

Aug. 10, 1937.

W. BUSCHBECK

2,089,781

KEYING

Filed Sept. 9, 1935

3 Sheets-Sheet 1

Fig. 1

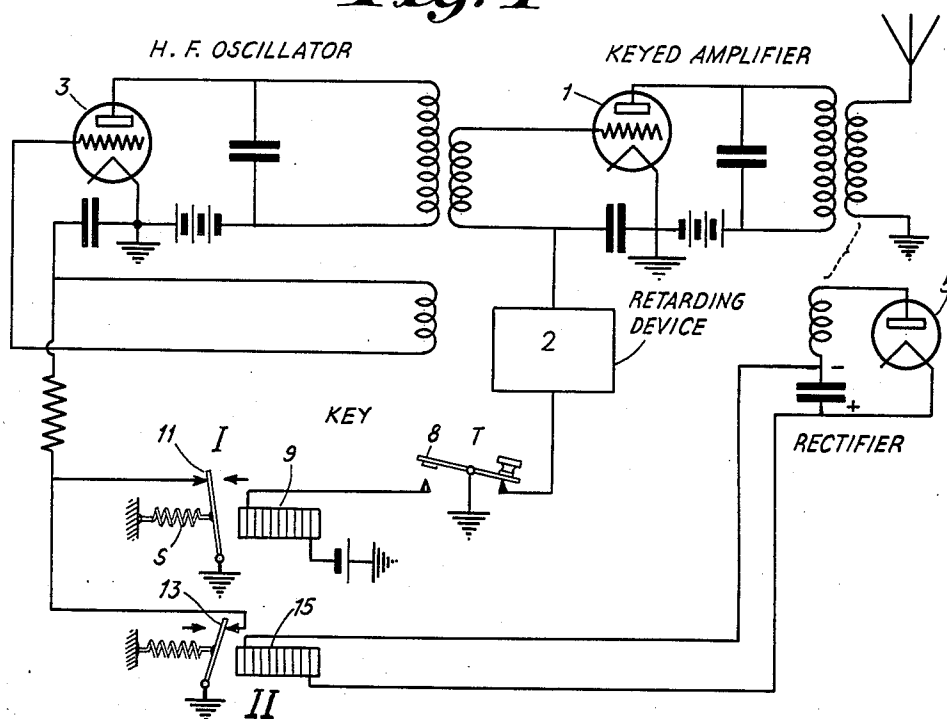


Fig. 2a.

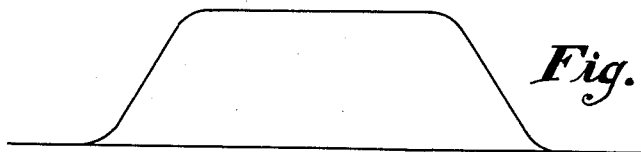


Fig. 26.

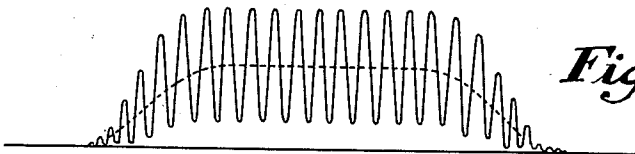
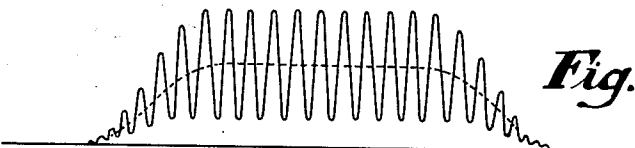


Fig. 2c.



INVENTOR.
Werner Buschbeck

BY

W.S. Grover
ATTORNEY.

Aug. 10, 1937.

