

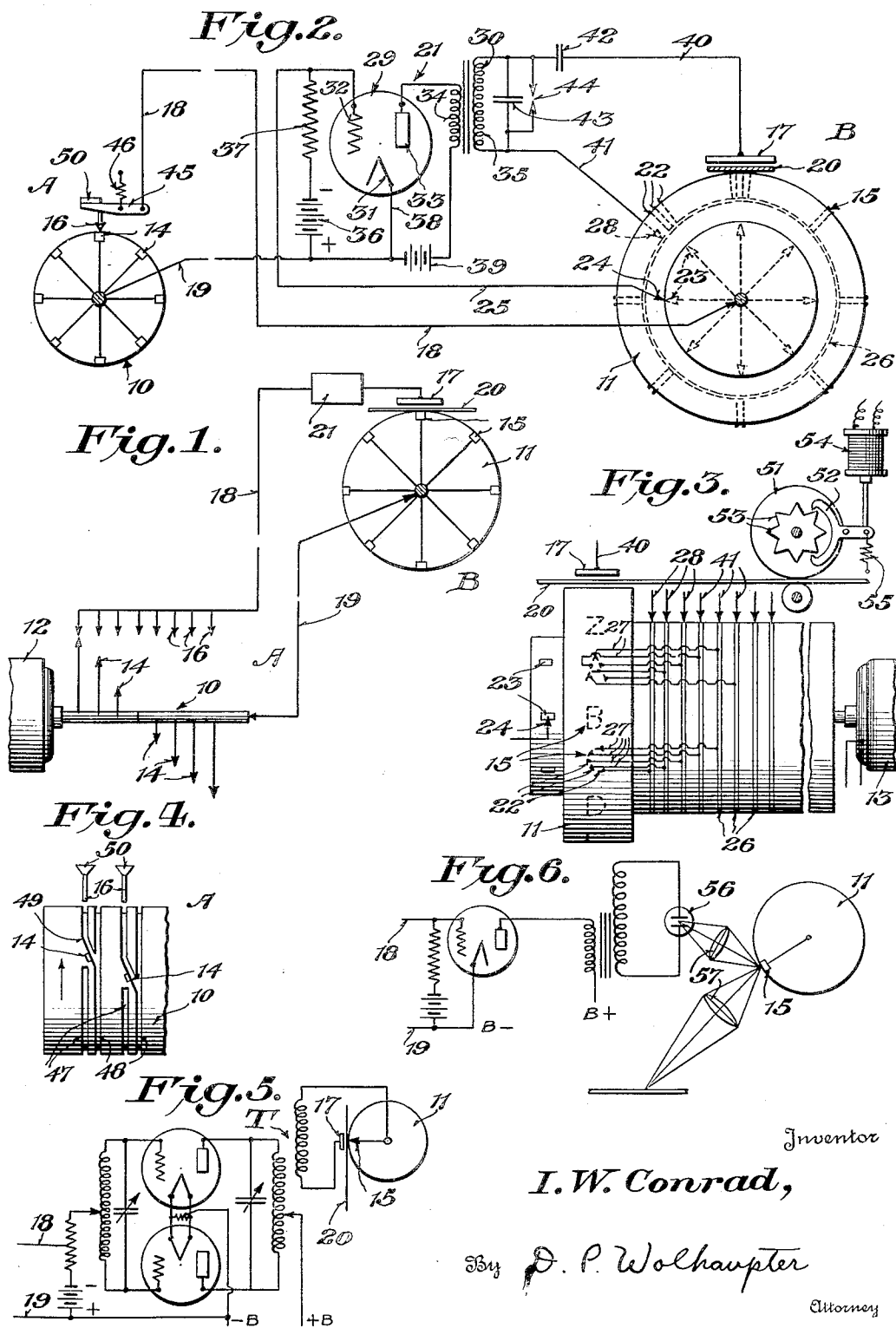
Nov. 7, 1939.

I. W. CONRAD

2,178,989

SYSTEM OF TELEGRAPHY

Filed July 19, 1937



Inventor

I. W. Conrad,

By D. P. Wolhaupter

Attorney

UNITED STATES PATENT OFFICE

2,178,989

SYSTEM OF TELEGRAPHY

Ivan Willard Conrad, Washington, D. C.

