N° 17,707 A.D. 1902

Date of Application, 12th Aug., 1902—Accepted, 30th July, 1903

COMPLETE SPECIFICATION.

Improvements in Transmitting and Receiving Signals:

I, REGINALD AUBREY FESSENDEN, Electrical Engineer, residing at Manteo, County of Dare, State of North Carolina, United States of America, *do hereby* declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

The invention described herein relates to certain improvements in the transmission and receipt of multiple messages or signals.

In the system of wireless telegraphy now in use difficulty is experienced in the selection of messages or signals. This difficulty arises from the fact that when magnetic waves are generated from one point they move equally in all directions and will be received at all stations reached by the waves. The object of the present invention is to provide for the generation at the sending station in varying order, of two or more series of groups of magnetic waves or electrical impulses, the waves or impulses of each of the series or groups differing from those of the other series or groups, and for the recording, at each receiving station, of only such series or groups of waves or impulses as are sent in a particular order.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification, Fig. 1 is a diagrammatic view illustrating my improved system of generating and receiving magnetic waves; Figs. 2 and 3 illustrate the mechanism employed at the receiving stations; Figs. 4, 5, and 6 are detail views of the mechanism employed at the sending or generating stations; Fig. 7 is a diagrammatic view illustrating the application of my improvement to systems employing a wire or other conductor for the transmission of the electrical impulses, and Fig. 8 illustrates a form of receiving mechanism. and one of the parallel branch circuits—

In the practice of my invention a series or group of two or more vertical generating wires or generating surfaces 5, 6, 7, 8, *etc.* are connected at the sending station A to a series of two or more terminals or knobs, 9, 10, 11, 12, *etc.* of a series of two or more induction coils, 13, 14, 15, 16, *etc.* The secondary coils are connected as usual to both discharge terminals or knobs of the induction coils and also to ground. The primaries of the induction coils are each included in circuits of a generator or series of generators 17, and in each circuit is included a circuit make and break mechanism. A convenient form of make and break mechanism is shown in Figs. 1, 4 and 5 and consists of metal disks 18, 19, 20, 21 *etc.* dependent upon the number of generating or sending wires employed, mounted upon a shaft 22, but preferably separated from each other by disks 23 of insulating material. The shaft is electrically connected to one pole of the generator 17, and the disks 18, 19, *etc.*, which are in electrical contact with the shaft, are provided with shoulders or knobs 24 adapted when the disks are shifted to strike against plates 25, 26, 27, 28, *etc.* connected to the opposite pole of the generator 17. The disks 18, 19, *etc.* are adjustably held in position on the shaft by suitable means, such for example as that shown in Fig. 4 con-

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sisting of a shoulder on the shaft and a nut screwing onto the shaft, whereby the disks may be clamped in any desired position.

By the rotation of the shaft, the circuits of the generator will be made and broken in any desired order or interval of time dependent on the adjustment of the disks around the shaft, and the speed of rotation of the shaft. As the periodicity of magnetic waves is dependent upon the self-induction multiplied by the capacity and as self induction and capacity of the sending wires varies with the length or the diameter of the wires, the latter are so proportioned relative to each other, as by varying their lengths, that the periodicity of the waves generated by one wire will differ from that of the waves generated by the other wires. By adjusting the disks 18, 19, *etc.* on the shaft the series of waves may be sent out in any desired order, *i.e.*, *a*, *b*, *c*, *d*, these letters designating the waves discharged respectively from wires 5, 6, 7 and 8.

The receiver is formed by a series of wires 29, 30, 31 and 32 *etc.* projecting up vertically or at an inclination, or other suitable surfaces. The wires forming the receiver correspond in number and are electrically equivalent in height, *i.e.* are electrically tuned to the discharging wires, 5, 6, 7, 8, *etc.* at the sending station. That is each wire 29, 30, *etc.* at the receiving station and the corresponding wire 5, 6, *etc.* at the sending station have the same value of the quantity $\sqrt{\text{self-induction}}$ multiplied by the $\sqrt{\text{capacity}}$, this product being different for different pairs of wires. A pair of wires consists of a wire 5 at sending station and a wire 29 at receiving station. The tuning of each pair of wires may be done conveniently by slightly varying the length or diameter of one of them. The mechanisms controlled or operated by the voltages or currents induced in the receiving wires, are so tuned in accordance with practices and rules well known in the art, that the recording mechanism connected to each receiving wire will be acted on or operated only by the voltages or current induced by the magnetic waves from the corresponding wire at the sending station, the characteristics of the induced voltages varying with the periodicity of the magnetic waves. As for example the recording mechanism connected to receiving wire 29 will not be acted on or operated by any voltages or current other than that induced by magnetic waves generated by discharging or sending wire 5.

