

May 30, 1933.

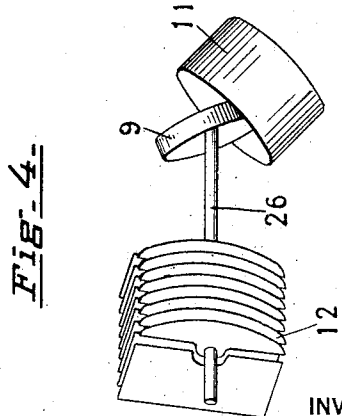
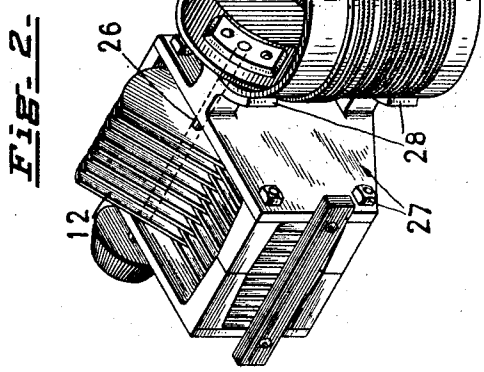
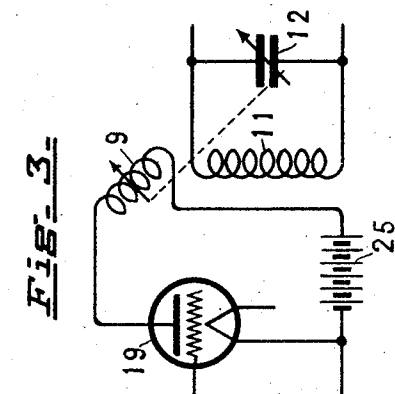
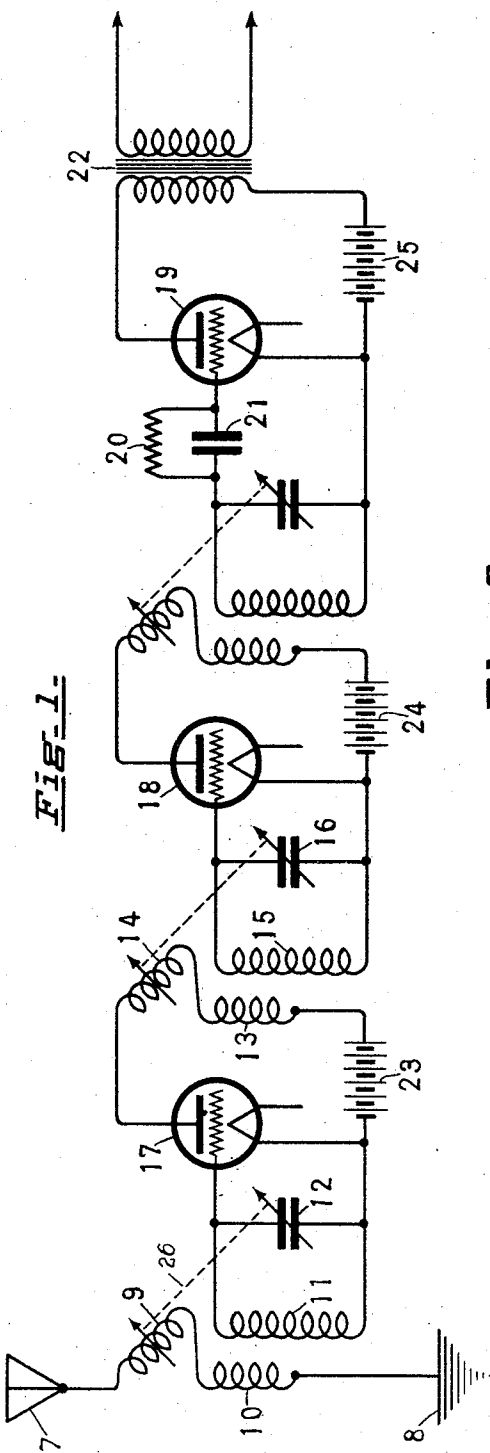
B. WASHINGTON

1,911,253

RADIO RECEIVING APPARATUS

Filed Sept. 13, 1926

3 Sheets-Sheet 1



INVENTOR
Bowden Washington,
BY *[Signature]*
ATTORNEY

May 30, 1933.