Application July 19, 1937, Serial No. 154,511

30 Claims. (Cl. 178—15)

This invention relates to telegraphy, and has for its primary object to provide simple, practical, extremely high speed means for the recording at a receiving station of characters selected
5 at a sending station.

Another object of the invention is to provide an extremely high speed telegraph system which is quite flexible in that it may be operated either by wire or radio transmission; in that the selection of characters at the sending station may be effected by actuation of keys or by a perforated tape in a known manner, and in that the recording of the characters may be effected either by spark discharges or through the agency of electro-magnetic radiant energy acting upon a suitable recording medium, as, for example, photographically.

With the foregoing general object in view the invention consists in the novel combinations and arrangements of features as will be hereinafter more fully described, illustrated in the accompanying drawing and defined in the appended claims.

In the accompanying drawing, wherein are illustrated different practical embodiments of the invention and wherein like characters of reference denote corresponding parts in related views:

Figure 1 is a diagrammatic view illustrating the general principle of the invention.

Figure 2 is a diagrammatic view illustrating one practical embodiment of the invention.

Figure 3 is a side elevation of the receiving station mechanism diagrammatically illustrated in Fig. 2.

Figure 4 is a side elevation of the sending station mechanism diagrammatically illustrated in Fig. 2; and

Figures 5 and 6 are diagrammatic views illustrating alternative forms of recording means which may be used in lieu of the recording means shown in Figs. 2 and 3.

Referring to the drawing in detail, A and B designate generally, and respectively, sending and receiving station mechanisms including rotatable elements 10 and 11, respectively, which, in accordance with the invention, are driven at high speeds and partake of equal, or substantially equal, angular increments of movement during any given period of operation of the system. In this connection the synchronous or the substantially synchronous driving of said elements 10 and 11 may be effected in any suitable manner, as, for example, through the instrumentality of synchronous electric motors designated as 12 and

13, respectively, which may derive their power either from a common A. C. source or from separate frequency sources. If said motors derive their power from a common A. C. source they will be synchronized within their angular "hunting" limit. If, on the other hand, said motors derive their power from separate frequency sources, they must be approximately synchronized and any error in synchronization may be permitted to accumulate for one or a series of revolutions but must periodically be reduced to zero, which can be done by timing impulses in a well known manner. In other words, while it is not essential to the successful operation of the present invention that the elements 10 and 11 be exactly synchronized, it is essential that they be driven approximately synchronously, either by synchronous motors or in some appropriate manner, as aforesaid.

The rotatable element 10 of the sending mechanism A carries a plurality of contacts 14 which are spaced angularly about the axis of rotation of said element and also longitudinally along said element. On the other hand, the rotatable element 11 of the receiving mechanism B carries a plurality of characters 15 which are spaced angularly about the axis of rotation of said element corresponding to the angular spacing of the contacts 14, but which are disposed in a common plane normal to the axis of rotation of said member.

A plurality of contacts 16, one individual to each of the contacts 14, are provided for cooperation with said contacts 14. These contacts 16 normally are disposed out of the paths of rotation of the contacts 14, but are movable into the paths of rotation of said contacts 14 so as to be engaged by said contacts 14 responsive to rotation of the element 10. Moreover, said contacts 16 are disposed in a common plane including the axis of rotation of the element 10 and thereby have fixed positions so far as concerns rotation of the element 10 and the contacts 14, so that no two of said contacts 16 can simultaneously engage related contacts 14 because of the aforesaid angular spacing of the contacts 14.

The characters 15 are, according to one practical embodiment of the invention, in the form of electrodes and cooperate with an electrode 17 which is mounted outwardly of and adjacent to the rotatable element 11 in a fixed position, so that the characters 15 successively move past the same in suitable spaced relationship thereto as the element 11 rotates.

