

Sept. 30, 1924.

1,510,341

J. A. PROCTOR

ELECTRICAL APPARATUS

Filed June 4, 1921

2 Sheets-Sheet 1

Fig. 1.

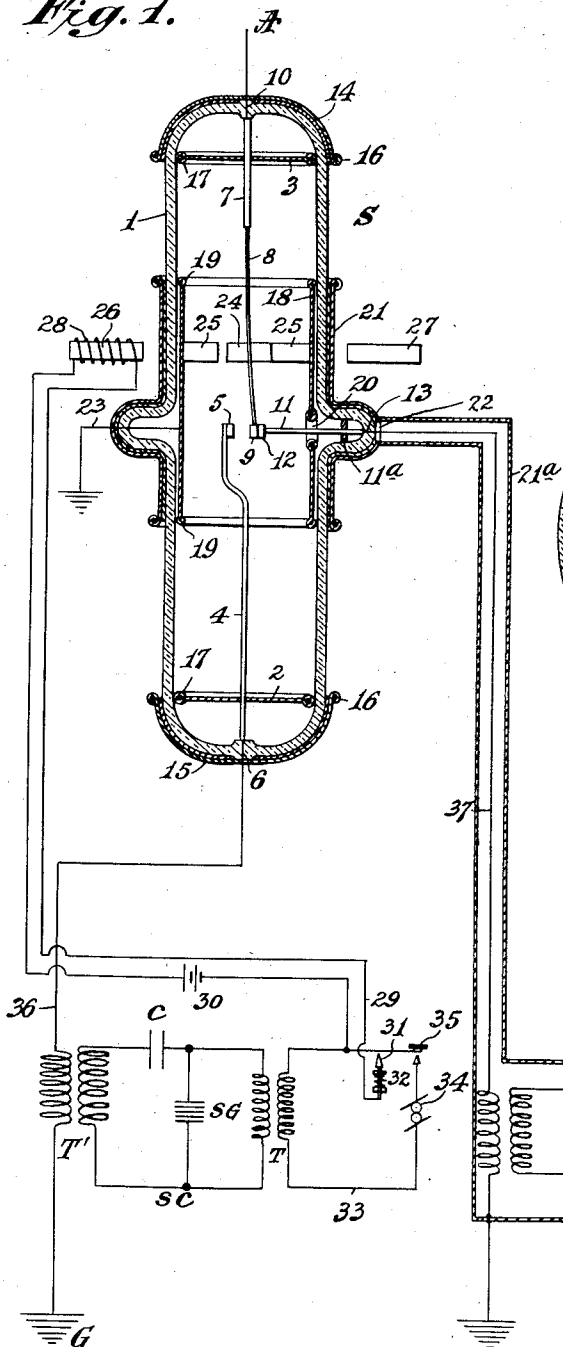
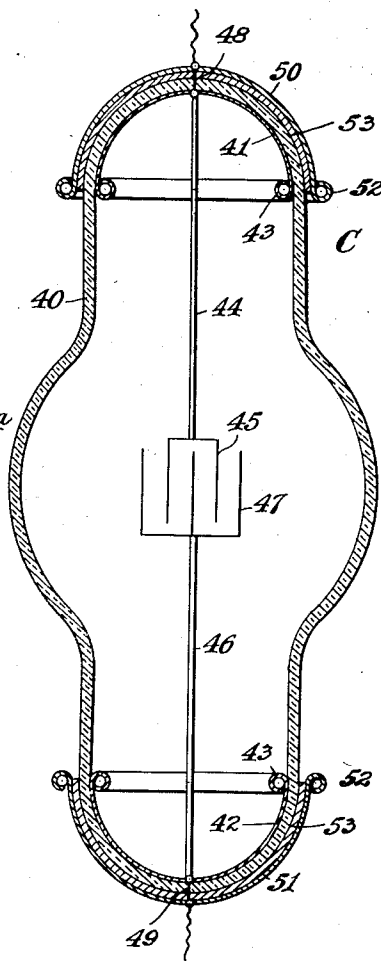


Fig. 2.