B. WASHINGTON

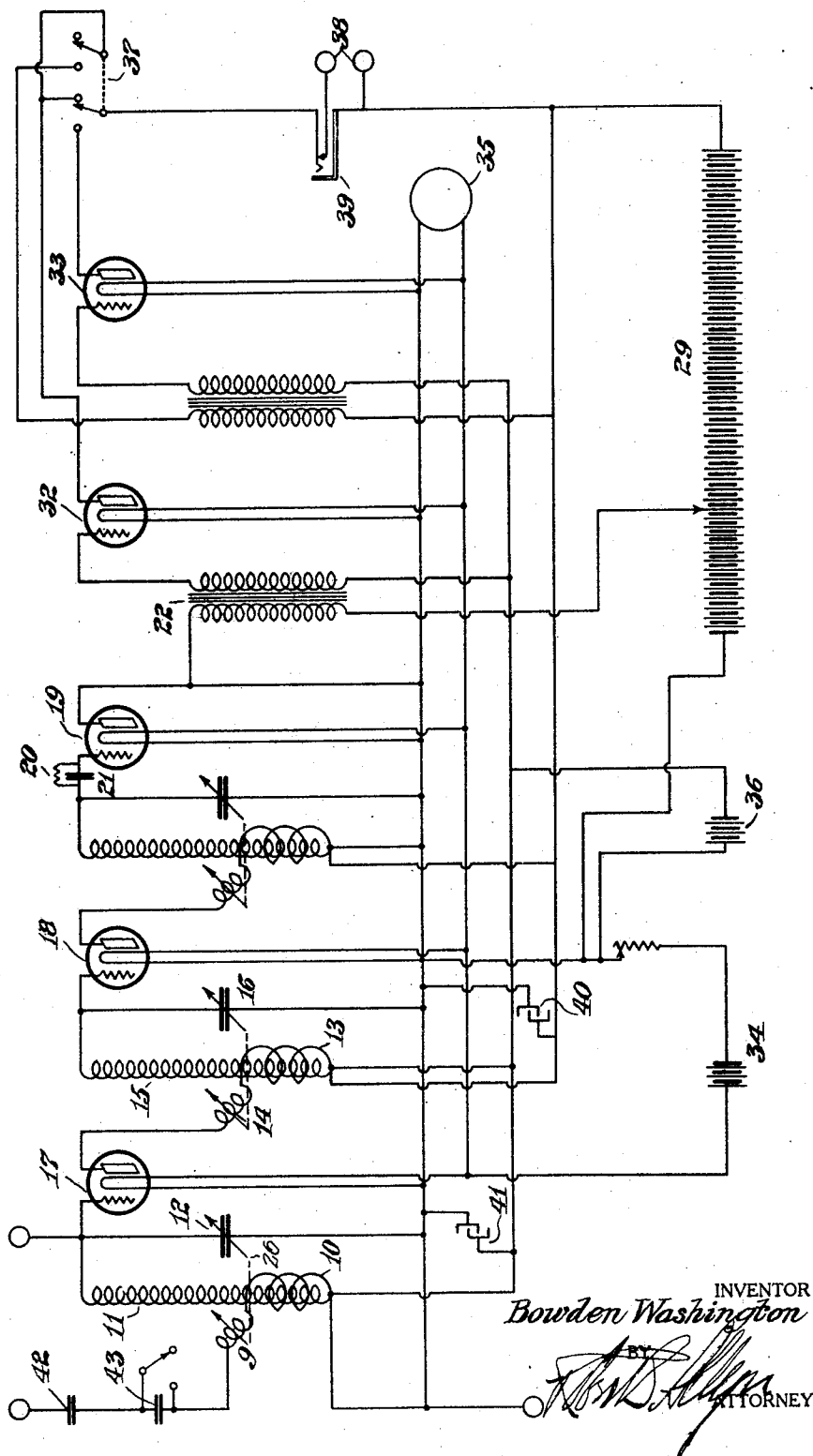
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3 Sheets-Sheet 2

Fig. 5.



INVENTOR
Bowden Washington
BY [Signature]
ATTORNEY

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B. WASHINGTON

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3 Sheets-Sheet 3

Fig. 6.