Since the elements 10 and 11 rotate synchro-

nously or approximately synchronously, and since the contacts 14 and the characters 15 are equally spaced apart angularly, it is apparent that the individual contacts 16 are related to the individual characters 15. In other words, it is apparent that when any given contact 16 is engaged with its related contact 14, a certain one of the characters 15 is aligned, or approximately is aligned, with the fixed electrode 17. Thus, upon moving any given contact 16 into the path of rotation of its related contact 14, and upon subsequent movement of the related contact 14 into engagement with said contact 16 as a result of rotation of the element 10, the related character 15 will be in a position in alignment with the fixed electrode 17. The contacts 16 may bear characters or designations corresponding to the related characters 15. Thus, by the selection of a contact 16 bearing any particular designation or character, and by the actuation of said contact so that the related contact 14 will engage therewith, there is assured that, upon engagement of the related contact 14 therewith, the corresponding character 15 will be in a position aligned with the electrode 17 when engagement between the contacts 14, 16 occurs. In this connection any suitable means responsive to engagement of any given pair of the contacts 14, 16 with each other, may be provided to effect recording of the related character 15 at the instant of its alignment with the fixed electrode 17. One such means is illustrated conventionally in Fig. 1, from which figure it will be observed that all of the contacts 16 are connected with the electrode 17 by a common line wire 18; that all of the contacts 14 are connected with all of the characters 15 by a common line wire 19; that a suitable recording medium 20 affected by spark discharge is interposed between the element 11 and the fixed electrode 17, and that interposed in the line wire 18 is a means 21 for producing a spark discharge between the electrode 17 and the particular character 15 which may be aligned therewith when the circuit is closed by engagement of a related pair of the contacts 14 and 16. Thus, upon closing of the circuit as a result of movement of any selected contact 16 into the path of movement of its related contact 14 and subsequent movement of the contact 14 into engagement with the selected contact 16, a recording of the character 15 related to the selected contact 16 will be effected on the recording medium 20 by spark discharge between the electrode 17 and the said related character 15.

The recording medium 20 may be in the form of a strip of paper or other suitable material sensitized or otherwise treated so as to be affected by spark discharge, and any suitable means may be provided for advancing the same as the characters 15 are successively recorded so that the successively recorded characters will be properly spaced and will follow one another in a line on the recording medium. In this connection it is well known that synchronous motors tend to over-run or lag behind one another, which is called "hunting." Obviously, if such "hunting" occurs between the synchronous motors driving the elements 10 and 11 the characters 15 may not be recorded in a straight line, but may be more or less staggered with respect to each other. Accordingly, a feature of the present invention resides in the provision of means to assure straight line recording of the characters 15. Moreover, while some or all of the characters 15 may comprise only a single electrode for cooperation with the fixed electrode 17, it is preferred that said

characters, except in the cases of such of the same as are relatively small, as commas, periods and the like, shall be comprised by pluralities of electrodes designated as 22, and that the spark discharges between the fixed electrode 17 and the different electrodes 22 shall be distinct from each other, thereby to assure recording of the complete outlines of said characters 15. These features of the invention, as well as a novel spark discharge producing means especially suited for use in the present system, are illustrated in Figs. 2 to 4 of the drawing.

Referring in detail to Figs. 2 to 4 which illustrate a refined embodiment of the invention as compared with the conventional Figure 1 illustration, it will be observed that the rotatable element 11 is provided with a series of contacts 23 which are angularly spaced apart corresponding to the angular spacing of the characters 15; that a fixed contact 24 is provided for cooperation with said contacts 23; that the line wire 18 connects all of the contacts 16 with all of the contacts 23; that a wire 25 leads from the fixed contact 24 to the spark discharge producing means designated generally as 21, and that the line wire 19 connects all of the contacts 14 with said spark discharge producing means 21. It will further be observed that the rotary element 11 carries a plurality of conductor rings 26; that there are separate connections 27 between said rings and the electrodes 22 of each of the characters 15, and that each conductor ring 26 has cooperating therewith an individual fixed contact 28.

Of course, some of the characters 15 may be comprised by a greater or lesser number of electrodes 22 than other of said characters. Accordingly, there are as many of the conductor rings 26 as the maximum number of electrodes in any given character 15 so that each electrode of each character may have a connection 27 with a distinct ring. Thus, all of the rings 26 may be utilized to provide separate connections for the electrodes 22 of certain of the characters 15 and only some of said rings may be utilized to provide separate connections for the electrodes of other of said characters, depending, of course, upon the number of electrodes comprising the different characters.

There is a spark discharge producing means 21 individual to each of the conductor rings 26 to assure a separate spark discharge between the electrode 17 and each of the electrodes 22 comprising any given character being recorded. Since, however, said spark discharge producing means are, or may be, duplicates of one another, only one of the same has been illustrated for the sake of simplifying the description and to avoid complicating the illustration.

