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RADIO HOOK-UPS



A BOOK OF THE MOST ADVANCED CIRCUITS
OF RECEIVERS, AMPLIFIERS AND TRANSMITTERS
FOR DAMPED AND UNDAMPED WAVE WORK:

By

M. B. SLEEPER.

⑤

EVERYDAY ENGINEERING SERIES
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RADIO HOOK-UPS

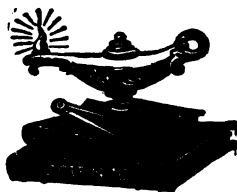
A REFERENCE AND RECORD BOOK
OF CIRCUITS USED FOR CONNECT-
ING WIRELESS INSTRUMENTS

THE MOST RECENT AND EFFICIENT DIAGRAMS
ARE GIVEN FOR ALL TYPES OF CRYSTAL
AND AUDION RECEIVERS FOR DAMPED
AND UNDAMPED WAVES, SPARK
COIL, TRANSFORMER, AND VACUUM
TUBE TRANSMITTERS, AMPLIFIERS,
OSCILLATORS, AND MEASURING
APPARATUS. 18

PROVISION IS MADE FOR NOTES ON THE
RESULTS OBTAINED WITH VARIOUS HOOK-
UPS, GIVING THE EXPERIMENTER A COM-
PLETE RECORD OF THE COMPARATIVE
MERITS OF DIFFERENT CIRCUITS.

John L. S.
BY
M. B. SLEEPER

*Radio Editor of Everyday Engineering Magazine,
Author of Design Data for Radio Transmitters and Receivers,
Radio Experimenters' Handbook, Electric Bells, etc.*



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INTERNATIONAL MORSE CODE AND CONVENTIONAL SIGNALS

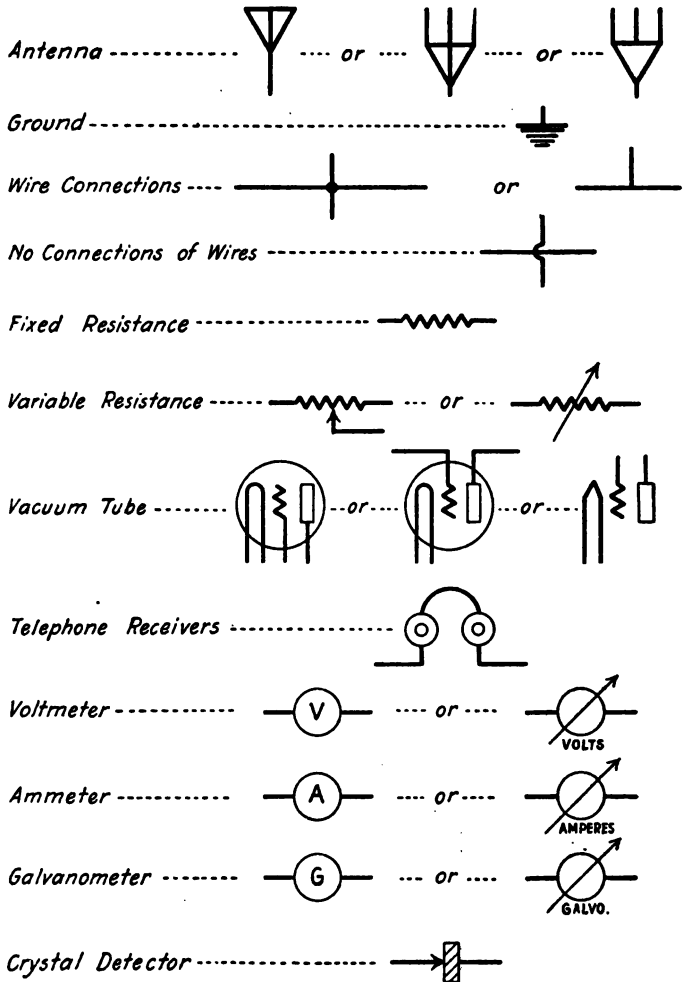
VO EN USED FOR ALL GENERAL PUBLIC SERVICE RADIO COMMUNICATION

1. A dash is equal to three dots. 3. The space between two letters is equal to three dots.
 2. The space between parts of the same letter is equal to one dot. 4. The space between two words is equal to five dots.

Reference 3-21-42 M J Z

<p>A •••</p> <p>B •••••</p> <p>C ••••••</p> <p>D ••••</p> <p>E •••</p> <p>F ••••••</p> <p>G •••••</p> <p>H ••••••</p> <p>I •••</p> <p>J •••••••</p> <p>K •••••</p> <p>L ••••••</p> <p>M ••••</p> <p>N •••••</p> <p>O ••••••</p> <p>P •••••••</p> <p>Q ••••••••</p> <p>R •••••</p> <p>S ••••••</p> <p>T ••••</p> <p>U •••••</p> <p>V •••••••</p> <p>W ••••••</p> <p>X ••••••••</p> <p>Y •••••••••</p> <p>Z ••••••••</p> <hr/> <p>Ä (German) •••••••</p> <p>Á or Ā (Spain-Scandinavia) ••••••••</p> <p>CH (German-Spanish) ••••••••</p> <p>É (French) ••••••••</p> <p>Ñ (Spanish) •••••••••</p> <p>Ö (German) ••••••••</p> <p>Ü (German) •••••••••</p> <hr/> <p>1 •••••••••</p> <p>2 •••••••••</p> <p>3 •••••••••</p> <p>4 ••••••••</p> <p>5 •••••••</p> <p>6 ••••••••</p> <p>7 •••••••••</p> <p>8 •••••••••</p> <p>9 ••••••••••</p> <p>0 ••••••••••</p>	<p>Period ••••••••••</p> <p>Semicolon ••••••••••</p> <p>Comma ••••••••••</p> <p>Colon ••••••••••</p> <p>Interrogation •••••••••</p> <p>Exclamation point ••••••••••</p> <p>Apostrophe ••••••••••</p> <p>Hyphen •••••••••</p> <p>Bar indicating fraction ••••••••</p> <p>Parenthesis ••••••••••</p> <p>Inverted commas •••••••••</p> <p>Underline ••••••••••</p> <p>Double dash ••••••••</p> <p>Distress Call ••••••••••••••</p> <p>Attention call to precede every transmission ••••••••</p> <p>General inquiry call ••••••••••••••</p> <p>From (de) ••••••</p> <p>Invitation to transmit (go ahead) ••••••</p> <p>Warning—high power •••••••••••</p> <p>Question (please repeat after)—interrupting long messages ••••••••••</p> <p>Wait ••••••••</p> <p>Break (Bk.) (double dash) ••••••••</p> <p>Understand ••••••••</p> <p>Error ••••••••••</p> <p>Received (O. K.) •••••••</p> <p>Position report (to precede all position messages) ••••••••</p> <p>End of each message (cross) ••••••••</p> <p>Transmission finished (end of work) (conclusion of correspondence) ••••••••••</p>
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~ LIST OF SYMBOLS ~



~ LIST OF SYMBOLS ~

- Battery*
- Direct Current Dynamo* or
- Alternating Current Generator* } or
- Fixed Capacitance (Condenser)* or
- Variable Capacitance (Var. Condenser)*
- Fixed Inductance (Air Core Coil)*
- Variable Inductance (Air Core Coil)* or
- Variometer (Variable Inductance)*
- Fixed Coupling of Coils (Fixed Inductive Coupling)*
- Variable Coupling of Coils*
- Transformer*
- Iron Core Inductance (or Reactance Coil)*

