T. GIARA.

MULTIPLEX TELEGRAPH SYSTEM.

APPLICATION FILED JULY 28, 1905.

914,713.

Patented Mar. 9, 1909.

5 SHEETS—SHEET 1.

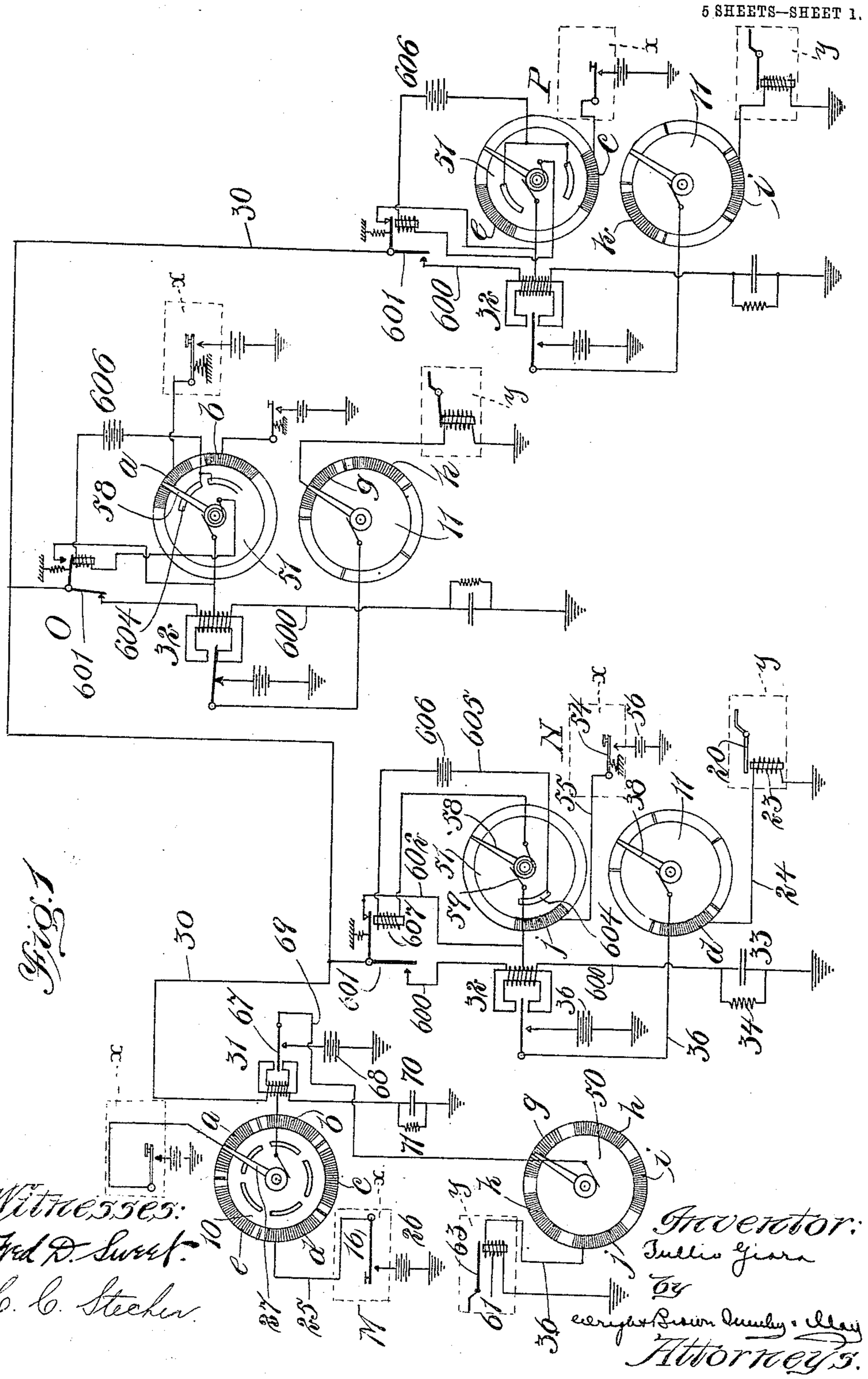

Fig. 1.

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5 SHEETS—SHEET 2.

