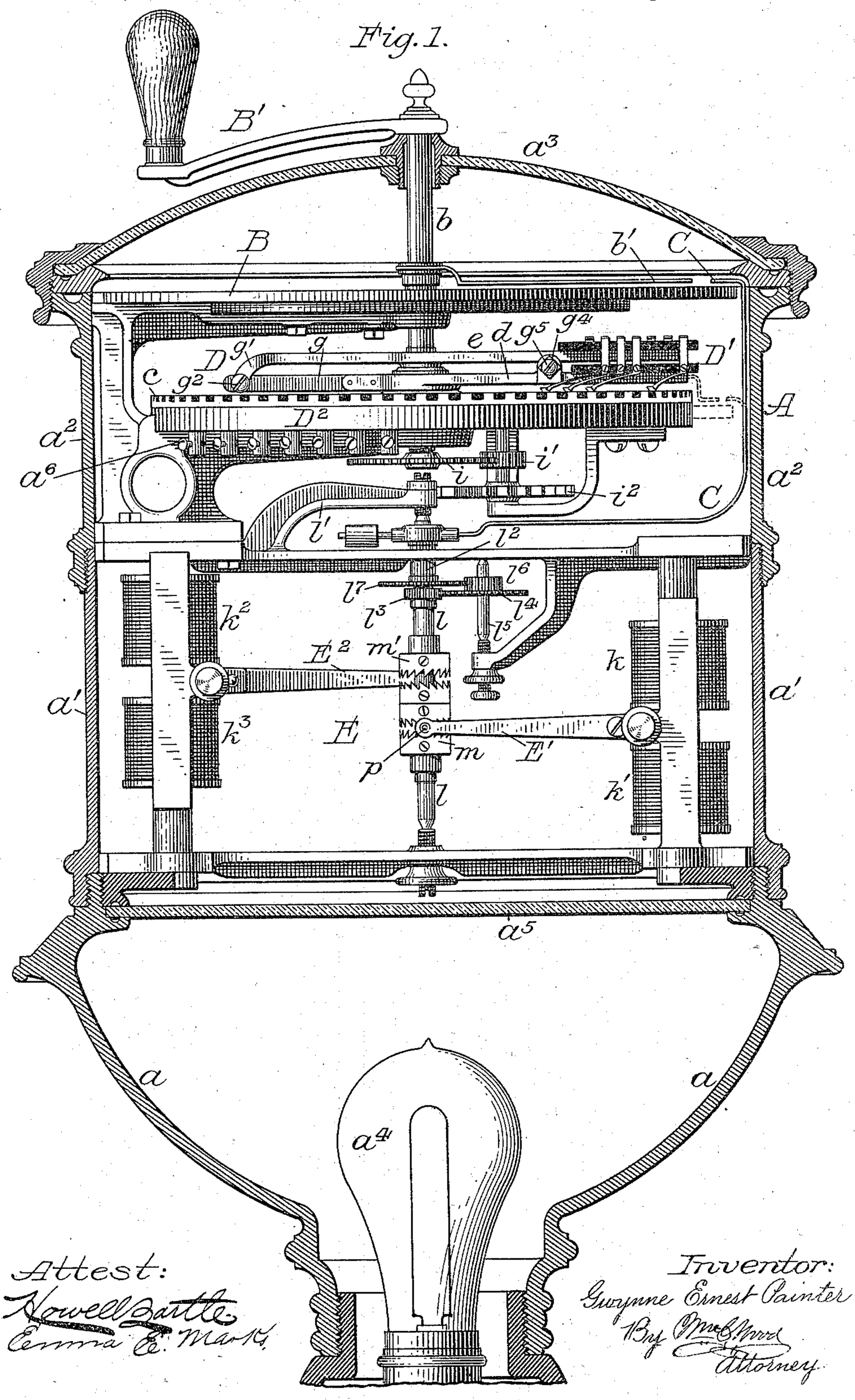
(No Model.) 7 Sheets—Sheet 1.

G. E. PAINTER.

ELECTRICAL SIGNALING APPARATUS.

No. 559,039. Patented Apr. 28, 1896.

Fig. 1.



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(No Model.) 7 Sheets—Sheet 2.

G. E. PAINTER.

ELECTRICAL SIGNALING APPARATUS.

No. 559,039. Patented Apr. 28, 1896.

Fig. 2.

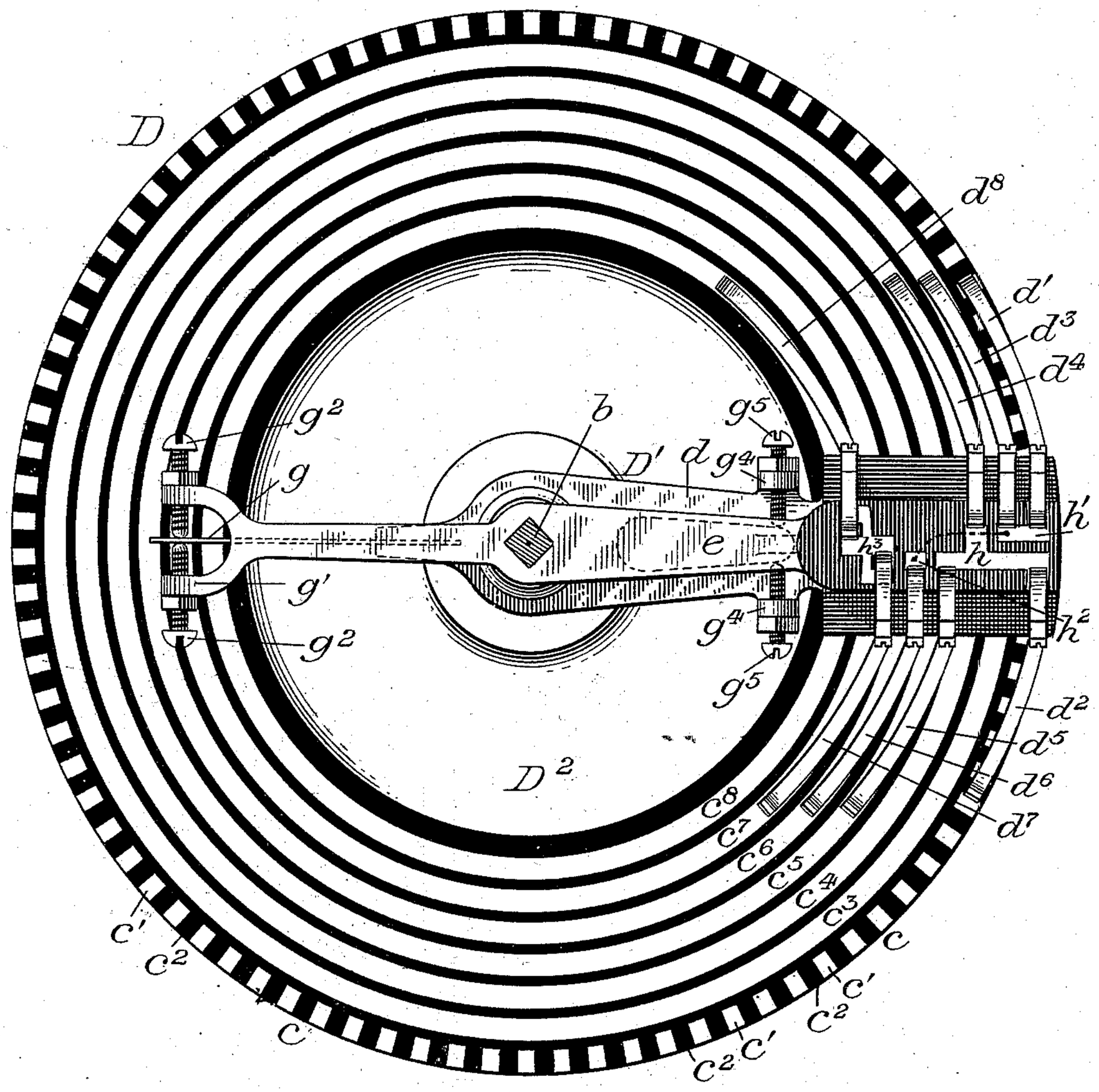
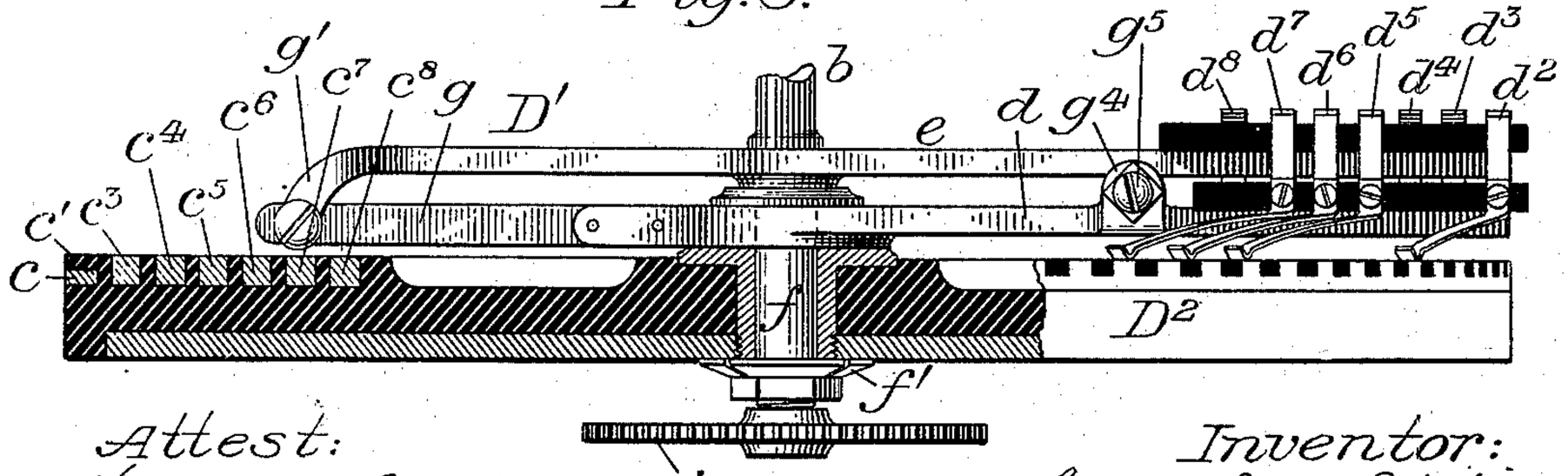


Fig. 3.