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION

LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION.	QUESTION.	ANSWER OR NOTICE.
PBE	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?.....	This is.....
QRB	What is your distance?.....	My distance is.....
QRC	What is your true bearing?.....	My true bearing is..... degrees.
QRD	Where are you bound for?.....	I am bound for.....
QRF	Where are you bound from?.....	I am bound from.....
QRG	What line do you belong to?.....	I belong to the..... Line.
QRH	What is your wave length in meters?.....	My wave length is..... meters.
QRJ	How many words have you to send?.....	I have..... words to send.
QRK	How do you receive me?.....	I am receiving well.
QRL	Are you receiving badly? Shall I send 30?..... * * * * *	I am receiving badly. Please send 30. * * * * *
	for adjustment?.....	for adjustment.
QRM	Are you being interfered with?.....	I am being interfered with.
QRN	Are the atmospherics strong?.....	Atmospherics are very strong.
QRO	Shall I increase power?.....	Increase power.
QRP	Shall I decrease power?.....	Decrease power.
QRQ	Shall I send faster?.....	Send faster.
QRS	Shall I send slower?.....	Send slower.
QRT	Shall I stop sending?.....	Stop sending.
QRU	Have you anything for me?.....	I have nothing for you.
QRV	Are you ready?.....	I am ready. All right now.
QRW	Are you busy?.....	I am busy (or: I am busy with.....). Please do not interfere.
QRX	Shall I stand by?.....	Stand by. I will call you when required.
QRY	When will be my turn?.....	Your turn will be No.
QRZ	Are my signals weak?.....	Your signals are weak.
QSA	Are my signals strong?.....	Your signals are strong.
QSB	Is my tone bad?.....	The tone is bad.
QSC	Is my spark bad?.....	The spark is bad.
QSD	Is my spacing bad?.....	Your spacing is bad.
QSE	What is your time?.....	My time is.....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	Transmission will be in series of 5 messages.
QSH	Transmission will be in series of 10 messages.
QSI	What rate shall I collect for?.....	Collect.....
QSK	Is the last radiogram canceled?.....	The last radiogram is canceled.
QSL	Did you get my receipt?.....	Please acknowledge.
QSM	What is your true course?.....	My true course is..... degrees.
QSN	Are you in communication with land?.....	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with.....)?.....	I am in communication with..... (through.....).
QSP	Shall I inform..... that you are calling him?.....	Inform..... that I am calling him.
QSQ	Is..... calling me?.....	You are being called by.....
QSR	Will you forward the radiogram?.....	I will forward the radiogram.
QST	Have you received the general call?.....	General call to all stations.
QSU	Please call me when you have finished (or: at..... o'clock)?.....	Will call when I have finished.
*QSV	Is public correspondence being handled?.....	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?.....	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?.....	Decrease your spark frequency.
QSY	Shall I send on a wave length of..... meters?	Let us change to the wave length of..... meters.
QSZ	Send each word twice. I have difficulty in receiving you.
QTA	Repeat the last radiogram.

*Public correspondence is any radio work, official or private, handled on commercial wave lengths. When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

INTRODUCTION

The circuits contained in this book have been carefully chosen from the great variety which have been used for different purposes. All freak diagrams and those which are unnecessarily complicated have been eliminated.

No attempt has been made to include every known circuit. So many audion hook-ups, for example, contain entirely too many unnecessary instruments. The diagrams given here are the most practical and the most satisfactory known.

This elimination of non-essentials is a part of the policy which has been followed thruout the Radio Department of Everyday Engineering, a policy which has won universal approval among the radio experimenters.

Circuits developed subsequent to the publication of this book will be found in the current issues of Everyday.

MAY, 1922.

Radio Hook-Ups

1. This is the simplest receiving circuit that can be used. The detector is connected between the antenna and ground, with the phones in shunt.

The set will respond over a rather broad range of wavelengths, since such a large amount of resistance is introduced into the antenna circuit.

Notes:

2. By using a single slide tuner, the receiving set can be adjusted to the wavelength of the incoming signals. Good results can be obtained with this system, though the tuning is not sharp enough to cut out any serious interference.

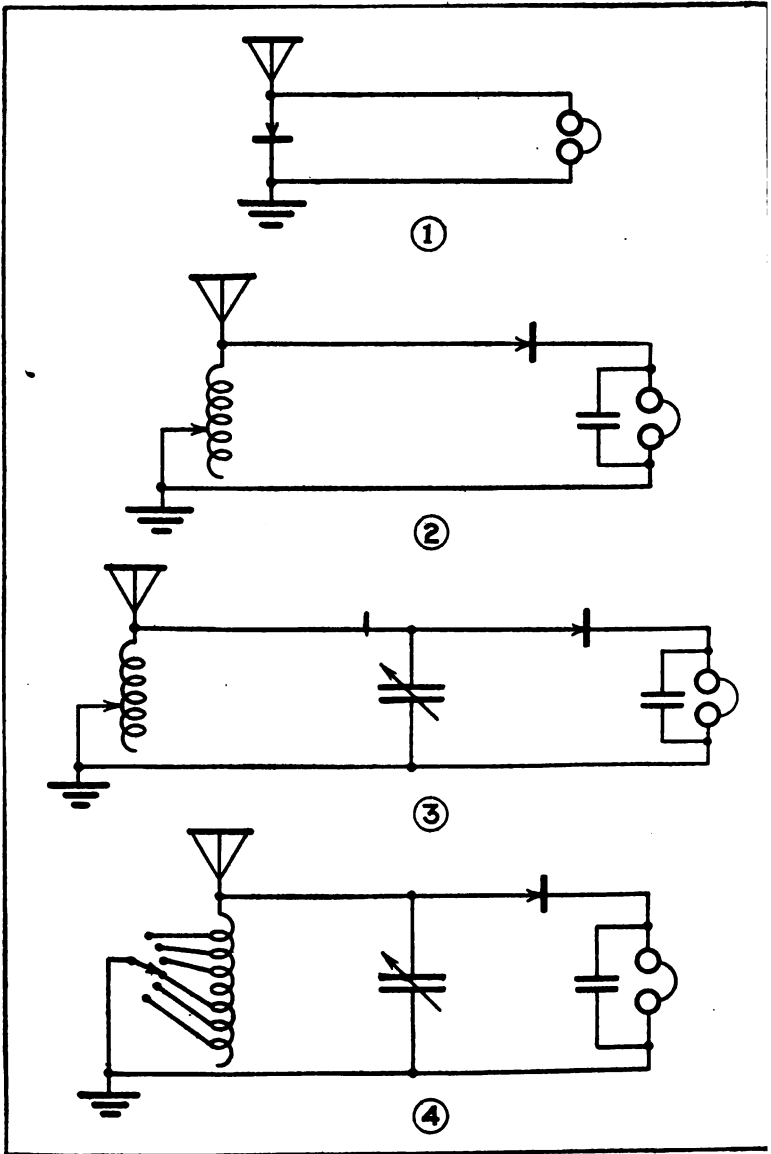
Notes:

3. Adding a variable condenser of 0.005 or 0.001 mfd. maximum capacity helps to increase the sharpness of tuning. When used with a Short Range antenna, a set of this sort, having a good crystal detector, will copy Arlington time signals over a distance of several hundred miles.

Notes:

4. Here a tuning coil, similar to the one described in 2, is tapped at 0, $\frac{1}{2}$, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 inches. The substitution of a switch for the slider does not give quite as sharp tuning, but simplifies the design of the apparatus. A coil of this sort can be connected in series with a single slide tuner to act as a loading coil for longer wavelengths.

Notes:



5. Efficiency is increased by the use of two sliders, for more accurate tuning can be accomplished. A coil of the dimensions given in 4 will serve for the two slide tuner. The path over which the sliders travel should be dusted off frequently so that the copper grains worn off will not short-circuit the turns.