Fig: 2

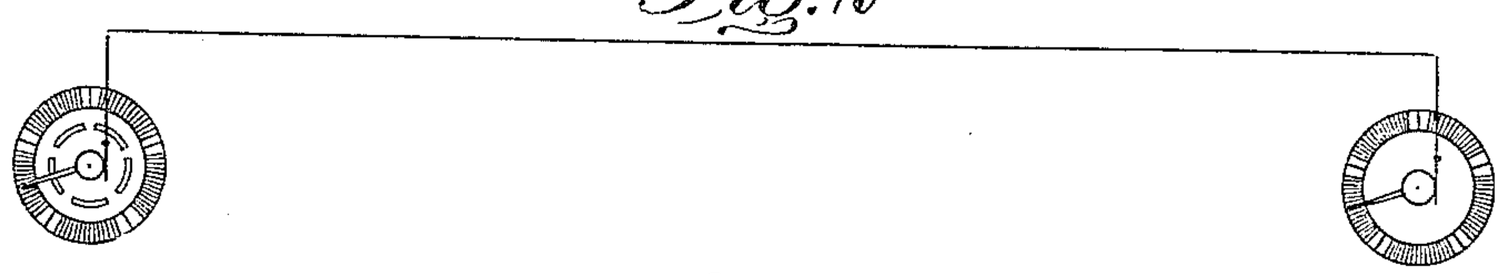


Fig: 3

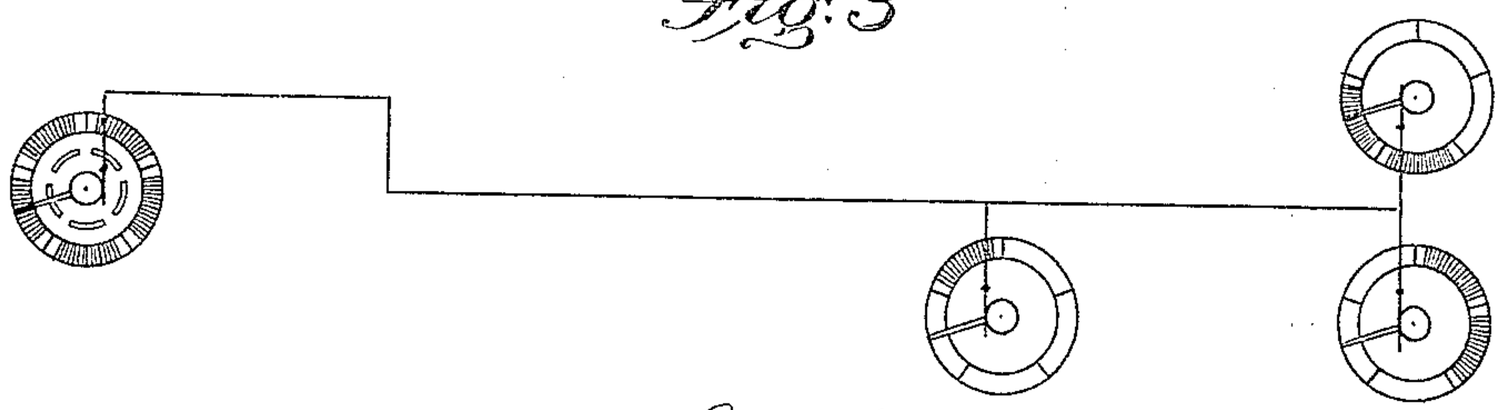


