No. 725,592. PATENTED APR. 14, 1903.

H. A. ROWLAND.

ART OF TELEGRAPHY.

APPLICATION FILED NOV. 23, 1897.

NO MODEL. 2 SHEETS—SHEET 1.

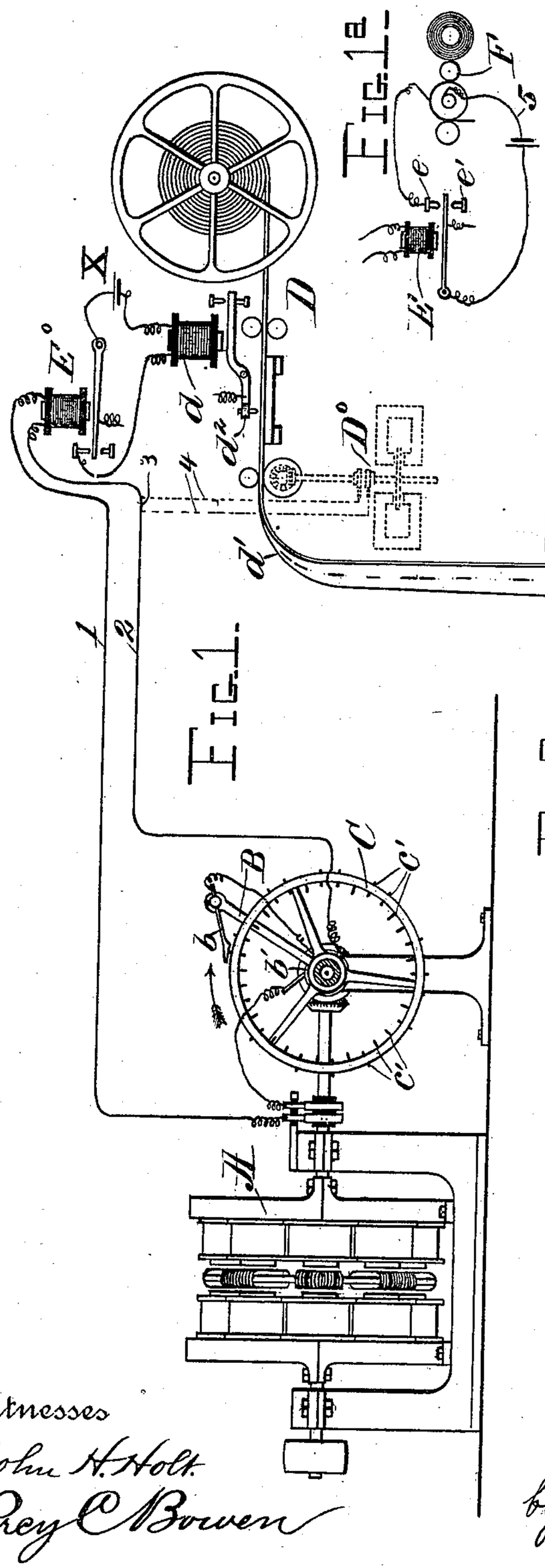

FIG. 1.

FIG. 2.

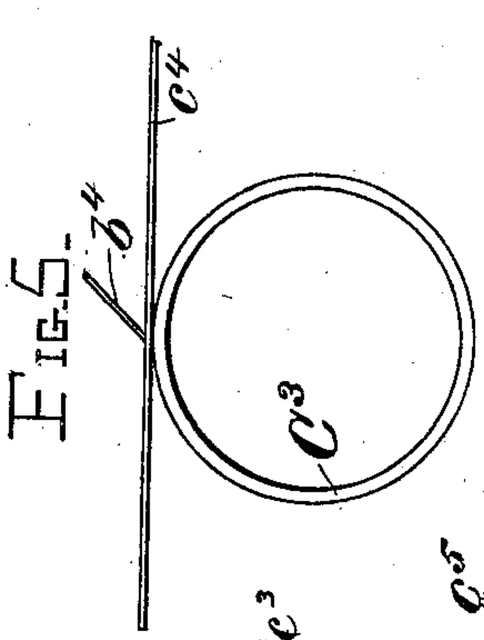

FIG. 5.