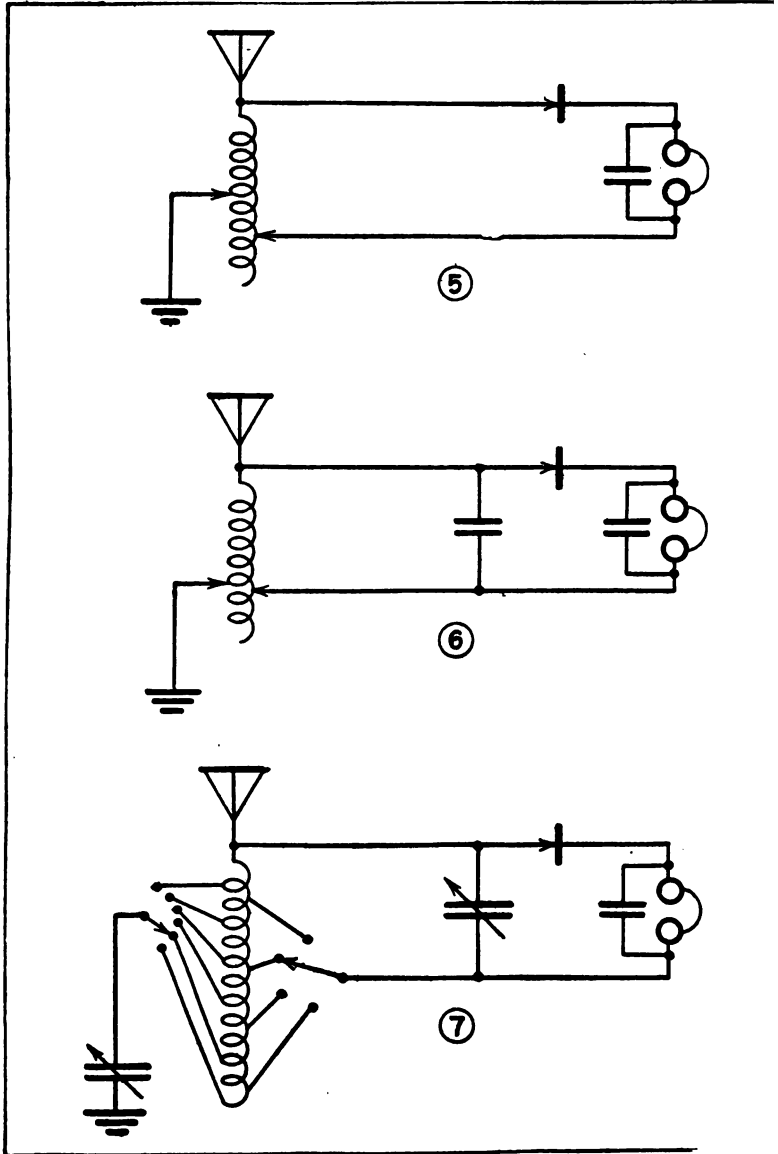
Notes:

6. Sharper tuning and better signals are produced when a variable air condenser is shunted across the detector circuit. This will give better results than 3. When used with the coil described in 4 and a condenser of 0.001 mfd. maximum, the circuit will respond to wavelengths up to 2,800 meters, approximately.

Notes:

7. Switches are substituted for sliders. The ground circuit switch has 10 taps, taken off at $\frac{1}{2}$, $\frac{3}{4}$, 2, 3, 4, 5, $6\frac{1}{4}$, $7\frac{1}{2}$, 8 and 10 inches from the start of the winding. Detector circuit taps are at 1, 2, 4, 6, 8 and 10 inches. The ground circuit condenser is of 0.001 mfd., and the detector circuit condenser of 0.0005 mfd. maximum. Such a set will give sharp tuning and operate at high efficiency.

Notes:



8. A three-slide tuner gives a slight coupling effect by moving both detector circuit sliders toward or away from the part of the coil included in the antenna circuit. There is really very little advantage in the three-slide type, however.

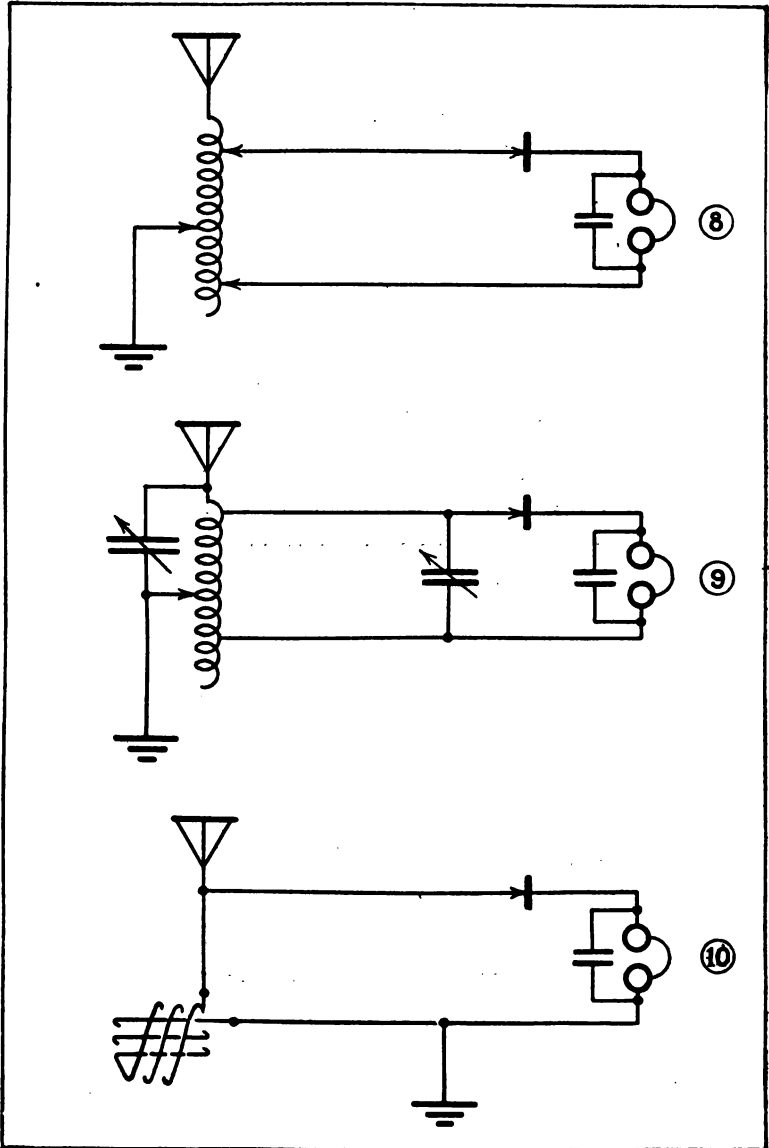
Notes:

9. Tuning condensers are added to the three-slide tuner. The antenna condenser should have a maximum capacity of 0.0005 mfd., and the detector circuit condenser, 0.001 mfd. The use of these condensers increase the wavelength range considerably.

Notes:

10. When a very small wavelength range is required, a variometer can be used, connected in a way similar to the circuit of a single slide tuner. For receiving 200-meter stations, the inner coil may be $3\frac{1}{2}$ inches in diameter, wound with 20 turns of No. 24 s.s.c. wire, and the outer coil, 4 inches in diameter, wound with 15 turns of No. 24 s.s.c. wire.

Notes:



11. The addition of a condenser of 0.001 mfd. increases the wavelength range. Larger variometers can be made to cover a very considerable range of wavelengths.

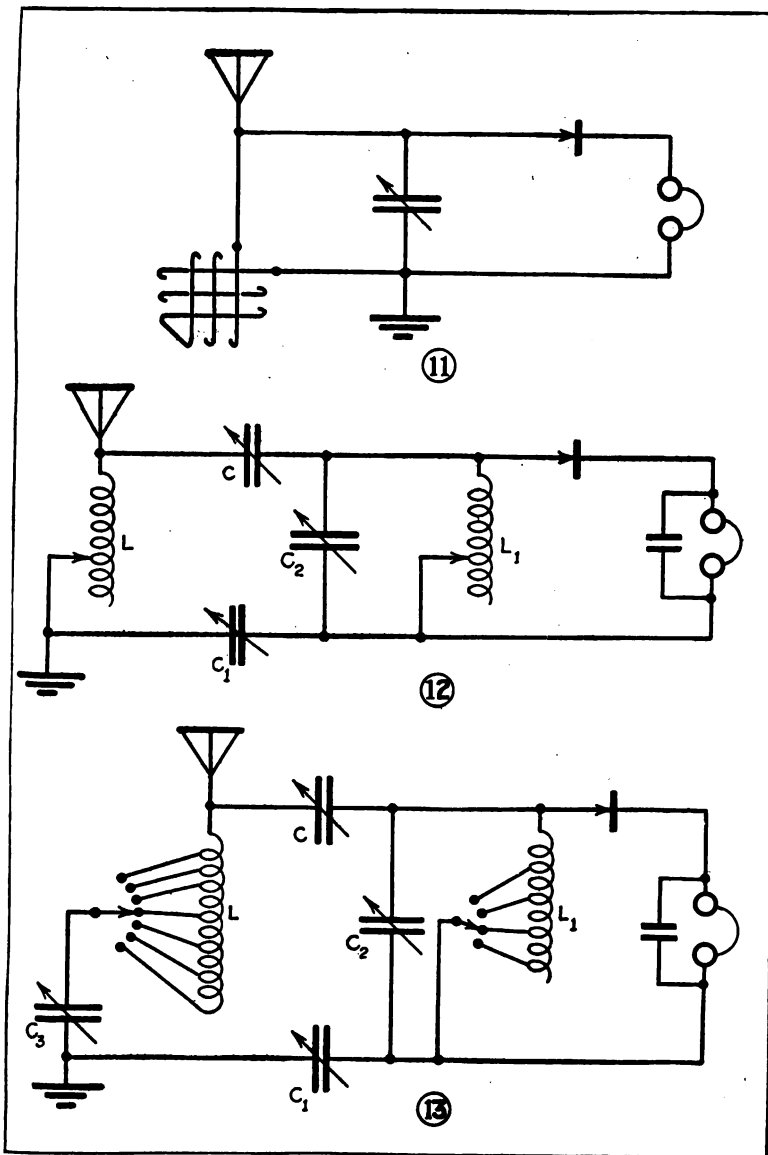
Notes:

12. Capacity coupling between the antenna and secondary or detector circuit gives sharper tuning than with closely coupled circuits. Condenser C and C_1 are mounted on the same shaft, and should have a capacity of 0.0005 mfd. C_2 and L_1 comprise the secondary circuit. They are not affected by changes of C and C_1 . C_2 should be of 0.001 mfd.

