

Aug. 26, 1924.

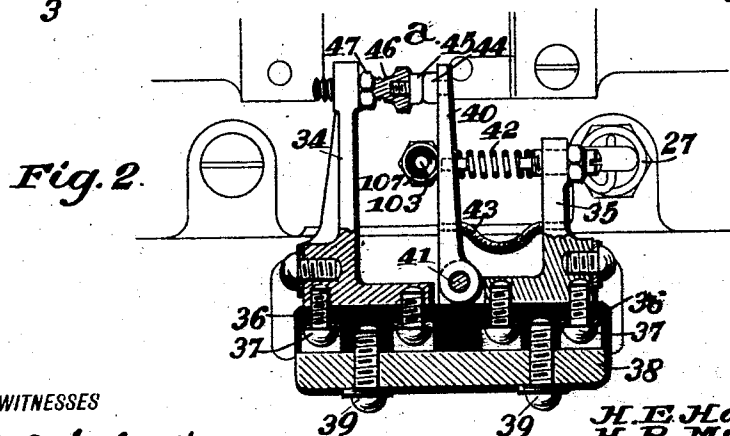
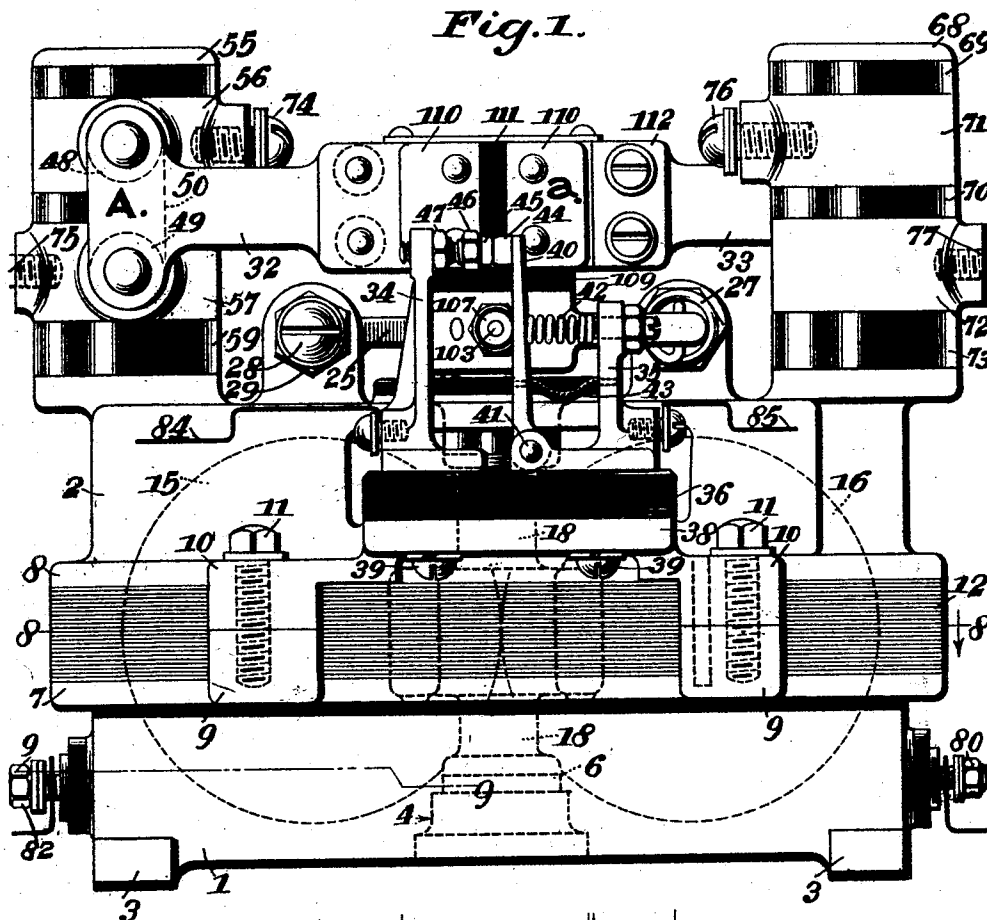
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1,506,580

QUICK ACTING AMPLIFYING BREAK KEY FOR WIRELESS TELEGRAPHY

Filed Oct. 25, 1920

8 Sheets-Sheet 1



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8 Sheets-Sheet 2

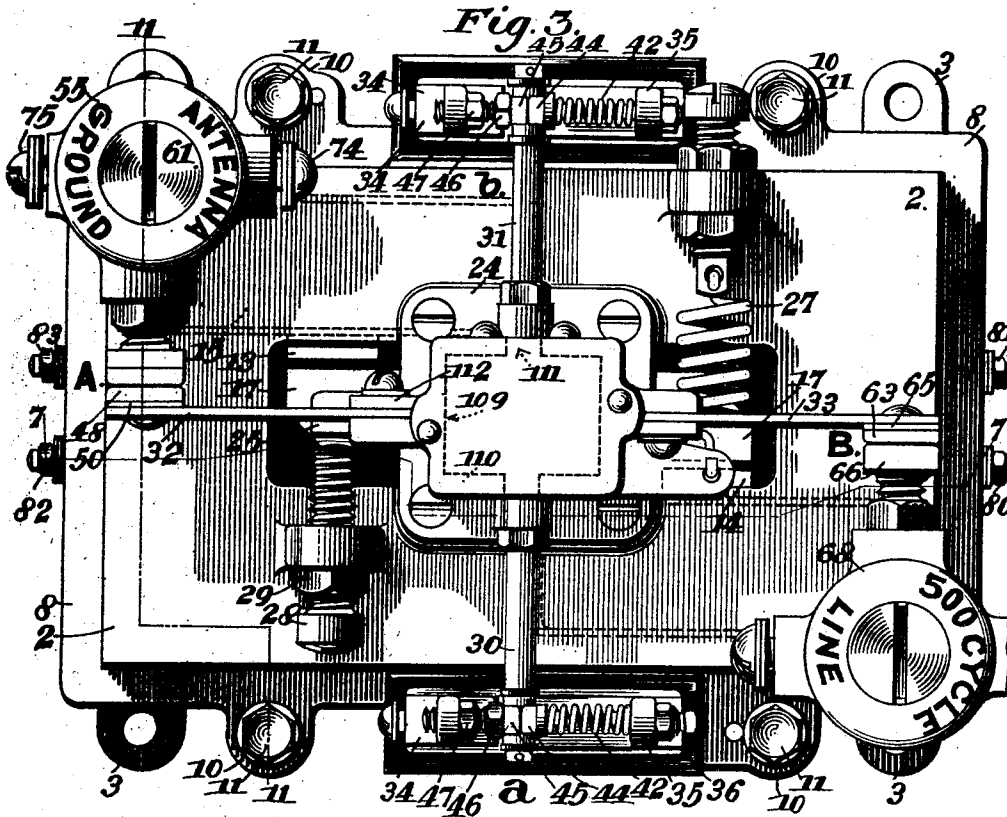


Fig. 4.