Any suitable form or construction of mechanism may be employed for recording the signals or electrical impulses received. As for example in Fig. 1 coherers 33, 34, 35, 36, *etc.* are arranged in the circuits of the receiving wires, which are grounded. These coherers are also included as is customary in circuits 37, 38, 39, 40, *etc.* from a generator or generators 41, said circuits also including portions of the recording mechanism. Generally stated the recording mechanism consists of a series of two or more electrically actuated devices which by their combined action will give an audible or visible indication, said devices being directly controlled or operated by the voltages or currents induced by the electrically generated impulses, or included in a circuit or circuits controlled by the induced voltages or currents, so that all such devices must be operated or the circuits completed in a certain predetermined order corresponding to the order in which the circuits of the generator at the sending station are made and broken, to produce an indication or signal by the indicating instrument.

In lieu of coherers, any suitable form or construction of mechanism may be employed for transforming the current or voltages induced by the magnetic waves into energy of motion. In Fig. 2 is shown, a form of such mechanism, which consists of a coil 42 in series with the receiving wire 29 and a ring or element 43 so supported in the coil that a plane at right angles to the axis of the ring or element will be at an angle of approximately forty-five degrees (45°) with a plane at right angles to the axis of the coil. This ring is balanced on knife edges or supporting rods 44, 45, one of which is formed of a good electrical conductor, as silver, the ring or element being preferably formed of aluminum,

silver, or other good conductor. A carbon block 46 is so arranged that a portion of the ring will normally rest lightly thereon. This microphonic contact, the element 43 and the conducting pivotal support 44 for the latter forms parts of a circuit from a generator 47. While the indicating or regulating mechanism may be directly controlled or operated by the circuit of generator 47, it is preferred to include in the circuit of the generator 47, a relay 48, which in turn controls a circuit controlling or operating the indicating or recording mechanism.

A convenient form of mechanism for receiving indications is illustrated in Figs. 1, 2 and 3. This mechanism consists of a bed 49, over which is drawn a band or strip 50 of paper or other flexible non-conducting material. The strip is drawn from a spool 51 by a drum 52 driven at regular speed by clockwork or other suitable driving mechanism. A series of perforating mechanisms dependent on the number of receiving wires 29, 30, 31, 32, *etc.* are arranged in such relation to the strip of paper, that when actuated as hereinafter described, the paper will be perforated.

While any form of electrically controlled mechanism may be employed, that shown in Figs. 2 and 3 is convenient for the purpose. Each of these mechanisms consists of a lever 53 having a punch at one end and having its opposite end attached to the armature of an electro-magnet 54, which is included in the circuit controlled by the coherer or by the circuit of generator 47. As each of the coherers or other translating devices are rendered conductive, the perforating mechanism included in the circuit therewith, will be operated and a hole formed through the strip. As the operation of the perforators correspond in succession to the successive operations of the circuit make and break mechanism at the sending station and as the strip is in constant motion, it follows that the relative positions of the perforations in the strip will correspond to the relative times of operation of the make and break mechanism. As the paper strips move along the bed it will pass over metal bands 55, 56, 57, 58, *etc.* and under contact springs or brushes 59, 60, 61, 62, *etc.* in line with the bands. These bands are arranged in the several paths of movement of the perforations so that the springs or brushes will contact with the bands as the perforated portions pass between them. These brushes are adjustably supported so that they can be positioned in accordance with the consecutive operation of the make and break mechanisms at the sending station. When so adjusted they will all be in contact with their respective bands 55, 56, 57, 58, *etc.* at the same time completing an electric circuit formed as follows: wire 63, brush 59, band 55, wire 64, brush 60, band 56, wire 65, brush 61, band 67, wire 66, brush 62, band 58, wire 67, indicating instrument 68 to battery.