Notes:

13. Switches are used for the primary and secondary circuits, with variable condensers for close tuning. Coil L should be half as large again as L_1 . C and C_1 are the same as in 12, while C_2 is of 0.005 mfd., and C_3 , 0.001 mfd. capacity. This is an interesting experimental circuit, and has been used for Navy equipment, though the capacity coupling is not considered as efficient as inductive coupling.

Notes:



14. A simple form of inductive coupling. The primary and secondary coils are set up a foot or more apart, or at right angles. Coupling is effected by a closed circuit having two turns around both primary and secondary coils.

Notes :

15. This is a loosely coupled set, in which the secondary slides in or out of the primary. At maximum coupling the tuning is broad and the signals loud. For sharp tuning during interference, the coupling is reduced by pulling out the secondary.

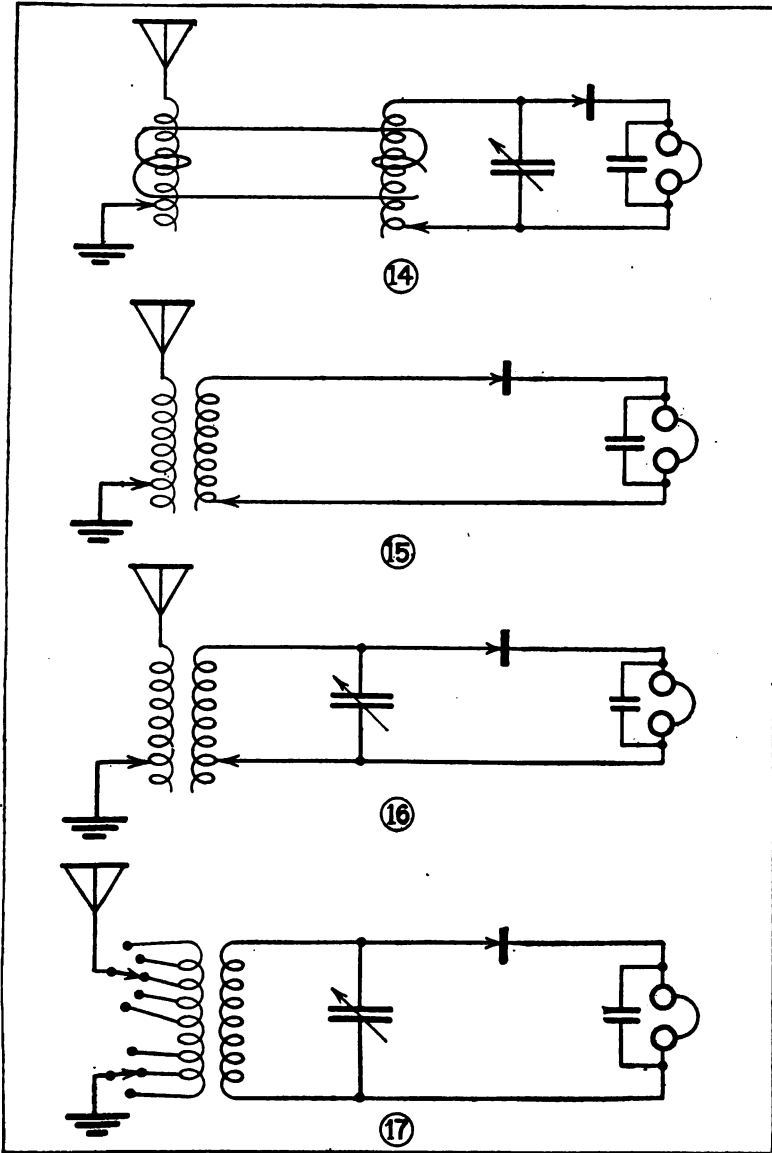
Notes :

16. Adding a variable condenser of 0.0005 mfd. makes the tuning still sharper, and increases the signal strength. A good loose coupler for reception up to several thousand meters can be made with a primary 6 inches long, $3\frac{1}{2}$ inches in diameter wound with No. 24 s.s.c. wire; the secondary 5 inches long, 3 inches in diameter, also wound with No. 24 s.s.c. wire.

Notes :

17. Units and tens switches are used on the primary of this coupler. Taps for the units switch are taken off every other turn, and tens taps, every twenty turns.

Notes :



18. Switches are used for large inductance variations in the primary and secondary. A series condenser in the primary circuit gives a close adjustment of the wavelength, while the secondary has a shunt condenser for the same purpose. It will be found that with the series primary condenser a larger number of taps are needed than in the secondary.

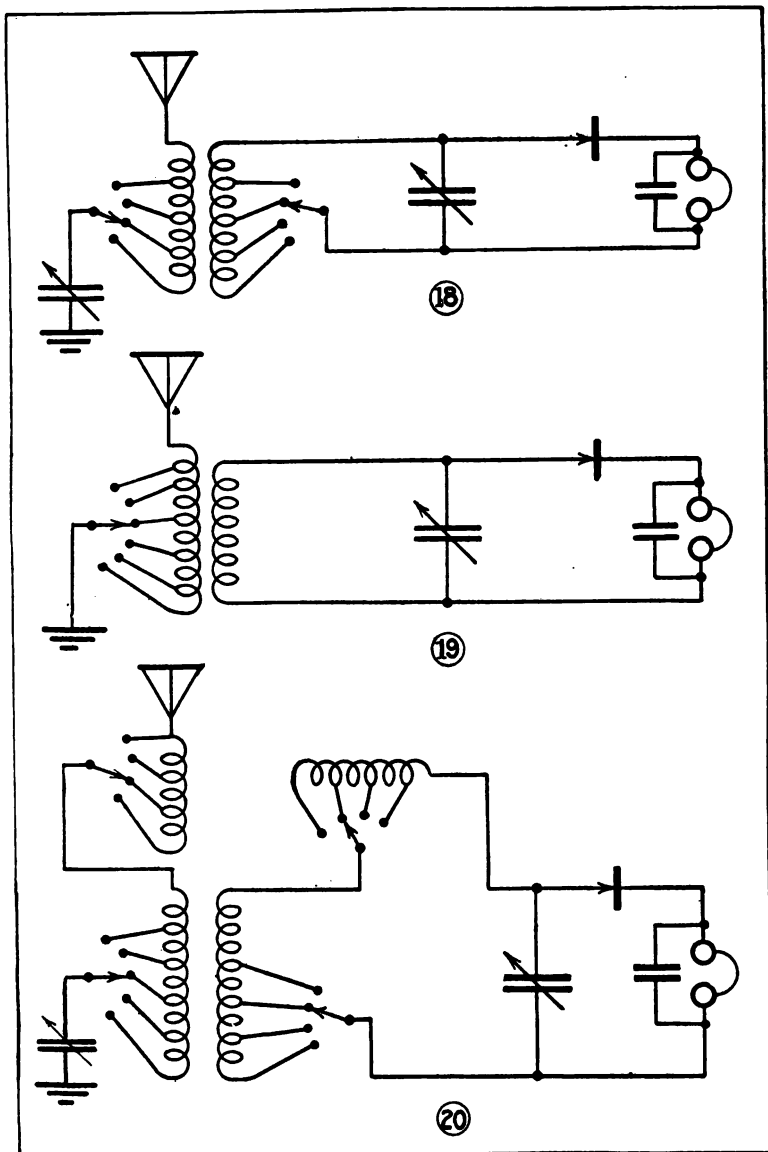
Notes :

19. This circuit is for very short wavelengths where in the primary the only adjustment is a series of taps taken off at every second or third turn. The entire secondary tuning is accomplished by the shunt condenser. With a 0.001 mfd. condenser a wavelength range of 200 to 800 meters can be covered.