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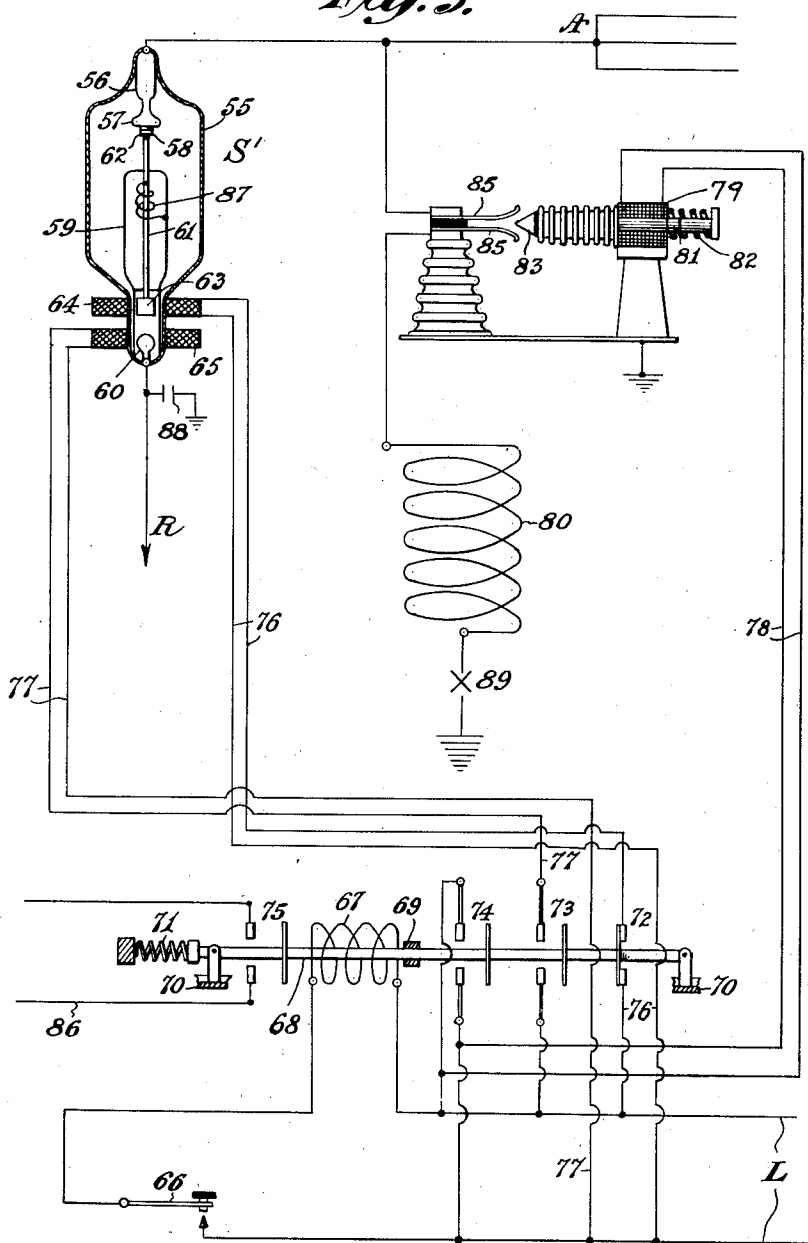
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2 Sheets-Sheet 2

Fig. 3.



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Patented Sept. 30, 1924.

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UNITED STATES PATENT OFFICE.

JOHN A. PROCTOR, OF LEXINGTON, MASSACHUSETTS, ASSIGNOR TO WIRELESS SPECIALTY APPARATUS COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF NEW YORK.

ELECTRICAL APPARATUS.

Application filed June 4, 1921. Serial No. 475,144.

To all whom it may concern:

Be it known that I, JOHN A. PROCTOR, a citizen of the United States of America, and a resident of Lexington, State of Massachusetts, have invented certain new and useful Electrical Apparatus, the principles of which are set forth in the following specification and accompanying drawings, which disclose the form of the invention which I now consider to be the best of the various forms in which the principles of the invention may be embodied.

This invention relates to electrical apparatus for use in high potential work such as in radio transmitters and receivers and in power factor work.

In radio telegraphy and telephony, it is an advantage, where the same antenna is used both for transmitting and receiving, to have the antenna connected up with the receiving apparatus, momentarily between successive actuations of the sending key in order that the sender may receive messages or signals when the distant receiving operator has failed to receive a message or a portion thereof which is being transmitted. In prior constructions for this purpose, it has been attempted to insert a switch of some sort between the transmitting inductance and the ground across the terminals of which the receiving apparatus is connected. This system, however, has the disadvantage that good reception cannot be obtained on wave lengths that are shorter than the wave lengths to which the transmitter is adjusted. On the other hand, no suitable switch or break key has been heretofore devised which is capable of withstanding, when open, the normal working voltage of the transmitter, say 50,000 volts, and at the same time to have the contacts close enough together so that they will work sufficiently quick and be sufficiently sensitive to open and close during the brief intervals between successive actuations of the transmitting key.