It is characteristic of my improvement that only such receiving station or stations as have their receiving mechanisms properly tuned or adjusted can receive intelligible indications. It is also necessary that the sequence of operation of the receiving mechanism should correspond to that of the sending mechanism, and also that the time interval between the operations of the elements of the receiving mechanism should correspond to the time interval between the successive operations of the elements of the sending mechanism. In other words, to produce a dot or dash or any other signal or indication at the receiving station, requires the conjoint action of electric impulses from all the sending wires and consequent operation of each and all the receiving mechanisms. In the form of apparatus shown, the shaft 22 must be rotated to complete all the circuits from the generator 17, so that waves will be generated by all the wires 5, 6, 7, 8, *etc.* Each series of waves will produce voltages or currents in one of the receiving wires 29, 30, 31, 32, *etc.* thereby operating in due sequence each of the perforating mechanisms, to produce properly arranged perforations in the moving strip. It is only when all these properly spaced perforations pass simultaneously under the brushes that a circuit will be completed through the indicator 68 to produce a dot or dash or other signal or in-

dication. From the foregoing it will be understood that although all of the perforators may be operated by waves from other sources, if the perforations are not in the predetermined order, a closure of the circuit of the indicator will not be effected.

It will be observed that the recording mechanism shown and described is in effect a circuit closing mechanism, whose parts or elements co-operate to effect a closure of the signaling or indicating circuit and are controlled by currents or voltages induced by magnetic waves generated at the sending station. Hence I include as within the terms of my invention any form or construction of circuit make or break mechanism which is operated or controlled by electrical impulses applied successively or applied simultaneously but differing in duration.

As will be understood by those skilled in the art a moving strip normally non-conductive but capable of being rendered conductive by the action of an electric current or other electrically controlled means, may be employed, the perforating mechanism being replaced by mechanisms known in the art for rendering portions conductive.

As the wires of surfaces 5, 6, 7, 8, *etc.* at one station are employed both for generating and receiving the megnetic waves, as signals are sent or received, the indicating or receiving mechanism and the generating mechanism are connected to said wires or surfaces as shown in Fig. 1. In order to protect the indicating or receiving mechanism from receiving excessive currents which would burn out or injure it, when sending messages, a switch mechanism is interposed between the wires or surfaces 5, 6, 7, 8, *etc.* and the indicating mechanism. A convenient form or construction of such switch consists of a cylinder 69 of insulating material mounted on the shaft 22, and metal springs 70 bearing on the shell. Metal bands 71 are placed on the cylinder in line with the springs 70, said bands extending around the cylinder except for a distance a little greater than the peripheral length of the knobs 24 on the disks 18 &c of the circuit breaker. The bands 71 are so arranged that the springs 70 will not be in contact with the bands when the knobs 24 are in contact with the plates 25 &c. In lieu of entirely breaking the circuits of the coherers shunt circuits 72 having suitable resistances are arranged around the switch mechanism, the resistances being such as to permit the receiving mechanism to indicate, but yet to prevent excessive currents from flowing through and injuring it.

The character of the waves generated by the surfaces or wires can be varied by increasing the heights or diameters of the wires thereby increasing the generating area. The character of the waves can also be varied by connecting to the wire or wires a condenser or capacity or a self inductance in the form of a coil.

As shown in Fig. 7 my improvement is applicable to the sending and receiving of signals through wires or other conductors. At the sending station a series of two or more generators, 73, 74, 75, 76, *etc.*, constructed to generate currents of different periodicities, are connected to the terminals 77, 78, 79, 80, *etc.* of a make and break mechanism. These terminals which may be formed by springs, are constructed and arranged so that they will be normally out of contact with disks 81, 82, 83, 84, *etc.* which are mounted on the shaft 85 and in electrical contact therewith but insulated from each other. The shaft 85 is electrically connected to the line wire 86 extending to another station, where the line wire is connected to a series of two or more recording mechanisms 87, 88, 89, 90, *etc.* each mechanism being tuned so as to actuate only by a current of a certain periodicity.