Notes :

20. Loading coils should be used in both primary and secondary circuits in order that they can be tuned to the same wavelength. The loading coils are adjustable in large steps, while the primary and secondary coils have small steps between which tuning is done, by means of a variable condenser. It should be remembered that the minimum capacity of a primary series condenser should not be less than one-half the capacity of the antenna, or for most work 0.00025 mfd.

Notes :

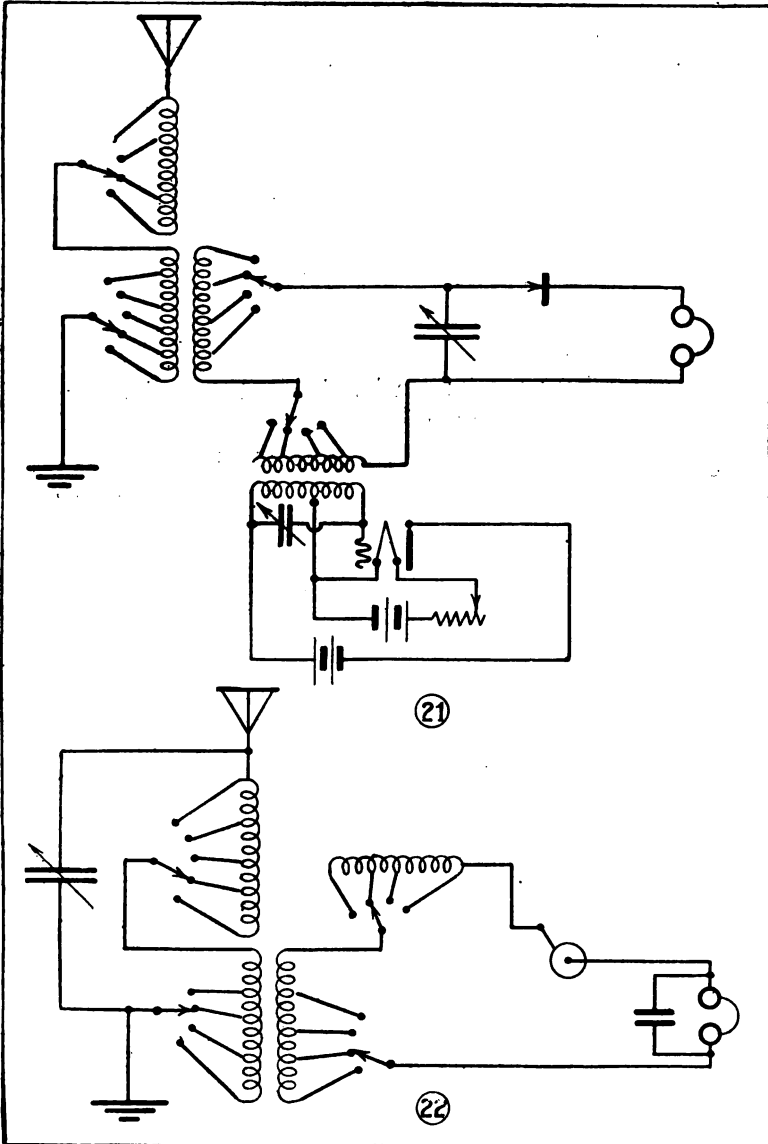


21. The use of an audion oscillator coupled to a crystal detector receiving set makes possible the reception of undamped waves. The oscillator coil is tapped at the center for connection to the filament. This coil is coupled loosely to the secondary loading coil or to a small non-adjustable coupling coil, if all the inductance is contained in the secondary of the loose coupler. While not as efficient as an audion receiver for undamped waves, this circuit can be used for considerable distances.

Notes:

22. Another way to receive undamped waves is by the use of a tikker. This is simply a brass disc rotated by a motor with a spring contact on the disc. The varying resistance of the contact breaks up the high frequency undamped waves into audio frequency groups. A shunt primary condenser is used for an additional wavelength range, though it does not give as sharp tuning as a series condenser.

Notes:



23. This is the simplest circuit for a damped wave audion receiver. Only a single slide coil is used for tuning. The fixed condenser connected to the grid is of the postage-stamp type.

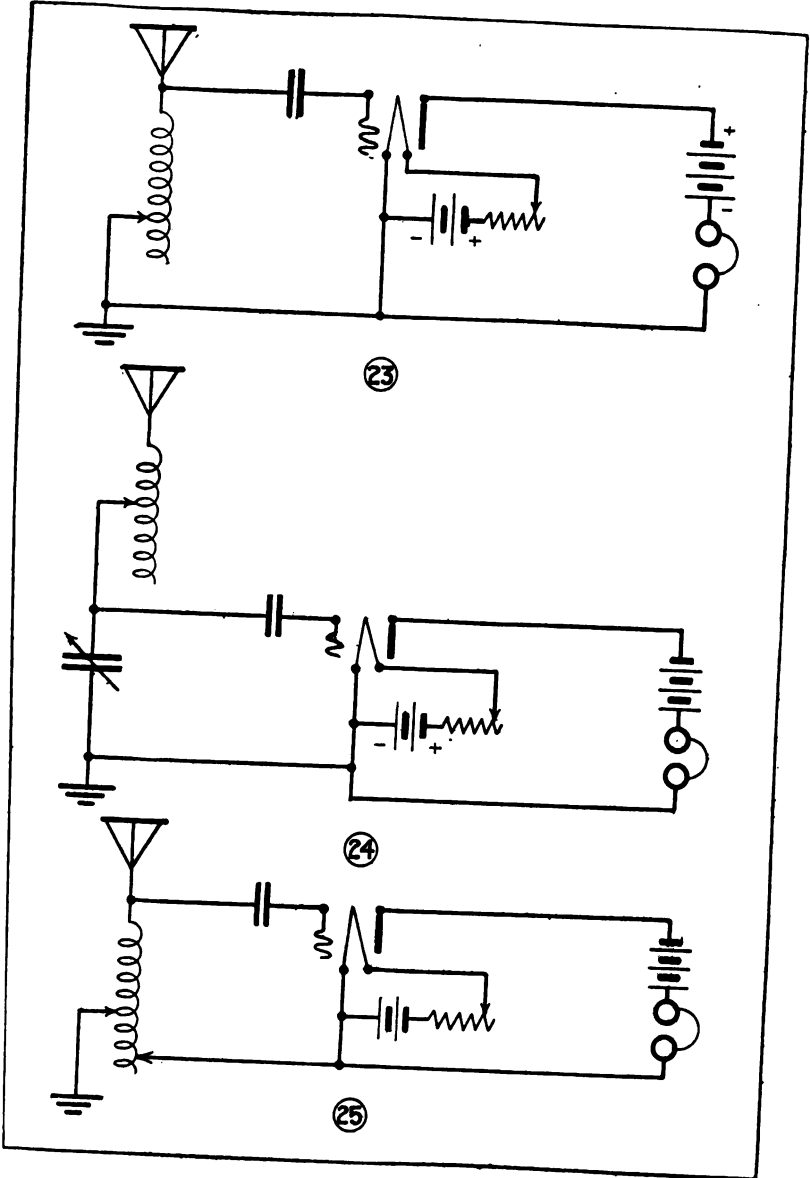
Notes:

24. Excellent results can be obtained with the combination of a single slide tuner and variable condenser. Some experimenters prefer to connect the audion around the inductance instead of the condenser, though it makes very little difference.

Notes:

25. A two-slide tuner and variable condenser are used for tuning here. In operating an audion circuit it is always well to keep in mind that the lower the brilliancy of the filament the longer the audion bulb and B battery will last.