Also in power factor work, a reliable high voltage disconnecting switch has not been available for use in connection with static condenser installations.

The power factor of a high voltage system varies with the load on the system. It is, therefore, of great importance to be able to control the amount of condenser current placed across these lines in such a manner as to provide the best power factor for con-

ditions of load on the system. In a power factor static condenser installation across a fairly low voltage line, the amount of correction may be varied by switching condensers on and off the line, using oil or other switches of standard design. However, if condensers are placed directly in the high potential line, the standard switching means now on the market is not suitable for use in continuously making and breaking circuits connected to them, due to the destructive arcing accompanying their operation. Oil switches of proportions ample to take care of the disconnection and re-connection of apparatus on high potential lines are too expensive to warrant their use for this work. Disconnecting switches, therefore, form an important element of the static condenser power factor system. Inasmuch as the hourly variation of power factor on a high voltage line is large, and therefore if economic correction is provided for the maximum lagging conditions, means must be provided for reducing this correction as the load is removed.

An important thing in the use of condensers for power factor work hinges about the ability to successfully and cheaply disconnect at will banks of high voltage condensers. Assume, for example, a high voltage line without load. The line would simply be carrying charging current or have a very low leading power factor. As the sub-stations take off load, the power factor would increase and still be leading. Since sub-station loads are usually at a lagging power factor, the capacity reactance of the line is ultimately neutralized by the inductive reactance of the load. A point is usually reached within a range of 10% to 75% of the full output of the system when the power factor is approximately unity. As more load with lagging characteristic is added to the line, the whole system becomes lagging and the power factor drops. The power factor may be restored by adding a condenser at the consuming end. It will be appreciated that if this is done and the consumers cut off their load and leave the condenser connected to the line for light loads on the line, the power factor will be low and leading. The main objection to this is not that there will be high losses on low loads, but is primarily one of poor voltage regulation. If the condensers are cut out of cir-

cuit in steps as the load is varied, the power factor can be maintained at a high value over a considerable variation in load. The importance of correction control increases with the length and voltage of the line.

In like manner, in condensers of the sheet or jar type now in use, the electrical losses where high voltages are used are comparatively great, resulting in loss of efficiency and also in heating and ultimate disintegration of the condenser. This heating is due partly to losses in the dielectric, apparently arising from dielectric hysteresis, or frictionally-impeeded movements of the electrons of the dielectric, due to the change of electric flux through the latter; partly to brush or corona discharges in the medium surrounding such condensers, and partly to the mechanical motion of the elements in the condenser owing to the change in forces resulting from the change in applied potential.

The condensers may comprise an organic filler such as oil, wax or varnishes as the dielectric held between the conducting elements of the condenser by a fibrous material such as paper. Under conditions of high alternating dielectric stress, the organic material slowly changes and releases free carbon, and in many cases water. This deterioration in its initial stages causes heating in the condenser and ultimate breakdown. Mica condensers are generally impregnated with organic materials similar to the ones mentioned. These materials are in thin layers between the mica and the metal elements for binding purposes, and fill voids and replace gas between the mica and metal elements to prevent brush discharge which would otherwise take place in these voids. The organic materials previously mentioned are likewise used to embed a mica condenser stack. A high potential alternating electric field acts to gradually deteriorate the binder or filler and finally causes failure in such condensers. Condensers of the usual type in which the dielectric is of oil, impregnated paper or of mica have been used to a certain extent for power factor correction on low voltage lines and also in radio transmitters. In such cases, the condensers, in order to withstand the high voltages employed, are connected in series or the individual stacks of the condenser are built up in series sections. Such condensers are relatively costly and have relatively low efficiency, and are also more or less unreliable.

In the present invention, it is my plan to provide vacuous apparatus replacing the condensers of solid dielectric and switches now in use. In the former case, the dielectric between the plates of the condenser is a vacuum, the condenser being inserted in a casing or bulb from which air has been exhausted, and in the latter case I provide

relatively movable contacts which operate in a vacuum, the contacts being enclosed in a bulb from which air has been exhausted. Means is also provided to prevent the heating of the glass or other fusible material used in the construction of the apparatus due to the cutting of the glass by the electric lines of force developed at high potentials.