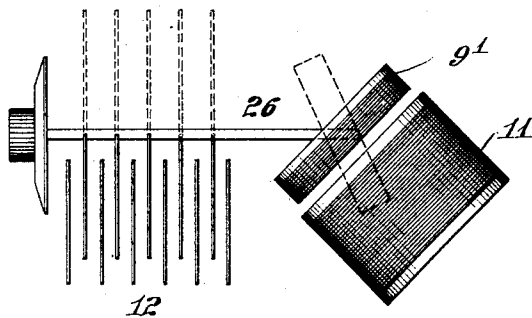


Fig. 7.

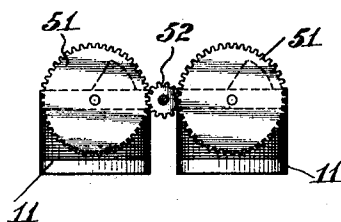


Fig. 9.

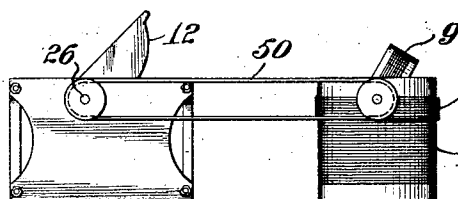


Fig. 8.

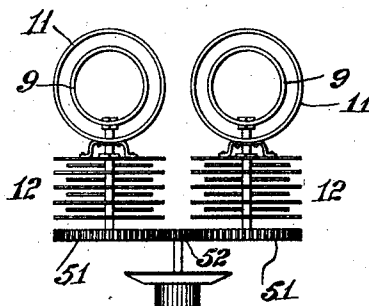
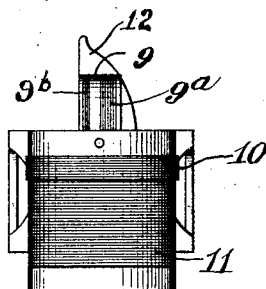


Fig. 10.



INVENTOR
BOWDEN WASHINGTON.

BY
Robert S. Allen
ATTORNEY

UNITED STATES PATENT OFFICE

BOWDEN WASHINGTON, OF NEW YORK, N. Y.; DOROTHY CLINTON WASHINGTON
ADMINISTRATRIX OF SAID BOWDEN WASHINGTON, DECEASED

RADIO RECEIVING APPARATUS

Application filed September 13, 1926. Serial No. 135,148.

The main object of my invention is to produce a radio receiver that will have substantially uniform response throughout its entire frequency range.

5 Another object is to produce a receiver having substantially uniform selectivity throughout its entire frequency range.

10 Another object is to produce a receiver which is stable in operation and will not oscillate when tuned to any frequency within its range.

It is well known that if a receiver of the type usually described as tuned radio frequency, in other words a receiver having a series of adjustably periodic circuits each containing a three electrode vacuum tube with the anode circuit of each tube coupled to the grid circuit of the following tube, is built with fixed interstage coupling of a value
15 appropriate for best energy transfer at the lowest frequency within its tuning range, it will not only oscillate strongly when tuned to higher frequencies unless means to prevent oscillation are taken, but will become
20 broad or unselective. On the other hand, if the coupling is appropriate to the higher frequencies the receiver becomes not only so selective that it may have a tendency to exclude side bands when tuned to the lower frequencies but also insensitive due to insufficient coupling to effect proper energy transfer at these frequencies. As is well known the correct coupling for any given frequency must be a matter of compromise between
25 loss of selectivity and gain of response.

My invention relates to means for automatically varying this interstage coupling throughout the tuning range of the receiver so that at any frequency within its range the desired selectivity and sensitivity will be
30 attained.

Referring to the drawings:

35 Fig. 1 is a schematic wiring diagram of one embodiment of my invention.

Fig. 2 shows a perspective view of one form of tuning unit such as would be embodied in Fig. 1.

Fig. 3 shows a schematic wiring diagram of still another embodiment.

Fig. 4 shows a perspective view of a tuning unit such as would be embodied in Fig. 1.

Fig. 5 shows a wiring diagram of a complete receiver.

Fig. 6 is a side view showing a somewhat
55 modified arrangement of coils with respect to the condenser showing the parts in full lines in the maximum capacity and maximum coupling and in dotted lines their relation at minimum capacity and minimum coupling.