Fig: 4

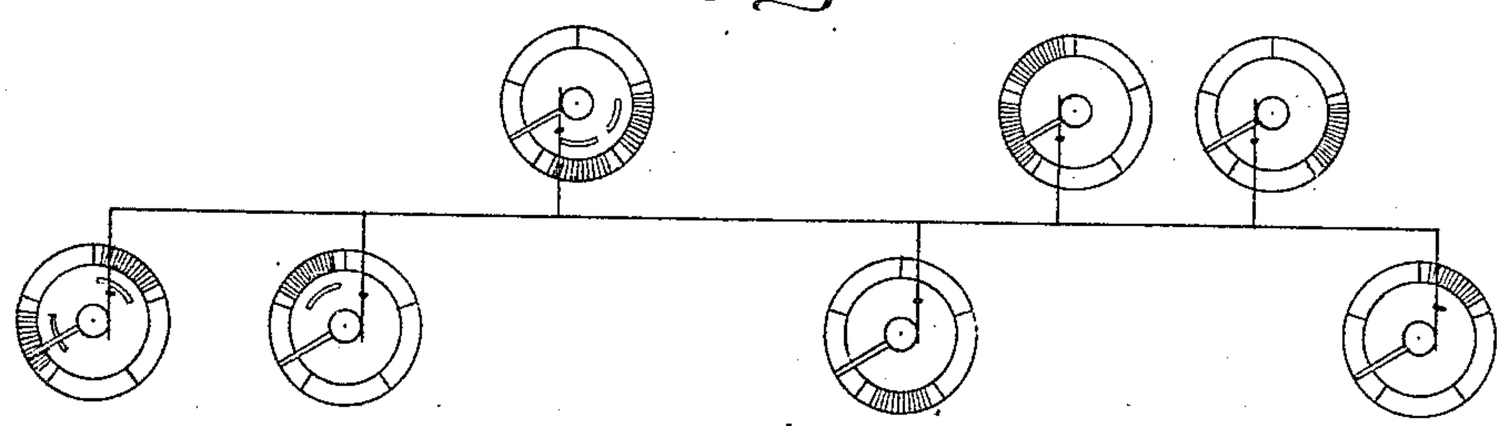
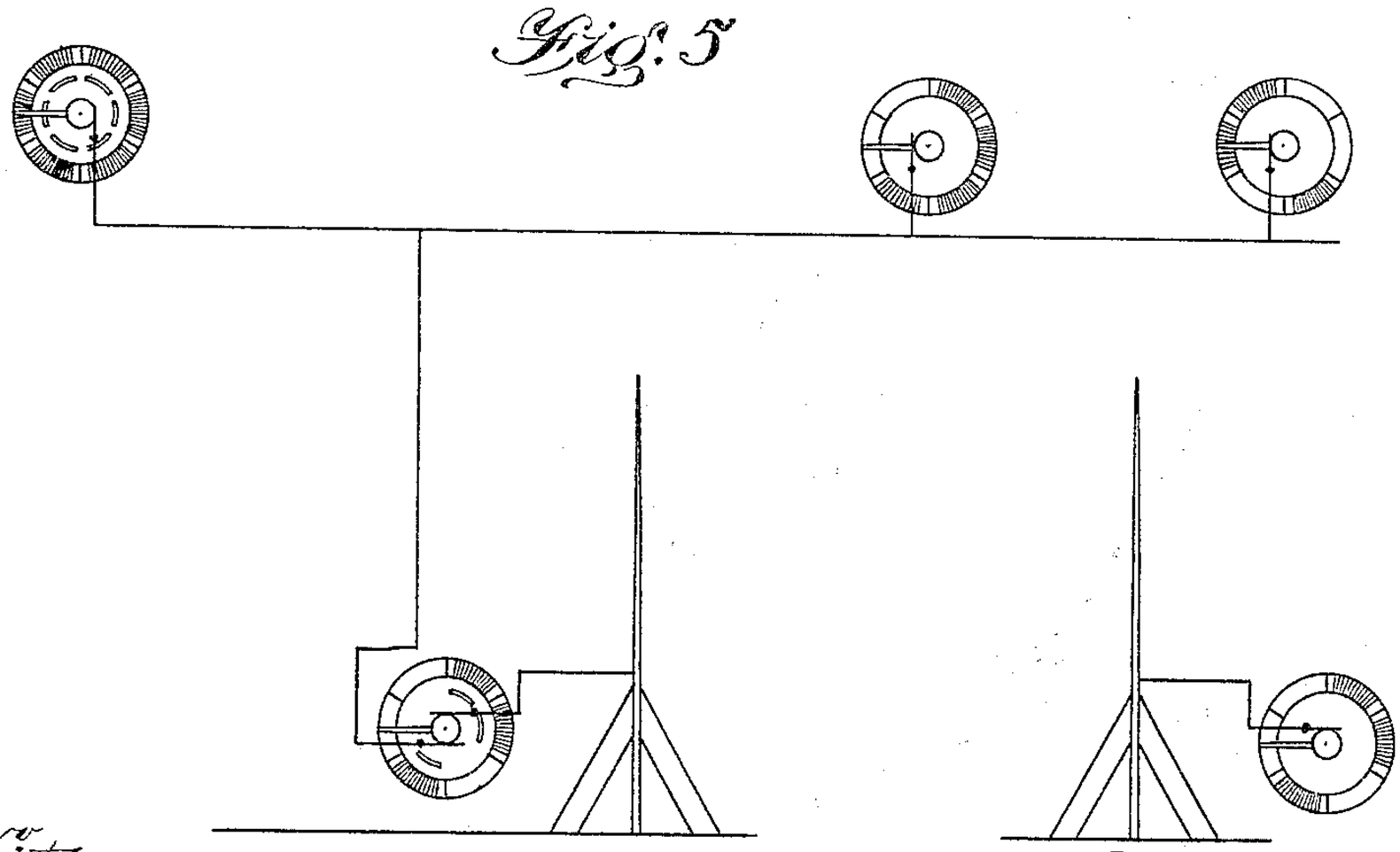