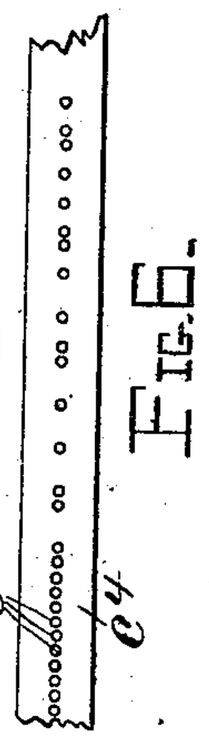

FIG. 6.

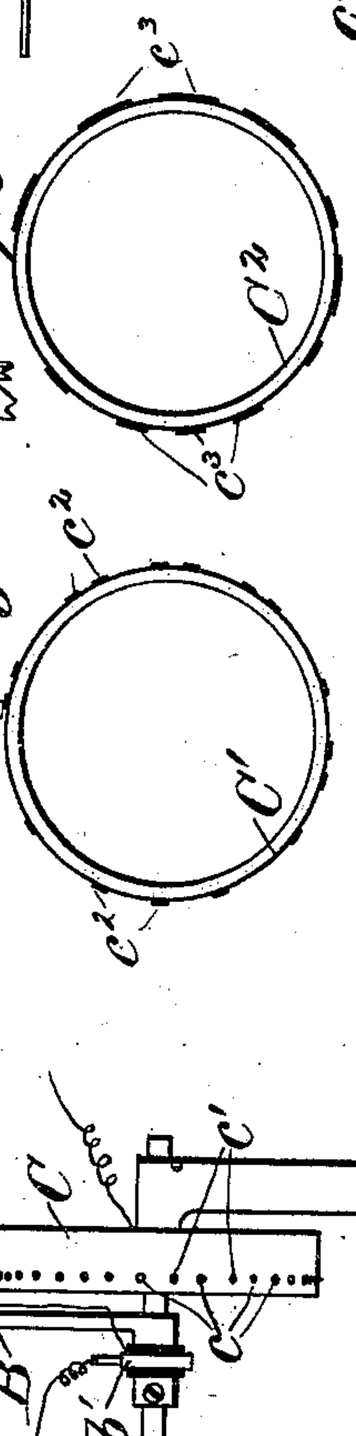

FIG. 4.

FIG. 3.

FIG. 7.

Witnesses
John A. Holt.
Percy C. Bowen

Inventor
Henry A. Rowland.
by Wilkinson & Dieher.
Attorneys.

No. 725,592. PATENTED APR. 14, 1903.

H. A. ROWLAND.

ART OF TELEGRAPHY.

APPLICATION FILED NOV. 23, 1897.

NO MODEL. 2 SHEETS—SHEET 2.

