describe the operation, suppose that the switch S is closed and all other parts of the apparatus are in the position as shown on Fig. 3, and the ore bucket, which is to be revolved, is at the zero position. Since the shaft k^8 makes the same number of revolutions per minute as the ore bucket, the arm k^7 will have the same rotary movement as the ore bucket. Therefore, only the movement of the cut-out arm k^7 will be considered in this description. The zero position is that shown on Fig. 3. The master switch arm n always moves in a clockwise direction over the fixed contacts n^7, n^8, n^9, and n^{10}. The contacts p', p^3, and p^5 are connected to the master-controller contact n^7, and the contacts p^2, p^4, and p^6 are connected to the master controller contact n^{10}. The contact k^{10} is connected to the contacts n^8 and n^9. The contact k^{11} is connected to the terminal of the windings of the switches B′ and B^2 and the contact p^{12} is connected to one terminal of the windings of the switches F′ and F^2. If the master handle n is moved to the contact n^7, a circuit is established as follows: from the positive side of the switch S through the auxiliary contacts of the switches S^4 and S^5, the windings of the switches F′ and F^2, the contact p^{12}, the brush p^{13}, the contact p', the wire 1, the contact n^7, the brush n^6 and the contact ring n^5 to the negative side of the switch. This circuit closes the switches F′ and F^2 completing the motor circuit as follows: from the positive side of the switch S through the resistance R, the resistance R′, and the winding of the throttle H, the field m' of the motor M′, the switch F′, the armature m, and the switch F^2 to the negative side of the switch S. As the motor speeds up, the switch S^5 will be closed automatically as were the switches S^2 and S^3 shown in Fig. 1.

The motor M′ is started and will stop when the arm p^8 has left the contact p'. The movement of the master-handle n to the contact n^9, causes the controlling circuit to pass through the windings of the switches B′ and B^2, through the contact k^{11}, the brush k^{13}, the contact k^{10}, and the contact n^9 to the contact ring n^5. This circuit closes the switches B′ and B^2 which complete the motor circuit, the current pasing through the armature in the reverse direction, causing the arms k^7 and p^7 to return to their original positions, where the arm k^7 again causes the motor circuit to be opened. When the handle n is moved to the contact n^{10}, the windings of the switches F′ and F^2 are again energized, the current passing from the contact p^2, the wire 2, and the contact n^{10} to the brush n^6 and the contact ring of the controller N′. This starts the motor again in a forward direction and it is stopped when the arm p^8 leaves the contact p^2, the arm k^7 having revolved through 170°. When the arm n is moved to the contact n^8, the switches B′ and B^2 will be closed and the motor will again be reversed, causing the return of the arms k^7 and p^8 to zero.

These operations described are repeated as desired, it requiring 72 forward movements before the cycle begins to repeat. For each successive movement, the arm k^7 is stopped 85° in advance of the preceding one. By changing the number of teeth in the gears or the arrangement of the contacts on the cut-out sections K and P, any desired cycle may be obtained.

With the construction shown on Figs. 3 and 4 it is not necessary that the arm p^8 be carried across the gaps between consecutive contacts by means of the momentum of the moving mechanism, since the gaps may be small enough to be bridged by the brush p^{13}, and contact will always be made with either one of the two sets of contacts.

My invention is not limited to the uses described, but is applicable to any apparatus wherein the described movements are required.

The means described may be variously modified while retaining the spirit of my invention.

I claim—

1. The combination of an electric motor, a mechanism driven thereby, a starting switch for said motor, a cut-out switch for said motor, means for driving the movable member to successive cut-out positions, and means for rendering the said cut-out driving means inoperative for a predetermined travel of the driven mechanism after each cut-out operation.

2. The combination of an electric motor, a mechanism driven thereby, a starting switch for said motor, a cut-out switch for said motor, means for driving the movable member to successive cut-out positions, and means for rendering the said cut-out driving means inoperative for a successively different period after each cut-out operation.

3. The combination of an electric motor, a mechanism driven thereby, a starting switch for said motor, a series of spaced contacts, connections including said spaced and movable contacts for making said motor operative, and means for driving said movable contact intermittently past the successive spaced contacts, and for rendering said movable contact inactive for variable successive periods prior to its actuation by its said driving means.

4. In a rotary automatic cut-out, stationary contact members spaced with reference to the successive degrees of angular travel required, a movable contact member coöperating with said stationary contact members, means for moving said movable contact forward at a definite angular ratio with respect to the mechanism to be controlled, and automatic means for returning said moving means to an initial position subsequent to each operation of the cut-out.

Signed at New York city, this 28th day of February, 1908.

JAY H. HALL.

Witnesses:
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