Any construction of mechanism suitable for the purpose may be employed at the receiving station, such for example as that shown in Figs. 2 and 3. When used for recording signals transmitted over a conductor, each of the magnets 54, *etc.* is connected to the line wire and to ground or return wire, and is constructed or arranged in accordance with rules well known in the art, so as to be responsive only to currents of certain predetermined periodicity, which should corre-

spond to the periodicity of the current generated by one of the generators 73, 74, 75, 76, *etc.*

In lieu of the mechanism shown in Figs, 2 and 3 a series of siphon recorders may be employed. In such case the circuits of such mechanisms would be tuned so as to be responsive only to such electrical impulses as have a certain periodicity. Figure 8 shows how the local circuit of one of the magnets 54 can be tuned by the inclusion of an inductance and a condenser.

As the receiving mechanism is so constructed as to be responsive only to electrical impulses of certain predetermined periodicities and sent out in a certain predetermined order or with a certain predetermined time interval, it will be readily understood by those skilled in the art, that a large number of sending instruments and a corresponding number of receiving instruments may be connected to the same line wire, so that a large number of signals may be transmitted practically simultaneously without any liability of confusion or mixing up of signals. It is characteristic of my improvement that each signal or indication is formed by two or more waves or impulses differing in periodicity.

Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:

1. A telegraph system having in combination means for producing and transmitting two or more impulses of different periodicities to form a signal in a predetermined order of succession, substantially as set forth.

2. A telegraphy system having in combination, means for producing and transmitting two or more impulses of different periodicities in a predetermined order of succession, and a series of two or more impulse controlled devices, conjointly operative to produce an indication, substantially as set forth.

3. In a wireless telegraph system, the combination of a series of two or more discharge or generating surfaces differing in their electrical constants, two or more induction apparatus connected to said surfaces and two or more circuit controllers arranged in the circuit of the primary coils of the induction apparatus, and constructed to be operated in a predetermined order of succession, substantially as set forth.

4. In a wireless telegraph system, the combination of means for generating a series of magnetic waves of different periodicities, a signal circuit and a circuit controller in said circuit, said controller being operated or controlled by a series of two or more magnetic waves, substantially as set forth.

5. In a wireless telegraph system, the combination of means for generating a series of electro-magnetic waves of different periodicities, receiving surfaces of correspondingly different electrical receptivities and a circuit controller arranged in a signal circuit and operative only by the conjoint action of all the voltages or currents generated by the waves from the sending station, substantially as set forth.

6. In a wireless telegraph system, the combination of means for generating a series of magnetic waves of different periodicities, receiving surfaces of differing electrical receptivities and an indicating mechanism operative to give an intelligible indication only when currents are induced in the receiving surfaces in a predetermined order, substantially as set forth.

7. In a wireless telegraph sytem, the combination of two or more surfaces differing with respect of one of their electrical constants, means for electrically charging and discharging said surfaces, and an indicating mechanism operative only by conjoint action of two or more currents or voltages generated by waves from sending station substantially as set forth.

8. In a wireless telegraph system, the combination of to or more surfaces of different capacities and inductances, means for electrically charging and discharging said surfaces, indicating mechanism operative only by conjoint action

of currents induced in said surfaces and circuit make and break mechanism interposed between the surfaces and ground, substantially as set forth.

9. In a telegraph system adapted or designed for the transmission of electrical signalling waves or impulses of different periodicities, and the receipt thereof, audible or recorded, the method of operation herein described which consists in varying the order of transmittal of waves or impulses forming elements of the signal sent according to one or another receiving station is to be signalled where (proper circuit closing mechanisms being provided at each receiving station) the transmitted signal will be intelligible at and only at the intended receiving station, substantially as set forth.

10. A method of telegraphy, which consists in selecting and associating together in predetermined order of succession two or more electrically generated impulses of different periodicity forming elements of the signal sent and transmitting such selected impulses with reference to the conjoint action of both or all in the production of an audible or visible signal at a distant point, substantially as set forth.