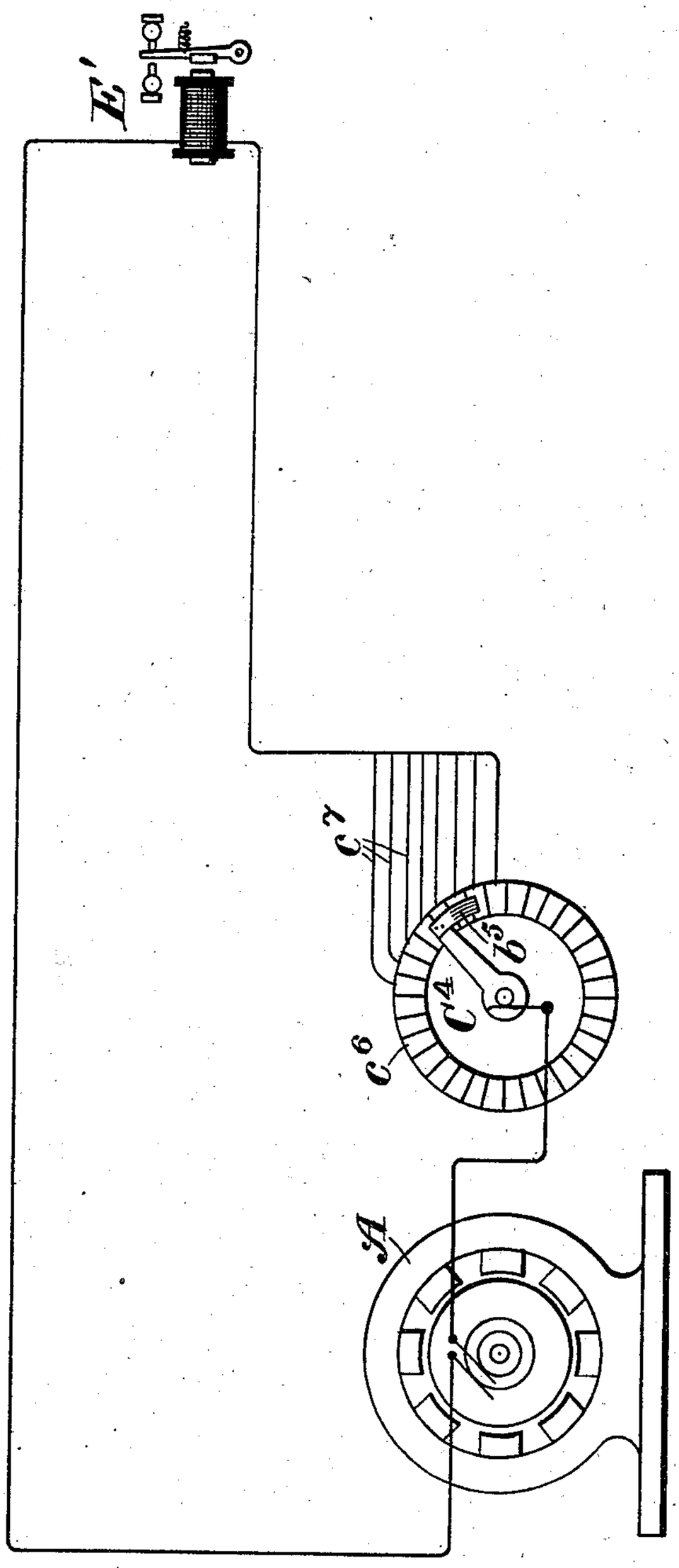

FIG. 7.

Witnesses

John A. Holt.

Geo. A. Byrne.

Inventor

H. A. Rowland.

By Wilkinson & Fisher.

Attorneys

UNITED STATES PATENT OFFICE.

HENRY A. ROWLAND, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE ROWLAND TELEGRAPHIC COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF NEW JERSEY.

ART OF TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 725,592, dated April 14, 1903.

Application filed November 23, 1897. Serial No. 659,629. (No model.)

To all whom it may concern:

Be it known that I, HENRY A. ROWLAND, a citizen of the United States, residing at Baltimore city, State of Maryland, have invented certain new and useful Improvements in the Art of Telegraphy; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in the art of telegraphy, and more particularly to an improved method of transmitting intelligence by means of alternating electric currents.

Specifically considered, the invention consists in transmitting intelligence over an alternating-current circuit by modifying one or more of the current impulses for each character or symbol or combination of characters or symbols by cutting out or suppressing the said impulses of the current in combinations and so adjusting the times of current modification that such times shall commence at the point of zero current, or, in other words, at the non-sparking point of the current.

The invention further contemplates the allowance for the difference in phase between the impressed electromotive force and resultant current in the modification of current above referred to.

By the employment of an alternating current in this manner messages may be transmitted much greater distances without relaying and without diminution in speed than could otherwise be possible. Moreover, the present method of transmission lends itself readily to many of the well-known methods of receiving or recording messages, as well as to special forms of type-printing receivers. Indeed, it is not intended to limit the present invention to any special form of receiver or recorder.

The said invention further consists in the novel features herein described, and particularly pointed out in the claims.

Referring to the accompanying drawings, Figure 1 is a diagram representing one of the forms of my transmitting device as used with a Morse recorder. Fig. 1ª is a diagram showing connections to a Bain recorder. Fig. 2 represents a part of the transmitting apparatus in front elevation. Fig. 3 represents a form of the device for suppressing the waves. Fig. 4 represents another form of the same. Fig. 5 represents still another form of apparatus for suppressing the waves. Fig. 6 is a plan view of the tape employed in the device shown in Fig. 5. Fig. 7 is a diagram illustrating the case in which I carry out my invention by suppressing the impulses by breaking the segment-circuits of a sunflower device through which pass the impulses to line.

Similar letters and numerals refer to similar parts throughout the several views.