As illustrated in Fig. 2 the present novel spark discharge producing means includes essentially a vacuum tube 29 and a step-up transformer 30, the vacuum tube 29 including, as usual, a filament 31, a grid 32 and a plate 33, and the transformer 30 including, as usual, primary and secondary windings 34 and 35, respectively. The line wire 19 is connected with the filament 31 of the tube 29; the wire 25 is connected with the grid 32 of said tube 29, and across the wires 19 and 25 are connected a source of E. M. F. 36 and an impedance 37, these connections comprising the input circuit of said spark discharge producing means.

The plate 33 of the tube 29 is fed from a high voltage source 38 in a circuit 39 between said plate and the filament 31 and in said circuit is interposed the primary winding 34 of the trans-

former 30. In addition, the secondary winding 35 of the transformer 30 is connected at one end with the fixed electrode 17 by a wire 40 and at its other end with the related contact 28 by a wire 41, these connections comprising the output circuit of the spark discharge producing means, of which the transformer output may be condensed either by a series capacitance 42, or by a parallel capacitance 43, or by both. Preferably, a safety spark gap 44 also is provided.

Now, in view of the foregoing it will be apparent that normally a high negative bias is applied to the grid 32 of the tube 29 by the source of E. M. F. 36 and that upon engagement of any given contact 23 with the fixed contact 24 while the related pair of the contacts 14, 16 are engaged with each other, said bias will be removed, thereby permitting a large increase in plate current through the tube 29 with consequent creation of a high potential across the secondary 35 of the transformer 30 and the production of a spark discharge between the fixed electrode 17 and one of the electrodes 22 comprising the character 15 which, at the instant of engagement of the related contact 23 with the fixed contact 24, is alined with the fixed electrode 17.

The contacts 14, 16 have sufficient relative width to remain engaged with each other throughout the angle represented by the maximum "hunting" range of the synchronous motors 12 and 13. The contacts 23 are, on the other hand, of knife-edge type to assure that a spark discharge between the fixed electrode 17 and any given character 15 will occur only when said character 15 is exactly alined with said fixed electrode 17. Thus, straight line recording of the characters 15, as distinguished from staggered recording thereof, is assured. Moreover, since there is, as aforesaid, one of the spark discharge producing means 21 individual to each of the rings 26 and, therefore, individual to each of the electrodes 22 of each of the characters 15, it is apparent that there will occur a separate spark discharge between the fixed electrode 17 and all of the electrodes 22 of any character being recorded, with the result that a distinct outline of the complete character will be recorded.

When the input circuits of the spark discharge producing means are broken a high negative bias is reapplied to the grids of the tubes 29 with consequent sharp decrease in the plate current of said tubes. This sharp decrease also develops a high voltage and a spark discharge. Accordingly, by suitably proportioning the width of the contacts 23 it obviously is possible to make the two spark discharges occur within a very small arc of revolution of the characters 16 to obtain the effect of both discharges in recording said characters. On the other hand, it obviously is possible by proper choice of circuit constants to utilize either of the spark discharges to the exclusion of the other.

In the foregoing description the vacuum tube 29 is assumed to be of the high vacuum type. However, it is to be understood that grid controlled gaseous discharge tubes may be used equally as well with proper choice of circuit components and constants.

According to the specific embodiment of the invention illustrated in Figs. 2 to 4, the contacts 16 are disposed above the rotatable element 10 and are in the form of laterally deflectable fingers depending from pivoted lever arms 45 which are constantly urged upwardly by spring means 46. Accordingly, said fingers normally are