W. BUSCHBECK

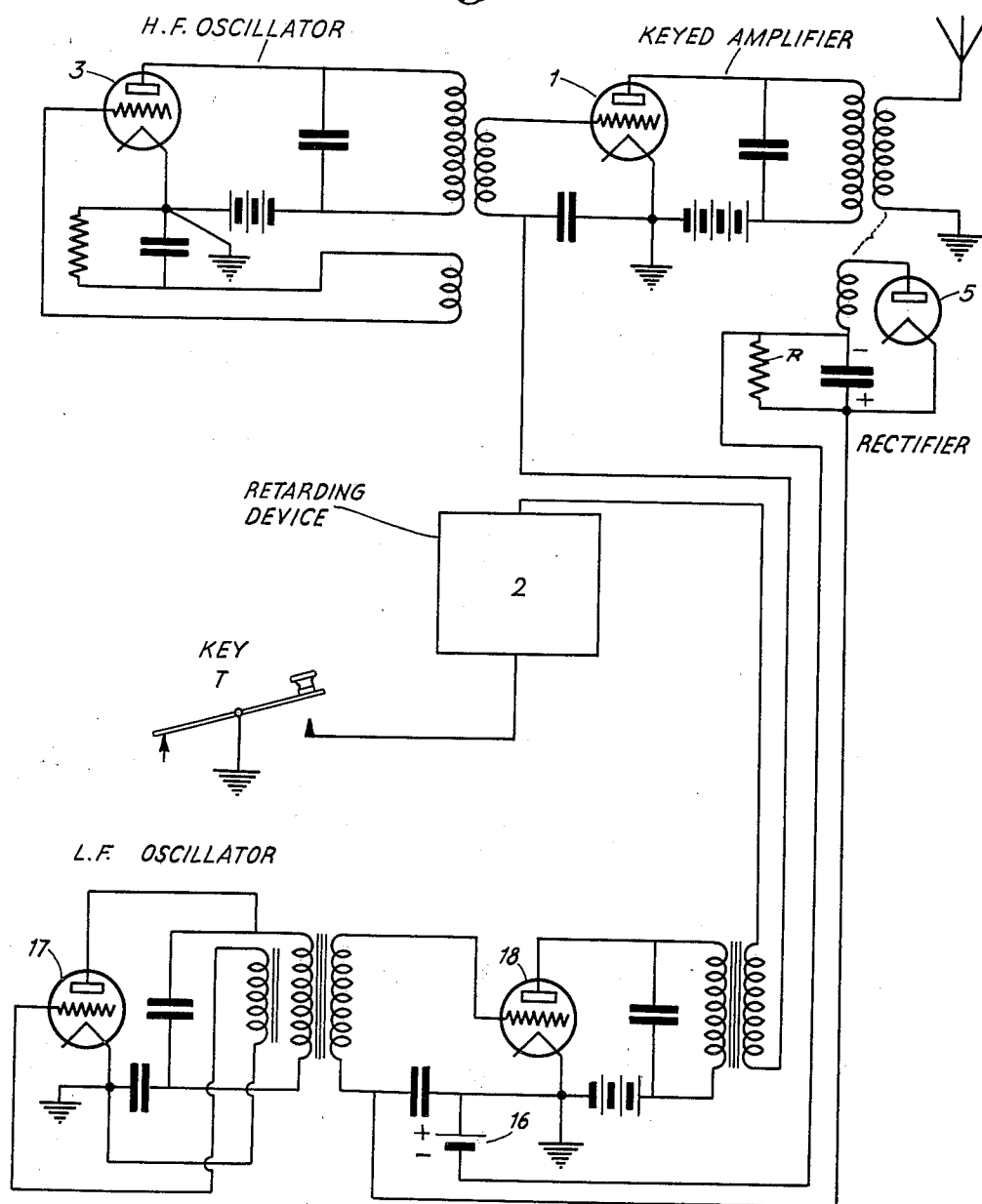
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Fig. 3



INVENTOR.
Werner Buschbeck
BY *W. S. Swen*
ATTORNEY.

Aug. 10, 1937.