Fig: 5



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5 SHEETS—SHEET 3.

Fig. 6

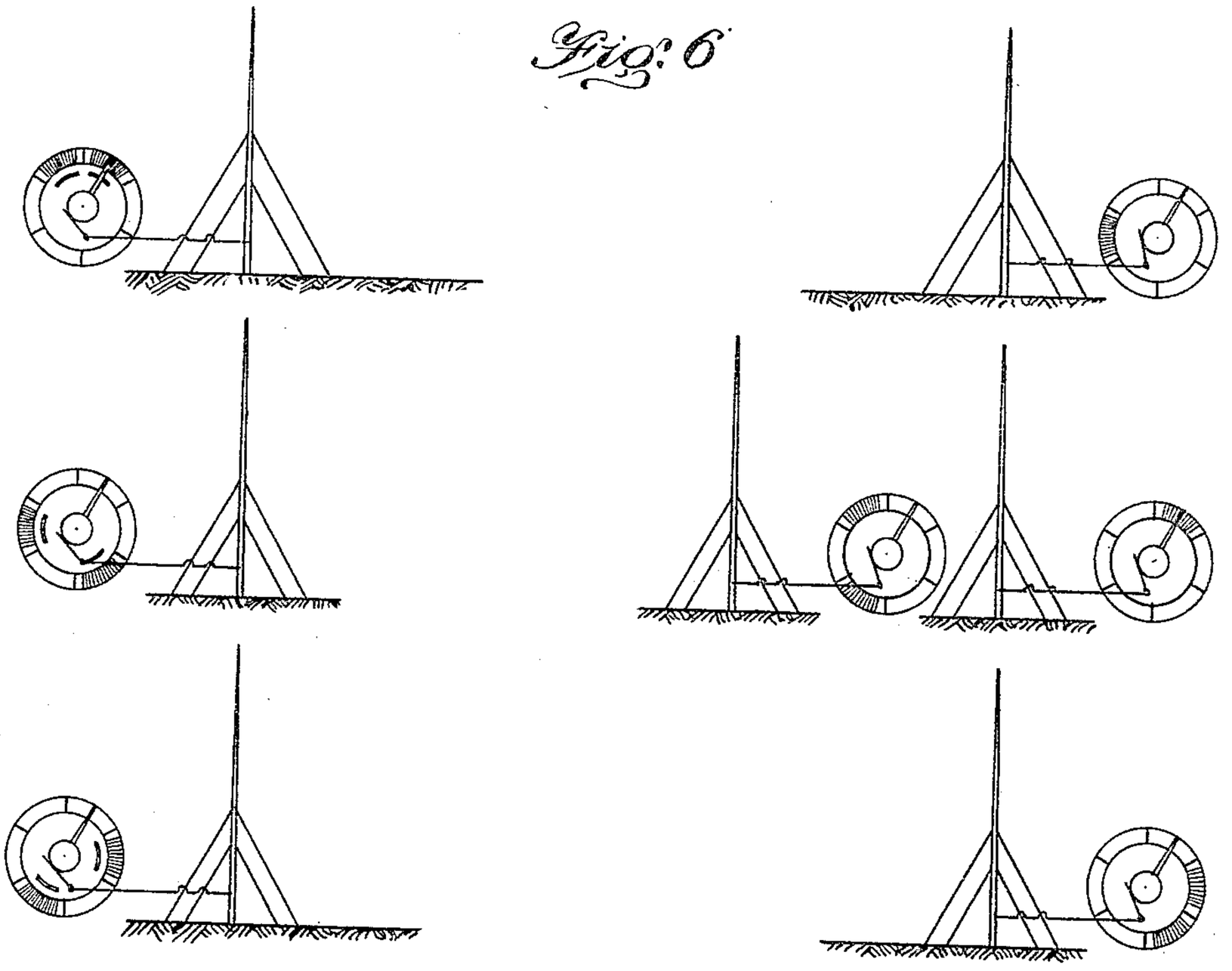
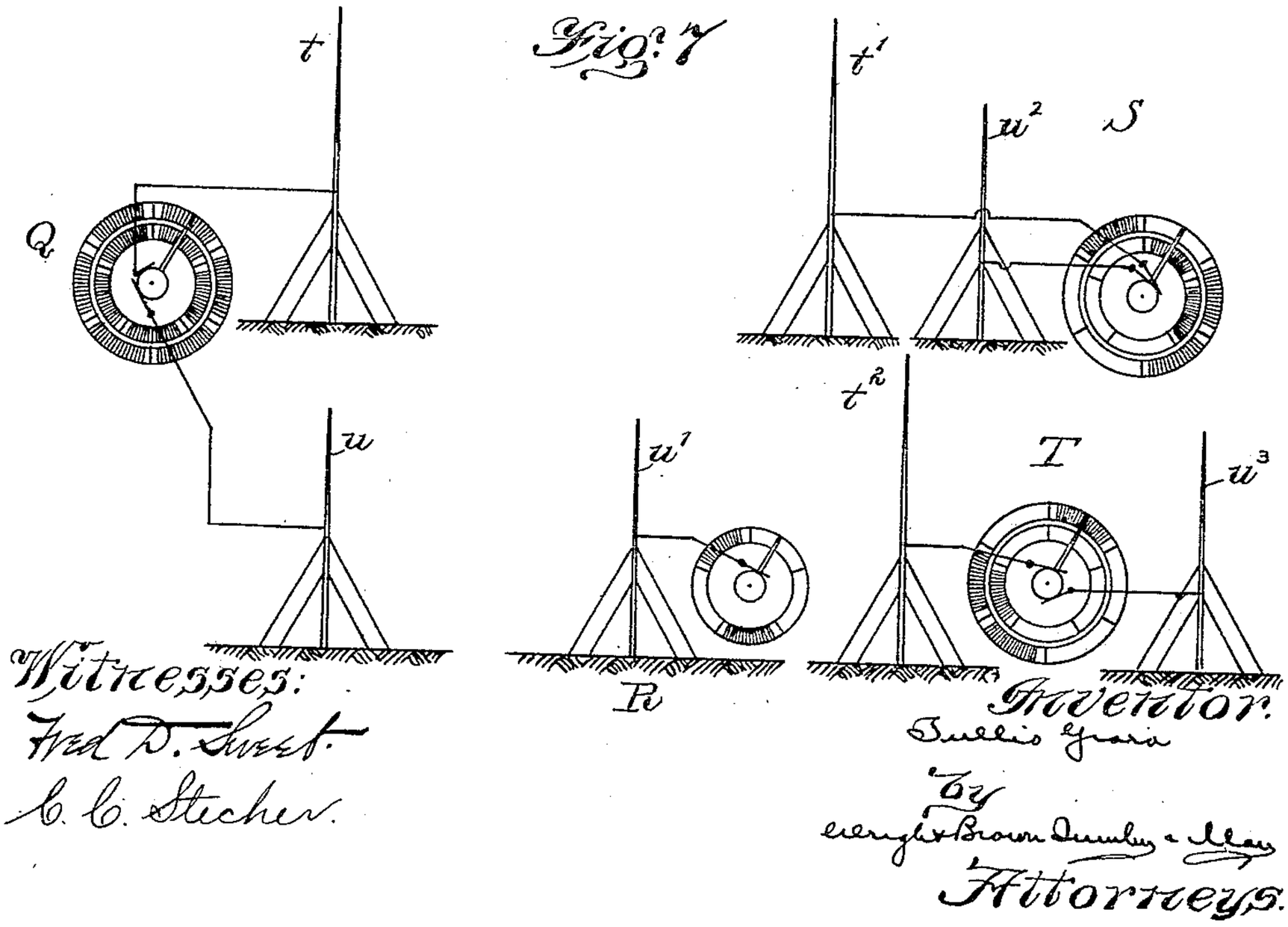


Fig. 7



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5 SHEETS—SHEET 4.