Notes:



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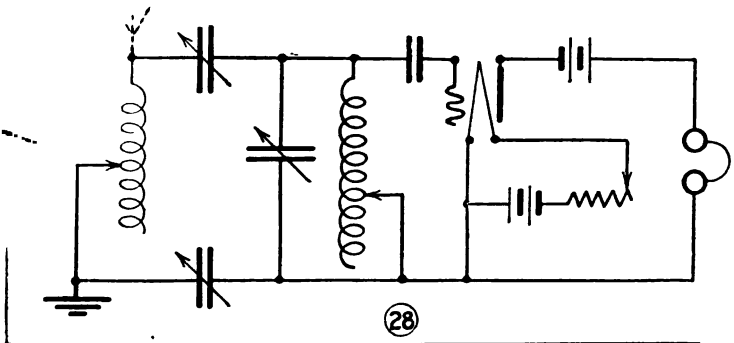
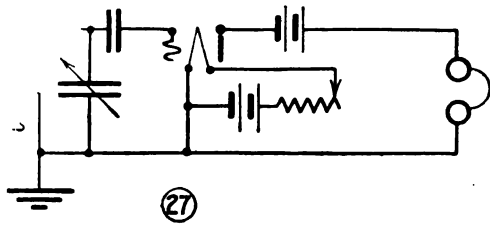
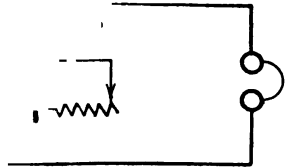
Notes :

25. A two-slide tuner and variable inductor are used for tuning here. In operation it is always well to keep in mind the brilliancy of the filament the and B battery will last.

Notes :

in this diagram. The two series windings are mounted so that they can be adjusted with the same handle. Changing the capacity does not vary the wave-

Can. 14



29. A simple loosely coupled circuit for the audion detector. It is advisable, although not absolutely necessary, to use a condenser across the secondary of the loose coupler.

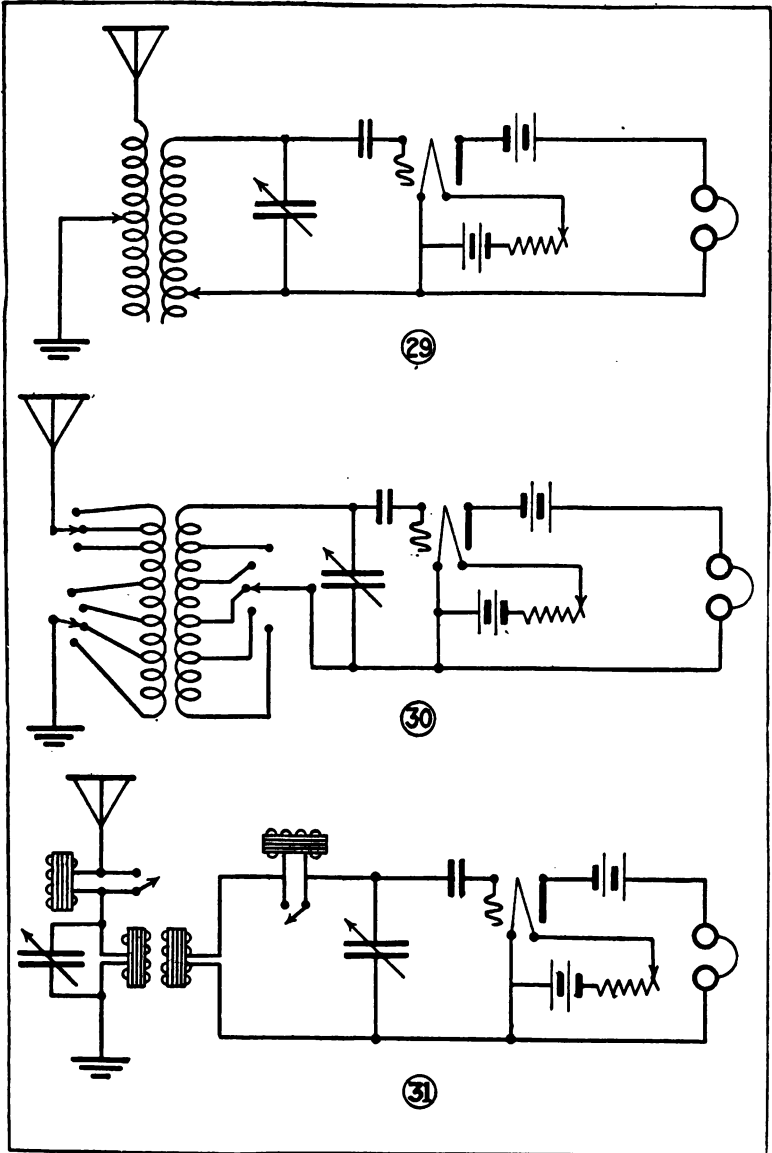
Notes:

30. Units and tens switches are used on the primary of this coupler. The secondary is adjustable in steps with a variable condenser for the intermediate wavelengths.

Notes:

31. A circuit using G. A. or honeycomb coils without taps. A loading coil is inserted in the antenna which can be cut out by a short-circuiting switch. Tuning is accomplished by the primary shunt condenser. A loading coil is also provided in the secondary circuit. This is particularly good for long wave work.

Notes:



32. Tickler coil coupling between the plate and grid circuits makes possible the reception of undamped waves. The tickler coil should have approximately $\frac{1}{4}$ the inductance of the secondary.

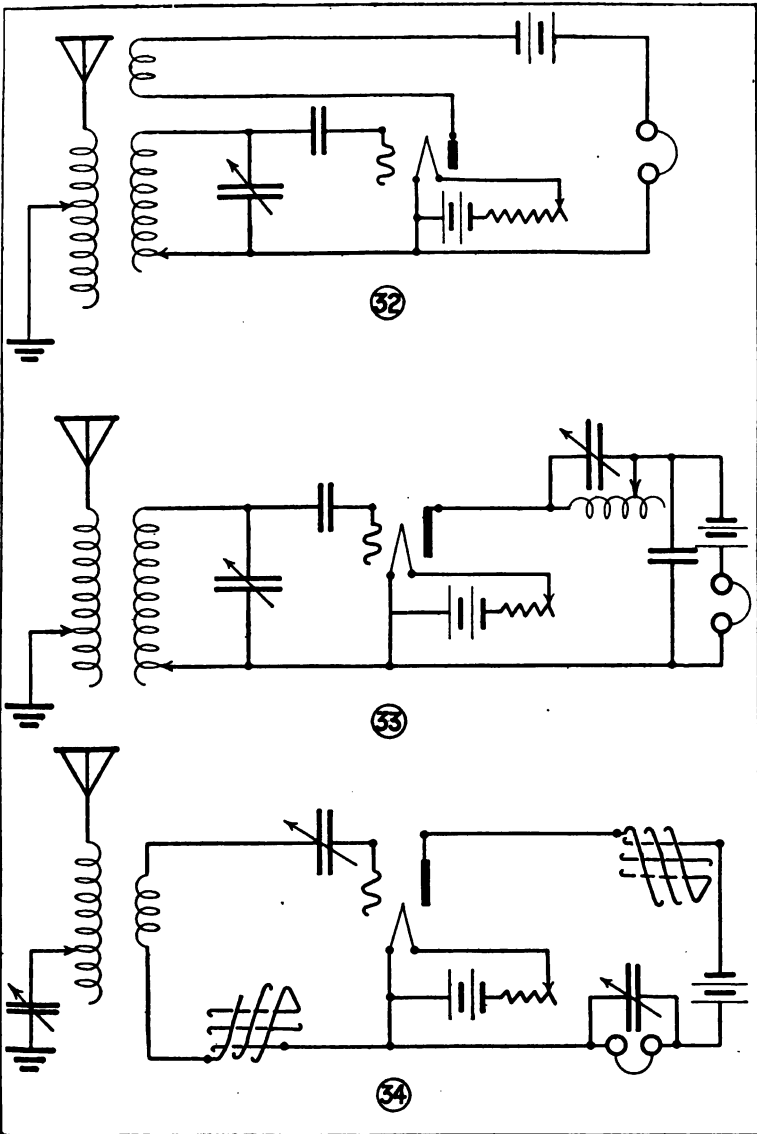
Notes:

33. A tuned circuit in the plate can also be used for undamped waves. The coil and condenser should have approximately the same inductance and capacity as the secondary of the loose coupler and the secondary tuning coil.

Notes:

34. A small coupling coil with a secondary variometer makes this circuit adaptable for short wave work. Another variometer is inserted in the plate circuit with a 0.0005 mfd. condenser around the telephones.

Notes:



35. G. A. or honeycomb coils connected for undamped wave reception. Coupling is varied by swinging the primary coil and the strength of the oscillations by moving the tickler coil.