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G. E. PAINTER.

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Fig. 4.

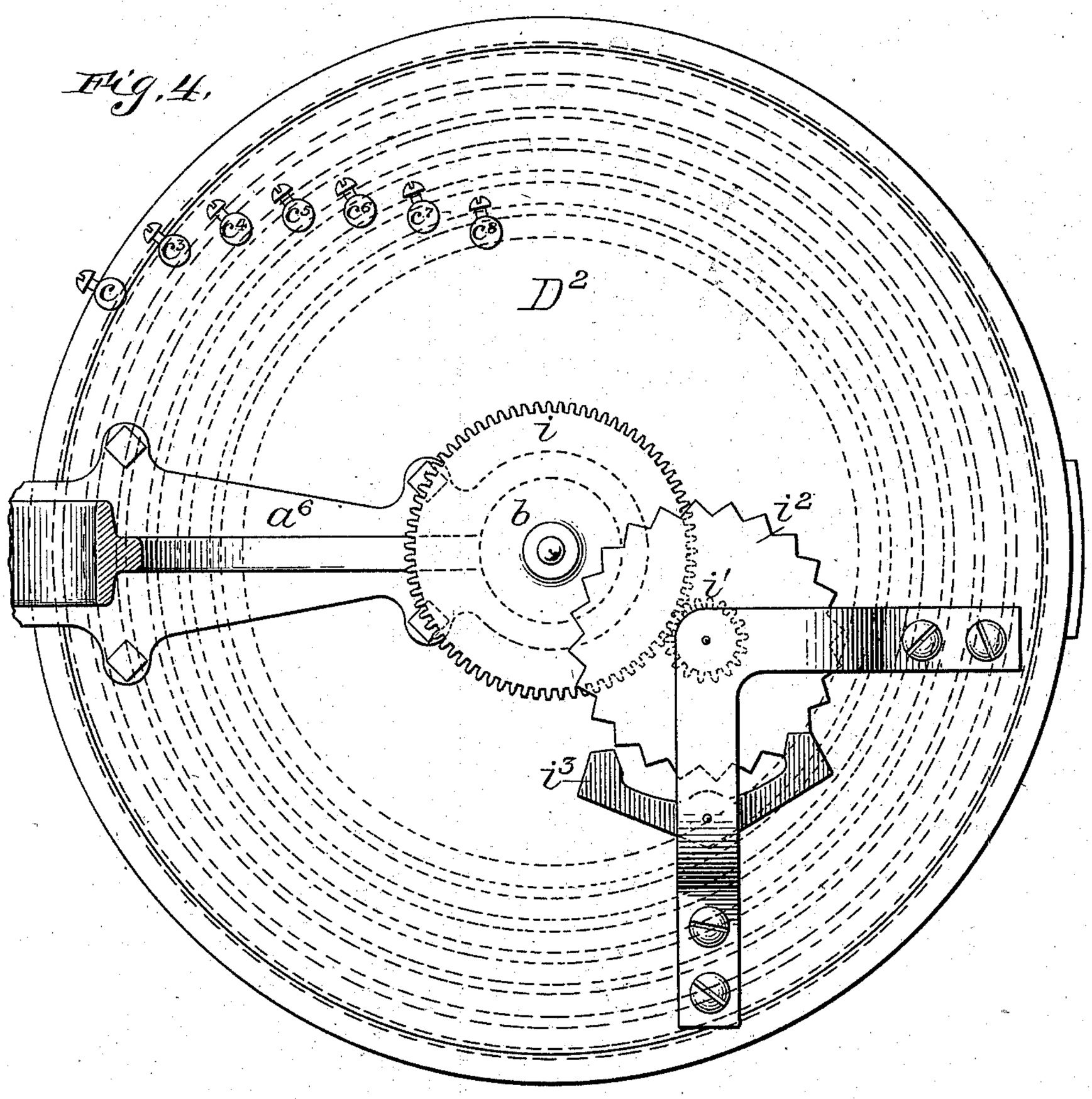
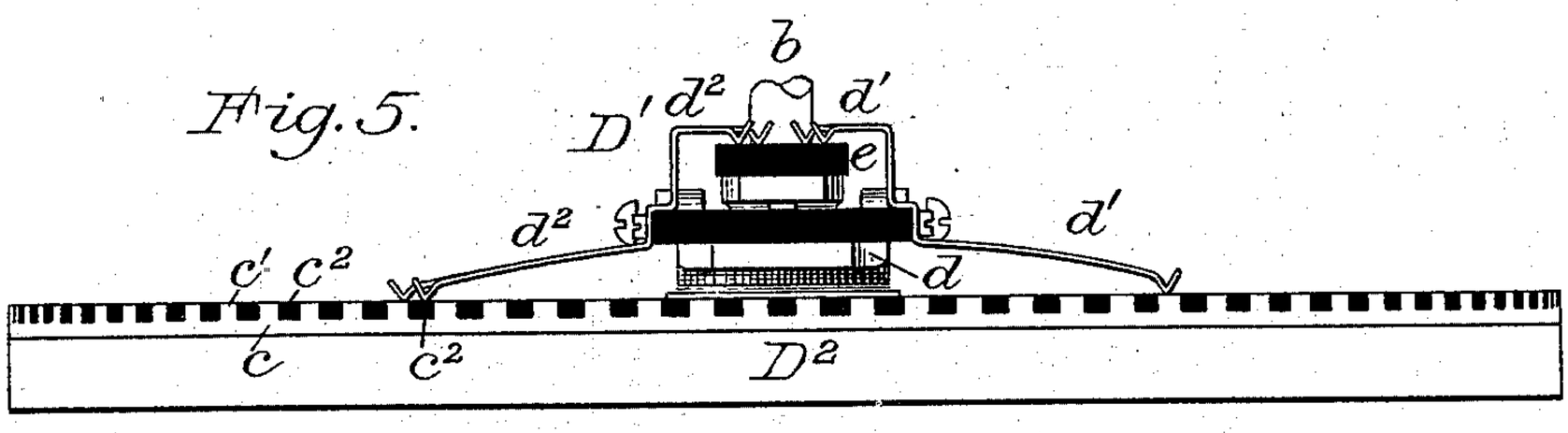


Fig. 5.



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ELECTRICAL SIGNALING APPARATUS.

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Fig. 6.

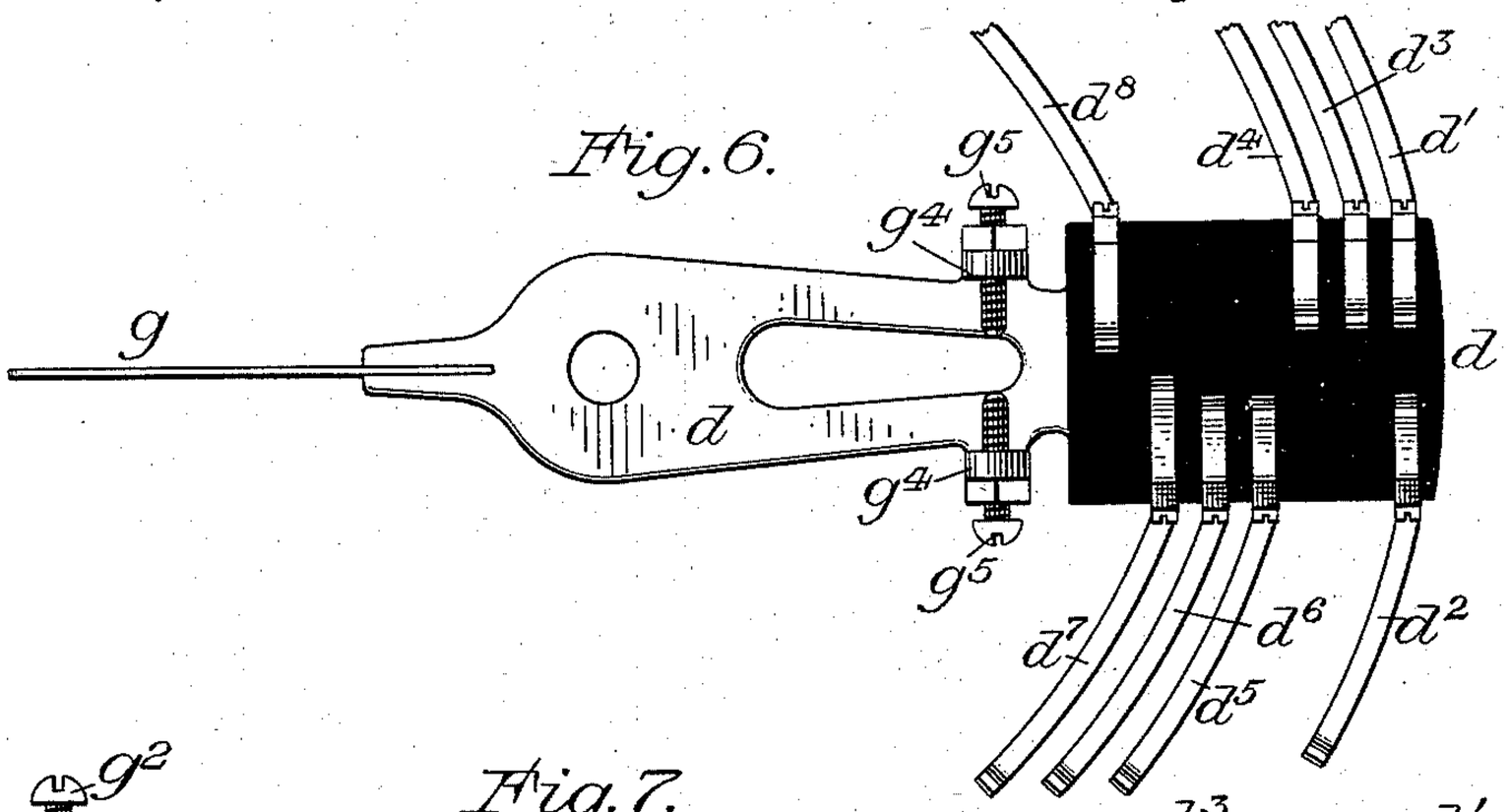


Fig. 7.