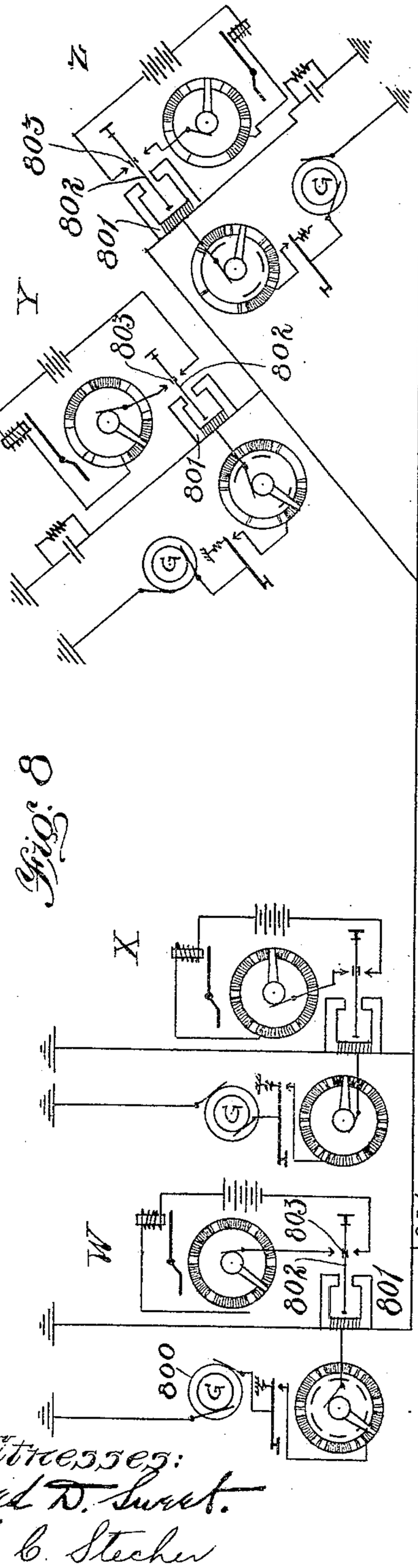

Fig. 8

Fig. 9

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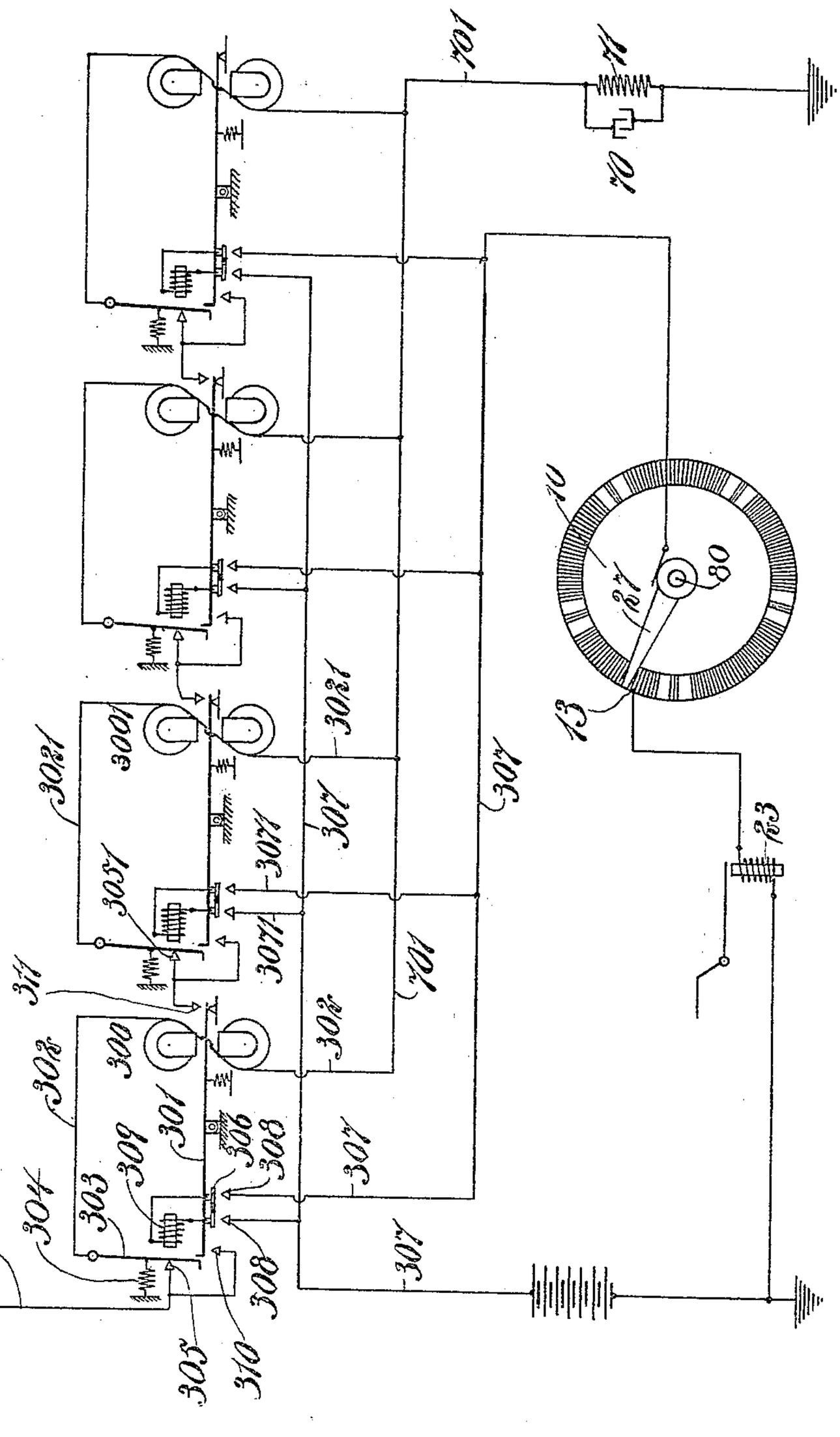
5 SHEETS—SHEET 5.