W. BUSCHBECK

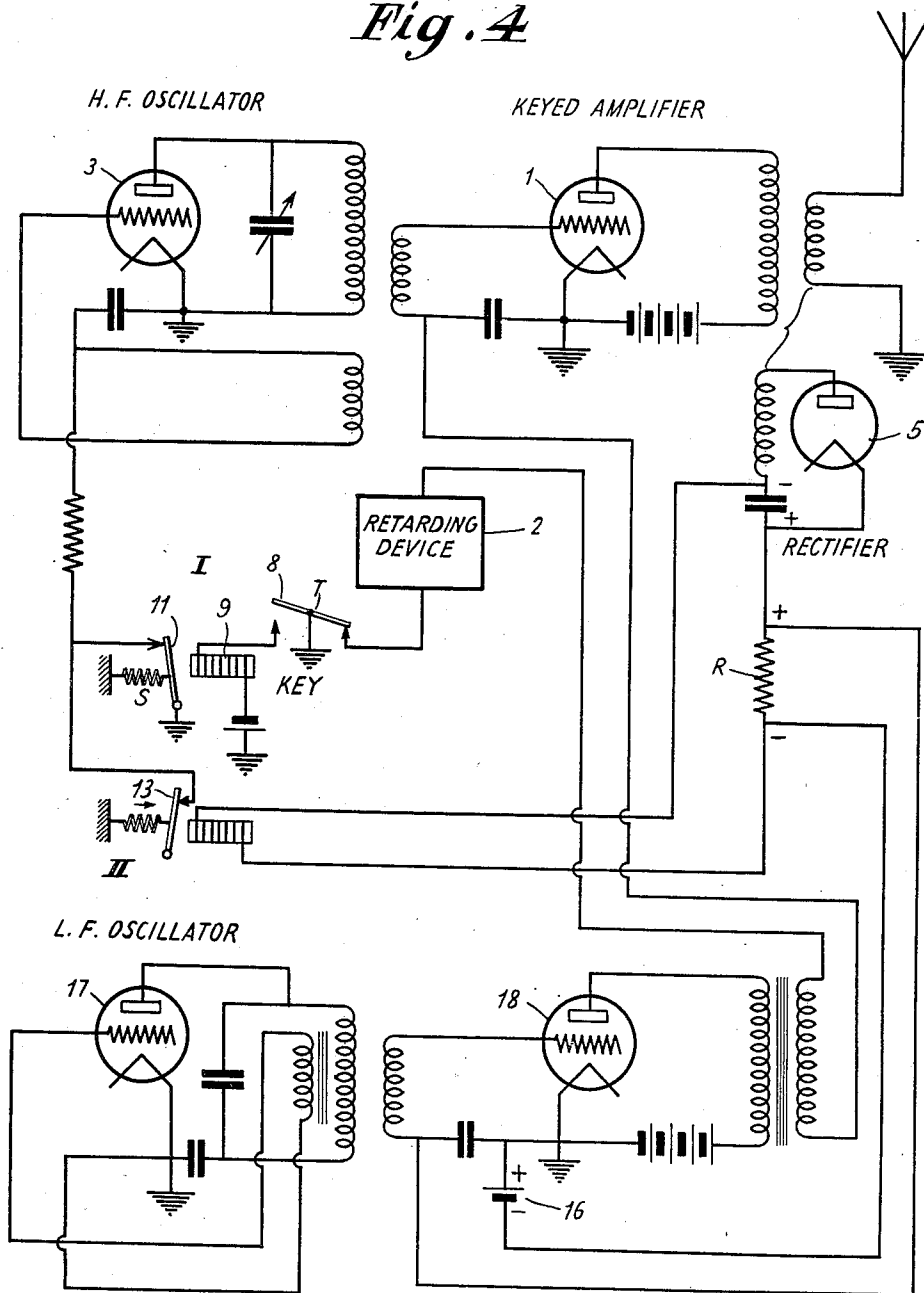
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Fig. 4



INVENTOR
Werner Buschbeck

BY *H. G. Howe*

ATTORNEY

UNITED STATES PATENT OFFICE

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KEYING

Werner Buschbeck, Berlin, Germany, assignor to
Telefunken Gesellschaft für Drahtlose Tele-
graphie m. b. H., Berlin, Germany, a corpora-
tion of Germany

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6 Claims. (Cl. 250—17)