An object of the present invention is to provide constructions of the above types in which the losses are at a minimum.

In particular, the object of the invention is to provide a condenser or break key which will be comparatively cheap and economical to build and which is efficient and durable.

Another object of the invention is to provide a high voltage switch or a break key in which there will be very little loss or sparking when the switch is open, and which can be quickly made and broken.

Another object of the invention is to so form the terminals of the vacuous apparatus that the electric field is parallel to the dielectric at all points.

Another object of the invention is to provide a relay break system for radio transmitters which avoids receiving through the transmitting inductance.

This application is a continuation in part of my application Serial Number 441,628, filed February 1, 1921.

In the accompanying drawings,

Figure 1 is a sectional elevation of one embodiment of the present invention illustrating a break key with the transmitting and receiving circuits connected thereto and illustrated diagrammatically;

Fig. 2 is a sectional elevation of another embodiment of my invention illustrating the application of the idea of the invention to a condenser; and

Fig. 3 is a sectional elevation of a modified form of break key embodying the present invention, this break key being illustrated connected up to a receiving and transmitting circuit having modified features and shown diagrammatically.

Referring to Figure 1, there is illustrated a switch or break key S having a casing or bulb 1 which may comprise any fusible dielectric material, such as high melting point glass, from the interior of which air may be exhausted. Secured at opposite ends within the casing 1 are metal discs or shields 2 and 3. A metal conducting rod 4 is supported by the disc 2 and terminates adjacent the central portion of casing 1 in a contact 5, the rod 4 being electrically connected to a wire conductor 6 sealed in the glass of the casing 1 in the manner hereinafter described. Supported by the metal disc 3 at the opposite end of the casing 1 is a metal conducting rod 7 which terminates at its inner end in a flexible metal spring member

8 having a contact 9 at its free end adapted to engage with the contact 5. The rod 7 is conductively connected to a wire 10 sealed in the glass of the casing 1 as hereinafter described. Projecting inwardly towards the contacts 5 and 9 is a third conductive rod 11 supported within the casing 1 by means of a frame 11^a and arranged at an angle to rods 4 and 7. The rod 11 terminates in a contact 12 between which and the contact 5 is interposed the contact 9, the contact 9 being adapted to alternately engage the contacts 5 and 12. The rod 11 is electrically connected to a wire 13 sealed in the glass casing 1 and extending therethrough. The contacts 5, 9 and 12 may comprise some high melting point metal and good conducting metal such as tungsten which will not melt under the high heat developed in the switch during service nor at such temperatures give off gases which would impair the vacuum.

In order to localize the electric fields both inside and outside of the casing 1 and to maintain such field parallel with the casing 1 at all points to prevent the cutting of the casing by the lines of force which would otherwise heat the casing, I use the two metal discs or shields 2 and 3 within the casing at opposite ends and which are electrically connected to the rods 4 and 7, the rods having a difference of potential, the difference of potential under transmitting conditions being of the order of 50,000 volts. Upon the outside of the casing 1 at opposite ends, I place metal caps or shields 14 and 15, which may serve as terminals and which are secured to the ends of the casing in any suitable manner and are flared out away from casing 1 and rolled at their edges 16 to prevent brushing and concentration of the electric field and space the edges of the caps from the casing. In like manner, the discs 2 and 3 are rolled up at their edges 17 to prevent concentration of the field. The caps 14 and 15 are electrically connected to the discs 2 and 3 through conductors 6 and 10, and are therefore at the same potential as the discs. Centrally arranged within the casing is a cylindrical metal shield 18 which has its opposite edges rolled at 19 and spaced from shields 2 and 3 for the purpose specified and is provided with a hole 20 through which the rod 11 extends and from which it is spaced. Arranged concentrically with the shield 18 upon the outside of the casing 1 is a metal shield 21 provided with an opening 22 through which the conductor or lead 13 passes and whereby it is insulated from the shield 21. The shields 18 and 21 are electrically connected together by a conductor 23 which is grounded and which is sealed in the glass 1 of the casing. It is well to statically shield the conductor 37 as well as the entire receiver structure R by a metal shield 21^a constituting an extension of

shield 21 and in a manner which will not introduce appreciable dielectric or other losses. This will reduce the inductive effect from the transmitter to receiver in operation, to the relatively minute capacity of the contacts 5 and 9, said capacity effects being confined to a vacuous or lossless dielectric.