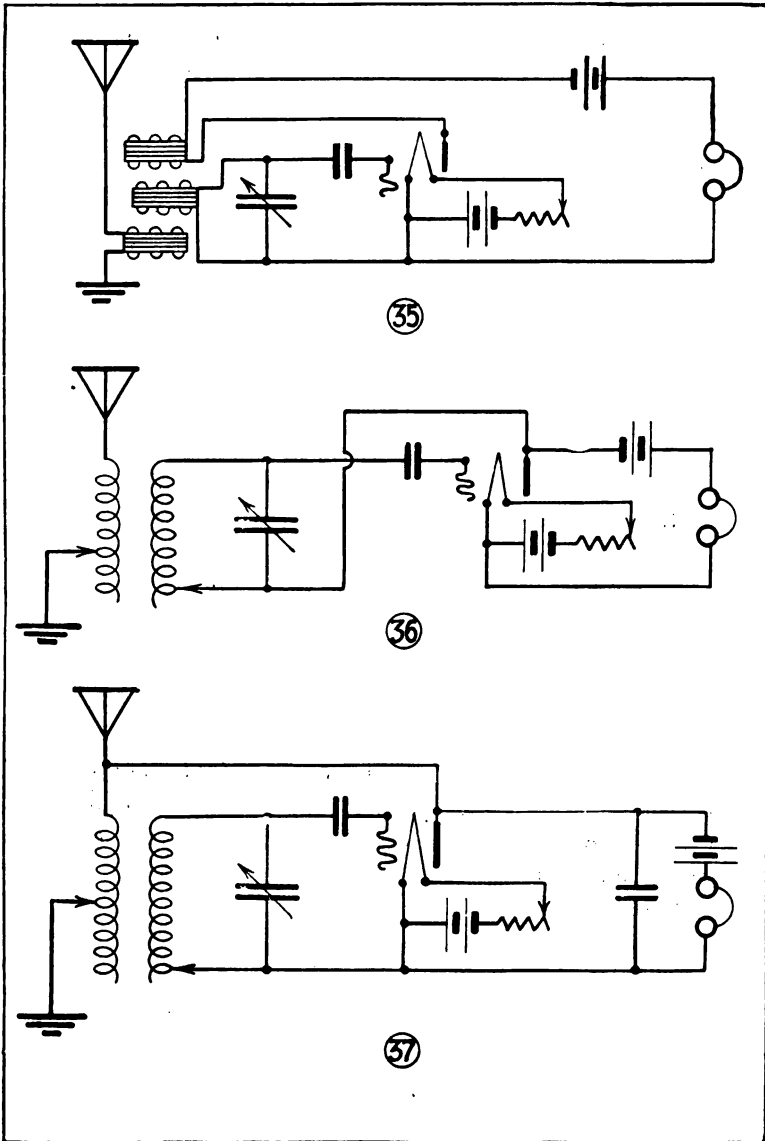
Notes:

36. The original ultra-audion circuit. One end of the secondary is connected to the plate instead of to the filament as in the case of other audion circuits.

Notes:

37. Here a feed back effect is obtained by connecting the plate to the antenna. A condenser of 0.001 mfd. is shunted across the telephones. This circuit is not particularly good for undamped wave work because the strength of the oscillations cannot be readily controlled.

Notes:



38. A small variable air condenser is put across the grid and plate to provide a feed-back coupling.

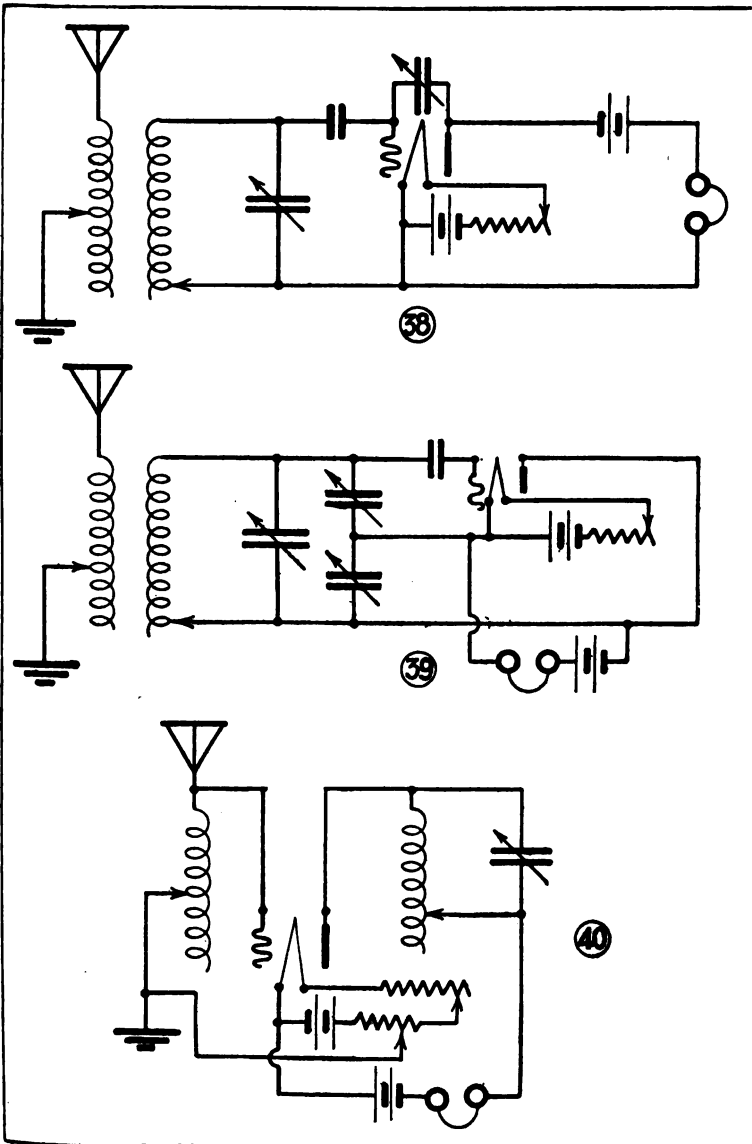
Notes:

39. An Eaton oscillator circuit. Two small condensers, either fixed or variable, are connected across the secondary condenser with a tap taken from the center to the filament. If variable condensers are used the oscillations can be readily controlled.

Notes:

40. A loose coupler wired so that the primary and secondary furnish feed back coupling for undamped wave reception. A 0.001 mfd. condenser around the secondary is used for tuning.

Notes:

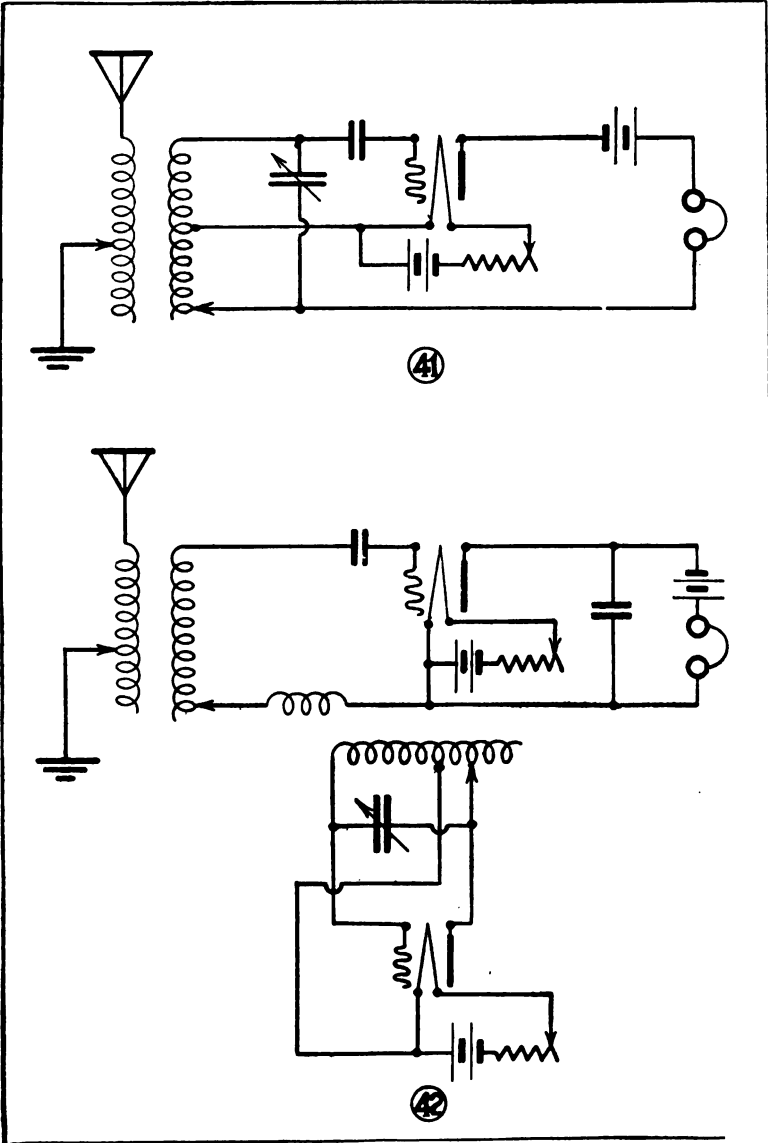


41. The secondary circuit really is an oscillator coupled to the primary coil. The tap to the filament should be taken off a little below the center point. Undamped waves can be received in this manner.