This application concerns a method of and means to insure "Soft" keying in multi-stage transmitters. Methods of and means for insuring soft keying of circuits to avoid unnecessarily large frequency bands in telegraph transmitters are generally known in the art. Such means are often referred to in the art as key shock elimination systems. In such systems, suitable retarding means are provided to retard abrupt rise and decline of the antenna current during the keying operations. This means that there must be a steady "follow up" of antenna current in reference to the electromotive force produced by keying. But this is not insurable, in the case of self-oscillatory stages, since during operation, "rupturing" or "discontinuity" regions occur, especially with grid keying or grid modulation, in which the antenna current does not follow exactly the electromotive force. In other words, if soft keying is to be secured in multi-stage transmitters, this must be practiced not in the self-oscillatory or driving stage, but rather in one of the following or driven stages which are subject to separate control or master action. In fact, the latter scheme is recommendable if for no other reason than that of insuring frequency stability. However, this most commonly used mode of keying involves a serious drawback which is that with antenna current keyed off, part of the transmitter, e. g., the oscillator and stages prior to the keyed stage, will persist in swinging through, which, to be sure, may not cause much trouble at the distant station in most cases, but is likely to become troublesome at the sending station itself, with close proximity of sender and receiver. Particularly is this true in a case where transmitter and receiver are arranged for duplex work on the same wavelength or where sender and receiver are alternately associated with one and the same antenna. It has therefore been attempted in the prior art, by use of suitable electrical or mechanical retarding means, to operate the modulation stage with keying lag. However, such an arrangement involves a variety of difficulties seeing that the instant of key delay would have to be altered in accordance with the degree of softness that is used or the rate of keying. But also for the same degree of softness, according to the particular wave-length in use or the mode of tuning and decoupling, the instant of keying would have to vary seeing that the time interval between incipency of signal and beginning of antenna current may vary. If the keyed master transmitter stage keys off too early,

there will be thumps or key shocks, while if the stage is keyed too late, duplexing and operation as above stated will be disturbed.

Now, these difficulties are to be obviated by the present invention. The presence or absence of the antenna current itself, or of energy of a quantity proportional to the antenna current to (say, the plate alternating voltage of the tubes) serves to control the operation of the oscillator while in a modification the keyed stage also is controlled.

In further describing my invention, reference will be made to Figs. 1 and 3 of the drawings, wherein I have shown two transmitter arrangements each of which includes the key shock eliminating or reducing means of the present invention. In this circuit arrangement the amplifier is keyed and the oscillator is controlled as to operation by the amplifier output. Figure 4 illustrates a keyed tone transmitter arrangement which includes novel features incorporated in the arrangements of Figures 1 and 3, while in Figures 2a, 2b, and 2c, curves are shown which are used to illustrate operation of the circuit of Fig. 3. An exemplified embodiment of this idea is shown in Fig. 1. The main transmitter stage 1, under control of key T, acting through the intermediary of suitable retarding means 2 which insures soft keying (filter circuits), is gradually keyed in and out. At the instant under consideration, the antenna shall be regarded as carrying no current e. g., the grid direct current circuit of tube 1 is open at the key T. Now, as soon as the back contact shown at 8, is lifted and opens the circuit of 9, when key T is depressed, the winding 9 of the relay is deenergized and releases, and 11, under the action of S, closes the grid circuit of 3, and 3 instantaneously starts to oscillate. The grid direct current circuit of 1 is now closed by T and the antenna current sets in gradually. As soon as the latter has been built up beyond a certain value, the relay II normally deenergized so that its contact 13 is open, the latter being in parallel relation to the contact 11 of relay I and relay winding 15 being energized from the antenna current by way of a rectifier 5 is energized to close its contact 13. This action does not affect the electrical circuit of the oscillator 3 since the contact 11 was closed when 8 was raised by depressing key T and is still closed. If, then, the key T is released, that is, opened, the cathode to grid direct current circuit of tube 1 is opened, 8 is closed and the winding 9 of relay I is energized at once to open its contact 11 breaking

the grid circuit of oscillator 3. However, inasmuch as the antenna current because of the action of the device II designed to insure soft keying action decays only gradually, and the contact 13 of II is closed due to antenna current acting through rectifier 5 and relay 15, the grid to cathode circuit of 3 is still completed and the generator 3 will be put out of operation only after disappearance of the antenna current which acts through 5 to hold closed the contact of the relay II. If desired, the relay II may be equipped with a retarding winding, or else the time-constant of the relay circuit may be so dimensioned that the relay will open only at the instant when the antenna current has dropped to the zero level.