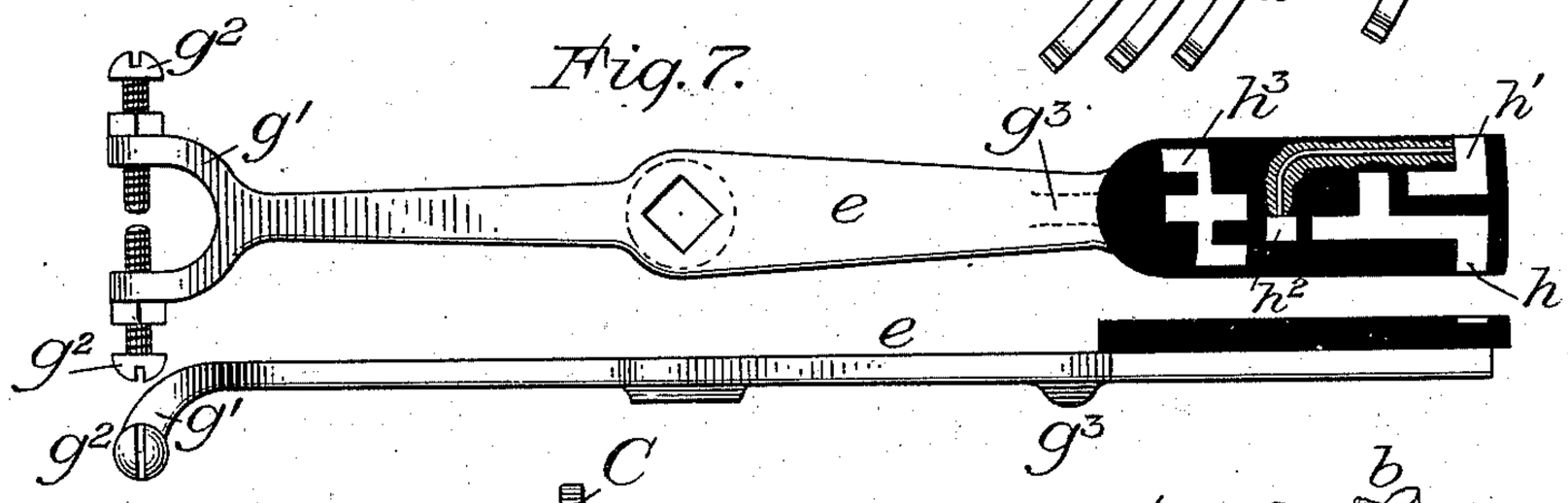


Fig. 9.

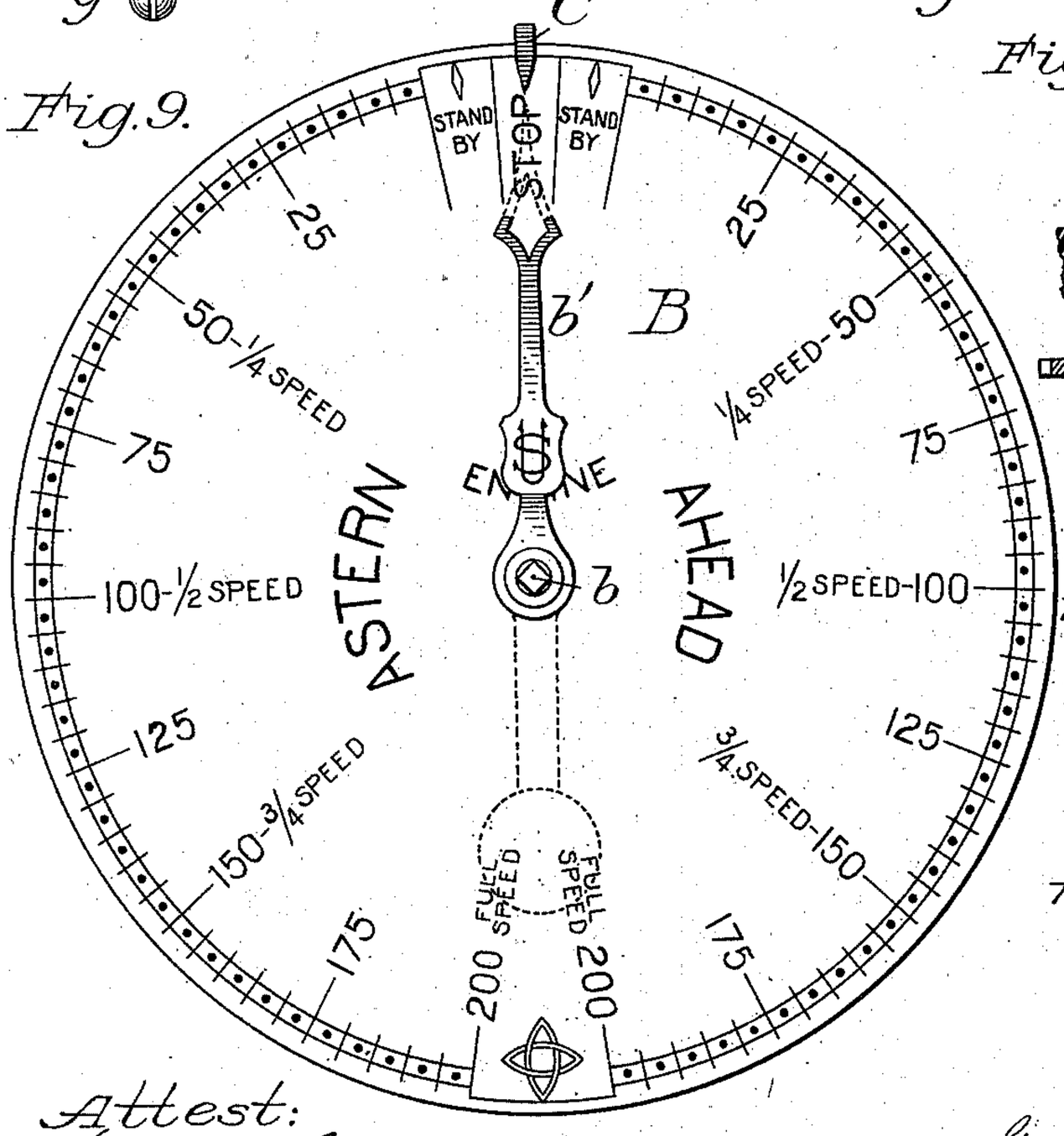


Fig. 8.

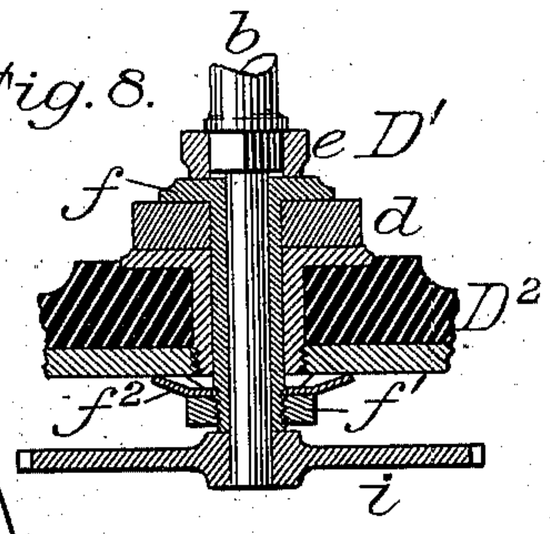


Fig. 10.

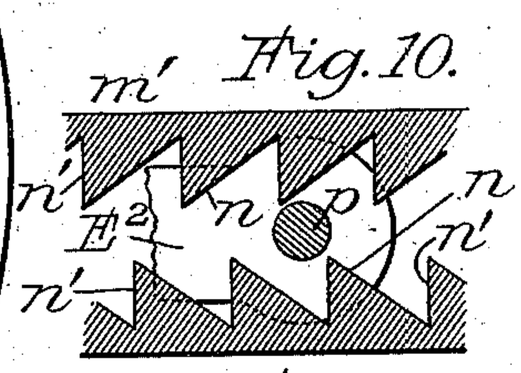
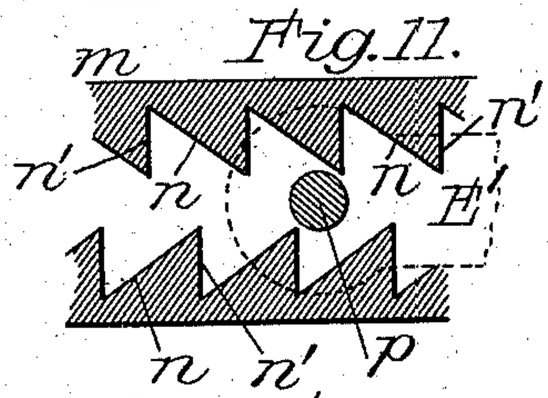


Fig. 11.