I also provide means for actuating the switch S herein disclosed so that the contact 9 alternately engages contacts 5 and 12. This means in the present embodiment of the invention as disclosed in Fig. 1 comprising a soft iron armature 24 secured to the flexible support 8 and movable between spaced soft iron pieces 25 secured to the shield 18 and providing a magnetic path. The contact 9 is actuated from a point exterior of the casing 1 by magnetic means such as the electromagnet 26, which is connected in a circuit containing a suitable source of energy as hereinafter described, and a permanent magnet or electromagnet 27 which tends normally to draw the contact 9 into engagement with the contact 12, the electromagnet 26 when energized opposing the magnet 27 and overcoming the force thereof to bring the contacts 5 and 9 together. The iron pieces 25 provide a magnetic path between the outside magnets and armature 24. As more fully described hereinafter, the air has been exhausted from within the casing 1 whereby the contacts 5, 9 and 12 operate in a vacuum in the manner hereinafter more fully described.

The form of switch disclosed in Fig. 1, for the purpose of illustration, has been shown connected to radio transmitting and receiving apparatus. For this purpose, the specific embodiment of switch illustrated is especially adapted. The electromagnet 26 comprises a coil 28 and a circuit 29 having a battery 30 therein for energizing the magnet. This circuit 29 is completed in part by means of a contact 31, which is spring-mounted at 32, and in part by a circuit 33 containing an alternator 34. The circuit 33 of the alternator 34 is closed by means of the usual transmitting key 35. Upon the depression of the key 35 to close the circuit of the alternator 34, the former first engages the contact 31 which energizes the circuit of the electromagnet 26 to draw the contact 9 into engagement with contact 5 for transmitting. Immediately thereafter, the key closes the circuit 33 and the transmitter is in operation. The switch S when in transmitting position is directly connected at one end to the antenna A and through contacts 5 and 9 is connected at its other end by conductor 36 to ground, the energy of the alternator being transferred to conductor 36. I have illustrated diagrammatically a usual form of quenched spark transmitter in which the energy developed by the alternator 34 in the circuit 33 upon the depression of the

key 35 is transferred through the transformer T to a secondary circuit SC containing the spark gap SG and condenser C, which condenser may be of the form illustrated in Fig. 2. The energy developed in the circuit SC is then transferred through the transformer T' to the antenna circuit. When the key 35 is released, the transmitter circuits to the antenna are deenergized, the electromagnet 26 is subsequently deenergized, and the permanent magnet 27 then automatically draws the contact 9 into engagement with contact 12, whereby the apparatus is in position for receiving. When switch S is in receiving position, rod 11 and conductor 13 are connected to the antenna A, which through a conductor 37 to ground is coupled to the receiver R of the usual construction. In the transmitting circuits of the radio apparatus disclosed, the switch S of the present invention is located between the secondary inductance of the transformer T' and the antenna, this location being the most advantageous location for receiving operation. In this position, however, the receiving circuit R, even when the contacts 9 and 12 are out of engagement, would be subject to the high voltage developed during transmission unless special means were provided for preventing it. This is especially true because it is necessary in switches of this character to maintain the contacts as close together as possible when open in order to secure quick action in operation. The transmitting operator as a general rule very rapidly operates the key 35 for sending messages with very slight intervals between actuations of the key for receiving signals and the like. By operating the contacts 5, 9 and 12 in a vacuum, however, the dielectric strength of the vacuum is such that the contacts 9 and 12 may be placed very close together when transmitting is taking place and still be capable of withstanding without breakdown or the slightest leakage the high potentials which are developed in a radio transmitter. Another advantage secured by the employment of a vacuum break key of the character herein described is that the receiving may be done directly from the antenna without having to go through the transmitting inductance T'.