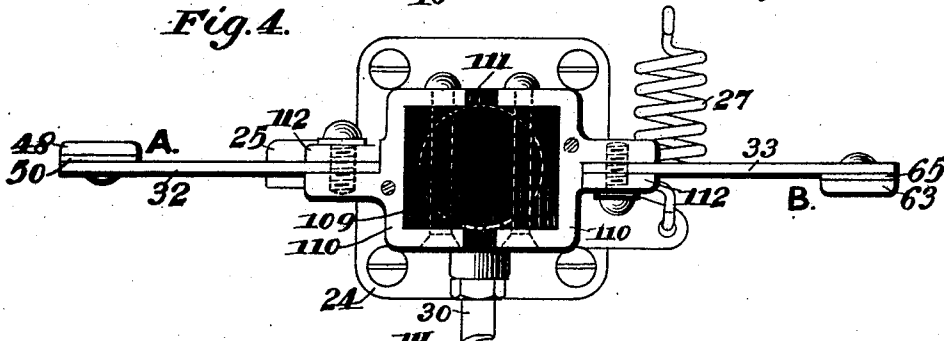


Fig. 5.

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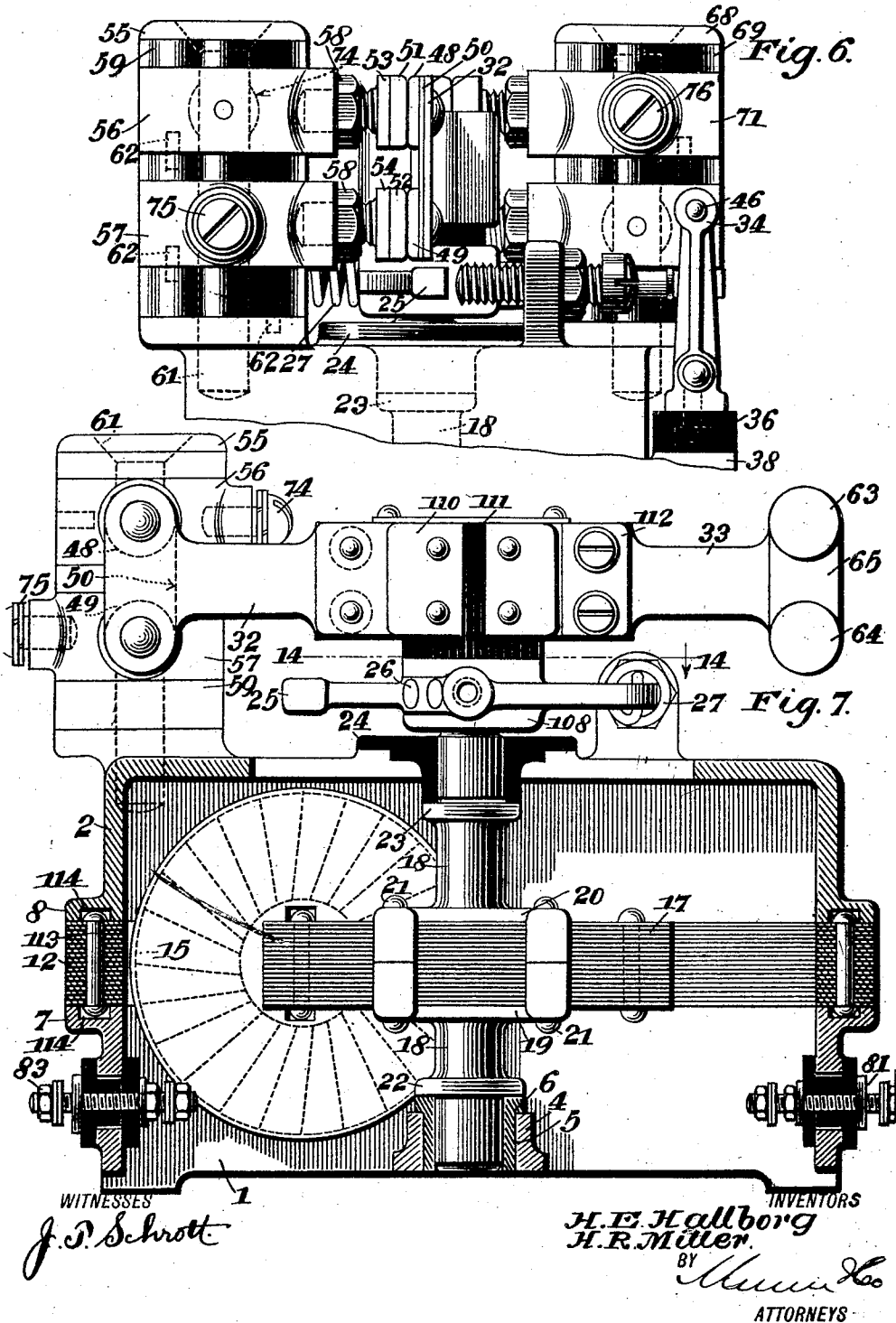
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Fig. 8.

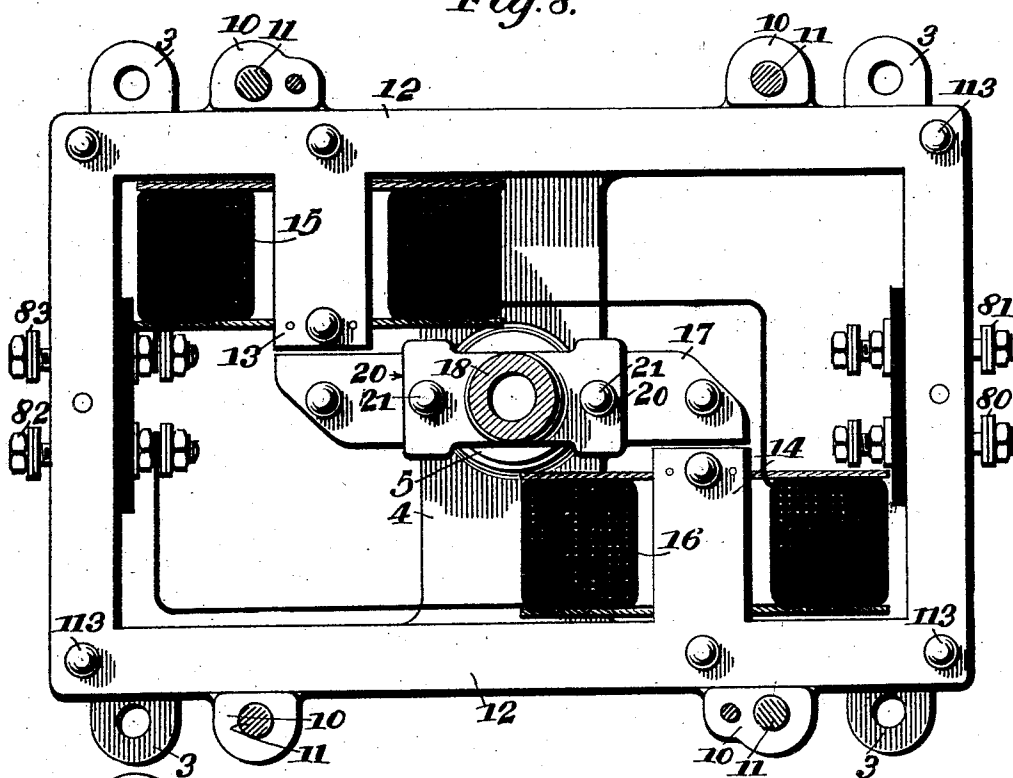


Fig. 9.