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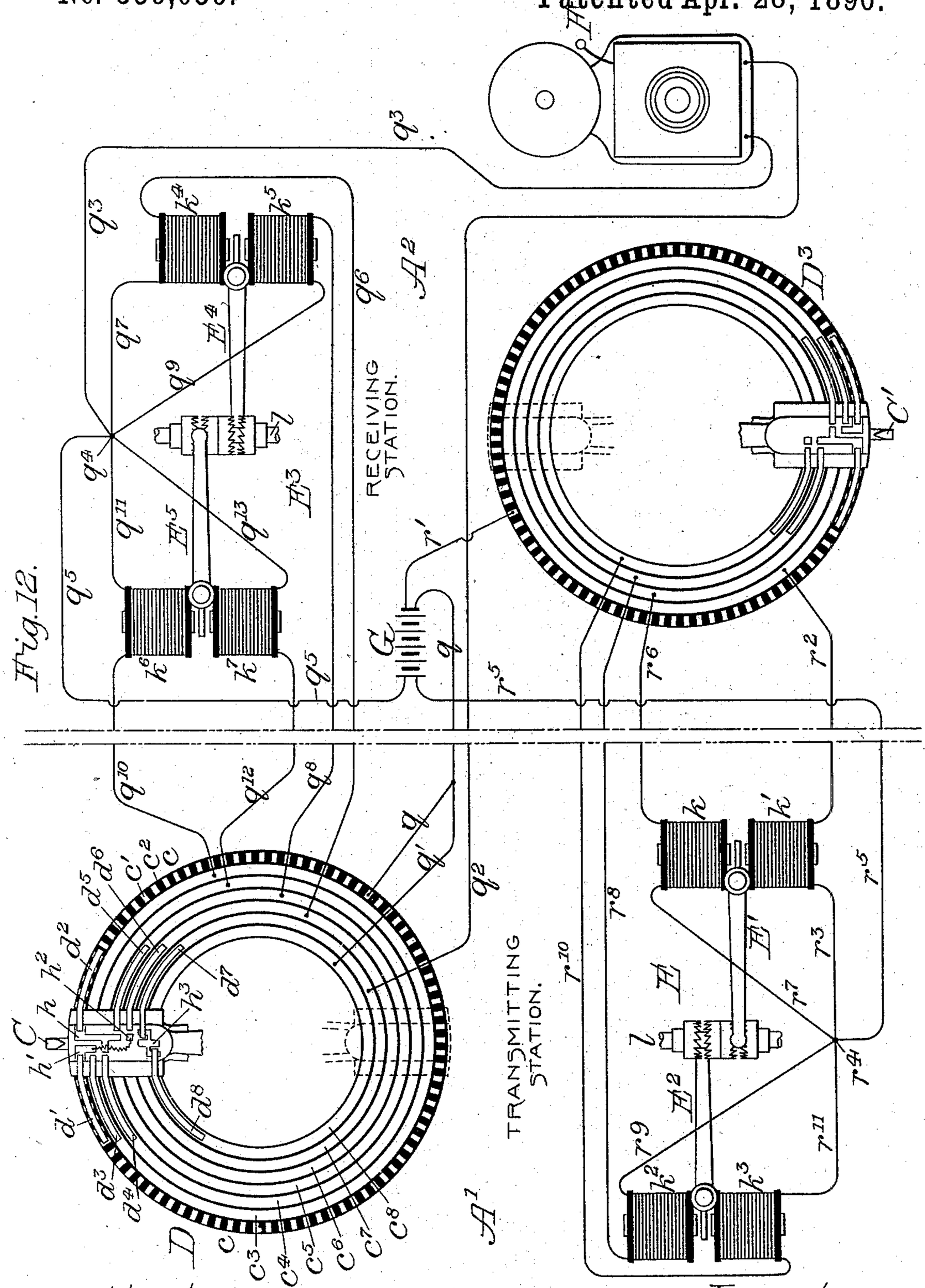
G. E. PAINTER.

ELECTRICAL SIGNALING APPARATUS.

No. 559,039. Patented Apr. 28, 1896.

Fig. 12.



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(No Model.) 7 Sheets—Sheet 6.

G. E. PAINTER.

ELECTRICAL SIGNALING APPARATUS.

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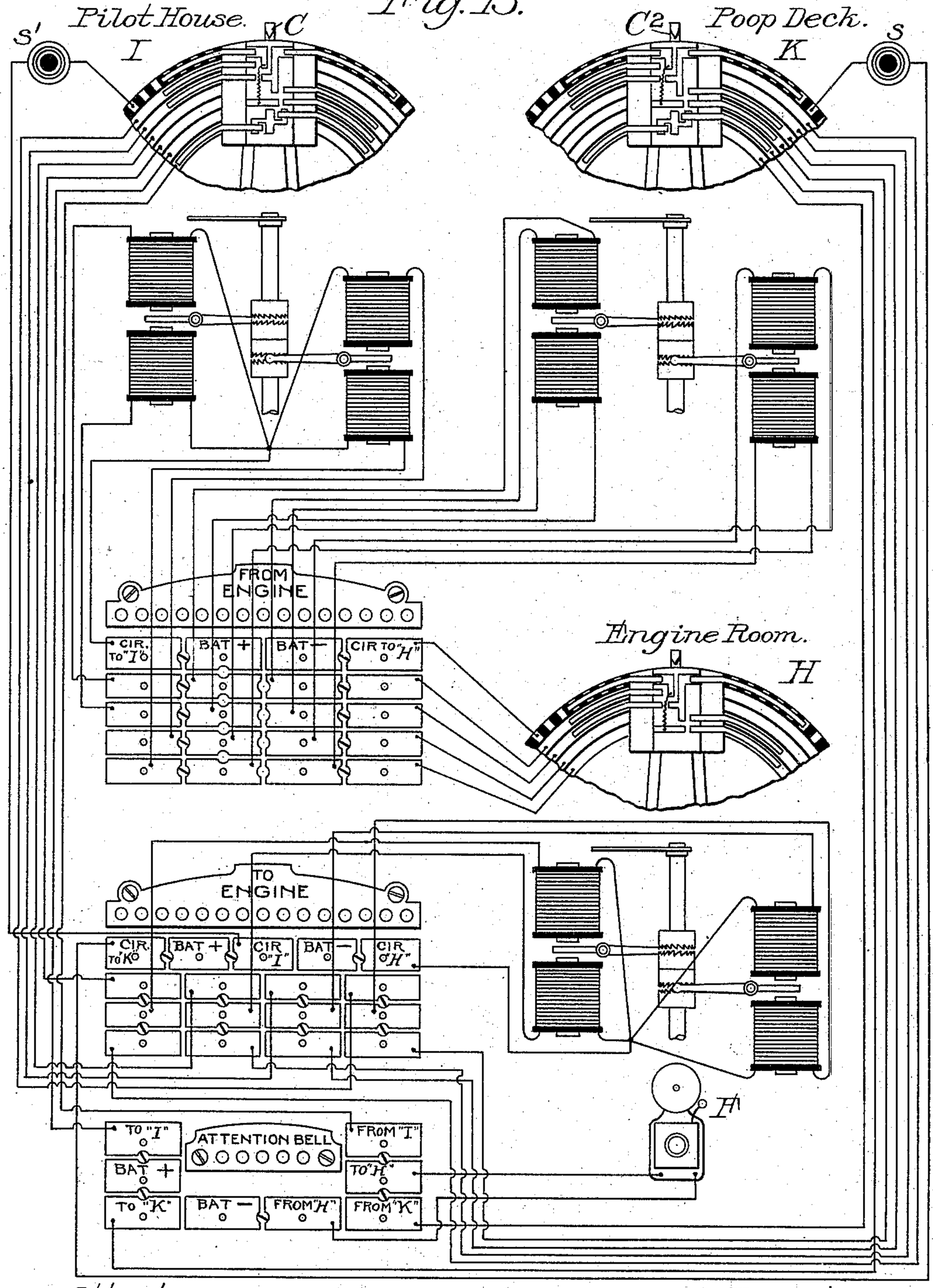
Fig. 13.



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(No Model.) 7 Sheets—Sheet 7.

G. E. PAINTER.

ELECTRICAL SIGNALING APPARATUS.

No. 559,039. Patented Apr. 28, 1896.

Fig. 14.