11. In a system of telegraphy, wherein messages are sent by use of a plurality of electrically generated impulses of different periodicities and in a predetermined order of succession, the method of ascertaining (visually or audibly) at any particular station, the particular signal sent to that station, which consists in the selection to form a signal of certain transmitted impulses of different periodicities and of a predetermined order of succession to the exclusion of all others, substantially as set forth.

12. An improvement in the art of transmitting signals electrically, which consists in operating or controlling an indicating mechanism by a series or group of electrically generated impulses of differing periodicities and of a predetermined order of succession, substantially as set forth.

13. In a wireless telegraph system adapted or designed for the transmission of a message to any one of two or more receiving stations, the method of transmitting the message with reference to the intellible receipt thereof at the desired station, which method consists in the transmission of electro-magnetic waves or impulses of different periodicities in varying order of transmittal by a separate order or grouping of transmittal for each receiving station, substantially as set forth.

Washington, District of Columbia, U.S.A., June 28th 1902.

REGINALD AUBREY FESSENDEN.

Signed in the presence of
DARWIN S. WOLCOTT.
F. E. GAITHER.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1903.

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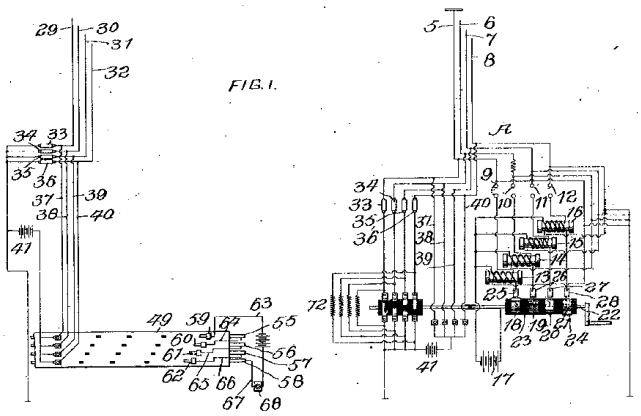
FESSENDEN'S Complete Specification.

[3 SHEETS]

SHEET 1.



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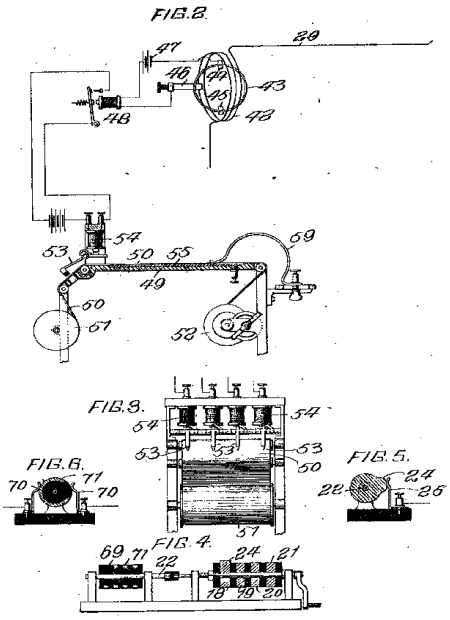

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FESSENDEN'S Complete Specification.