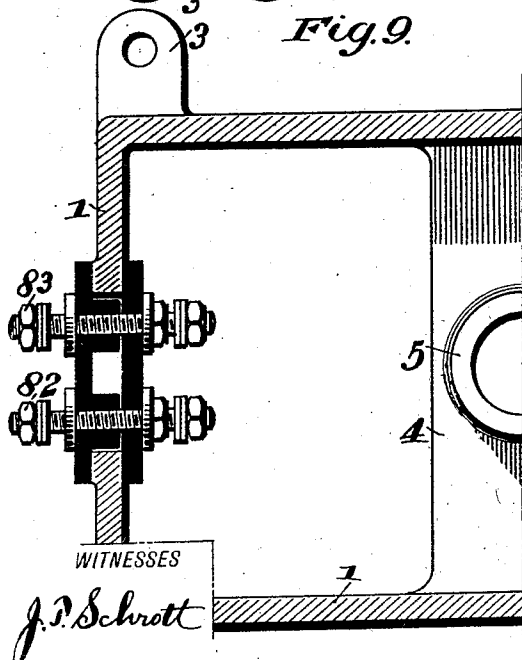
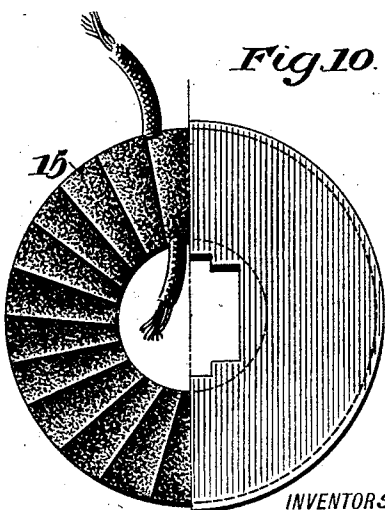


Fig. 10.



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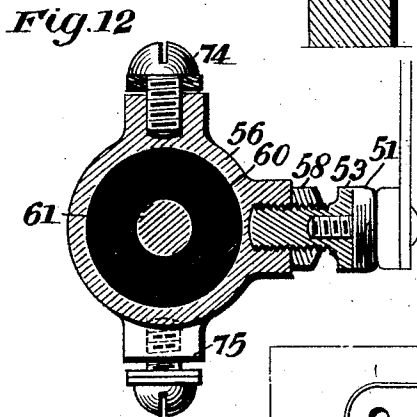
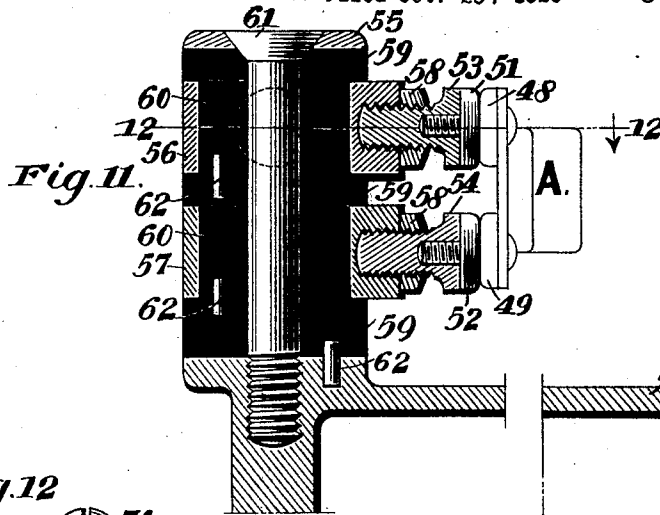
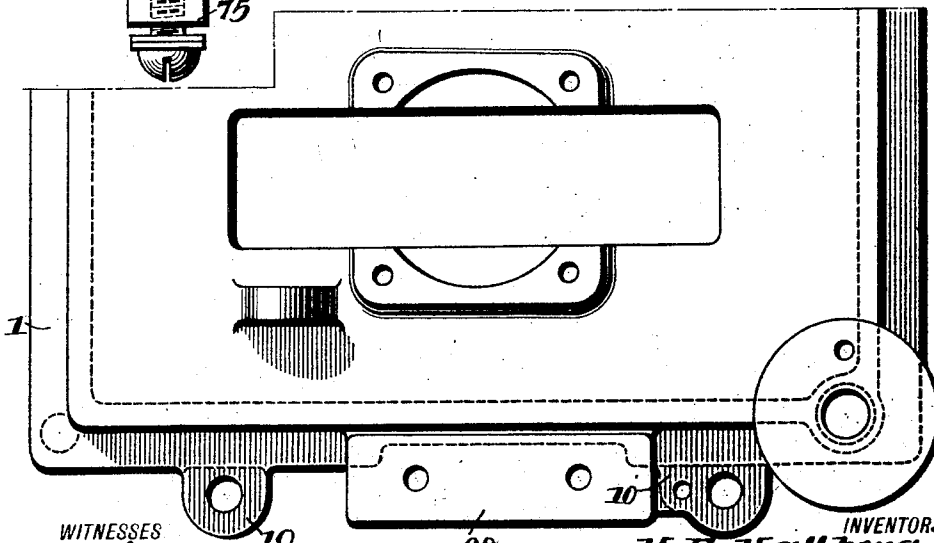
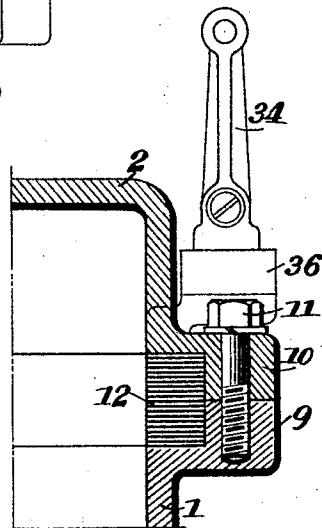


Fig. 13.