FIG. 10



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UNITED STATES PATENT OFFICE.

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MULTIPLEX-TELEGRAPH SYSTEM.

No. 914,713. Specification of Letters Patent. Patented March 9, 1909.

Application filed July 28, 1905. Serial No. 271,617.

To all whom it may concern:

Be it known that I, TULLIO GIARA, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Multiplex-Telegraph Systems, of which the following is a specification.

This invention has relation to multiplex telegraph systems of the character of that set forth in my Letters Patent No. 797,570, granted to me August 20, 1905. The said Letters Patent illustrates and describes a system comprising a main line, (either a metallic conductor or else a conducting medium such as used in wireless telegraphy), sending apparatus and receiving apparatus at each end of the line, the sending apparatus consisting of a plurality of keyboards similar, for instance, to that of a typewriting machine, and the receiving apparatus consisting of a plurality of separate printing mechanisms such as electrically-actuated typewriters. Each sending and receiving apparatus includes a "sun-flower" (so called) with a movable contact and a plurality of sets of contacts arranged on a stationary disk. The movable contacts are actuated synchronously by suitable motors, there being automatic synchronizing mechanism for the motors.

The present invention has for its object to provide certain improvements in this system thus briefly described, by means of which from one signal station some of the impulses may be sent over a conductor to one station, and others through the air to another station. Different messages may be sent in this way or the same messages may be sent to different stations. I have found that it is possible to multiply the number of messages sent at any one time by using several harmonic currents of which the impulses may be sent simultaneously and yet be received at the receiving station separately from each other.

It is well known that any alternating electric current can be divided into a number of elementary sinusoidal currents of different frequencies, and further that any musical sound may be divided into a number of elementary sounds of different pitch and vibrations. Harmonic electric currents, like harmonic musical sounds, are the alternating currents composed of several elementary sinusoidal currents, the frequencies of which are in certain well-known ratios. It is now well known that a vibrator, such as a string having a predetermined number of vibrations may be caused to vibrate when placed under the magnetic influence of a magnet, through which an alternating current is sent, the frequency of which is the same or a multiple of the number of vibrations of the string or vibrator. I may utilize an electro-magnetically-controlled vibrator in my system, as will be hereinafter pointed out.

Referring to the accompanying drawings:—Figure 1 represents diagrammatically one embodiment of the present invention. Fig. 2 is a simple diagram showing an arrangement by which all of the messages are sent from one station to another single station. Fig. 3 illustrates in the same simple manner the sending of messages from one station to different stations. Fig. 4 illustrates diagrammatically how messages may be sent from a plurality of sending stations to a plurality of receiving stations. Fig. 5 illustrates how messages may be sent, some over a metallic conductor, and some through the air. Fig. 6 illustrates a wireless system by which the same results may be accomplished as by the mechanism diagrammatically illustrated in Fig. 1. Fig. 7 illustrates diagrammatically another form of the system in which the impulses are sent without wires. Fig. 8 illustrates diagrammatically a system wherein harmonic alternating currents are utilized for transmitting messages. Fig. 9 illustrates a fork employed in connection with a vibrator. Fig. 10 represents a special form of relay which I may utilize in connection with my system.

I may state that so far as possible I have preserved, for the same features of the invention set forth in my previous application, which are referred to in the following specification, the same reference characters, and I shall not attempt to describe in detail those features which are common to the two inventions, nor have I attempted to illustrate the apparatus in detail on account of the confusion which would result, simply illustrating so much of the system as will enable one skilled in the art to embody the invention in practical working form.

In Fig. 1 the sending and receiving disks of the sun-flowers are indicated at 10 and 11. On the disk 10 are a plurality of sets of

sections or stationary contacts, said sets being indicated at *a b c d* and *e*. On the receiving disk 10 are similar sets of contacts or sections which are indicated at *g h i j* and *k*. At each end of the line there is both a sending disk and a receiving disk.

The movable contacts or arms are indicated at 27 and 58 respectively, and they move synchronously, successively engaging the contacts of each set or section in regular sequence. Each contact of the sending disk is connected in a local circuit in which there is a key which may be closed by the operator. These keys are all on a key-board as indicated conventionally at *x* and may be similar to the keys of a typewriting machine. The main line is indicated at 30.