held out of the paths of rotation of their related contacts 14, but are depressible to positions where they will be engaged by said contacts 14 and, when released, will return to their normal positions. In this connection a feature of the invention resides in the provision of means whereby depression of any given contact 16 into the path of rotation of its related contact 14 will result in engagement of said contact 14 with said contact 16 only once even though the contact 16 may be held depressed, thereby to assure that the related character 15 will be recorded only once despite the high speed rotation of the element 10 and despite the possibility, and probability, that the contact 14 may travel past the contact 16 a number of times while the latter contact is held depressed. In the present instance the means referred to comprises, in association with each of the contacts 16, two channels 47 and 48 (Fig. 4) in the element 10 respectively alined with and disalined from the contact 16 when the latter is in its normal, retracted position. The last mentioned channel 48 of each pair is annular, and the companion channel 47 is substantially annular, but instead of continuing entirely around the element 10, is interrupted and is joined, at its trailing end, as regards the direction of rotation of the element 10, with the channel 48 by a diagonal channel 49 in which, at the side thereof toward the channel 47, is located the contact 14. Accordingly, when the contact 16 is depressed, its lower end enters the channel 47 and remains therein until, by rotation of the element 10, it is deflected into the channel 48 by the diagonal connecting channel 49. As this deflection or switching occurs the contact 14 wipes against the contact 16 and provides for closing of the related circuit by engagement of the related contact 23 with the fixed contact 24 at the instant when the related character 15 is exactly alined with the fixed electrode 17. Obviously, once the contact 16 is deflected laterally into the channel 48, it will remain therein as long as it is held depressed and cannot again enter the channel 47 until it has been released and again depressed, which means, of course, that despite the high rotary speed of the element 10, the related circuit will be closed once, and only once, upon depression of any given contact 16, no matter how long said contact may be held depressed. In short, the means described insures against repeated records of any character 15 being made on the recording medium 20 as the result of any single actuation of the related contact 16.

The arms 45 carrying the contacts 16 may be arranged in the manner of the keyboard arms of a typewriter, and may be equipped with finger buttons or keys 50 having thereon characters corresponding to the related characters 15. Alternatively, any suitable means other than the means described may be provided for controlling engagement and disengagement of the contacts 14, 16. For example, engagement and disengagement of said contacts may be under the control of a perforated tape in a manner well known in so-called tape transmission telegraph systems.

As aforesaid, any suitable means may be employed to effect advance of the recording medium 20 as recordation of successive of the characters 15 takes place. As illustrated in Fig. 3 this means may comprise a wheel or roll 51 rotatably urged by a spring or other suitable means

in a direction to advance said medium 20; an escapement lever 52 cooperating with teeth 53 on said wheel or roll, and suitable electro-magnetic means 54 cooperating with spring means 55 to actuate said lever 52 to permit said wheel or roll 51 to advance the recording medium 20 one step each time a recording of any one of the characters 15 takes place. This electro-magnetic means may derive its actuating energy from a thermionic tube, the grid of which is affected by the recording impulse. There may also be provided any suitable means for actuating said sheet or strip advancing means for the purpose of obtaining spaces between characters 15 and between words or the like formed by groups of said characters, said means including, for example, a pair of contacts 14, 16 cooperating with a blank space in lieu of a character 15 on the element 11.

The forms of the invention illustrated in Figs. 1 to 4 utilize uni-directional sparks to effect recordation of the characters on the recording medium 20. However, it will be readily understood that other forms of spark discharges may be used. For example, the electrical discharge from a high frequency, high voltage source such as a Tesla coil might be used in lieu of the spark discharge heretofore described. A simplified circuit capable of actuating such a coil is shown in Fig. 5, wherein a Tesla coil for furnishing the high frequency, high voltage discharge is designated as T. With such a system it obviously is possible to record from continuous knife-edge outlines of the characters 15 as distinguished from dividing said characters into pluralities of dot-like or dash-like electrodes.

Further, it is apparent that instead of recording by means of spark discharges, the electrical impulses produced by operation of the sending mechanism A may be utilized to flash a neon or other discharge lamp or to create an intense spark to illuminate for a very brief period of time the character 15 disposed in recording position, thereby permitting the recording of the character through the agency of electro-magnetic radiant energy acting upon a suitable recording medium as, for example, photographically. A simplified circuit capable of accomplishing this result is shown in Fig. 6 wherein a glow lamp, subject to energization upon engagement of any related pair of the contacts 14, 16, is designated as 56 and has cooperating therewith lenses 57 for directing light from said lamp to the character 15 in recording position and from said character onto the recording medium 20.

While the drawing illustrates wire connections between the sending and receiving mechanisms A and B, it is manifest that such connections may readily be replaced by suitable wireless transmitting and receiving devices associated with the sending and receiving mechanisms A and B, respectively, and that it accordingly is within the purview of the invention to employ such devices if desired. Moreover, while only certain specific embodiments of the invention have been illustrated and described to convey the general concept of the invention, it is to be understood that the same is readily capable of various other embodiments within its spirit and scope as defined in the appended claims.