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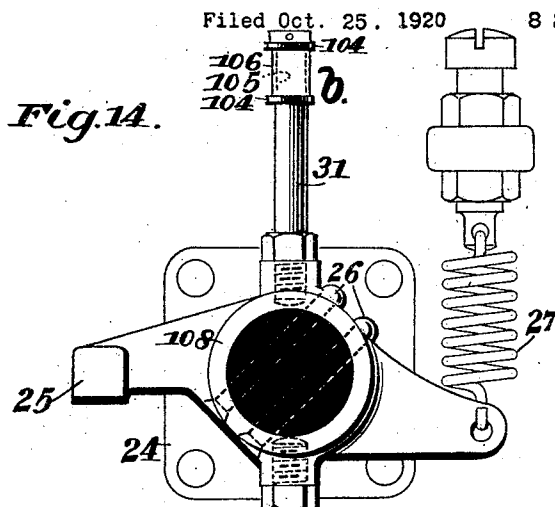
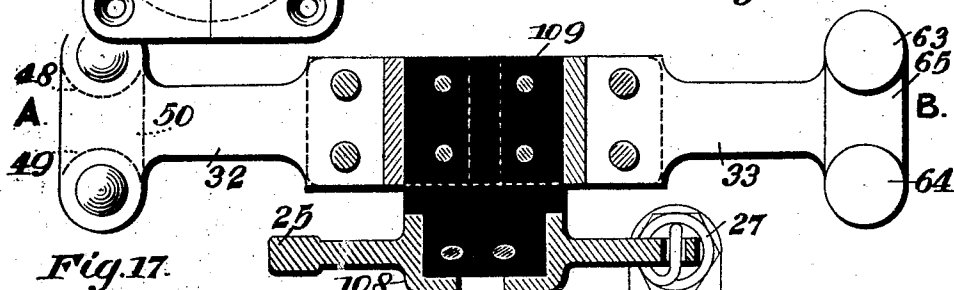
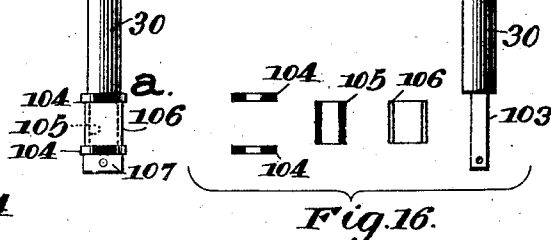
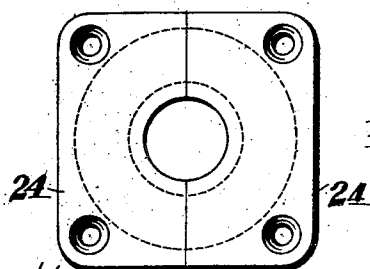


Fig. 15



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Fig. 18.

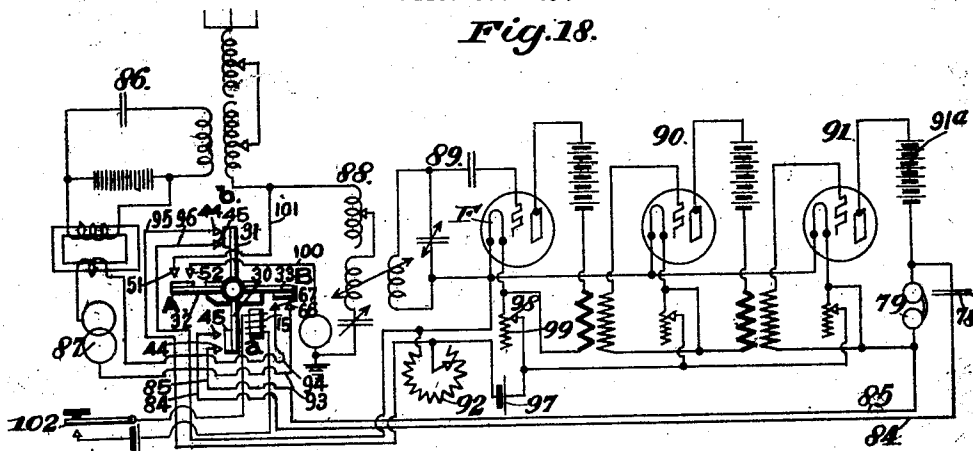


Fig. 19.

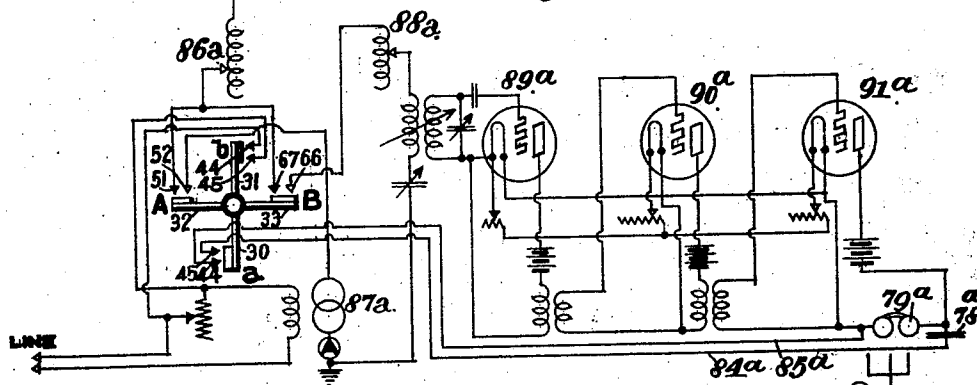
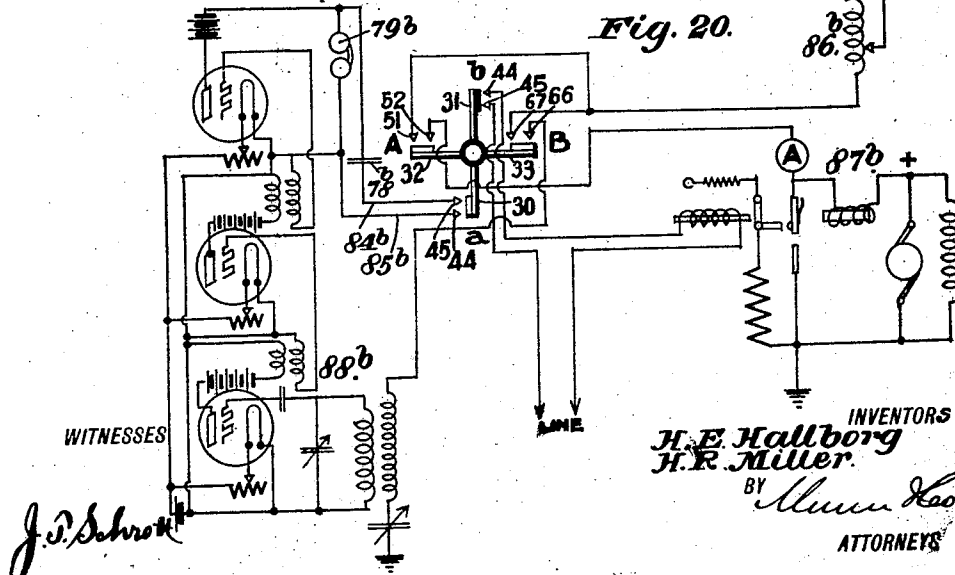


Fig. 20.