The system illustrated in Fig. 1 provides for sending messages from one station to a plurality of different stations. In this figure, M indicates a sending and receiving station from and to which all of the messages may be sent. The sending disk 10 and the receiving disk 50 have their full complement of sets of contacts, as respectively indicated at *a b c d* and *e*, and *g h i j* and *k*. The duplex relay which is used at this station may be similar to that at the station A in Fig. 1 of my said Letters Patent No. 797,570. There are three other stations indicated, however, at N O and P. At the station N, the disks 11 and 51 have only one set of contacts, as indicated at *d* and *j*, placed in sectors of the circle corresponding to those on the disks 10 and 50, so that messages may be sent to or received from the station N only through one set of contacts, and therefore but one operator could be sending to or from the station N. At the station O, the disks 51 and 11 have the sets of contacts *a* and *b*, and *g* and *h* respectively, so that at this station only two messages can be simultaneously sent and two messages simultaneously received. At the station P the disk 51 has the set of contacts *e* and *c* and the disk 11, the contacts *k* and *i*. Now it will be seen that although messages may be sent from the disk 10 at the station M from all of the sets of contacts thereon, (there being, as will be remembered, one set of contacts for each sending typewriting machine), some of the messages will be received by the station N, others by station O, and others by station P, according to the sectors in which the sets of contacts are placed. At each of the stations N O P there is a branch-circuit 500 in which the duplexing or relay 32 is located. The circuit 600, however, through all of the coils of the relay 32, may be electrically connected with the main line 30 by a switch 601. The main line 30 is, however, conected by a branch-circuit 602 to a portion of the coils of the relay and to the brush 59 of the disk 51 to provide for messages being at all times sent from the station N to the station M and to provide also for the synchronizing of the various rotating arms. At each of the stations N O P there is on the disk 51 one or more elongated contacts 604 with which the arm 58 must engage when it is passing over the contacts *j* at station N, *a* and *b* at station O, and *e* and *c* at station P. This contact is in each case in a branch-circuit 605 having a battery or source of power 606, said circuit including an electro-magnet 607, which when the arm 58 is in engagement with the contact 604, moves the switch 601 against the contact in the circuit 600 to close the said circuit 600. Thus, when the arms 58 are in engagement with the contacts 604, impulses sent from the disk 10 at station M will be received through the relay to cause the operation of the receiving typewriting machine (illustrated conventionally at *y*) at the particular station to which the message is sent.

From this description, it will be seen that messages can be sent from the stations N O P to the station M only when the arm 58 at each of the first-mentioned stations is in engagement with the contact 604. It is quite apparent that instead of equipping the station M with disks having a full complement of sets of contacts, the disks may be provided with only one or more sets of contacts so as to send messages to a number of stations, each of which has similarly located sets of contacts upon their disks, and it will be likewise seen that my system may be used with equal facility both with wireless apparatus and with the apparatus shown in the last figure.

As illustrating diagrammatically various connections that may be made between some of the stations, both with and without a metallic conductor, reference may be had to Figs. 2 to 7, inclusive, with the following brief description. In this description, it may be stated that the stations are divided into two classes, (first), "total stations",—at which the sending and receiving disks are provided with the full complement of sets of contacts; and (second), "partial stations",—where the sending and receiving disks have less than the whole complement of sets of contacts. In Fig. 2, two total stations are illustrated at each end of the line. In Fig. 3, there is a total station at one end and three partial stations at the other end. In Fig. 4, there are three partial stations at one end and four partial stations at the other end. In Fig. 5, there is a complete station at one end and three partial stations at the other end. One of the partial stations is shown as equipped for repeating by wireless the messages to a fourth partial station. In Fig. 6, the system is illustrated as applied to wireless telegraphy. There

are three partial sending stations at the left and four partial receiving stations at the right.

If, in the use of wireless telegraphy, it be desired to utilize different electric waves, for which the receiving apparatus must be attuned, I may utilize the system as diagrammatically portrayed in Fig. 7. In this case, the disk at the total sending station Q has a double complement of contacts. The impulses transmitted from the contacts of the outer series of sets are transmitted from the mast t to the masts t' and t^2 of the stations S T. The stations S T are only partial stations. Impulses from the mast u at the station Q are received at the masts u' u^2 u^3 at the receiving stations R S T.

Now referring to Fig. 8, I have illustrated a system in which alternating currents of different frequencies are employed. The system illustrated in Fig. 8 is substantially the same as that shown in Fig. 1, except that it is particularly adapted for an alternating current of different frequencies. These currents may be produced by any suitable source as by an alternating generator, which is indicated at 800 at the station W. The sending apparatus is the same as previously described, and the receiving apparatus differs only in the relay which in this case is formed of an electromagnet 801 between the poles of which is a vibrator or vibrating body 802. This vibrating body may consist of a wire whose number of vibrations corresponds to the number of periods of the current produced at the transmitting station. The said wire is so regulated by a weight, screw, or other device that when an impulse passes through the electromagnet 801, the wire vibrates in attunement therewith and opens a fork, indicated conventionally at 803, to close the local circuit 804. In Fig. 9 there is illustrated a fork consisting of two members pivoted together at 806 with the vibrator 802 between the shorter ends. As the wire vibrates, the longer ends of the members are caused to engage two contacts 808 808 of the local circuit 804 through the receiving disk to cause the actuation of the printing-bar, as previously described. The current through the circuit 804 is continuous and not periodical, since the action of the spring 809 which connects the longer ends of the members 805 does not act quickly enough to withdraw said members from the contacts 808 in the period between the vibrations of the wire.

It will be understood that the vibrators may be properly attuned to respond to certain harmonic frequencies or sinusoidal currents, being attuned, as it were, to different pitches, so that although the current is composed of a complex sinusoidal current, yet one vibrator will respond to an elementary sinusoidal current of a predetermined frequency and not to others. By varying the speed of the generator, if an alternating generator be employed, the frequencies of the current may be so increased that impulses sent from one station can be received only at a certain other station at which the vibrator is set to vibrate, at a rate corresponding to the frequencies of the current through the electromagnet which controls the said vibrator. It will also be understood that even if the wire or vibrator does not enter into a well-defined vibration, as can be produced only by the corresponding alternating current, the local circuit is not closed.