It will be understood that the basic idea of this invention is not confined to the above exemplified embodiment, for the key effects could be accomplished by purely electrical means. Also, the two relays I and II could be combined by furnishing one single relay with two windings, one thereof being energized by the key current and the other one by the rectifier current.

The same basic idea as hereinbefore described is applicable to tone transmitters for insuring soft keying work also with said tone modulated transmitters. In such systems the difficulty is that during the gradual rise and decay of the keying action in the antenna current as illustrated in Figure 2a, the modulation percentage chosen for steady-state operation could not be maintained, but that in the gradual changing of the grid potential it is first the crests or peaks that become active until finally, as the full value of current is attained, the normal modulated antenna current is present. The rectified antenna current, therefore, would have an oscillographic pattern of the kind shown in Fig. 2b. Even in the presence of a relatively low end modulation of only 60% quasi or semi-sinusoidal current peaks will arise, and these, of course, because of their sudden beginning and end contain an appreciable amount of overtones or higher harmonics so that the result would be key thumps.

Now, according to the present invention this condition is avoided by so regulating the modulation percentage during the beginning and end of the keying process that the same is maintained stable, or practically so, or at any rate is so controlled that over-modulation will nowhere be produced. Now, since this condition is unattainable in multi-stage transmitters comprising a relatively large wave range in practice by an independent retarding device at the tonal generator because of the fact that the resultant curve-shape of the retarding action of tonal transmitter and radio frequency transmitter are always different, the antenna current itself is in accordance with the present invention caused to take care of the regulation of the percentage modulation. To accomplish this the tonal transmitter is controlled by current representative of the antenna current and is caused to be more or less active in accordance with the said antenna current prevailing at any given time. The signal thus produced will have a form as shown in Fig. 2c.

An exemplified embodiment of a retarding circuit scheme of this kind is shown in Fig. 3. A rectifier 5 coupled with the antenna produces a voltage across a resistance R which, acting as a counter voltage in relation to a blocking potential furnished from a source 16, becomes active

in the grid of a tone frequency amplifier 18 which is energized by tone frequency oscillations from the audio frequency of oscillator 17. When the antenna current is of zero value, amplifier 18 is blocked by 16 and will supply no voltage to the grid of 1. When the antenna current grows, gradually, by virtue of the action of retarding device 2 provided to insure soft keying, the tonal transmitter 18 will also start to pass audio frequency oscillations growing in amplitude slowly as the antenna current grows regardless of the particular curve-form of rise or decline of current in the antenna. It will be understood that the arrangement shown in Fig. 3 may be combined also with the scheme of Fig. 1 for keying off the radio frequency generator 3, and in this combination the same rectifier 5 which insures the regulation of the tone amplifier 18, Fig. 3, could be made to actuate the keying relay II in Fig. 1. Such an arrangement has been shown in Figure 4. In Figure 4 the control grid to cathode circuit of the oscillator 3 is similar to that shown in Figure 1 being completed by way of contact 11 of a relay I and contact 13 of relay II in parallel with contact 11. These relays and the key T cooperate with the retarding device 2 and the rectifier 5 in a manner set forth fully in connection with Figure 1 to key the oscillator 3 and the amplifier 1 in such a manner that the oscillator 3 generates oscillations and impresses them on amplifier 1 wherein they are built up slowly by the amplifier 1 on the closing of its grid circuit by T and the oscillator 3 continues to furnish oscillations to the amplifier 1 until the output of amplifier 1 decreases when T is opened to a point at which rectifier 5 no longer supplies energy to control 15, thus stopping the keying gradually. The arrangement of Figure 4 is adapted to tone keying and tone frequencies are produced in an oscillator 17 as in Figure 3, and supplied by way of an amplifier 18 normally biased to cut off, by source 16, to the grid circuit of tube 1 in series with retarding device 2. These tone oscillations are supplied only in the event the output of the amplifier 1 is sufficient to energize rectifier 5 enough to produce a potential drop in the resistance R of the rectifier circuit to overcome the rectified bias normally applied to the control grid of tube 13 by source 16. This circuit arrangement is as shown in Figure 3. However, a single rectifier 5 provides the controlling current for the winding of relay II and for overcoming the biasing of the control grid of 18.