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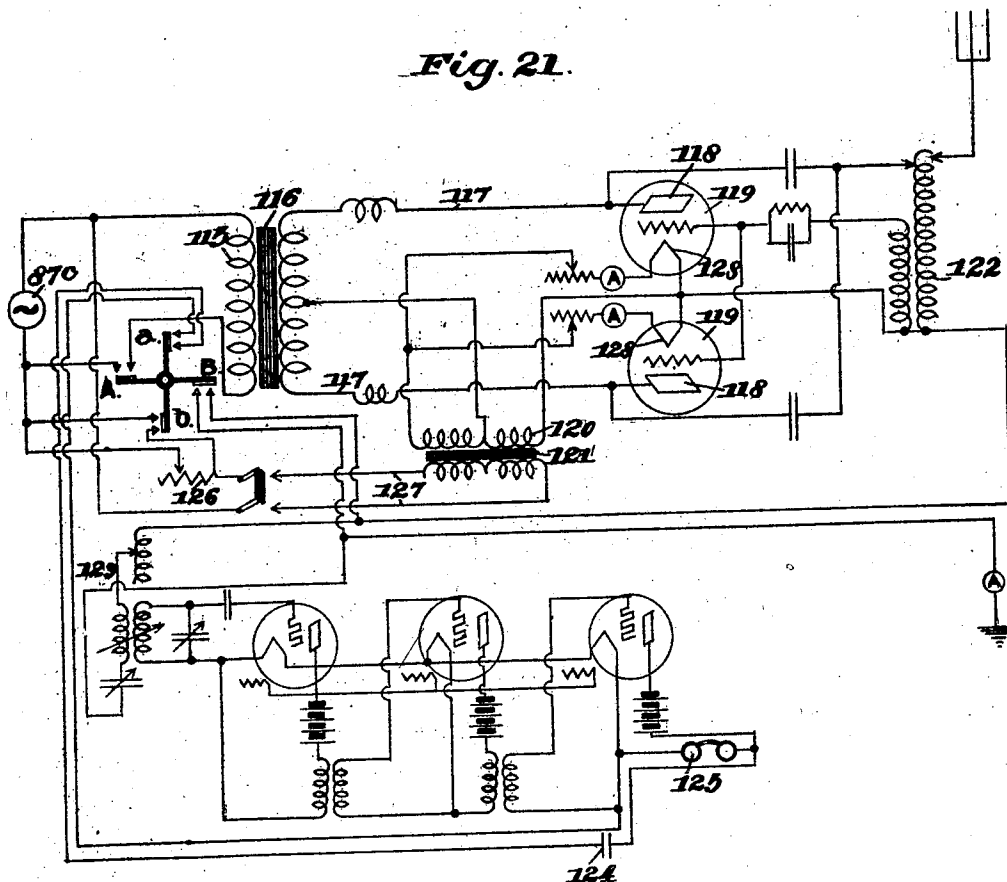
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Fig. 21.



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UNITED STATES PATENT OFFICE.

HENRY EMMANUEL HALLBORG, OF NORFOLK, VIRGINIA, AND HAROLD REDMORE MILLER, OF WASHINGTON, DISTRICT OF COLUMBIA.

QUICK-ACTING, AMPLIFYING BREAK KEY FOR WIRELESS TELEGRAPHY.

Application filed October 25, 1920. Serial No. 419,231.

To all whom it may concern:

Be it known that we, HENRY EMMANUEL HALLBORG, a citizen of the United States, and residing at Norfolk, in the county of Norfolk and State of Virginia, and HAROLD REDMORE MILLER, a citizen of the United States, and residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Quick-Acting, Amplifying Break Keys for Wireless Telegraphy, of which the following is a specification.

Our invention relates to improvements in wireless apparatus, and it consists in the constructions, combinations and mode of operation herein described and claimed.

One of the foremost objects of the invention is to provide a device to be used in conjunction with wireless telegraph apparatus, enabling the reception of amplified signals from either a damped or undamped wave distant transmitter between the dots and dashes of the transmitter of the local station, thereby saving much time in the handling of messages and also eliminating the "send to receive" transmitter switch.

A further object of the invention is to provide an improved relay or break key adapted more particularly for handling messages at high speed by wireless telegraph, to this end the break key being provided with an annealed sheet steel magnetic circuit.

A further object of the invention is to provide a quick-acting break key which is rendered sensitive to the slightest touch of the hand key by virtue of the selection of magnetic material possessing a maximum permeability at minimum magneto-motive force, thus obtaining the required rapidity of response and contact pressure and wholly avoiding sluggishness of operation.

A further object of the invention is to provide an improved break key wherein all of the parts are easily accessible, this being particularly true of the various contacts which are also independently adjustable as to the order of striking.

Other objects and advantages will appear in the following specification, reference being had to the accompanying drawings, in which:

Figure 1 is a front elevation of the improved wireless relay or break key,

Figure 2 is a detail sectional view of the

front auxiliary contacts which control the shunt condenser of the telephones,

Figure 3 is a plan view of the break key illustrated in Figure 1,

Figure 4 is a detail plan view of the main contactor,

Figure 5 is a detail perspective view of the insulating coupling on which the contactor arms of the main contactor are mounted,

Figure 6 is a detail end elevation of the key, showing the main contact pedestals which cooperate with the main contactor,

Figure 7 is a longitudinal section of the break key, taken substantially on the line 7-7 of Figure 3,

Figure 8 is a horizontal section taken substantially on the line 8-8 of Figure 1,

Figure 9 is a detail horizontal section taken substantially on the line 9-9 of Figure 1, showing the field coil connection posts,

Figure 10 is a detail side elevation of a part of one of the field coils and one of the fibre washers,

Figure 11 is a detail cross section of one of the contact pedestals, taken substantially on the line 11-11 of Figure 3,

Figure 12 is a detail section of the pedestal on the line 12-12 of Figure 11,

Figure 13 is a detail plan view of a part of the upper casing and the base,

Figure 14 is a detail cross section on the line 14-14 of Figure 7, showing the movable stop of the armature shaft, with its auxiliary contact arms,

Figure 15 is a detail plan view of the upper bearing of the armature shaft,

Figure 16 is a view of one of the auxiliary contact arms in Figure 14, the various parts being disassembled,

Figure 17 is a longitudinal section of the break key, illustrating the associated parts of the armature shaft in detail,

Figure 18 is a diagram illustrating the application of the quick-acting break key to a spark system having vacuum tube and amplifier system of reception,

Figure 19 is a diagram illustrating the application of the break key to an undamped system having vacuum tube and amplifier system of reception,

Figure 20 is a diagram illustrating the application of the break key to an undamped system using the ignition type of arc trans-

mitter with vacuum tube and amplifier system of reception, and

Figure 21 is a diagram illustrating the application of the break key to a 500 cycle vacuum tube transmitter with vacuum tube and amplifier system of reception.