I claim:

1. In a telegraph system, a receiving station mechanism comprising spark discharge character recording means including recordable char-

acters in the form of letters, numerals and symbols and means with which said characters cooperate to effect complete, instantaneous recording of the same by substantially instantaneous spark discharge, and means controlling said spark discharge and selection of the characters to be recorded.

2. In a telegraph system, a receiving station mechanism comprising spark discharge character recording means including recordable characters in the form of letters, numerals and symbols, a recording medium, means with which said characters cooperate to effect complete, instantaneous recording of the same by spark discharge acting directly upon said recording medium, and means controlling said spark discharge and selection of the characters to be recorded.

3. In a telegraph system, a receiving station mechanism comprising character recording means, said means including recordable electrodic characters in the form of letters, numerals and symbols, and means with which said characters cooperate to effect complete, instantaneous recording of the same, said last mentioned means comprising an electrode, means for producing spark discharge between a selected electrodic character and said electrode, a recording medium affected by said spark discharge, and means controlling said spark discharge and selection of the characters to be recorded.

4. In a telegraph system, a receiving station mechanism comprising spark discharge electrodic character recording means including recordable electrodic characters in the form of letters, numerals and symbols and means with which said characters cooperate to effect complete, instantaneous recording of the same by substantially instantaneous spark discharge from the same, and means controlling said spark discharge and selection of the characters to be recorded.

5. In a telegraph system, a receiving station mechanism comprising spark discharge electrodic character recording means including recordable electrodic characters in the form of letters, numerals, and symbols, each comprised of a plurality of electrodes, and means with which said characters cooperate to effect complete, instantaneous recording of same by substantially instantaneous spark discharge from the same, and means controlling said spark discharge and selection of the characters to be recorded.

6. A telegraph system as set forth in claim 5 including a separate spark discharge producing means for each electrode of any given character.

7. In a telegraph system, a receiving station mechanism comprising character recording means, said means including recordable characters each comprised of a plurality of electrodes, means with which said characters cooperate to effect complete instantaneous recording of the same, said last mentioned means comprising an electrode, means for producing spark discharge between said electrode and the electrodes of a selected character, a recording medium affected by said spark discharge, and means controlling said spark discharge and selection of the characters to be recorded.

8. A telegraph system as set forth in claim 7 including a separate spark discharge producing means for each electrode of any given character.

9. In a telegraph system, a receiving station mechanism comprising character recording means including recordable characters and a recording element movable relative to each other, a sending station mechanism comprising rela-

tively movable circuit controlling means substantially synchronized with relative movement between said characters and said recording element and electrically interconnected with and controlling recording operation of said receiving station mechanism, and means in addition to the substantially synchronized relative movement between said characters and said circuit controlling means to assure that successive character recordations shall have the same recording position relative to a base line on a recording medium irrespective of deviations from perfect synchronism of said characters and said circuit controlling means.

10. A telegraph system as set forth in claim 9 in which the means to assure that successive character recordations shall have the same position relative to a base line on a recording medium comprises contacts one related to and movable with each character and controlling the electrical interconnection between the sending and receiving station mechanisms.

11. A telegraph system as set forth in claim 1 in which the spark discharge character recording means includes a transformer and a source of high frequency alternating current operating through said transformer to produce the spark discharge.

12. A telegraph system as set forth in claim 2 in which the spark discharge character recording means includes a transformer and a source of high frequency alternating current operating through said transformer to produce the spark discharge.

13. A telegraph system as set forth in claim 1 in which the spark discharge character recording means includes a transformer, and a vacuum tube oscillator to furnish high frequency alternating current for operation through said transformer to produce the spark discharge.

14. A telegraph system as set forth in claim 2 in which the spark discharge character recording means includes a transformer, and a vacuum tube oscillator to furnish high frequency alternating current for operation through said transformer to produce the spark discharge.

15. A telegraph system as set forth in claim 1 in which the spark discharge character recording means includes a transformer, and a vacuum tube operating as a relay through said transformer to produce the spark discharge.