Referring first particularly to Fig. 1, A represents an alternating-current generator of any approved form adapted to deliver its current to the line 1 2. An arm B, carrying a brush *b*, is suitably mounted near the said generator and is so geared therewith that it rotates in synchronism with the said alternator or alternating current. Obviously this arm B may be driven in synchronism with the current either by connecting it directly to the alternator-shaft, gearing it therewith in any well-known way, or by driving the same by a special synchronizing device, such as is described in Letters Patent No. 622,636, granted to me April 4, 1899, and, indeed, in any event where a transmitter is employed at a distance from the generating-station it is my purpose to drive them by the said synchronizing device. Suitably mounted near this arm B and so that the brush *b* may revolve around and make contact with its periphery is a metallic ring C. This ring C is provided with a plurality of small holes *c*, extending radially through the ring, and in each of these holes is inserted an insulating pin or peg *c'*. The holes *c* are arranged at equal intervals from each other, and the distance between two adjacent pins plus the thickness of the pins is equal in length to the distance from one zero-point of the current to the next zero-point thereof. The contact portion of the brush *b* or that portion which makes contact with the ring C is of such length that for a given angular velocity of the said brush or ring the time that the said brush takes to pass over a given point

on the surface of the said ring is equal to the time consumed by the current in passing from one zero-point to the next. The holes *c* are so arranged that they will at all times be in the path of the brush *b*—that is, of course, as long as the apparatus is in an operative condition. One terminal of the alternator A is electrically connected with the brush *b* through the collector-ring *b'*, and the other terminal is connected direct to line. The electric current passes from the brush *b* through the metallic ring C and out to line-wire 1, as shown, though obviously instead of being connected to the line-wire the ring C may be connected to earth.

For receiving the message sent by my transmitter I have shown in Fig. 1 a Morse recorder D. In showing such a recorder it is not attempted to represent all of the working parts of a complete Morse machine, but just enough thereof to show the adaptability of such an instrument to my system. Obviously this instrument may be either an embossing or ink-recording instrument. The line-wires 1 2 are connected to a line-relay E^0. One of the contacts of this line-relay is connected to one terminal of the magnet *d* of the recorder, and the other terminal of the recorder-magnet is connected through the local battery X to the tongue of the line-relay, as shown. The paper strip *d'* is fed along in front of the recorder d^2, as is usually done with such instruments, or the paper-feeding may be accomplished in another way. If it is desired to have the paper strip *d'* travel in synchronism with the alternator or the line-current, I may gear one of my synchronizing devices D^0 to the paper-feeding apparatus, in which case the line-circuit would be broken at the point 3 and the connections made to the synchronizing device, as shown by dotted lines 4, or the said synchronizing device may be operated by a current relayed from the main line.

The operation of the device is as follows: Assuming that none of the pins *c'* project beyond the outer surface of the ring C, an uninterrupted alternating current will be delivered from the alternator A through the brush *b* and ring C to the line 1 2 and to the relay. As long as this uninterrupted alternating current continues to flow over the line and through the coils of the relay-magnet that magnet will cause the recorder d^2 to make a mark on the strip *d'* for each semicycle of the alternating current, the length of the said marks depending upon the speed of the paper strips and the frequency of the alternations. The marks thus recorded on the strip will have the appearance of a broken line, the space between the successive marks representing the point in the current where it becomes zero. Obviously if the local circuit is completed through the lower contact of the relay for every suppressed wave then the recorder would make a mark for each suppressed wave. Now should one of the semicycles be cut out or otherwise suppressed the recorder line-relay will for that length of time cease to act, and the record on the strip d^2 will be a space. If two semicycles are suppressed in succession, the record will be a correspondingly long space, and so on. The ways of suppressing these waves or semicycles are numerous, I having shown in my Patent No. 622,636 many such ways; but in the present application I shall confine myself to one method—that is, by interposing an insulator or its equivalent, so far as this invention is concerned, between two electrical conductors for a definite time. It has been herein shown that as long as the pins *c'* did not project beyond the surface of the ring C an uninterrupted alternating current would be delivered to the line. It is then obvious that if one of these pins is allowed to project beyond the surface of the ring once in every revolution the brush *b* will come in contact with the said pin, which will raise the brush from the ring and keep it in this position until it has passed out of contact with the pin. Therefore one complete semicycle will be cut out or suppressed every time the brush *b* passes over one of the projecting pins. If two adjacent pins are made to project, then they will cut out a whole cycle; if three, three semicycles, and so on. If I desire to send the letter "M" according to the Morse continental code, two adjacent pins would be projected beyond the surface of the ring, which would raise the brush *b* from contact with the ring long enough to suppress a whole cycle, which would be represented on the paper strip of the Morse instrument (or Bain receiver, as I will presently show) by a long space, which may represent a dash of the Morse code. I do not, however, confine myself to the use of the Morse continental code, as it is obvious that many other codes may be used with this invention. If it is desired to send the letter "O," then six pins are projected beyond the surface of the ring C, but not six consecutive pins. The letter "O" is represented by three dashes. Hence two adjacent pins would be projected, one skipped, two more projected, one skipped, and two more adjacent ones projected. The pins skipped between each pair projected will allow a semicycle to be recorded between each dash or long space on the paper strip. The letters on the strip may be separated from each other by two or more marks indicating semicycles, and the separate parts of each letter may be separated by one or more of such marks, as may be found convenient. As shown, the pins on the ring C are arranged to send the word "Morse," the projection of one pin representing a dot and the projection of two adjacent pins a dash.