A brief survey of the particular field in which the improved relay or break key is employed, will aid in the understanding of the purpose of the invention. The break key is primarily designed to enable speeding up of radio traffic between ships at sea and ship and shore stations. Such speeding up, when the instruments are operated manually, is largely dependent upon the development of a simple, fast and dependable break key. The merits of the break system have long been recognized, yet out of a wide experience it has been found that none of the break keys in present use have been unqualified successes with contact detectors, and particularly have none been successful with vacuum tube detector and amplifier receptions.

The major defects of break keys in common use have been observed to be as follows:

- (a) Sluggishness of operation.
- (b) Noisy reception.
- (c) Rugged contact detector required.
- (d) Inaccessibility and unreliability of adjustment.
- (e) Frailness of construction.
- (f) Multiplicity of contacts.

As more fully appears below, the above defects have been satisfactorily remedied in the herein disclosed break key. By using a magnetic material having very high permeability at low magnetizing force, a high magnetic flux density is instantly developed, giving the proper contact pressure which is necessary for high speed work. Cast and wrought iron have been found entirely useless for high speed work. Cast steel is satisfactory for comparatively slow speeds, as for example, 60 w. p. m. For high speed work, as for example 150 w. p. m. and over, the use of annealed sheet steel has been found absolutely essential. This material is employed in the magnetic circuit of the improved key.

There is a very close relationship between the magnet materials employed in the break key and the speed at which the key can be operated. By using a magnetizing current of proper strength, a very high magnetomotive force is instantly developed giving the proper contact pressure which is necessary for high speed work. To this end, the break key is sensitive to the slightest touch of the hand key so that the sluggishness of operation, enumerated above, is wholly avoided. The reader may now follow the construction of the break key, the major parts being described in order.

The base comprises the lower and upper

casings 1 and 2; the former with feet 3, by means of which the key is fixed in place, and a bridge 4 with a central bore 5 for the reception of the flanged brass bearing bushing 6.

Companion flanges 7 and 8, respectively on the lower and upper casings, have oppositely extending lugs 9 and 10 through which the screws 11 pass to clamp the laminated magnet frame 12 in position when the parts are assembled.

The magnet frame includes the diametrically opposite pole pieces 13 and 14, well illustrated in Figure 8, on which the field coils 15 and 16 are mounted. The laminations of the magnet frame 12 are made of annealed sheet steel, and when the field coils 15 and 16 are properly energized, a powerful magnetomotive force is set up at the pole pieces for the attraction of the adjacent ends of the laminated armature 17, substantially in the center of the shaft 18. As well shown in Figures 7 and 17, this shaft is made in two parts: Both parts have brackets 19 and 20 with lugs similar to the lugs 9 and 10 of the base casings, for embracing the laminations of the armature 17 and holding them as a unit when the rivets 21 are driven home.

Both shaft ends have collars 22 and 23, respectively bearing on the bushing 6 at the bottom, and engaging the bearing 24 at the top. This bearing is made in two parts, as in Figure 15, for convenience in assembling around the shaft.

A movable stop 25, riveted to the upper shaft at 26, limits the counter rotation of the shaft by virtue of the spring 27, when the coils 15 and 16 are deenergized and the armature 17 is released. The rotation of the shaft, under the influence of the magnets, is limited by the engagement of the stop 25 with the fixed stop screw 28, which may be adjusted, however, and fixed to its adjustments by the jamb nut 29. Surmounting the upper shaft 18 is the main contactor which carries the contacts A and B, generally so indicated for the purposes of the description below. The upper shaft also carries brass contact arms 30 and 31, at right angles to the spring steel contact arms 32 and 33 which carry part of the main contacts A and B, for the purpose of controlling the auxiliary contacts *a* and *b*. The arrangement of the auxiliary contact *a* is precisely the same as *b* when the break key is employed in the spark system shown diagrammatically in Figure 18, and therefore a brief description of the first will suffice for the second.

As shown in Figure 2, the auxiliary contact *a* comprises the contact bracket 34 and bearing bracket 35, both securely mounted on the insulating base 36 by means of machine screws 37, which base is in turn

mounted on the projection 38 from the upper casing 2, by means of screws 39. The contact arm 40 is movable on its fulcrum 41 on the base of the bracket 35, being urged toward the bracket 34 by the spring 42 and away from the bracket by the contact arm 30. The bond wire 43 provides a good electrical connection between the bracket 35 and contact arm 40, which connection might be interfered with were the metallic path through the fulcrum 41 relied upon solely.

The arm 40 carries a silver contact tip 44, to engage a similar tip 45 in the brass contact stud 46 of the contact bracket 34. The stud 46 is adjustable and its adjustments are set by the jamb nut 47. A brief description of the details of the main contacts A and B will enable the reader to pass on to the diagrams in Figures 18, 19, 20 and 21, in which connection the operation of the break key is described.

Consider first the main contact A: The arm 32 of the main contactor, carries contact tips 48 and 49, joined by a copper connector 50, for engaging companion contact tips 51 and 52 on the studs 53 and 54 of the pedestal 55. The contact studs are screwed into contact holders 56 and 57 of the pedestal 55, where they are held in place by jamb nuts 58. Insulating washers 59 and bushings 60 separate the contact holders 56 and 57, the central screw 61 securing all of the parts on the contact pedestal to the upper casing 2. Dowel pins 62 prevent relative turning of the washers and bushings.

The elements of the main contact B are precisely like those of the contact A but for purposes of distinction are designated as follows: The arm 33 of the main contactor has contact tips 63 and 64, joined by a copper connector 65, and cooperating with contact studs 66 and 67 of the other pedestal 68. These studs are made of hard ground copper and have no extra contact tip, whereas the studs 53 and 54 and the pedestal 55 are made of brass and have extra contact tips 51 and 52, made of silver.

Similarly, the tips 48 and 49 are made of silver, whereas the tips 63 and 64 are of copper. Bushings 69 and 70 separate the contact holders 71 and 72, as in the first instance, the washers 73 insulating the lowermost holder from the upper casing 2. The contact holders 56, 57, 71 and 72 respectively carry binding screws 74, 75, 76 and 77, so that the necessary circuit connection shown in the diagram in Figure 18, may be made. The shunt condenser 78 of the telephones 79, although shown separated from the break key, is housed within the base of the break key, in actual practice, and to that end, the base is provided at one end with a pair of connection posts 80, 81, similar to the connection posts 82, 83 of the

field coils 15 and 16, so that the wires 84, 85 may be connected between the break key and the telephone sets.