16. A telegraph system as set forth in claim 2 in which the spark discharge character recording means includes a transformer, and a vacuum tube operating as a relay through said transformer to produce the spark discharge.

17. A telegraph system as set forth in claim 1 in which the spark discharge character recording means includes a recording spark gap, a transformer including a primary and a secondary, a vacuum tube operating as a relay through said transformer to produce a spark discharge at said recording spark gap, a second spark gap connected in parallel to the secondary of the transformer, and a series condenser connected between said spark gaps.

18. In a telegraph system, a receiving station mechanism comprising spark discharge character recording means including recordable characters in the form of letters, numerals, and symbols, a recording medium, means with which said characters cooperate to effect complete, instantaneous recording of same by substantially instantaneous spark discharge, said cooperating means including electro-magnetic radiant en-

ergy means acting directly on said recording medium to record characters, and means controlling said spark discharge and selection of the characters to be recorded.

19. In a telegraph system, a sending station mechanism including a plurality of contacts mounted for collective rotation about a common axis and spaced apart angularly and longitudinally relative to said axis, cooperating contacts selectively engageable with said first mentioned contacts and all disposed in a plane including said axis, a receiving station mechanism including a plurality of characters in the form of letters, numerals and symbols rotatable about a common axis and having the same angular spacing as said first mentioned contacts of said sending station mechanism, means for synchronously rotating said characters and the first mentioned contacts of said sending station mechanism, a character recording means, and electrical means whereby engagement of any selected contact of the second mentioned contacts of said sending station mechanism with a related first mentioned contact of said mechanism causes actuation of said recording means to effect substantially instantaneous spark discharge and recording of a complete related character by said spark discharge.

20. In a telegraph system, a receiving station mechanism including a fixed electrically operable recording means and constantly moving recordable characters successively movable into recording position relative to said means, and a sending station mechanism including constantly moving means synchronized with movement of said characters and electrically interconnected with said characters and said recording means so that said recording means may be subjected to a character recording impulse when any given character is disposed in recording position relative to said recording means, said characters being comprised by electrodes, said recording means including a fixed electrode for cooperation with said character electrodes, and said electrical interconnection including means for producing a spark discharge between said fixed electrode and the electrodes comprising any character aligned therewith when the circuit is completed through the electrodes of said character.

21. In a telegraph system, a sending station mechanism including a plurality of contacts mounted for collective rotation about a common axis and spaced apart angularly and longitudinally relative to said axis, cooperating contacts selectively depressible into the paths of rotation of said first mentioned contacts, means to assure only a single engagement between any given rotatable contact and its related second mentioned contact as a result of any one depression of any of said second mentioned contacts regardless of the number of revolutions made by the rotatable contact while the related contact is held depressed, and means operable responsive to engagement of any related pair of said contacts to record a character related to said pair of contacts.

22. In a telegraph system, a sending station mechanism, including a plurality of contacts mounted for collective rotation about a common axis and spaced apart angularly and longitudinally relative to said axis, cooperating contacts depressible into the paths of rotation of said first mentioned contacts, means to assure only a single engagement between any given rotatable contact and its related second mentioned contact

a result of any single depression of said second mentioned contact regardless of the number of rotations made by the rotatable contact while the related contact is held depressed, said means comprising trackways rotatable with said first mentioned contacts and effective to switch any second mentioned depressed contact out of the path of rotation of the related first mentioned contact after it has made contact thereon and to hold it out of the path of rotation of the first mentioned contact as long as the second mentioned contact is held depressed, and means operable responsive to engagement of any related one of said contacts to record a character related to said pair of contacts.

23. In a telegraph system, a receiving station mechanism including a plurality of characters rotatable about a common axis, said characters being composed of pluralities of electrodes, a fixed electrode for cooperation with any of said characters which, by rotation, may become aligned therewith, a separate spark discharge producing means for each electrode of any given character, means for each spark discharge producing means common to the electrodes of different characters, means for closing a circuit between said fixed electrode and the electrodes of any character aligned therewith and the spark discharge producing means related to said electrodes, and character recording means responsive to spark discharge between said fixed contact and the electrodes of any one of said characters aligned therewith.