Figs. 7 and 8 are front and plan views of two units geared or coupled mechanically together.

Fig. 9 is a front view showing one method
65 of coupling or gearing a condenser rotor and a coil primary typical of any well known mechanical movement for driving two elements simultaneously.

Fig. 10 is a front view of a transformer in
70 which the turns of the movable primary are distributed so that there are more on one side of the rotor axis than on the other.

Referring to Fig. 1 which shows essential parts of my invention, 7 is the antenna and
75 8 the ground, though other forms of energy collectors may be used. 9 and 10 are two parts of the antenna or primary inductance, while 11 and 12 are the inductance and variable condenser respectively of the tuned
80 grid circuit. The inductance 10 is mechanically fixed in a given coupling position with respect to the inductance 11, while the inductance 9 is movable co-incidentally with the shaft of the variable condenser 12. 13
85 and 14 are the fixed and movable portions of the inductance forming the output coil of the first radio frequency amplifier tube 17, while 15 and 16 are the grid inductance and tuning condenser of the grid circuit of the
90 second radio frequency amplifier tube 18. The connections for the detector tube 19 are substantially the same as for the tubes 17 and 18 with the exception that a grid leak and condenser are shown at 20 and 21 and
95 an audio frequency transformer at 22. It will be noted that separate anode batteries are indicated at 23, 24 and 25 but this was done, as was the omission of the cathode heating battery, merely to simplify the drawing
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and in general a common or partially common battery would be employed, as shown at 29, Fig. 5.

Referring to Fig. 2 which shows a tuning unit as would be employed in Fig. 1, 12 is a variable condenser carrying upon its shaft 26 the movable portion of a primary inductance 9 of a radio frequency transformer. 10 is a fixed part of the primary inductance and 11 the secondary or grid inductance which is tuned by the condenser 12. The inductance 10 is preferably secured to the cradle 28 which is integral with the die cast head 27. The inductance and position of 10 is such that the desired interstage coupling will be attained when the wave length to which the transformer is tuned is such that the axis of the inductance 9 is at right angles to the axis of the inductance 11. The inductances 9 and 10 are usually placed in series as shown in Fig. 1, although they can, of course, if suitably proportioned, be operated in parallel. The sense of direction of their windings is such that as the condenser is rotated in the direction of greater capacity both the self inductance of the primary circuit embodying inductances 9 and 10 and the mutual inductance between this circuit and the secondary inductance 11 are increased while if the condenser is rotated towards the position of lowest capacity the winding 9 magnetically opposes the winding 10 and decreases both the mutual and self inductance of the primary circuit.

The mechanical connection between the inductance 9 and the rotor of the condenser 12 is indicated in Fig. 1 by the dotted lines joining the arrows conventionally used to denote variables. It will be seen that by changing the position, size or number of turns in the inductance 10 and the size, number and distribution of turns of the inductance 9 and its angular relation with the condenser rotor plates, a large variation of the rate of change of coupling with the rotation of the tuning control may be obtained. For instance, if the turns of the inductance 9 are distributed so that there are more turns 9a on one side of the shaft 26 than the turns 9b on the other side—that is—if the greater part of the movable primary is largely on what would be the side of the rotor nearest the secondary inductance when the plates of the condenser are completely meshed, the increase of coupling at long waves will be greater than the corresponding decrease at short waves due to the fact that coils 9 and 10 are closer together in the additive position than in the subtractive.

By proper adjustment of these factors the receiver may be made stable and with the desired compromise between selectivity and sensitivity throughout its tuning range.

Fig. 5 shows the wiring diagram of a complete receiver containing the embodiment

of my invention as shown in Figs. 1 and 2. In this drawing two audio frequency amplifier tubes are shown at 32 and 33. 34 is the cathode heating battery and 29 the common anode battery. A filament voltmeter 35 is provided, as is a grid biasing battery 36. 37 is a switch to allow for the use of one or two low frequency stages. Binding posts for loud speaker 38 and a jack 39 are shown, as are by-pass condensers 40 and 41 and antenna series condensers 42 and 43.