In order to prevent high losses in the glass of casing 1 due to the intense electric fields generated in the high voltage circuits of this character as disclosed in Fig. 1 during transmission, the shields 2, 3 and 18 are located upon the inside of the casing 1 while the shields 14, 15 and 21 are located upon the outside of the casing. By utilizing the said shields, the electric fields that are set up in and around the break key or switch S during transmitting or the electric lines of force developed within the casing instead of cutting the casing 1 are substantially parallel

therewith, extending between the disc 2 and the shield 18, on the one hand, and between the disc 3 and the shield 18, on the other hand, within the casing 1, and on the outside of the casing extending between the cap 14 and shield 21 and cap 15 and shield 21. The shields 18 and 21 prevent the lines of force from cutting the conductors from contact 12 to the receiving circuit R and adjacent portions of the glass tube 1 during the transmission, the shields 18 and 21 being connected to ground and therefore at the same potential as the receiving conductor 37, which is also connected to ground. By flaring out the edges of the shields 14 and 15 and shield 21 upon the outside of the casing, a path is provided between them outside of the casing for the electric field which is spaced from the glass. The glass casing 1 provides the proper leakage distance between the caps 14 and 15 of opposite potential located at opposite ends of the casing. The field within the casing 1 is strongly localized therein by means of the inner shields 2, 3 and 18 whereby the lines of force are prevented from cutting the glass casing. The field on the outside of the casing is localized and spaced from the casing between the caps 14 and 15 and shield 21. The shields 2, 3 and 18 within the casing are at the potential of shields 14, 15 and 21 respectively outside of the casing; hence no field exists across the casing between adjacent or opposing shields.

In order to position or place the metal parts of the present invention within the casing 1, during construction, one or both ends of the casing is left open so that the parts may be inserted. The intermediate leads 13 and 23 extending through the glass are then sealed in. The end or ends are then sealed up and the leads through the ends sealed in. A glass tube is left extending into the casing and at some accessible point, through which tube the high degree of exhaustion can be obtained. After exhaustion, the tube through which the exhaustion has taken place may be melted from casing 1 and sealed up.

The order of vacuum or exhaustion which exists in a switch and condenser or vacuum apparatus of the above-described types should be extremely high, such that no appreciable gas ionization takes place to cause losses while the apparatus is in operation, which condition is obtained, for example, by a pressure of the order of a millionth of a millimeter of mercury. Such exhaustion may be obtained by any well-known means, such as a Gaede or molecular pump or Langmuir's condensation pump.

All materials inside the casings of such vacuum apparatus are to be suitably treated to remove gases (occluded or otherwise) according to any of the well-known processes in use for the production of high vacuum

apparatus. Such treatment may consist, for example, in initially, before assembling in the casing, treating these materials to remove gas preliminarily, as by heat of the order of the melting point of the materials or by heat of a lower order for a longer period. One method of removing such occluded gases is to place the metal parts in an oven and heat them to a high temperature, of the order of 500° to 1100° C., for a sufficient time to remove the gases. In addition, it is advisable, after assembling in the casing, which may be of high melting point glass, to subject the contained materials and casing to further treatment to remove any residual or occluded gases, while evacuation is taking place. This final treatment may consist of heating in an oven at the highest temperature the glass will stand,—say in the neighborhood of 500° C., evacuation taking place while being heated in the oven. The casing or bulb is then sealed off.

Another final treatment may be the well-known method of removing gases from metals by inserting the metallic portions and casing in a high frequency magnetic alternating field of a suitable intensity during exhaustion. In this final treatment, the entire device, while undergoing exhaustion, may be placed within the field of a coil-carrying high-frequency current. This heats the metal parts, inside the casing, thereby driving off and removing gases before the device is completely exhausted, and then sealed off.

The materials used in the vacuum apparatus such as the condenser and break key herein described should be of such a nature that the gases may easily be removed by the above-described processes. Therefore, in constructing them, nickel, tungsten, molybdenum, pure iron, preferably plated with cobalt, or rolled steel should be used wherever possible in constructing all parts.

The conductors 6, 10, 13 and 23 may be of platinum if so desired, especially when casing 1 is of glass, on account of the similar co-efficients of expansion of glass and platinum, and, in any instance, any well-known seal, such as used with high vacuum devices such as X-ray tubes, thermionic devices, and the like, may be used for bringing the conductors out and maintaining the high vacuum necessary in the present invention.