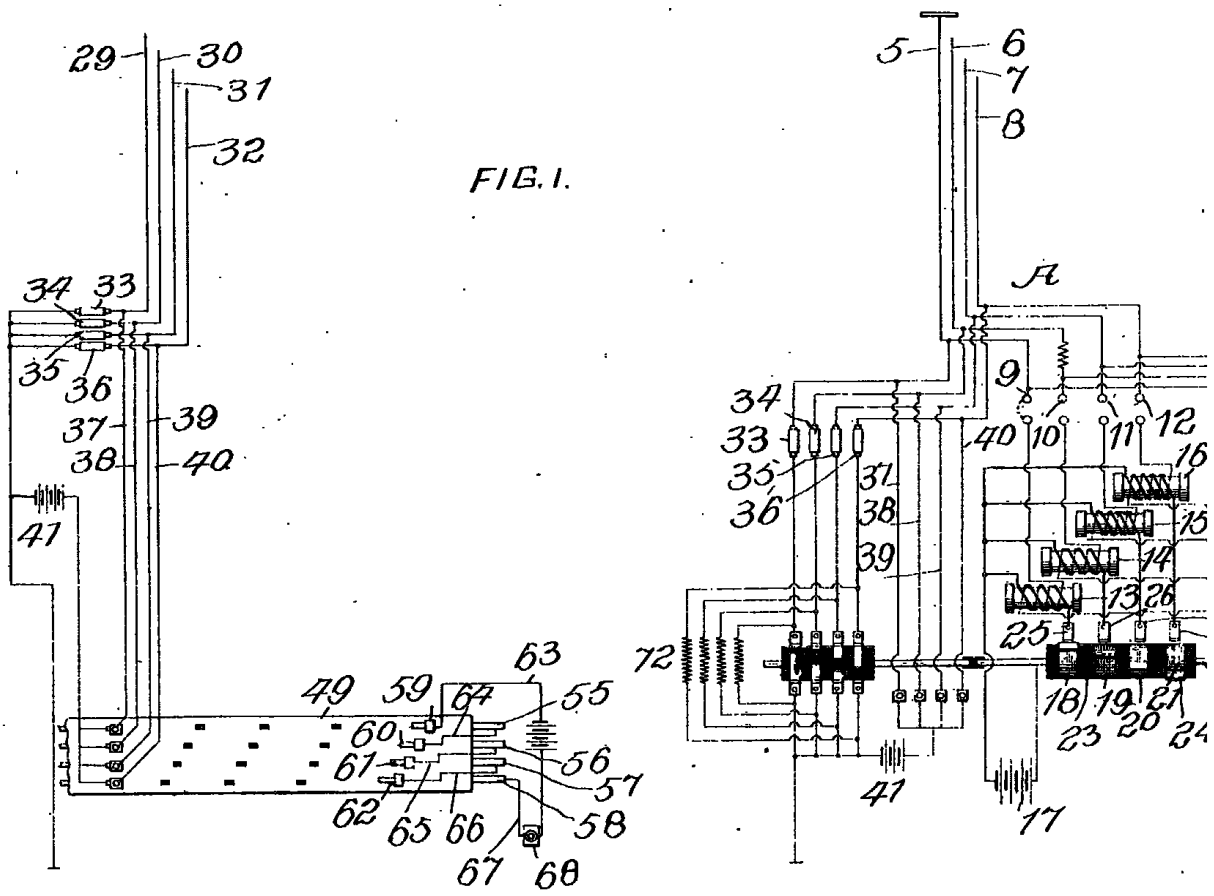

FIG. 1.

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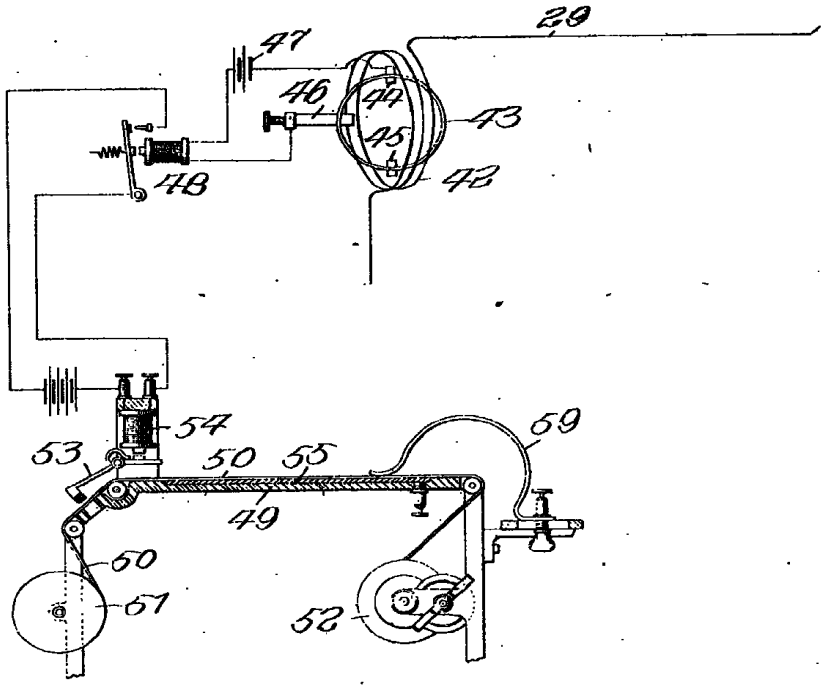
SHEET 1.