I have shown one way of suppressing one or more semicycles of an alternating current by introducing insulation in the form of a small pin between a metal surface and a brush

the length of the contact-surface of which is equal to that of a semicycle of the alternating current. It will be next shown how the same result may be accomplished by other devices.

Instead of employing the small pins, as shown in Fig. 1, and the brush b, with its broad contact-surface, I may diminish the length of the contact-surface of the brush to correspond to that of a quarter of a cycle of the alternating current and make the pins of the same length plus the length of the space which occurs at the zero-point of the current. Such an arrangement is shown in Fig. 3, where C′ represents the metallic ring, c^2 the insulating-pieces corresponding to the pins c' and b^2, the brush corresponding in function to brush b, but with its contact-surface half as long. Obviously when an insulating-piece c^2 comes beneath the brush or as the brush passes over an insulating-piece one semicycle of the current will be cut out or suppressed. Further, I may increase the length of the insulating-pieces on the ring, so that each will correspond to the time of the passage of a single semicycle, and may diminish the contact-surface of the brush to a mere point, or nearly so. This arrangement is shown in Fig. 4, where C^2 is the ring, c^3 the insulating-pieces, and b^4 the brush. I may develop this principle further by joining all of the insulating-pieces together, perforating them, and allowing the brush to make contact with the said conducting-surface through the successive perforations. Such means is shown in Fig. 5 and constitutes the ordinary transmitting-tape so well known in the art of telegraphy. The tape c^4, having perforations c^5, is made to pass between the brush b^4 and conducting-surface C^3. As long as the perforations in the tape are separated by a very thin piece of the tape, as shown, each successive semicycle will be recorded; but when the space occupied by one of these perforations is closed this will insulate the brush from the conducting-surface for a sufficient time to cut out or suppress one semicycle. By closing two or more of the holes obviously as many more semicycles will be suppressed or cut out.

Reference will next be had to Fig. 7, which shows still another way of carrying out the invention. In this case a ring C^4, composed of metal segments c^6, separated by insulation, is employed in the place of the rings C C^3, and b^5 represents the brush, which is adapted to travel over the segments of the rings C^4 at the proper speed and in this case is adapted to rest on a small portion only of a segment. This brush may be driven by the alternator or in any other suitable manner. A′ represents the alternating-current generator, and c^7 conductors connecting the segments of the ring C^4 to line. All of the segments c^6, or as many as desired, may be thus connected to line, as will hereinafter be more fully explained. The segments c^6 are of such a breadth, measured circumferentially, and the brush b^5 is driven at such a speed that the said brush passes over one complete segment for each semicycle of the alternating current developed, and as the brush passes over the segments connected to line as long as no message is transmitted the semicycles will pass to line uninterrupted. If the continuity of any of the conductors c^7 is broken, the segments connected to those conductors will be rendered dead, so that the semicycles which would otherwise have been transmitted to line through such segments will be cut out or suppressed. Therefore by breaking the segment circuits through the conductors c^7 in desired combinations the semicycles of the alternating current may be thus cut out in corresponding order, and the order in which these semicycles are thus suppressed may constitute a code for the transmission of intelligence, as described with relation to Fig. 1. As to the manner of breaking the continuity of the segment-circuits, this may be done either by the keyboard shown in the Patent No. 622,636 or improvements thereon or in any other suitable way, so that the combinations of circuits thus interrupted shall render corresponding segments c^6 dead in the proper combinations to transmit the intelligence.