In Fig. 2, I have illustrated the application of static shields to a condenser, shown more or less diagrammatically, for use on high power work such as in power factor lines or in radio transmitters. This condenser C comprises a casing 40 of insulating material, preferably high melting point glass. Located at one end of the casing 40 within the same is a metal shield or cap

41, a similar metal shield or cap 42 being located within the casing 40 at its opposite end. These shields have their edges facing and spaced from each other and rolled up and flared inwardly as indicated at 43. A conducting rod or frame 44 extends from one end of the casing, being electrically connected to cap 41, and terminates centrally of the casing 40 in condenser armatures or plates 45. A similar conducting rod or frame 46 extends from the opposite end of casing 40, being electrically connected to cap 42, and terminates in condenser armatures or plates 47 which alternate with the armatures 45, constituting the plates of opposite polarity of the condenser. The rods 44 and 46 are electrically connected to the outside by means of wire leads 48 and 49, which are sealed in the glass in the manner above described. Similar metal shields or caps 50 and 51 are located upon the outside of the casing at the ends, opposing the caps 41 and 42 and electrically connected thereto. The adjacent edges of the caps 50 and 51 are flared out from the casing and rolled up as indicated at 52, and are secured to the casing 40 by any suitable securing means 53. The dielectric for the plates 45 and 47 is a vacuum, and the metal parts may be treated and the casing evacuated in the manner above described. These metal parts should be composed of non-gas-occluding metal such as those specified above. A construction of condenser is shown in my co-pending application above-mentioned which I consider more practical. The shields 41 and 42 and 50 and 51 co-operate with each other to protect the casing against heating by maintaining the electric lines of force parallel therewith in the manner above described in connection with Fig. 1.

By the above construction and invention, a condenser in which the plates 45 and 47 are separated a centimeter can be constructed to withstand potentials in the neighborhood of a million volts. In such a condenser and with the vacuum dielectric of the order specified, the loss is practically zero, being limited to the minute Joulean losses in the metal plates and leads.

Referring to Fig. 3, I have illustrated a modified form of vacuum break key or switch S'. This switch comprises a casing 55 of insulating material having within the same at one end a metal support 56, terminating in a spring or cushion 57 having a contact 58 thereon. Mounted in the opposite end of the casing 55 is a metal support or guide 59 having at its lower end a spring buffer or cushion 60. Slidably mounted within the guide 59 and between the cushions 57 and 60 is a rod 61 having at its inner end a contact 62 co-operating with contact 58. At the opposite end of rod 61

is a soft iron armature 63 whereby the rod 61 and its contact 62 may be actuated in the manner hereinafter described. The parts within the casing 55 may be assembled, treated and evacuated in the manner above-described in connection with Fig. 1, and the operation of the break or relay is substantially like that disclosed in Fig. 1, although in this embodiment the number of contacts have been reduced and spring means have been provided for taking up the shock of impact of the relatively moving contacts. These contacts, which may be of silver or similar good conducting metal, like the contacts of Fig. 1, operate in a vacuum whereby their separation and contact may be rapid and quick while maintaining high insulation resistance between them when opened by reason of the high dielectric properties of the vacuum. Surrounding the end of the tube 55 having movable armature 63 are a pair of solenoids or electromagnets 64 and 65, adapted when energized to alternately close the contacts 58 and 62 and separate them. For purposes of illustration, as disclosed in Fig. 1, I have illustrated the switch of Fig. 3 diagrammatically in circuit with a radio transmitting and receiving apparatus, although it is to be understood that these switches are of general application and are especially adapted for use in power factor work. In the illustration of Fig. 3, the switch S' is so arranged that during the interim between successive actuations of the transmitter by the transmitting key 66, the receiving circuit will be automatically connected to the antenna. For this purpose, I have illustrated the transmitting key 66 in series with the line L, which, when it is depressed, energizes a solenoid 67, which in turn actuates a multiple switching device or rod 68 by reason of its attraction for a soft metal core 69 secured to the rod 68. The rod 68 is slidably mounted in suitable guides 70, and is constrained to move in one direction by means of a spring 71, the solenoid 67 actuating rod 68 in the opposite direction upon the depression of the key 66, the spring actuating the rod upon the release of the key 66. The rod 68 successively controls the switches 72, 73, 74 and 75. When the transmitting key 66 is depressed to close the circuit L, the switch 72 is opened, and then the switches 73, 74 and 75 successively close as hereinafter described. In the position illustrated in the drawings, the switch 72 is closed, the other switches being open, thereby energizing the solenoid 64 which is connected to the line by lead 76 through switch 72. In this position, which is the receiving position, the contacts 58 and 62 are closed, connecting the receiver R, not illustrated fully, and the antenna A. Upon the depression of key 66, switch 72 opens, de-energizing the solenoid 64, and then yielding switch 73 closes, energizing the solenoid 65 connected to the line through conductor 77 to rapidly open the contacts 58 and 62 by the attraction of the solenoid 65 for the armature 63. At the next instant, the yielding switch 74 closes, the switch 74 being connected by a lead 78 to a solenoid 79 for controlling a switch interposed between the transmitter inductance 80 and the antenna A. Upon the energizing of the solenoid 79, iron core 81, slidably mounted relative to the solenoid, is attracted against the tension of spring 82, which causes the metal nose 83 mounted on an insulator 84, movable with core 81, to electrically connect the spring contacts 85, thereby closing the circuit between the antenna and ground of the radio transmitter. The antenna inductance 80 corresponds with the antenna inductance secondary T' of Fig. 1. After the contacts 85 are electrically connected upon the energizing of the solenoid 79, the relay switch 75 closes, thereby closing the alternator circuit 86. The alternator circuit 86 of Fig. 3 is otherwise identical with the circuit 33 of Fig. 1 and is connected up to the inductance 80 in the same manner that the circuit 33 is connected to the antenna lead 36. The operation of the circuit of Fig. 3 and the location of the vacuum switch therein is substantially like that of Fig. 1. By the construction of Fig. 3, I can insert the switch S' in the high potential portions of the antenna in such position that receiving need not take place through the transmitter inductance. The contacts 58 and 62, although close together when open, are sufficiently insulated by the vacuum dielectric to prevent sparking or brushing during the operation of the transmitter. On the other hand, these contacts 58 and 62 are closed whenever the key 66 is released. The form of switches disclosed in Figs. 1 and 3 are characterized by rapidity of opening in a vacuum and are especially advantageous for use in handling high potentials. The shields disclosed in Figs. 1 and 2 may be incorporated in the break switch disclosed in Fig. 3.