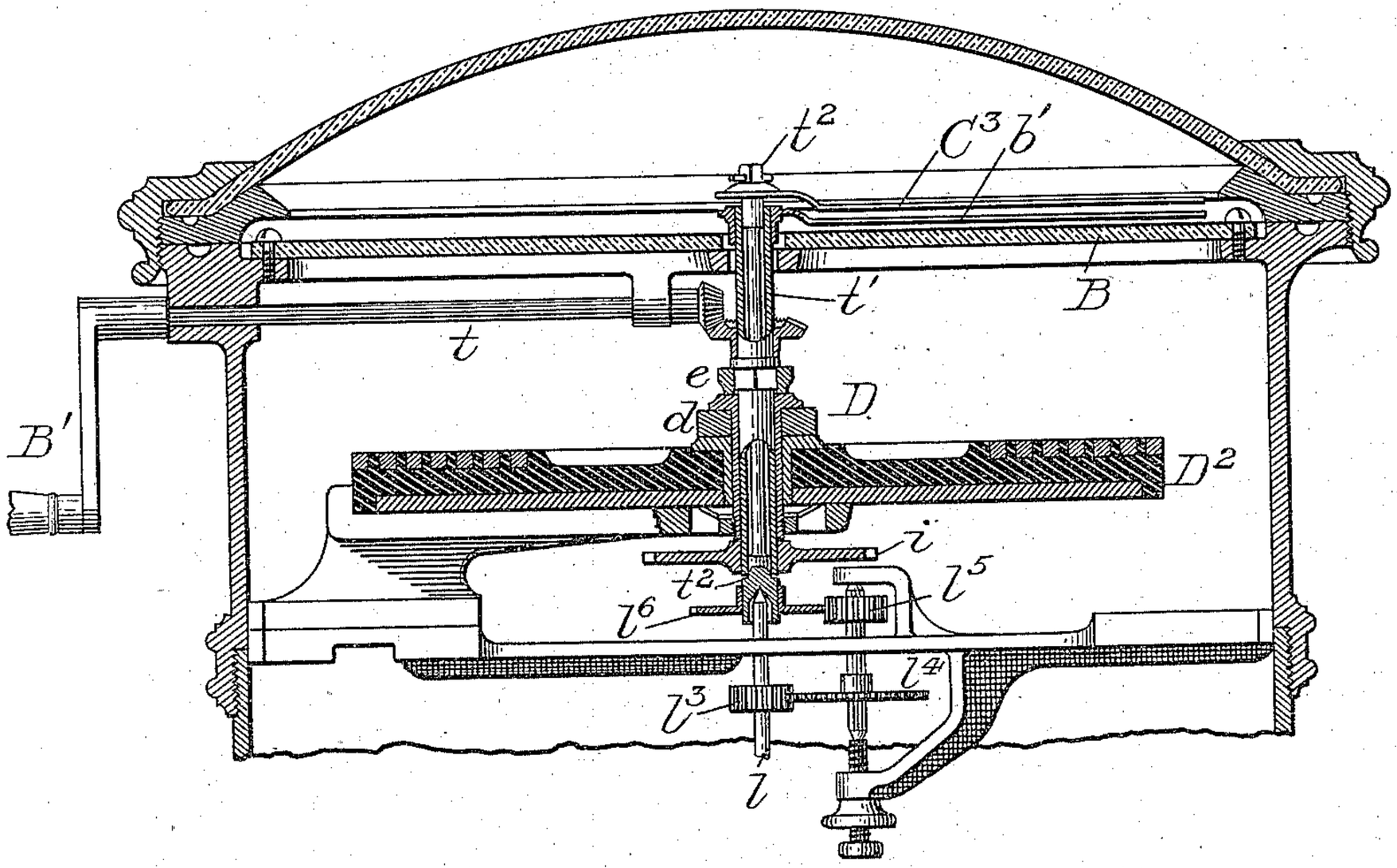
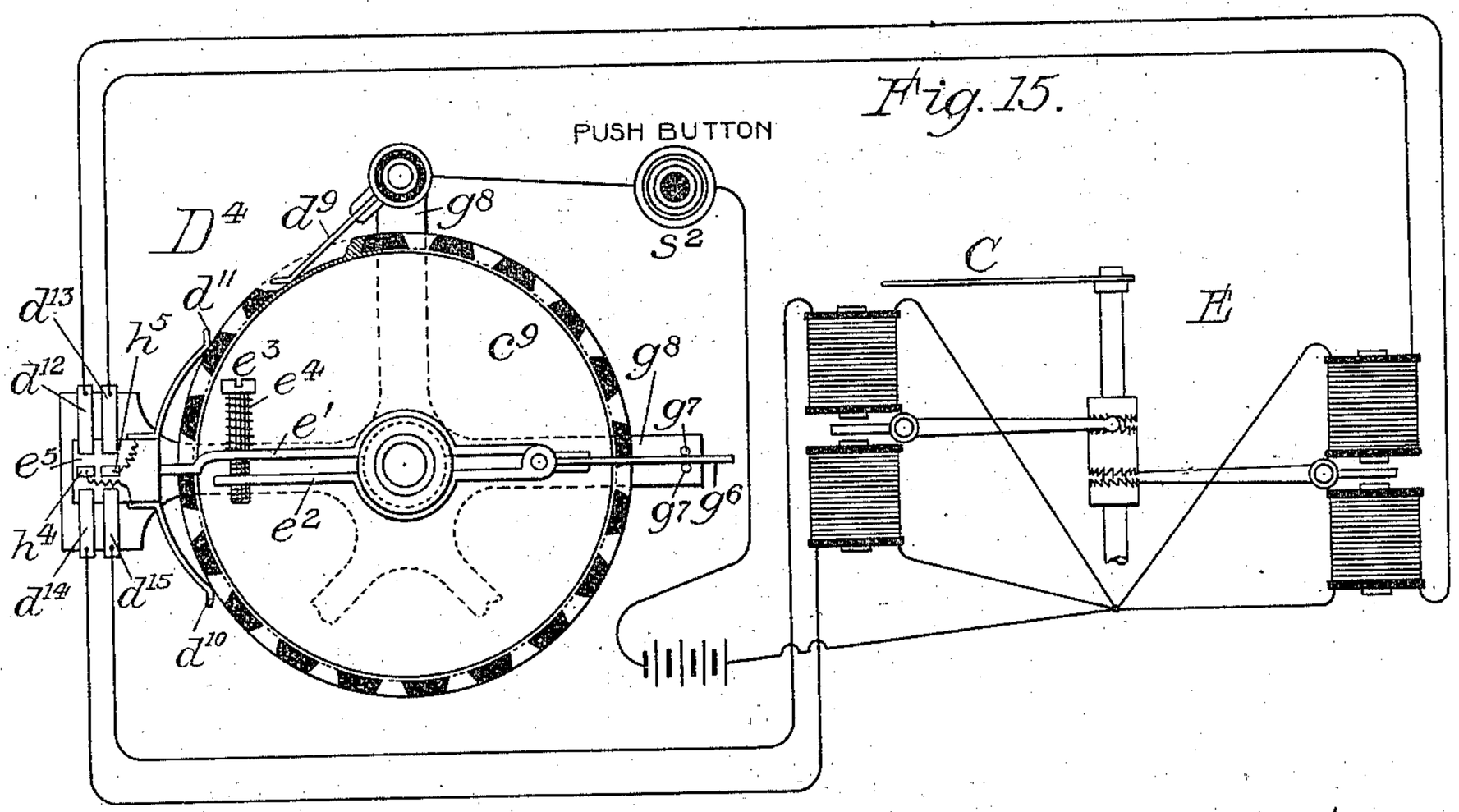


Fig. 15.



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UNITED STATES PATENT OFFICE.

GWYNNE ERNEST PAINTER, OF BALTIMORE, MARYLAND.

ELECTRICAL SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 559,039, dated April 28, 1896.

Application filed February 16, 1895. Renewed December 7, 1895. Serial No. 571,444. (No model.)

To all whom it may concern:

Be it known that I, GWYNNE ERNEST PAINTER, of the city of Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Electrical Signaling Apparatus; and I do hereby declare that the following specification, taken in connection with the drawings furnished and forming a part thereof, is a clear, true, and complete description of the several features of my invention.

The object of my complete invention is to enable prompt reliable detailed communication between more or less widely-separated points by merely moving electric brushes into appropriate positions and to enable a receiving party to at once signal to the transmitting party a detailed repetition of the communication received, thus affording absolute assurance as to whether or not the desired communication has been accurately delivered to and understood by the receiving party, and in the event of discrepancy to promptly indicate faulty operation of the apparatus. As, for instance, with an apparatus embodying my complete invention in service on steamships an officer at any accessible instrument can by operating an electric switch, as by swinging the handle of a brush or switch arm, promptly transmit orders to the engineer on duty in any desired predetermined detail relating to stopping or starting the engines ahead or astern and at any speed, or to cause any desired number of revolutions, and the engineer, by similar manipulation of his instrument, can promptly indicate to the officer the precise instructions received and under which he has acted or will immediately act.

Various organizations have been heretofore devised for electric signaling, and some of them have been specially adapted to service on shipboard for communication from various places on the ship to the engine-room.

In my complete apparatus there are two or more instruments, electrically coupled, and each is provided with a circuit-controlling switch, having either an arm or a rotative switch-plate, which, being movable by hand and swung into such position as may have been predetermined for imparting a given signal, is then allowed to rest. Each instrument is also provided with a receiving-pointer, which, when electrically operated by the switch at a distant similar instrument, can be made to move to and rest in a position conforming with that occupied by the movable portion of its controlling-switch, and as the receiving-pointer in each instrument can only be actuated because of the movement of the switch-arm (or plate) in a distant instrument, and as both switches are operated by hand it follows that the character of the signal transmitted and acknowledged remains indicated until the next transmittal and acknowledgment. If the range of signaling be limited—as, for instance, "Start," "Ahead," "Astern," "Fast," "Slow," and "Stop"—the variations in the position of the switch-arm being few and radical in their nature would enable skilled operators of both instruments to rely for guidance upon the mere positions of the switch-arm and the receiving-pointer; but inasmuch as it is important to specify particular speeds and stated numbers of revolutions by the engines and also to make the signals promptly and surely readable a suitably inscribed and graduated dial is provided for and swept by the receiving-pointer of each instrument. With such a dial the switch-arm may serve as a home-pointer for assuring accuracy in the position required for transmitting a desired signal; but I employ a separate home-pointer, which enables a dial to be located above the switch and its arm, and when I make said dial of transparent material it can be illuminated and enable it to be promptly read at night.

Although I have devised, and will hereinafter describe, certain novel features pertaining to the switch and other novel features which pertain to the mechanism intervening between the electromagnets and the receiving-pointer, and still other features which pertain to said magnets and their working armatures, I desire it to be understood that I do not restrict the main features of my invention to details of construction and arrangement in those connections.

I employ in my instruments a main switch-arm, which carries the brushes, and a spring-mounted auxiliary arm coupled to the main arm and capable of a slight initial movement independently of the main arm in either direction, but which then moves therewith.

The auxiliary arm is provided with contact-plates, by which appropriate brushes are electrically coupled. The auxiliary switch-arm is normally so maintained that its contact-plates afford no circuits; but when continuously moved in either direction it will first establish circuits and then, by moving the main arm, cause one pair of opposing cooperating magnets to be alternately and intermittingly excited, while the other pair of magnets will remain inactive, one of said pairs of magnets being operated when the switch-arm as a whole is moved in one direction and the other pair operated when said arm is moved in the opposite direction. My switch has also a bell-ringing capacity whenever the arm is moved in either direction, this, however, being necessary on but one instrument, if orders are to be transmitted in but one direction, for attracting the attention of the receiving party.

For convenience in operating the switch-arm I have provided it with a suitable handle or hand-crank, and for preventing it from being actuated with undue rapidity a retarder is employed, which may be frictional, but preferably in the form of a lever-escapement coupled with the crank shaft or spindle.

The mechanism devised by me for operatively coupling the receiving-pointer with the actuating-magnets consists of a shaft rotatively coupled to the pointer and provided with a wheel or drum, having at its periphery a cam-slot occupied by a suitable pin at the free end of the armature-lever, so that during the vibratory movements of the lever the pointer-shaft is partially rotated, this action occurring step by step in the same direction during both movements of said lever in opposite directions. For driving the pointer in the opposite direction there is a second cam-slot, operative reversely to the other, and this is occupied by a pin at the free end of another armature-lever. As but one of said armature-levers can be in active service at any one time the other must not only be inoperative, but free from any capacity to obstruct the proper operation of the lever which is in service, and therefore I have provided for magnetically actuating each lever in both directions instead of actuating a lever in one direction by a spring, as is usual for securing return movements in ratchet-and-pawl organizations.

As to means for operatively coupling the cam-slotted wheel with the receiving-pointer, they may be indefinitely varied, according to whether or not the pointer is to indicate many or few distinctive signals. Speed-reducing gearing renders it possible to provide for many signals, while for a few the pointer may be directly actuated by the shaft on which the cam-slot wheel is carried. For protecting their mechanism and enabling the instruments to be exposed to the weather, if need be, they are each housed within an inclosing structure, the switch-crank being externally accessible, and a dial is provided for the receiving-pointer, and also for a home-pointer, which follows the exact movement of the switch-arm, and within said structure suitable lighting apparatus is provided for night service.

In many cases no detailed repeat or acknowledgment of a signal received is desired, and in some cases no such repeat is possible—as, for instance, when the act of transmittal depends upon the movement of some mechanically-operated device—and my instrument, when organized for such service, will not of course embody my entire invention, but would contain certain substantial portions thereof.

My invention embraces certain other features in matters of construction and organization, which, after detailed description thereof, will, with those already indicated, be duly specified in appropriate clauses of claim hereunto annexed.