Generally described, the spark system in Figure 18 comprises the spark transmitter 86, the generator 87, the receiver 88, the vacuum tube detector 89, the first and second stage audion amplifiers 90 and 91 and the filament ballast resistance 92. The generator 87 is a 500 cycle generator, and its line wires 93, 94 are connected to the binding posts 76 and 77 of the contact pedestal 78, the current thus reaching the contact tips 66 and 67. Although not so shown, it is to be noted that the device is operative on more than the two stages of amplification described.

Wires 95, 96, lead from the tips 44, 45 of the auxiliary contact *b* respectively to the battery 97 and movable member 98 of the rheostat 99, which serves the purpose of bringing the filament F of the audion detector 89 to the proper degree of incandescence, and directly to the filament F (in the case of the wire 96).

The filament ballast resistance 92 is connected in parallel with the wires 95, 96. Wires 100, 101 shut the primary of the receiving set 88 when the tips 51, 52 of the main contact A are bridged.

The operation of the arrangement in Figure 18 is best understood from the following schedule:

Contacts.	Sending position.	Receiving position.
A.....	Short circuits primary of receiving set 88.	Removes short circuit from primary of receiving set 88.
B.....	Closes 500 cycle circuit 87.	Open 500 cycle circuit 87.
a.....	Connects condenser 78 of low resistance in shunt to telephones 79.	Disconnects condenser 78.
b.....	Inserts variable ballast resistance 92 in filament circuits of vacuum tubes 89, 90 and 91.	Short circuit ballast resistance 92.

It is to be understood that the insertion of the variable ballast resistance 92 is of considerable importance especially when used on very high power sets. This resistance operates to reduce the emission of ions in the thermionic current in the sending position of the key. At such a time (especially in a high-powered transmission set) there is grave danger of injury to the vacuum tube by induced current during the sending operation. During such sending operation the current induced thereby, increases the thermionic current (which is the current flowing from the filament to the plate) tending to the detriment of the vacuum tube, but it is here that the resistance 92 performs its functions. This function is to reduce the emission of ions from the filament to such an extent that the thermionic current never exceeds a safe value when the induced (sending) current is added

thereto. The shunt condenser 78 of the telephones 79 is a very important feature. Ordinarily, the elimination of noise in the telephones is a particularly difficult problem in the case of highly amplified received signals, this being so because the plate circuit of the amplifier is extremely sensitive to any change in its constants and particularly to a change in its resistance.

The paralleling of the telephones 79 by the condenser 78 does not affect the resistance of the plate circuit and hence arc or spark signals are readily received, all noise in the telephones, as caused by induction in the local transmitter, being prevented by the condenser.

This principle of the invention is operative with any type of transmission apparatus and with any kind of detector (crystal, vacuum tube). The battery 91^a produces a steady flow of current from the filament to the plate of the detector 91, and so long as it remains at its normal value no sound in the telephones results. When transmitting signals, the signal pulse which is superimposed on the plate current, produces a current of such strength that a deafening sound results in the telephones. However, by providing the condenser 78, the signal pulse is shunted around the telephones rendering them insensitive to excitation from the local transmitter.

The degree to which the signal pulse is shunted from the telephones depends on the relative reactances of the telephones and condenser, and the degree of reactance of the condenser depends on its capacity.

Those parts of the wireless sets in Figures 19 and 20, corresponding to similar parts in Figure 18, are designated by similar reference characters with the exception of the addition of index letters *a* and *b* in the respective diagrams. For example, in Figure 19, the transmitter is designated 86^a, the high frequency generator 87^a, the receiver 88^a, etc., while in Figure 20, the transmitter is indicated 86^b, the arc set 87^b, the receiver 88^b, etc. The operation of the break key in Figure 19 can be understood at a glance from the following schedule:

UNDAMPED WAVE SYSTEM.

High frequency generator transmitter.

Contacts.	Sending position.	Receiving position.
A-----	Connects high frequency generator 87 ^a to antenna system 86 ^a .	Disconnects high frequency generator 87 ^a .
B-----	Disconnects receiver 88 ^a from antenna system.	Connects receiver 88 ^a to antenna system.
a-----	Connects condenser of low reactance 78 ^a in shunt to telephones 79 ^a .	Disconnects condenser 78 ^a .
b-----	Short circuits resistance in field of high frequency generator.	Inserts resistance in field of high frequency generator.

The operation of the break key in its position in the arrangement in Figure 20, is also best understood from the accompanying schedule:

UNDAMPED WAVE SYSTEM.

Uni wave-ignition key type arc transmission.

Contacts.	Sending position.	Receiving position.
A-----	Connects arc generator to antenna system.	Disconnects arc generator from antenna system.
B-----	Disconnects receiver from antenna system.	Connects receiver to antenna system.
a-----	Connects condenser of low reactance in shunt to telephones.	Disconnects condenser from telephones.
b-----	Closes magnet circuit of ignition key.	Opens magnet circuit of ignition key.

The reader must understand, in connection with the three diagrams described above, that in each instance the ordinary hand key 102 is used to energize the field coils 15 and 16 from any suitable source of electrical energy. This key is employed by the operator in sending his messages, a depression of the key energizing the coils of the relay of break-key, a release thereof deenergizing them. The attraction of the armature 17, by the energization of these coils, rotates the shaft 18 and consequently closes and opens certain of the contacts as clearly pointed out in the above schedules in connection with the various wireless systems. The reader will also understand from the above schedules, that when the break key is in one position the contacts A, B, *a*, *b*, enable the receiving of a signal, while when the same contacts are in the opposite positions they enable the sending of a signal. It is by this dual performance of the break key that wireless traffic is successfully speeded up and many actual exhaustive tests have demonstrated the merits of the improved break key. The foregoing description is purposely made as brief as possible so as not to seriously interfere with a quick understanding of the operation of the break key, attention being now directed to those details of construction which are omitted above but must now be included. Beginning with the contact arm 30 (and the same construction is carried out in respect to the arm 31) the free end is reduced into a spindle 103, on which insulating washers 104 are fitted, the insulating sleeve 105 fixing the space between them. The metal sleeve 106, mounted on the insulating sleeve 105 between the washers 104, engages the contact arm 40 of the auxiliary contact *a* (also *b*), a brass collar 107 being pinned to the spindle 103 to hold the various parts in Figure 16 in place.

The movable stop 25 is substantially of the shape shown in Figure 14, including a receptacle 108 in which the circular plug

of the coupling 109 is fixed by the rivets 26. A metallic bracket 110 is secured to the coupling 109 at each side and in abutment with dividing ribs 111, for the purpose of providing mountings for the arms 32, 33 of the main contactor. These arms are held in place by clips 112 and suitable screws, all as clearly shown in Figure 4. The coupling 109 is made of insulating material as illustrated.