In Figs. 3 and 4 and 6 the movable portion of the primary 9' is mounted with its general plane at an angle to the condenser shaft 26 instead of parallel to it as in Fig. 2. The secondary winding 11' is mounted with its axis at an angle approximately 45° with the condenser shaft rather than with its axis at right angles as is shown in Fig. 2. With this embodiment there need be no fixed primary winding as an angular relation of axis may be chosen such that at the position of minimum capacity (dotted lines Fig. 6) the primary 9', although nearly at right angles with the secondary 11', still has adequate coupling for the highest frequency and as the capacity is increased this coupling will increase properly to a maximum with the parts in the full line position of Fig. 6, where the coils 9' and 11' are coaxial.

It will be seen that the mechanical and electrical constants of the device may be varied so that the values and rate of change of coupling in the different stages may be suited to the values of plate load and grid circuit resistance etc. found in these stages.

Although I have shown and described simple and preferred forms of my invention I wish it understood that other variations in construction and arrangement of the various elements may be made within its broad scope and still obtain many of its advantages. For instance, the movable primary coil may be geared to the condenser shaft or the condenser may be driven from the movable coil by any suitable form of driving connection such as a chain or band 50 shown in Fig. 9 so as to secure simultaneous variation of tuned capacity and mutual inductance.

It should also be understood that the movable elements of two or more combined transformer and condenser units may be mechanically connected or coupled together for simplifying the control as for instance by gears 51, 51' and an intervening gear 52—Figs. 7 and 8.

I claim:

1. A multi-stage transformer coupled radio frequency system comprising transformers each consisting of a fixed secondary coil and two primary coils, one of which is movable and coupled in an asymmetric relationship to the fixed primary coil, a tuning condenser electrically connected with the secondary of each radio frequency stage, means for me-

chanically coupling the movable primary coil of each stage with its condenser to thereby vary the self-inductance of each primary and the mutual inductance of each transformer simultaneously with and in the same direction as the variation of the capacity of the associated tuning circuit.

2. A multi-stage transformer coupled radio frequency system comprising transformers each having relatively fixed primary and secondary coil portions and a relatively movable primary coil portion, said movable primary coil portion and said fixed primary coil portion having their windings asymmetrically disposed relative to each other, so that their mutual coupling is unequal for positions of minimum and maximum self-inductance, a tuning condenser connected to the secondary of each stage and means for mounting the movable primary coil portions on the shaft to its associated tuning condenser to thereby vary the self-inductance of each primary and the mutual inductance of each transformer simultaneously and in the same direction as the variation in capacity of the circuit of the associated tuning condenser.

3. In a multi-stage transformer coupled radio frequency system, means for varying the capacity in each transformer secondary circuit, means for varying the self-inductance of each primary and the mutual inductance of each transformer, means for mechanically coupling said first named means with said second named means to thereby vary said capacity, said self-inductance and said mutual inductance simultaneously and in the same direction, said coils and said condensers being relatively so proportioned that objectionable feed-back oscillations are substantially eliminated, and means for supporting and moving the coils between positions of minimum and maximum coupling, so that their mutual coupling at low frequency positions is materially greater than in an inverse linear proportion to their coupling at high frequency positions.

4. In a multi-stage transformer coupled radio frequency system, each transformer comprising relatively fixed primary and secondary coil portions, each primary further including a relatively movable coil portion, said movable coil portion and said fixed primary coil portion having windings and means determining a path of relative movement so that said coils are unequally coupled to one another at the limits of said path of relative movement, a tuning condenser connected across the secondary of each radio frequency stage, and means for mechanically coupling each movable primary coil portion with its associated tuning condenser to thereby vary the self-inductance of each primary and the mutual inductance of each transformer simultaneously with and in the same direction as the variation of the capacity of the as-

sociated tuning condenser, said coils and said condensers being relatively so proportioned that objectionable feed-back oscillations are substantially eliminated.

5. A multi-stage tuned transformer coupled radio frequency system comprising a plurality of fixed secondaries, a plurality of primaries, each of said primaries including a fixed section and a section asymmetrically rotatable relative to the respective fixed primary section so as to be coupled thereto to different degrees at points substantially 180 degrees apart, a plurality of variable capacities tuning said fixed secondaries and means mechanically coupling each of said capacities to its respective rotatable primary section so as to vary the secondary capacity and the primary self-inductance at the same time and in the same direction.

BOWDEN WASHINGTON.

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