In all of the above-described ways of cutting out or suppressing the alternating current the transmitter is so adjusted that the semicycles will be cut or suppressed at that part of the current where the sparking will be a minimum, and this has been found to be at or approximately the point of zero current and not electromotive force as long as there is a difference of phase between the impressed electromotive force and the resultant current, which will be the case upon an alternating-current circuit of the character to which this invention is applied. The best and only practical way of allowing for this difference of phase and cutting the current at or as near the zero-point as possible is simply to adjust the transmitting apparatus until the sparking at the point where the circuit is interrupted is reduced to a minimum or practically zero. This, as stated above, will be point of zero current. The above may be accomplished by adjusting any of the rings C C^4 or the brushes which pass over them and in the case illustrated in Fig. 7 is attained by causing the brush b^5 to start upon a segment just as the current is commencing to rise from zero, or, in other words, by causing the insulation between the segments to coincide with points of zero current.

Though no special method of receiving is claimed as a part of this invention, messages transmitted as herein described may be received in many ways. In Fig. 1^a is shown a Bain chemical receiver F, connected to a relay E through a local battery-circuit 5. By disconnecting the line 1 2 from the relay E^0 and connecting it to the magnet of the relay E this Bain receiver will record the present

and absent semicycles, as may also be done with the Morse recorder. As each semicyle of the current passes through the relay E it will cause it to attract its armature and cause the same to complete the local circuit through the Bain receiver, thus recording each semicycle as it arrives, and when one or more of the said semicycles are suppressed or cut out the tongue of the relay R fails to complete the local circuit, and therefore causes the absence of such semicycle or semicycles to be indicated on the chemically-prepared strip by a space, just as with the Morse receiver. When the Bain receiver is supplied with a recording-strip treated with chemicals in such a way that both positive and negative impulses will be recorded on one face of the strip, or where the strip is made very thin, so that when held before a bright light the record on both sides of the strip may be read (in which latter case a lower stylus would be used in addition to the upper one) the relay E may be done away with and the alternating current directly recorded. Obviously I may employ one of my synchronizing devices before referred to for feeding the record-strip.

In Fig. 7 the relay E′ represents any suitable receiver and in the case shown is a main-line relay, to which may be connected any of the well-known receivers or type-printing machines—such, for example, as described in the Patent No. 622,636, hereinbefore referred to, or improvements thereon.

Multiplexing may be accomplished by dividing the segments of the ring C^4 into groups—four, for example, in which each group would occupy a quadrant of a ring—and operating these groups independently, as fully set forth and described in Patent No. 622,636, referred to. The line connecting the transmitting and receiving apparatus may be either wholly metallic, as shown, or grounded.

What I claim is—

1. The improvement in the art of telegraphy, which consists in impressing upon a line an electromotive force of a periodically-varying character, having alternate impulses of opposite polarity, suppressing a number of impulses for each character or signal, and adjusting the times of the commencement of the suppression of said impulses, with reference to the difference in phase between the impressed electromotive force and resultant current, so that said times shall coincide with the times of zero current.

2. The improvement in the art of telegraphy, which consists in impressing upon a line an electromotive force of a periodically-varying character, having alternate impulses of opposite polarity, suppressing a predetermined number of impulses for each character or signal, and adjusting the time of the commencement of the suppression of said impulses, with reference to the difference in phase between the impressed electromotive force and resultant current, so that said times shall coincide with the times of zero current, and receiving the signals thus transmitted.

3. The improvement in the art of telegraphy, which consists in impressing upon a line an alternating electromotive force of sine-wave or approximately sine-wave form, suppressing a predetermined number of impulses for each character or signal, and adjusting the time of the commencement of the suppression of said impulses, with reference to the difference in phase between the impressed electromotive force and resultant current, so that said times shall coincide with the times of zero current.

4. The improvement in the art of telegraphy, which consists in impressing upon a line an alternating electromotive force of sine-wave or approximately sine-wave form, suppressing a predetermined number of impulses for each character or signal, and adjusting the time of the commencement of the suppression of said impulses, with reference to the difference in phase between the impressed electromotive force and resultant current, so that said times shall coincide with the times of zero current, and recording the signals thus transmitted.

5. The improvement in the art of telegraphy, which consists in impressing upon a line an alternating electromotive force, suppressing a predetermined number of impulses for each character or signal, and adjusting the time of the commencement of the suppression of said impulses, with reference to the difference in phase between the impressed electromotive force and resultant current, so that said times shall coincide with the times of zero current, and making a visual record of the signals thus transmitted.

In testimony whereof I affix my signature in presence of two witnesses.

HENRY A. ROWLAND.

Witnesses:
MURRAY HANSON,
WILLIAM H. BERRY.