To more particularly describe my invention, I will refer to the accompanying seven sheets of drawings, in which—

Figure 1 illustrates one of my signaling instruments in an inclosing structure (shown in section) having a glass top and provided with a lamp. Fig. 2 is a top view of the switch-plate and its brush-arm. Fig. 3 is a side view of the brush-arm with the switch-plate partially in section. Fig. 4 is a bottom view of the switch-plate, showing its electrical connections and also the retarding escapement. Fig. 5 is an end view of the brush-arm complete with the switch-plate in edge view. Fig. 6 is a top view of the main brush-arm. Fig. 7 is a top and edge view of the auxiliary brush-arm. Fig. 8 illustrates in section the center of the switch and the pivotal connections of the brush-arm. Fig. 9 is a top view of a dial appropriately inscribed and graduated for steamship-engine service. Figs. 10 and 11, in plane projection, illustrate the two reversely-operative cam-slots and the free ends of the armature-levers. Fig. 12 diagrammatically illustrates a complete apparatus, with its battery and electric connections. Fig. 13 is a diagrammatic illustration of two separate instruments independent of each other, but both coupled with one engine-room instrument, with appropriate switchboards. Fig. 14 illustrates in section a modified form of my instrument, wherein both the receiving-pointer and the home-pointer radiate from the center of a dial. Fig. 15, in side view and diagrammatically, illustrates a modification of the switching organization, wherein the switch is in the form of a rotative break-wheel with stationary brushes, and also the magneto-mechanical organization with a pointer and its electric connections.

It is to be understood that the instrument shown in Fig. 1, and illustrated in detail, is adapted for use in the transmission of orders, and hence its switch controls a bell-ringing circuit for attracting the attention of the re-

ceiving party to a substantially counterpart instrument, the switch of which need not perform bell-ringing duty. For use on shipboard this transmitting instrument would ordinarily be located in the pilot-house.

The transmitting instrument, Fig. 1, is housed within a tight metallic structure or casing A, which may be widely varied in its form, but is preferably cylindrical and adapted to be mounted upon a hollow standard. The base a and side wall or barrel a' a^2 are separate parts detachably united to admit of the convenient assemblage of and access to the electrical and magneto-mechanical organizations. The top a^3 of the casing is transparent, usually composed of glass for exposing the dial B, and as that is also usually transparent it is illuminated for night service by means of a lamp a^4 in the base, there being a transparent partition above the lamp, as at a^5, and ample interior space is afforded for the diffusion of light to the dial, especially at or near its periphery where the inscriptions and graduations are located, as indicated in Fig. 9.

The transmission of signals is effected by means of a switch hand-crank B′ on a shaft b, projecting centrally through the cover of the casing, and said shaft is provided with a radial home-pointer b', which closely overlies a portion of the dial. A receiving-pointer C, operated electrically from the other end of a line, has an annular path at the periphery of the dial, over which its tip projects toward the center for sweeping the inscribed portion of the dial outside of the path of the tip of the home-pointer. The dial in this instrument being supported on a bracket at one side of the center, the pointers are restricted in their to-and-fro movements to a little less than a full circle.

Inasmuch as the function of the hand-crank is to operate the switch D by rotatively sweeping the brush-arm D′ over the face of the composite switch-plate D^2, it will be obvious that said brush, by its position on the switch-plate, will indicate the character of a signal transmitted, (if but few signals were deemed necessary,) and that without any dial the receiving or acknowledging pointer C could coöperate with the brush-arm, as well as with a home-pointer, and that if desired a narrow annular dial could be employed around the switch-plate, and a pendent home-pointer carried at the end of the brush-arm and the receiving-pointer tip overlying such dial, all as indicated in dotted lines in Fig. 1.

The dial here shown is appropriately inscribed for marine-engine signaling "Stand by," "Ahead," "Astern," "Quarter-speed," "Half-speed," "Three-quarter speed," "Full speed," and "Stop." The intermediate graduations (between "1" and "200") at each side enable the transmission of orders to drive ahead or astern, a given number of revolutions (and to stop without further signal) having first indicated the speed desired, such numerical signals being specially important in the working of war-ships. Aside from the fact that the dial in this case is common both to the electric switching organization and to the receiving-pointer the magneto-mechanical organization E, by which the receiving-pointer is actuated, is in no manner operatively connected with said switch, but is wholly controlled by way of suitable electro-magnetic circuits, coupled with a similar switch however remotely located.

I will first describe the construction of the several parts of the switching organization specially shown in Figs. 2 to 8, inclusive, and also in Fig. 1, wherein the switch as a whole is designated at D.

The composite switch-plate D^2 is securely mounted on a bracket or arm a^6, and it embodies six annular concentrically-arranged contact-plates, the largest of which, at c, is the circuit-controlling plate, having regularly-spaced contact-surfaces c', and intervening insulating material at c^2, in a manner common to break-wheels, (except that the insulating-surfaces are unusually wide,) said plate being common to electric circuits occupied by four properly-insulated interior continuous surfaced plates, as at c^3, c^4, c^5, and c^6, these with appropriate connections affording four separate electromagnetic circuits, as will be hereinafter fully described. Two interior annular plates c^7 and c^8, with suitable electric connections, afford a circuit independent of the others for bell-ringing. The post connections for these plates are on the under side and are designated by corresponding letters of reference, as shown in Figs. 1 and 4.

The switch-arm D′ is complex in its construction, in that it consists of a main or brush arm d and an auxiliary arm e.

The main or brush arm d is axially mounted on the switch-plate, as shown in Fig. 8, by means of a sleeve f, screw-threaded at one end and provided with a clamp-nut f' at the under side of the switch-plate, between which and said nut there is a spring-washer f^2, these parts being so arranged that the brush-arm is frictionally journaled and so prevented against being too easily moved. At its outer end said arm d, Figs. 2, 3, 5, and 6, has two oppositely-projecting brushes d' and d^2, which at their outer ends bear upon the outer plate c, but said brushes so differ in length that while, for instance, the brush d' bears upon or is passing over a contact-surface c' the brush d^2 will bear upon an insulated surface c^2, as shown in Fig. 5, and therefore they will alternate with each other in making metallic contact. Adjacent to the brush d' there are two other brushes d^3 and d^4, which maintain continuous contact, respectively, with the annular plates c^3 and c^4. At the opposite side of the brush there are two other brushes d^5 and d^6 in contact continuously with the annular plates c^5 and c^6. Two other oppositely-projecting brushes d^7 and d^8 are in continuous contact, respectively, with the

bell-ringing plates c^7 c^8. All of these brushes at their butts or inner ends perform brush duty, in connection with switching contact-plates carried by the auxiliary arm *e*, which is capable of a slight movement in either direction independently of the frictionally-controlled brush-arm *d*, and then its movement controls the movement of the latter.

The auxiliary arm *e* overlies (and has an axial bearing in the sleeve of) the main arm, and the two are coupled flexibly by means of a spring *g*, which projects as a tailpiece from the rear end of the brush-arm *d* and is freely embraced by a pendent fork g' on the auxiliary arm *e*, provided with adjusting-screws g^2, which enable an exact adjustment of the two arms, so that the contact switch-plates carried at the front end of the auxiliary arm may be normally maintained free from circuit-contact with the brushes. At the other side of its axis the auxiliary brush-arm has a pendent lug g^3, which occupies space between two vertical lugs g^4 on the main brush-arm, thus rotatively coupling said arms, and the extent of the free movement of the auxiliary arm is adjusted by means of oppositely-located nut-locked screws g^5 in said lugs g^4.

At the outer end of the auxiliary arm there is a switch contact-plate *h*, which coöperates with the brush d^2, plate *c*, and also with the brushes d^4 and d^5, (to annular plates c^4 and c^5.) Another contact-plate h' coöperates with two side-by-side brushes d' and d^3, (annular plates *c* and c^3,) and said plate h', by a sub electric connection with a small square contact-plate h^2, (see Fig. 7,) also coöperates with the brush d^6 and annular plate c^6. Another plate h^3, which is cross-shaped, has appropriate arms for coöperating with the bell-ringing brushes d^7 and d^8 and the annular plates c^7 and c^8.

It will now be seen that whichever way the switch-arm may be moved the bell-ringing circuit will be established, and that, according to whether the arms of the plate h^3 are wide or narrow, a bell may be rung during the entire movement of the arm, or limited to a brief ringing, as striking a gong, during the free movement of the auxiliary arm.

As hereinbefore indicated, the hand-crank B′ is relied upon for moving the switch-arm, as a whole, the shaft *b* being squared to fit a square hole in the auxiliary arm and journaled at the top of the casing and within the sleeved hub of the switch-plate, but projecting below the latter and carrying a spur-gear *i*, which meshes with a small pinion i', Fig. 4, attached to an escapement-wheel i^2, with which a rocking lever i^3 engages, all in a manner well known in retarding devices and employed here for preventing unduly rapid rotation of the switch-arm.

The magneto-mechanical organization E has its own frame, affording suitable supports for four electro magnets, and the base of the frame and appropriate brackets afford suitable supports for the bearings of the shafting of the mechanism.

Although each magnet is operated independently of the others, each two coöperate for vertically vibrating or reciprocating an armature-lever E′ or E^2 in both directions with sufficient force to enable said levers at their free ends to perform reliable mechanical duty during both movements.

The armature-lever E′ is pivoted on brackets and has its two magnets *k* and k' in the same vertical plane, and so that its armature is properly interposed between their pole-faces, the armature-lever E^2 and its magnets k^2 k^3 being similarly mounted at the other end of the frame, but in a higher plane. The outer ends of said levers are adjacent to each other, but in different vertical planes, affording space between them for a vertical shaft *l*, having an adjustable step-bearing on a base-piece of the frame and an adjustable pivot-bearing at its upper end in a bracket l'.

On the shaft *l* there are two drums or wheels *m* and m', which I will term "cam-slot wheels," because each has at its periphery an annular slot provided at its sides with a series of appropriately-inclined faces *n*, Figs. 10 and 11, which operate as cam-faces when forcibly engaged by the end of an armature-lever or a stud projecting therefrom into the slot, as at *p* or p'. The cam-faces of these wheels are reversely inclined, so that the shaft may be driven in opposite directions with a well-defined step-by-step movement, each cam-face having a stop-face n' at the foot of its incline, which abuts against the stud *p* or p' at the termination of each stroke. During the active operation of either lever the other or inoperative lever, by the contact of the cam-faces of its slot with its stud, is freely vibrated, and hence it offers no resistance to the rotation of the shaft *l*.