SHEET 2.

FIG. 2.



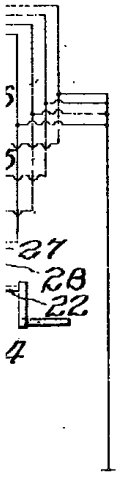


FIG. 3.

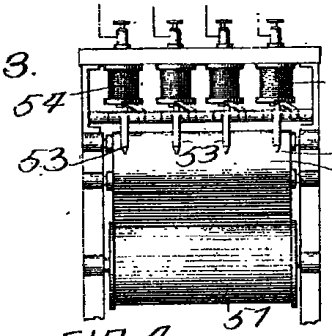


FIG. 6.

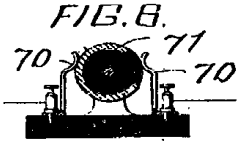
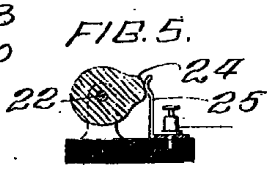


FIG. 5.



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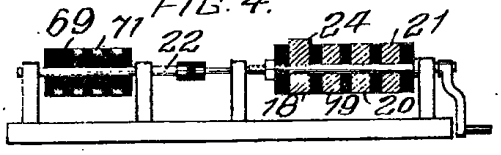

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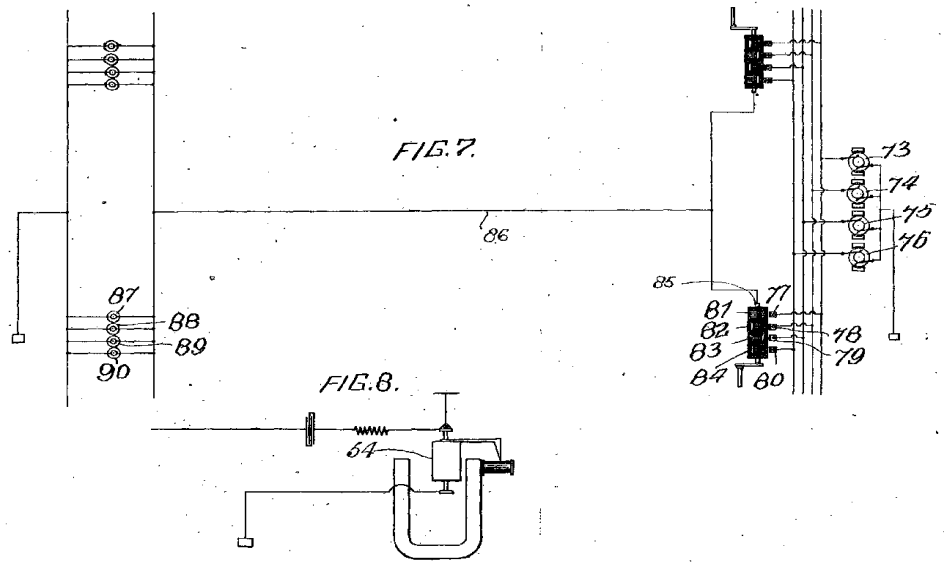

FIG. 7.

FIG. 8.