What is claimed is:

1. In a transmitter, a source of high frequency oscillations, a control circuit for controlling the operativeness of said source of high frequency oscillations, an amplifier tube having a control grid, a cathode, and an anode, an alternating current circuit connected between said control grid and cathode and coupled to said source of oscillations, a rectifier having an input circuit coupled to the anode and cathode of said tube, said rectifier having an output circuit, keying means connected in a circuit including wave retarding means between the control grid and cathode of said tube, and a relay coupled to the output circuit of said rectifier and operatively associated with said control circuit for said source of high frequency oscillations to control the operativeness thereof in accordance with the output of said rectifier.

2. In a telegraphy system, a source of high frequency oscillations, a thermionic tube having

a control grid, a cathode and an anode, an alternating current circuit coupling the control grid and cathode of said tube to said source of oscillations, a circuit including a reactance and a key connected between the control grid and cathode of said tube, an additional tube having its anode to cathode impedance coupled in series with said circuit including said reactance, said additional tube having a controlling electrode normally biased to cutoff, and a rectifier having input electrodes coupled to the anode and cathode of said first tube and having output electrodes coupled to the controlling electrode of said additional tube.

3. In a telegraph system, a tube having input and output electrodes connected in oscillation producing circuits one of which is completed by two keys in parallel, a relay winding associated with each of said keys, an amplifier tube having an anode, a cathode and a control grid, a circuit coupling the control grid and cathode of said amplifier tube to said oscillation producing circuits, a circuit including a control key connecting the control grid and cathode of said amplifier tube to one of said windings, and a rectifier coupled at its input to the anode and cathode of said amplifier tube and at its output to the other of said windings.

4. In a telegraph system, a source of high frequency oscillations, a load circuit, an electron discharge amplifier tube having a control grid, an anode and a cathode, an alternating current circuit coupling the control grid and cathode of said amplifier tube to said source of oscillations, an alternating current output circuit coupling the anode of said amplifier tube to the load circuit, a direct current circuit connected between the control grid and cathode of said amplifier tube, a key in said direct current circuit, a rectifier having an input circuit coupled to the output circuit of said amplifier, said rectifier having an output circuit, a circuit connecting the output circuit of said rectifier with said source of oscillations to control the operation thereof, and a circuit coupling the output circuit of said rectifier to said direct current circuit to control the operation of said amplifier tube.

5. In a telegraph system, a source of oscillations, means for controlling the operativeness of said source of oscillations, a load circuit, an

amplifier having a control grid, a cathode and an anode, an alternating circuit coupling the control grid and cathode of said amplifier to said source of oscillations, an alternating current circuit connecting the anode and cathode of said amplifier to said load circuit, a rectifier having input electrodes coupled to said alternating current circuit, said rectifier having output electrodes, a direct current circuit including a keying switch connected with the control grid and cathode of said amplifier tube, a relay connected with said direct current circuit and a relay connected to the output of said rectifier and means connecting said relays to said means for controlling said oscillator for rendering said oscillator operative before said amplifier grid direct current circuit is closed in the signalling position of said switch and for maintaining said oscillator operative after said amplifier grid direct current circuit is open in the spacing position of said switch.

6. In a telegraph system, a source of high frequency oscillations, a source of low frequency oscillations, an electron discharge amplifier tube having a control grid, a cathode and an anode, an alternating current circuit coupling the control grid and cathode of said discharge amplifier to said source of high frequency oscillations, a load circuit, an alternating current circuit coupling the anode and cathode of said discharge amplifier tube to said load circuit, a direct current circuit connected between the control grid and cathode of the said discharge amplifier, a key in said circuit, an additional discharge tube having a control grid, a cathode and an anode, an alternating current circuit coupling the control grid and cathode of said additional tube to said low frequency oscillator, an alternating current circuit coupling the anode and cathode of said additional tube to said direct current circuit, means for biasing the control grid of said additional electron discharge tube negative with respect to the cathode of said tube, a rectifier having its input electrodes coupled to the anode and cathode of said discharge amplifier tube, said rectifier having output electrodes, an impedance in circuit with said rectifier output electrodes and a coupling between said impedance and said biasing means for the control grid of said additional tube.

WERNER BUSCHBECK.