It will be obvious that the shaft *l* might carry a pointer moving therewith, and that if movement in one direction only was desired one pair of magnets and one armature-lever would, with the shaft and a cam-slot wheel, constitute an operative organization.

The value of magnetically actuating the two armature-levers in both directions, in connection with the two reversely-operative cam-slot wheels, should be obvious, because when one lever is in service the other is absolutely free, and although one magnet and a spring might be relied upon for actuating one lever the other must have its two coöperating magnets, it being obvious that if there were springs on both that either would operate obstructively to the other.

The stop-faces at the terminals of the reversely-inclined faces in the two cam-slots serve a double purpose. Although the shaft which carries the cam-slot drums may be and is so nicely mounted that it may be rotated in either direction by the armature-levers with a minimum of friction, it cannot be rotated as by jars or shocks, or by manipulating the pointer, because it is absolutely locked by the two armature-levers, each re-

spectively engaging normally with an appropriate stop-face n'. Each stop-face, therefore, serves to properly limit each step-by-step movement, and the stop-faces in both cam-slots serve as locking-faces for preventing the accidental rotation of the pointer, and a consequent derangement in adjustment.

In order that the receiving-pointer C may properly coöperate with a dial which is quite finely graduated, speed-reducing gearing is interposed between the shaft l and the pointer, as follows: The pointer is counterweighted to balance its long arm, and is carried upon a sleeve l^2, journaled on the shaft l and supported upon a spur-gear l^3, secured to said shaft. The spur-gear l^3 meshes with a large gear l^4 on a parallel counter-shaft l^5, which has secured to it a pinion l^6, which meshes with a large gear l^7, secured to the sleeve l^2, the arrangement for reducing speed in this instance being such that one full rotation of the shaft l causes about one-sixth of a revolution of the pointer.

For describing more particularly the operation of my complete apparatus I will now refer to Fig. 12, wherein at the "transmitting-station" at A′ essential portions of the instrument already described are shown, and at the "receiving-station" similar parts of an appropriate instrument A^2 are illustrated, with their electric connections graphically displayed, a central double-dotted line separating the figure into appropriate divisions.

With the auxiliary switch-arms of both instruments in their normal positions the battery-circuits are broken, but with the first movement of an arm in either direction the movable contact-plate h^3 of the instrument A′, for instance, causes the bell F at the receiving-station to be rung by closing the circuit from the battery G, via conductor q and branch q', to the annular switch-plate c^8, to brush d^8, plate h^3, brush d^7, to annular plate c^7, and thence to and from the bell by conductors q^2 q^3 to post q^4, and thence to battery by conductor q^5.

The auxiliary switch-arm of the instrument at A′ in moving toward the right hand, for instance, also couples the brushes d^2 and d^5 by way of the contact-plate h, and further couples the brushes d' and d^6 by way of the coupled contact-plates h' and h^2.

The brush on being continuously moved in the same direction, say one hundred and eighty degrees, and then stopped, as indicated in dotted lines, would have operated the magneto-mechanical organization E^3 at the receiving-station as follows: The magnets k^4 and k^5 of the instrument at A^2 would operate alternately, and each be intermittingly excited in proportion to the number of contact-surfaces c' swept by the brushes d' and d^2.

The electromagnetic circuit of the magnet k^4 is as follows: battery-conductor q, break-plate $c\,c'$ to brush d', contacts h' and h^2 to brush d^6, annular plate c^6, conductor q^6, through magnet-coil of k^4 and conductor q^7 to post q^4, and thence to battery by conductor q^5.

The brush d' having passed to insulating material c^2, the brush d^2 then makes contact with break-plate $c\,c'$, establishing circuit with the magnet k^5, via said brush d^2, contact-plate h, to brush d^5, to annular plate c^5, and thence by conductor q^8 to and through the magnet-coil and by conductor q^9 to post q^4 back to battery by conductor q^5. This alternate and intermitting action of the magnets k^4 and k^5 so actuates the armature-lever E^4 as to cause the transmitting-pointer C′ of the instrument A^2 to move to and rest at a position appropriately corresponding to that at which the brush-arm of the instrument A′ has been placed.

At the receiving-station in instrument A^2 the arm of the switch D^3 would have normally occupied the position indicated in dotted lines, but the receiving party would then move said arm one hundred and eighty degrees. This switch-arm is a duplicate of the other, except that in this instance it has no bell-ringing brushes, and it having been so moved would then be in the position occupied by the receiving-pointer C′, and in so moving the switch-arm this switch would, in the manner previously described, control the magneto-mechanical organization E at the transmitting-station and impart movement to the receiving-pointer C.

The electromagnets k^2 and k^3 would be operated, respectively, by way of conductors r^8 r^9 and r^{10} r^{11} to post r^4 and to battery by conductor r^5, the appropriate brushes, contact-plates, and annular plates having their connections with the battery by way of conductor r', and hence the armature-lever E^2 would be forcibly vibrated and impart proper movement to the receiving-pointer C until it coincided with the position at which the transmitting switch-arm was resting.

If the switch-arm of the switch D in the transmitting instrument A′ should be moved toward the left hand, the brushes d' and d^2 would operate precisely as before, but the brush d', by plate h', would couple with the brush d^3, and the brush d^2, by plate h, would connect with brush d^4, thus alternately exciting the electromagnets k^6 and k^7 at the receiving-station A^2, and by appropriately vibrating the armature-lever E^5 cause the receiving-pointer C′ to move to and rest at the position to which the transmitting brush-arm had been moved.

The circuit for the magnet k^6 includes switch-plate $c\,c'$, brush d', contact h', brush d^3, annular plate c^3, conductor q^{10}, through magnet coil and conductor q^{11} to post q^4, and thence by conductor q^5 to battery, the latter coupling with plate c by conductor q.

The circuit for magnet k^7 is afforded by battery-conductor q to switch-plate $c\,c'$, to brush d^2, and thence by contact-plate h to brush d^4 and annular plate c^4, out by con-

ductor q^{12}, through magnet-coil of k^7, to conductor q^{13} and post q^4, thence to battery by conductor q^5.

At the receiving-station the then appropriate movement for causing the receiving-pointer C at the transmitting instrument A′ to indicate the signal received would cause the magnets k and k' to alternately and intermittingly operate and to properly actuate the armature-lever E′. The electromagnetic circuits in such case would be as follows: for the magnet k, by the appropriate annular plates, brushes, and shifting-contacts of the switch D^3, as before described, said circuit including conductor r' from the break-plate of switch to the battery, conductor r^6 from the middle annular plate to and through coil of magnet k, thence by conductor r^7 to post r^4, and thence by conductor r^5 to battery.

The magnet k' has its circuit, via conductor r', from the battery to the break-plate c c' to the second annular plate through the proper brushes and contact-plate, and thence by conductor r^2 through magnet-coil, out on conductor r^3 to post r^4, and thence to battery by conductor r^5.

It will be readily understood that with such signaling requirements as would call for a sweeping movement of the switch-arm equal to or even greater than three hundred and sixty degrees no variation in the electric or the magneto-mechanical organizations would need be involved, and although the switch and dial supporting brackets in the instruments shown preclude a movement of three hundred and sixty degrees the restricted range is ample for the particular purposes indicated.

It will also be obvious that the switching and the magneto-mechanical organizations might be separated from each other and either or both provided with dials and each be within its own casing or in one without departure from substantial features of my invention.

Although I have illustrated my apparatus with dials and switch-plates horizontally arranged, each instrument will operate equally well, if so turned that the dials and switch-plates will be vertical.

Although two instruments, as already described, will constitute a complete apparatus embodying my invention, it is to be understood that any desired number of widely-separated instruments may be employed for separately signaling to or through one instrument in the engine-room—as, for instance, as illustrated in Fig. 13, wherein three instruments are indicated and appropriately designated "Engine-room" H, "Pilot-house" I, and "Poop-deck" K—with a suitable switch-board, (here shown as when used for more than these three instruments,) which should be located below the water-line and organized substantially as shown, so that should either the pilot-house or the poop-deck instrument or any other in the same system be carried away or disabled by the entanglement of its electric connections it can be at once wholly cut out and leave the remainder of the system intact.

The electric generators or batteries are not here shown, it being understood that they are to be coupled with the appropriately-designated switchboard "Bat." plates, and that the instruments may be coupled in series or in multiple. Assuming all of the instruments to be standing with the receiving-pointers C, C′, and C^2 in coincidence with their respective brushes, let it be supposed that an order for starting ahead at, say, "quarter-speed," has been transmitted from the pilot-house instrument I to the engine-room instrument H, and that the engineer in response had caused the receiving-pointers C and C^2 of both instruments I and K to stand at "quarter-speed." If now the officer of the deck should go to the stern of the ship, to the instrument K, he will find that its receiving-pointer indicates the acknowledgment of the quarter-speed order, and, preparatory to further orders, he will first throw that switch out of circuit by pressing upon an adjacent push-button s, and then, after swinging the brush-arm or home-pointer into coincidence with the receiving-pointer, he will restore the circuit by releasing the button, and then proceed with his orders—say for half-speed. The officer on returning to the pilot-house will find the receiving-pointer C located at "half-speed;" but the brush or home-pointer will be standing where he left it, whereupon he will press the adjacent push-button s' and move the brush-arm and home-pointer into coincidence with the receiving-pointer, after which, and a release of the button, he may proceed with further orders. Upon large warships four or more such separated instruments would be required for transmitting orders, and if intact each of them would at all times indicate the last order acknowledged from the engine-room, and either of them in the manner described would enable signaling without liability of error or confusion. If orders are being transmitted from the stern of a ship, the responses from the engine-room would be indicated at the pilot-house instrument, as well as at that on the bridge, so that the pilot may see just what orders have been given and are being carried out. Should the officer in control become disabled, his successor can at once determine from the inspection of an adjacent instrument the precise orders under which the engineer is acting. This organization of several independent instruments, each containing a receiving-pointer, and electrically coupled to a single instrument, and capable of controlling a receiving-pointer therein, and said single instrument electrically coupled to all of the others, and capable of simultaneously controlling their receiving-pointers, constitutes an important and valuable feature of my invention, both with and without means for throwing the switches of the independent instruments

out of circuit for enabling the adjustment of their switches with relation to the adjacent receiving-pointer, without affecting the receiving-pointer of the distant single instrument.