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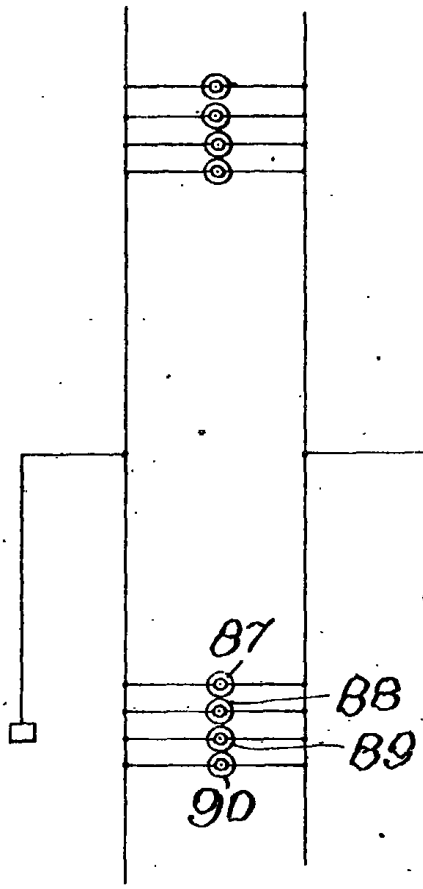
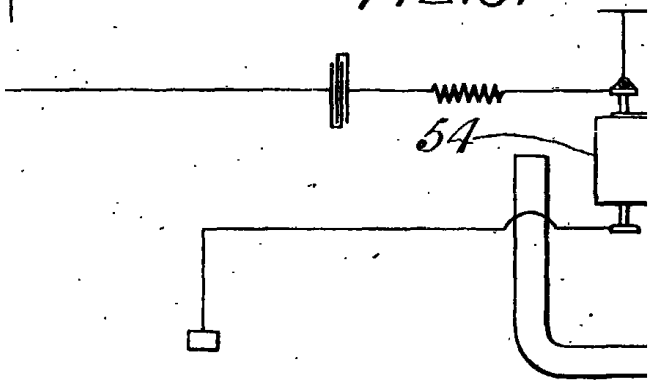
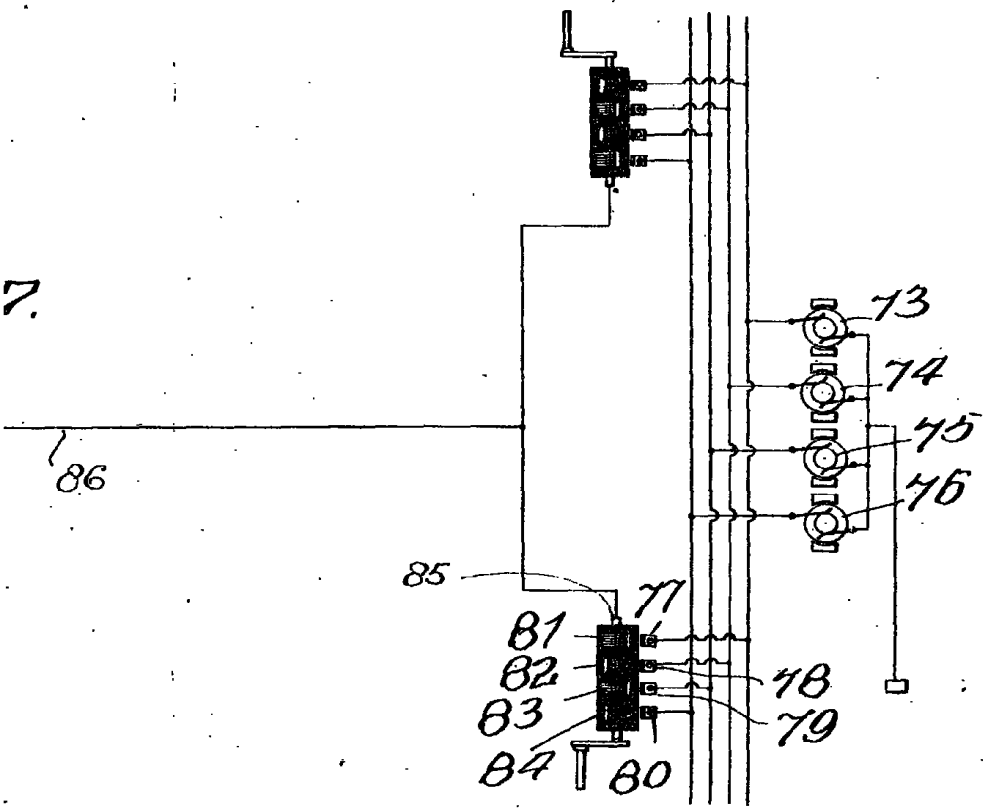


FIG.

FIG.8.





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