The laminations of the magnet frame 12 are punched out of a single sheet of annealed steel in the shape shown in Figure 8, heated rivets 113 being placed at the important points to hold the laminations together. The heads of the outermost ones of the rivets are pocketed in recesses 114 when the upper and lower casings of the base are assembled, so as to constitute keys as it were, to assist in the assembling.

To further this end, the frame holding lugs 10 are flat faced on the inside, these lugs, together with the rivets just mentioned above, securely holding the magnet frame in its proper place.

Mention has been made of the adjustability of the various main and auxiliary contacts A, B, a, b, but the particular construction in connection with which such mention has been made, must be supplemented by data giving the best contact adjustments, determined by actual practice. Such has been found as follows:

Contact A: A very small opening of about 1/100 inch. When the key is in the open position this opening acts as a receiver safety gap.

Contact B: Opening of about 1/16 of an inch.

Contact a: Opening of about 1/200 of an inch.

Contact b: Opening of about 1/200 of an inch.

From the foregoing gap spacing, the reader will understand at once that all contacts do not engage simultaneously, the order of closing and opening varying in the three systems in diagrammatic Figures 18, 19 and 20. For the spark system in Figure 18, the order of closing is a-A-B, and order of opening is B-A-a.

For the undamped system in Figure 19, the order of closing is a-b-A, and order of opening is A-b-a; and for the undamped system in Figure 20, the order of closing is a-A-b, and order of opening is b-A-a.

B opens immediately after a closes, B closes immediately after A opens.

Further experiments have developed the transmitting circuit illustrated in Figure 21 and is so directly applicable to the improved relay or break key that mention of the arrangement must be made. 87° is a 500 cycle generator, as in the preceding dia-

gram, which supplies energy to the primary winding 115 of the power transformer 116.

This transformer supplies current at high voltage to the circuit 117 of the plates 118 of the vacuum tubes 119 and to the primary 120 of the filament lighting transformer 121. The oscillation transformer 121 has a tickler connection to the input side of the tube. Briefly stated, the 500 cycle generator 87° provides means for dispensing with the usual plate and filament batteries and supplies pulses of continuous wave energy to the antenna. The following schedule clearly describes the operation of the break key:

Con- tacts.	Sending position.	Receiving position.	
A----	Connects generator 87° to primary 115 of transformer 116 to plate circuit 117 and antenna system.	Disconnects generator 87°, etc., from antenna system.	85
B----	Shunts primary of receiver circuit 123 from antenna system.	Removes shunt of primary 123 from antenna system.	
a-----	Connects condenser of low reactance 124 in shunt to telephones 125.	Disconnects condenser from telephones.	
b-----	Inserts resistance 126 in transformer circuit 127 to reduce incandescence of filaments 128.	Removes resistance from filament condenser circuit to increase incandescence of filaments.	90

For the vacuum tube transmitter system in Figure 21, the order of closing is a-B-b-A, order of opening is A-b-B-a.

While the construction and arrangement of the improved wireless break key as herein described and claimed is that of a generally preferred form, obviously modifications and changes may be made without departing from the spirit of the invention or the scope of the claims.

We claim:—

1. Wireless telegraph transmitting and receiving apparatus, comprising a series of oscillation valves, telephones in operative connection with said valves for receiving highly amplified signals, and a condenser in shunt with the telephones for shunting the signal pulses of the transmitting apparatus around the telephones thereby preventing noise therein.

2. Wireless telegraph apparatus, comprising a series of oscillation valves, telephones in operative connection therewith, a relay or break key with contacts placing the oscillation valves in a signal-receptive connection when the key is in one position, and a condenser normally shunted across the telephones when the key is in the original position, disconnected from the telephones when the key is in the signal-receptive position.

3. Radio telegraph apparatus comprising the combination of a receiver having a detector, an associated circuit including a source of current, telephones situated in said circuit; a transmitter, a sending key embodied in said transmitter, and a con-

denser in said circuit in shunt with the telephones adapted to render the telephones insensitive to excitation of said circuit upon operation of said key.

5 4. Radio telegraph apparatus comprising the combination of a receiver having a vacuum detector, an associated circuit including a source of current, telephones situated in said circuit; a transmitter, a sending key embodied in said transmitter, and
10 a condenser in said circuit in shunt with the telephones adapted to render the telephones insensitive to excitation of said circuit upon operation of said key.

15 5. Radio telegraph apparatus comprising a transmitter and receiver, a circuit embracing a detector, associated amplifying means and telephones situated in said circuit, a telegraph key in said transmitter, and a
20 condenser in said circuit in shunt with said telephones for the purpose of rendering them insensitive to excitation from the local transmitter during transmitting periods.

25 6. Radio telegraph apparatus comprising a receiver and local transmitter, a circuit in said receiver embodying a detector, associated amplifying means including telephones, a key in said transmitter, and a condenser of low reactance in respect to the
30 telephone reactance at signal pulse frequency situated in said circuit but in shunt across the telephones for the purpose of rendering the telephones insensitive to excitation from the local transmitter upon operation of said
35 key.

7. Radio telegraph apparatus comprising the combination of a vacuum tube detector with an associated circuit embracing telephones and a source of current, a condenser
40 bridging the telephones, and a break key having a closed and open position, and a condenser shunting the telephones when the key is closed to prevent disturbance of the steady thermionic current, but when open,
45 to cut out the condenser so that an incoming signal pulse may be imposed on said current and result in a response by the telephones.

8. Radio telegraph apparatus including telephones, a condenser adapted to be shunted
50 ed around the telephones, a receiving set, a

transmitter, and a break-key adapted to first shunt the condenser across the telephones, short circuit the primary of the receiving set, and energize the transmitter in moving to the sending position, and performing the
55 same functions in reverse order in moving to the receiving position.

9. In wireless telegraph apparatus consisting of a series of oscillation valves in which a steady thermionic current and
60 audio frequency current exist and telephones in circuit with said valves, the method of removing from the telephones the audio frequency current without disturbance to the normal steady thermionic current. 65

10. In wireless telegraph apparatus consisting of a series of oscillation valves in which a steady thermionic current and audio frequency current exist, and signal responsive means in circuit with said valves, the
70 method of removing from said signal responsive means the audio frequency current without disturbance to the normal steady thermionic current.

11. In wireless telegraph apparatus consisting of an oscillation valve, means for maintaining a steady thermionic current therein, an outgoing signal pulse superimposed upon said thermionic current, and telephones in circuit with said valve, the method
80 of shunting said superimposed current around the telephones to prevent objectionable noise therein and without disturbing said thermionic current.

12. Wireless telegraph apparatus comprising a series of oscillation valves, telephones in operative connection with said valves for receiving amplified signals, a break key with contacts placing the oscillation valves in a signal-receptive connection when the key is
90 in one position, and a low-reactance condenser normally shunted across the telephones when the key is in the other position, but disconnected from the telephones when the key is in the signal-receptive position, 95 thereby making the telephones instantly responsive when the key is released.

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