The construction and method of assembly of the vacuum switch S' of Fig. 3 may be accomplished just like that described in connection with Fig. 1, and the materials should be such as above enumerated. In Fig. 3, one of the solenoids for actuating the contact 62 may be replaced by any equivalent means such as a spring. As illustrated, the impact of the contact 62 is taken up and resisted by the springs 57 and 60 whereby jar upon the casing is eliminated. The wire lead from the contact 58 through the casing is sealed in as above described and connected to the antenna A, while the

contact 62 is electrically connected to the receiver through the guide 59 and loose conductor 87 and a wire lead sealed in the casing and connected to such guide. In order to provide a shunt path to earth, should contacts 58 and 62 fail to open at the proper instant, safety gap 88 is provided to take care of the discharge of the transmitter to ground and preventing injury to receiver

10 R. As an alternative connection, the switch 85 and associated parts may be placed in the grounded side of the transmitter as at 89. In this case, the general insulation of the switch may be reduced, inasmuch as the 15 electrical potential is substantially reduced. It is preferable, however, to place the switch in the antenna side as shown, as the capacity effect of the transmitting inductance and associated circuits, to the receiver is thereby 20 minimized.

The casings or bulbs herein referred to and claimed may comprise insulating material wholly or in part, in order to properly insulate the leads and should also comprise material such that a vacuum may be 25 maintained in a casing composed of it.

The constructions of break keys above described provide compact, cheap, efficient means for controlling the high potentials in 30 circuits where they are used. These break keys are highly sensitive and with very slight separation of contacts maintain the circuits electrically open, notwithstanding the high potentials existing in their neigh-

borhood. Furthermore, the cases are am- 35 ply protected by the static shields employed.

It is to be understood that the invention is not limited to the embodiments and features specifically shown and described herein, but that such embodiments and features 40 are subject to changes and modifications without any departure from the spirit of the invention.

I claim:—

In a radio communication installation of 45 the type wherein the same aerial is used for both transmitting and receiving apparatus alternately connected thereto, and wherein the aerial switch for the receiving apparatus is operated by the connection of the 50 transmitting apparatus to the aerial, and wherein the contacts of said switch have slight relative movement permitting action at a rate corresponding with a high rate of connection and disconnection of the 55 transmitting apparatus relative to the aerial, the improvement, permitting the connection of the receiving apparatus to the aerial on the high potential side of the transmitting apparatus and thereby permit- 60 ting the reception of short waves, said improvement comprising a vacuum between the contacts of said receiving apparatus switch, said vacuum constituting a strong dielectric resisting the high potential on the 65 aerial caused by the operation of the transmitting apparatus.

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