24. In a telegraph system, a sending station mechanism including a plurality of contacts mounted for collective rotation about a common axis and spaced apart angularly and longitudinally relative to said axis, relatively fixed cooperating contacts selectively engageable with said first mentioned contacts, a receiving station mechanism including an electrode and a plurality of electrodic characters in the form of letters, numerals and symbols rotatable relative thereto about a common axis and having angular spacing such that upon selective engagement of any given second mentioned contact with its related first mentioned contact of said sending station mechanism, a related character is operatively positioned relative to said electrode, means for substantially synchronously rotating said characters and the first mentioned contacts of said sending station mechanism, electrical means operable in response to engagement of any given second mentioned contact of said sending station mechanism with its related contact to produce a spark discharge between said electrode and the complete character which, at the time of engagement of said contacts, is operatively positioned relative to said electrode, and a recording medium affected by said spark discharge.

25. The combination as set forth in claim 24 in which the means responsive to engagement of any given second mentioned contact of the sending station mechanism with its related contact to effect recording of the related character includes means in addition to the synchronization of the characters and the first mentioned contacts of the sending station mechanism to assure that successively recorded characters shall have the same recording position relative to a base line on the recording medium irrespective of deviations from perfect synchronization of the characters and the first mentioned contacts of the sending station mechanism.

26. In a telegraph system, a receiving station

mechanism including a rotatable series of angularly spaced characters, a sending station mechanism including a series of rotatable contacts individually related to and having the same angular spacing as said characters, means for synchronously rotating said contacts and characters, relatively fixed contacts for cooperation with said series of rotatable contacts, a recording medium, a fixed recording element for cooperation with said characters to effect recording of the latter on said recording medium, and electrical interconnections between said rotatable and said fixed contacts and said characters and said fixed recording element including means effective upon engagement of a fixed contact with its related rotatable contact to record the related character on said recording medium and to advance said recording medium.

27. A telegraph system as set forth in claim 26 in which the fixed recording element comprises an electrode, in which the characters are comprised by plural electrodes, and in which the electrical interconnections between the contacts and characters and recording element include means for producing separate spark discharges between the electrode comprising the fixed recording element and the electrodes comprising the characters.

28. A pair of electrodes and means for initiating spark discharge therebetween, said means comprising a vacuum tube having a filament, a control grid and a plate, a step-up transformer having a primary and a secondary winding, an output circuit between the secondary winding and said electrodes, a connection between the plate and the filament of said tube including the primary winding of said transformer, a substantially constant high voltage source in said connection, an input circuit including a pair of conductors connected, respectively, with the filament and the grid of said tube, a source of substantially constant E. M. F. and an impedance connected in series across said conductors, and means variably and substantially instantaneously controlling the potential between the control grid and the filament of said tube through a wide range, thereby to alter the effective resistance of the vacuum tube and to cause a spark discharge to be produced between said electrodes.

29. A pair of electrodes and means for initiating spark discharge therebetween, said means comprising a vacuum tube having a filament, a control grid and a plate, a step-up transformer having a primary and a secondary winding, an output circuit between the secondary winding and said electrodes, a parallel capacitance in said output circuit, a connection between the plate and the filament of said tube including the primary winding of said transformer, a substantially constant high voltage source in said connection, an input circuit including a pair of conductors connected, respectively, with the filament and the grid of said tube, a source of substantially constant E. M. F. and an impedance connected in series across said conductors, and means variably and substantially instantaneously controlling the potential between the control grid and the filament of said tube through a wide range, thereby to alter the effective resistance of the vacuum tube and to cause a spark discharge to be produced between said electrodes.

30. A pair of electrodes and means for initiating spark discharge therebetween, said means comprising a vacuum tube having a filament, a control grid and a plate, a step-up transformer

having a primary and a secondary winding, an output circuit between the secondary winding and said electrodes, an auxiliary parallel spark gap across said circuit, a series condenser in said circuit between said auxiliary spark gap and said electrodes, a connection between the plate and the filament of said tube including the primary winding of said transformer, a substantially constant high voltage source in said connection, an input circuit including a pair of conductors connected, respectively, with the filament and the

grid of said tube, a source of substantially constant E. M. F. and an impedance connected in series across said conductors, and means variably and substantially instantaneously controlling the potential between the control grid and the filament of said tube through a wide range, thereby to alter the effective resistance of the vacuum tube and to cause a spark discharge to be produced between said electrodes.

IVAN WILLARD CONRAD.