Although it will generally be advisable to so organize the receiving-pointer that its tip will travel in a path peripheral to the switch-plate or the dial, I do not restrict myself to that arrangement, it being in some cases desirable, and sometimes even imperative, that the receiving-pointer should radiate from the center of a dial or a switch-plate and either overlie a home-pointer and a brush-arm, as the case may be—as, for instance, as illustrated in Fig. 14.

As here organized, the dial B may be peripherally supported by the casing, and both the home-pointer b' and the receiving-pointer C^3 radiate from the center of the dial. The switch-plate D^2 and the switch-arm D', with its main arm d and auxiliary arm e, are substantially as before described; but instead of applying a hand-crank directly to the switch-arm it is here applied to a counter-shaft t, geared to a sleeve t', which is coupled to the arm, like the crank-shaft before described, and to the top of this sleeve above the dial the home-pointer b' is secured, and at its base it carries the gear i, which operates the retarding escapement-wheel. Within said sleeve t' there is a spindle t^2, having at its base a center bearing for the top of the shaft l, and at its top it carries the receiving-pointer C^3. Power is communicated from the shaft l to the receiving-pointer by the gearing l^3, l^4, l^5, and l^6, as before described. This organization enables the two pointers to be moved throughout the entire circle in either direction, and if need be the capacity of the apparatus may be enlarged for general communication—as, for instance, the dials may be provided with numerous special inscriptions, and also with the letters of the alphabet, and so enable complete communication, without the slow operation incident to passing from one letter or inscription to another and always in one direction. My pointers can be actuated in either direction, and hence can be swung by the shortest route from point to point.

When arranged for general communication, the signal preceding a departure from the main purpose might be, for instance, a repeated to-and-fro movement for indicating that the matter to be imparted was not within the scope of ordinary signaling. During action on a war-ship the delicacy of telephones would render them liable to derangement, and noise might render speaking-tubes ineffective, in which case the means described for general communication would be profitably available. For rendering such a system more completely effective the engine-room instrument could be provided with means for bell-signaling to all of the distant instruments.

While it will generally be deemed advisable to employ stationary switch-plates and rotative or swinging brush-arms, as heretofore specially described, rotative switch-plates and stationary brushes or brush-arms may be employed without departure from my invention—as, for instance, as shown in Fig. 15. The magneto-mechanical organization at E, with a receiving-pointer C and the several electric connections, are mainly as heretofore described, but are modified to conform with this switching organization D^4. This break-wheel or switch-plate c^9 is axially mounted at the side of a suitable frame on a hollow stud within a sleeve, to which the wheel-plate is secured, and said plate would be rotated by gearing, shaft, and hand-crank, after the manner of moving the brush-arm shown in Fig. 14. A brush carrier or arm e' is frictionally mounted upon the sleeve of the wheel by means of a hinged clamping-finger e^2, and the frictional engagement is rendered adjustable by means of a screw e^3, tapped through the finger e^2, and having a spring e^4 interposed between the head of the screw and the arm e'. This arm has a spring tailpiece g^6, (like that previously described,) but its outer end is located between two fixed studs at g^7, projecting from a portion of the frame g^8, so that this arm possesses a similar capacity for slight movement, as does that of the auxiliary arm e in the other form of switch. This broken contact-plate c^9 is provided with an annular continuous contact-surface (indicated in dotted lines and also at a broken portion) upon which a stationary brush d^9 bears for coupling it with a battery, as shown, a push-button at s^2 enabling the circuit to be temporarily broken, as before described.

The brush arm or carrier e' is provided with a head e^5, on which there are two oppositely-projecting brushes d^{10} and d^{11}, which correspond to the brushes d' and d^2, before described, and on said head there are two contact-plates h^4 and h^5, respectively, coupled to the brushes d^{10} and d^{11}, as indicated. At each side of the brush-head and mounted on the framing there are two stationary brushes d^{12} d^{13} and d^{14} d^{15}, each pair of brushes being coupled by electric conductors with the appropriate pair of coöperative magnets, as fully shown. It will be readily seen that the contact-plates h^4 and h^5 will normally occupy a position between the stationary brushes, but that when the switch and its sleeve are rotated the brush-arm will be moved (because of its frictional engagement) so far as may be permitted by its spring, and that if the wheel be moved in one direction—say, so as to couple the plates h^4 and h^5 with the brushes d^{12} and d^{13}—the right-hand magnets will be separately and intermittingly excited, the circuits being, say, first from brush d^{11} to h^5 and brush d^{13} to the upper right-hand magnet, and then from brush d^{10} to h^4 and brush d^{12} to the lower right-hand magnet, and so on. A movement of the wheel in the opposite direction would excite the lower left-hand mag-

net through brush d^{10}, contact h^4, and brush d^{14}, while the upper left-hand magnet would be excited via brush d^{11}, contact h^5, and brush d^{15}.

A vertical dial could be used with this instrument, or the wheel might be horizontal. The sleeve of the wheel would project through the dial for carrying a home-pointer, and the receiving-pointer would overlie the home-pointer and be mounted on a spindle within the sleeve, all substantially as indicated in Fig. 14, wherein there is a swinging or rotative switch-arm.

The magneto-mechanical organization described operates equally well, regardless of shocks and in any and all positions or while being rocked to and fro, these being important requirements, inasmuch as it has been demonstrated that instruments intended for more or less similar purposes, but otherwise organized, will do good service on a ship while in smooth water or when tied up at a dock, but which when the ship was at sea and even moderately tumbled would become erratic and unreliable.

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

1. In an electric signaling apparatus, the combination substantially as hereinbefore described, of electric connections which afford separate electromagnetic circuits, a movable switch-arm, a main or circuit-breaking switch-plate having separated contact-surfaces insulated from each other, and a pair of brushes on said arm which alternate with each other in engaging with said surfaces; other adjacent contact-plates affording continuous surfaces, and brushes which engage therewith, and intermediate contact or coupling plates, which appropriately connect the brushes, and during the movement of the brush-arm, cause an intermittingly-broken current to be supplied to separate and alternately excite electromagnetic circuits.

2. In an electric signaling apparatus, the combination substantially as hereinbefore described, of a switch-arm, carrying brushes, and provided with coupling contact-plates movable between the butts of the brushes in either direction; a main or circuit-breaking switch-plate, provided with regularly spaced and separated contact-surfaces, and intervening insulating material, in the path of two of said brushes, which alternate with each other in making and breaking circuit; other adjacent contact-plates, having continuous surfaces, in the path of appropriate brushes; and suitable electric connections which afford separate electromagnetic circuits, whereby according to the direction in which said arm may be moving, some of said circuits will be cut out, and others will be alternately and intermittingly supplied with current.

3. In an electric signaling apparatus the combination substantially as hereinbefore described, of an axially-mounted pointer; two pairs of opposing but coöperating electromagnets two vibrative armature-levers, and suitable mechanism between both of said levers and the pointer for converting the vibrative movement of the levers into intermitting rotary motion for moving the pointer in either direction, according to which of said levers may be actuated by its magnets.

4. In an electric signaling apparatus, the combination with an axially-mounted pointer, of a vibrative armature-lever, provided with a pin or stud at its free end, an electromagnet for vibrating said lever, and a drum or wheel rotatively coupled to said pointer, and provided with a peripheral cam-slot occupied by said pin, substantially as described, whereby the movements of said lever, in both directions, impart an intermitting rotary movement to said pointer, in one direction.

5. In an electric signaling apparatus the combination with an axially-mounted pointer, of a drum or wheel rotatively coupled to said pointer and provided with two reversely-operative cam-slots; a pair of armature-levers, each at its free end provided with a pin, located in its appropriate cam-slot, and electromagnets for vibrating said levers, substantially as described, whereby said pointer will be intermittingly rotated in either direction, by the vibration of the appropriate lever.

6. In the switch of an electric signaling apparatus the combination with a brush-carrying arm of an auxiliary arm-spring coupled to said brush-arm, and initially movable independently of, and then movable with said brush-arm, and contact-plates on said auxiliary arm, which normally, and when at rest, afford no connections between the brushes, but which while being moved in either direction, connect some of said brushes for establishing circuits, substantially as described.

7. In an electric signaling apparatus, the combination of a shaft adapted to move a pointer, and provided with a cam-slot wheel, and a magnetically-operated lever provided at its free end with a stud or pin which occupies the cam-slot in said wheel, substantially as described.

8. In an electric signaling system, the combination substantially as hereinbefore described, of two or more independent signaling instruments, each containing a receiving-pointer; another single remotely-located signaling instrument containing a receiving-pointer, electric connections coupling said single instrument with each of the others, and all of them with it, and a switching organization in each instrument, which enables the receiving-pointer in the single instrument to be appropriately controlled by the switch in each of the other instruments, and their receiving-pointers to be simultaneously controlled by the switch of the single instrument.

9. In an electric signaling system, the combination of two or more independent instruments, a remotely-located single instrument, and receiving-pointers in each; electric con-

nections which couple the single instrument with all of the others, and each of them with it; a switching organization in each instrument and means for throwing the switches of the independent instruments out of circuit, whereby the receiving-pointers in all of the independent instruments may be appropriately actuated by the switch of the single instrument, and the receiving-pointer of the latter, actuated by either of the switches in the other instruments, and enabling either of these latter switches to be adjusted with relation to its adjacent receiving-pointer, without affecting the single instrument.

10. In an electric signaling system, the combination with a magneto-mechanical organization adapted to actuate a pointer in opposite directions, of a switch electrically coupled to said organization, and provided with a switch-arm carrying appropriate brushes, and having movable contact-plates between the butts of the brushes, substantially as described, whereby according to the direction in which the switch may be operated, said plates will couple such brushes as will afford circuits for actuating the pointer in a corresponding direction.

11. In an electric signaling apparatus, the combination of a pointer, a driving-shaft operatively coupled to said pointer, and provided with a drum or wheel having two slots, each provided with appropriately-inclined working faces, and with intermediate stop-faces, and two armature-levers actuated by appropriate magnets, and provided at their working ends with pins which occupy said cam-slots, substantially as described, said stop-faces serving to restrict the pointer to a precise step-by-step movement, and also for locking it against accidental rotation.

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