In Fig. 8, it may be assumed that the vibrator at station L will vibrate to produce a tone of a certain pitch. At station U, the vibrator will be attuned to a higher pitch, and at the stations X Y V and Z, to different other pitches. Consequently, when an impulse is sent over the line, all of the magnets 801 will be energized, but only the vibrator will be caused to vibrate whose vibrations are attuned to the frequencies of the circuit, and hence the message will be received only at that station. Therefore messages can be sent from the station U, to be received only by the station X, if desired, or from the station W, to be received only at the stations Y and Z, or from L to V.

The mechanical details of construction of the apparatus have not been illustrated since they may vary greatly and may be made to suit particular requirements. For instance, the keyboards which are utilized for sending the messages are preferably those of a typewriting machine, so that the sending operator not only sends the messages over the line, but prints them on the typewriting machine that he may preserve an accurate record of the message which he has sent. Similarly, the printing mechanisms connected with the receiving disks are all of suitable character, such as typewriting machines in which the carriage is automatically shifted and the platen automatically moved at the proper time.

As it might possibly happen that two impulses could follow each other over the line so rapidly that the relay 31 or 32 would not have time enough to return mechanically to proper position, a novel form of multiple relay is provided which will prevent any such trouble arising. This relay is illustrated in Fig. 10, and there may be one for each of the receiving stations connected with the main line. The multiple relay comprises a number of similar elements or relays all interposed between the main line 30 and the ground line 701. Each element consists of the polarized magnets 300 and the armature 301. The polarized magnets are connected by a line 302 with the ground line 701 and also in series with an armature 303 which is caused by a spring 304 to rest against a con-

tact 305 in the main line 30. When an impulse passes over the main line 30, it reaches the contact 305, and traversing the armature 303 and the circuit 302, reaches the ground line 701. Instantly the armature 301 is moved to cause a movable contact 306, carried thereby, but insulated therefrom to close the local circuit 307 through the arm 27 through a contact 13 and through one of the type-bar-actuating magnets 23, to cause the actuation of the type-bar. When the movable contact 306 engages the stationary contacts 308, to close the local circuit 307, it also closes a shunt circuit through an electromagnet 309, which attracts the armature 303 and breaks its connection with the contact 305. The end of the armature 303 is moved over the end of the pivoted armature 301 so as to temporarily hold it to maintain the engagement of the contact 306 with the contacts 308. At the same time that the armature 301 was moved, one end thereof engaged the stationary contact 310 and the other engaged the stationary contact 311. The contact 310 is in series connection with the main line 30, but arranged in multiple with the contact 305. The device thus described is multiplied as many times as may be desired, Fig. 10 illustrating four circuits similar to that at 302 for instance the second circuit which corresponds to 302 is indicated at 3021 and it is connected to the ground line 701. The polarized magnets are indicated at 3001. The contact similar to 305 is indicated at 3051, etc.

If an impulse follows the preceding impulse over the line so quickly that the armature 301 has not had sufficient time to assume the position illustrated in Fig. 10, and is still in engagement with the contact 310, the incoming impulse will then pass from the main line 30 through contact 310, armature 301, contact 311, to a contact 3051, which corresponds to that at 305, so that the impulse will then traverse the branch-circuit 3021 and the polarized magnet 3001 to the ground line 701, causing the closing of the circuit 307 through the conductors indicated at 3071; and should a third impulse follow again so rapidly, it will be grounded through the third branch-circuit, and so on. As soon, however, as the impulse through the magnet 309 ceases, the spring 304 draws the armature 303 away from the end of the armature 301, so as to release said armature 301, and permit it to return to normal position, the said armature 303 again engaging contact 305 so that the next impulse may follow the course first described. This relay mechanism as described may be used in lieu of that indicated at 31 and 32, for the receiving apparatus.

It will be understood that the invention is capable of a variety of embodiments and that it may be easily adapted to a great variety of conditions.

It will be further understood that many and various changes may be made in the hereinbefore described systems, without departing from the spirit and scope of the invention.

Having thus explained the nature of the invention and described a way of constructing and using the same, although without attempting to set forth all of the forms in which it may be made, or all of the modes of its use, I declare that what I claim is:—

1. In a multiplex telegraph system, a single main line having a sending station at one end and a receiving station at the other end, a generator for producing alternating currents, a keyboard having sets of keys for causing the sending of alternating current impulses over the main line, a printing mechanism at the receiving station having a set of type-bars, a local circuit controlling the printing mechanisms, and means for closing the local circuit comprising an electromagnet in the main line, and a vibrator attuned to respond to an alternating current of a predetermined frequency, substantially as described.

2. In a multiplex telegraph system, a single main line having a plurality of sending stations and a plurality of receiving stations, a generator at each sending station for producing alternating currents, one or more keyboards at each sending station, each having a set of keys for causing the sending of alternating current impulses over the main line, one or more printing mechanisms at each receiving station, a local circuit at each receiving station controlling the printing mechanisms thereat, and means for closing each local circuit comprising an electromagnet in the main line at each receiving station, a switch, and a vibrator under the influence of each magnet attuned to respond to magnetic impulses of a predetermined frequency and adapted to close the switch.

In testimony whereof I have affixed my signature, in presence of two witnesses.

TULLIO GIARA.

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FRED D. SWEET.