Notes:

42. The most efficient way to receive undamped waves is by the use of a separate oscillator. This diagram shows an ordinary spark receiving circuit to which an oscillator is connected. The circuit of the oscillator is the same as the secondary of diagram 41.

Notes:

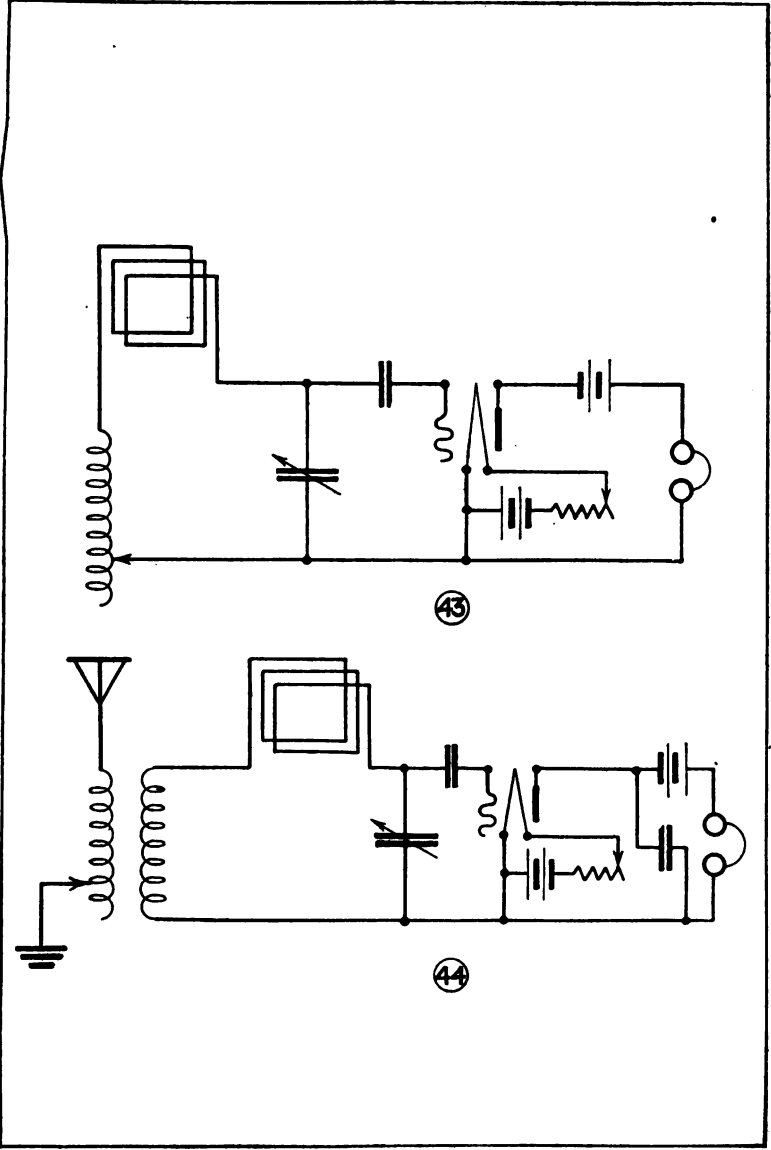


43. A loop antenna with a loading inductance and tuning condenser for directional reception. Signals are loudest when the horizontal turns of the loop point toward the transmitting station. This is called a bilateral radio compass.

Notes:

44. Unilateral connections for a loop receiver. The loop is connected to the secondary of a loose coupler and the regular antenna to the primary. When signals are received simultaneously and the coupling properly adjusted, maximum and minimum sides will be found. The transmitter is in the direction of the loudest signals.

Notes:



45. Either unilateral or bilateral receiving can be done on this circuit. The ground connection must be open if the loop is used alone for bilateral work.

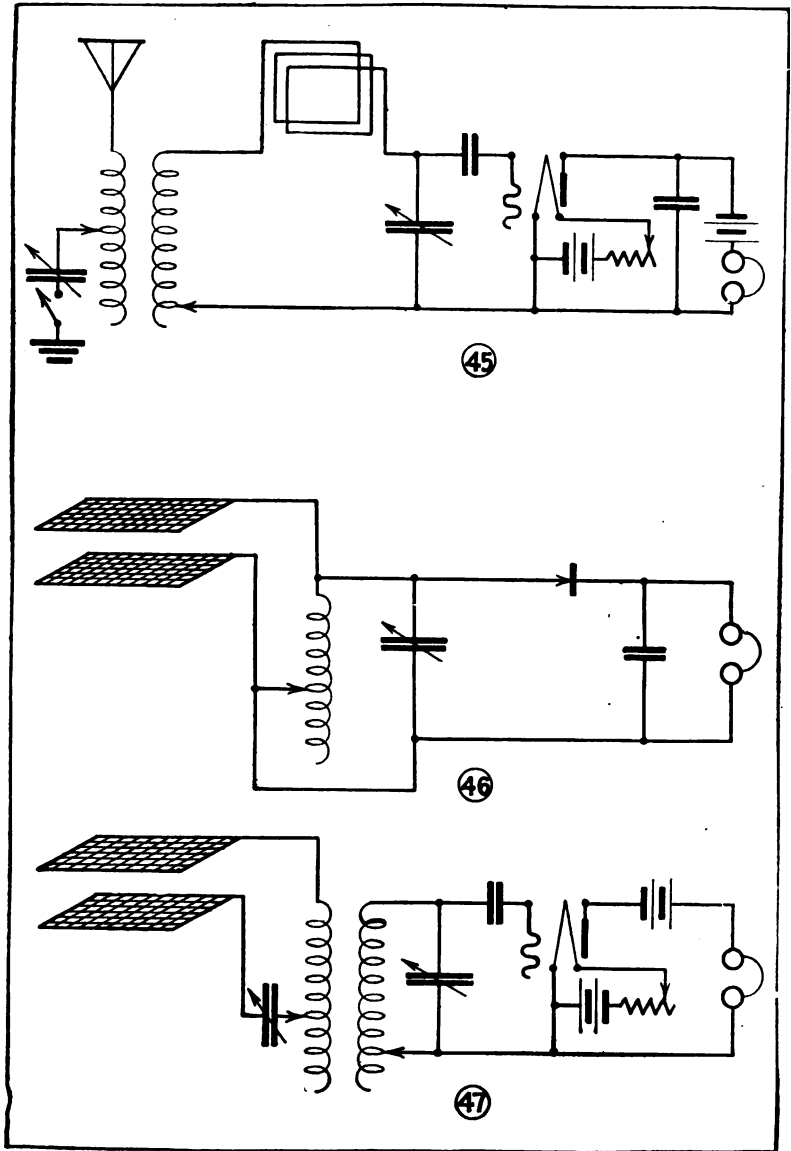
Notes:

46. The electro-static antenna is made of sheets of copper netting separated from six to twelve inches. The upper plate acts as the antenna and the lower plate as the ground.

Notes:

47. Here the condenser antenna is connected to a loosely coupled receiving set. The instruments are used in the same way as if an ordinary antenna and ground connection were employed.

Notes:



48. Connections for a tone condenser used for receiving very short undamped waves. The circuit is tuned to the frequency of the transmitter and the tone condenser gives an adjustment, as it revolves, above and below that wavelength. The note in the receivers is determined by the speed of the tone condenser.

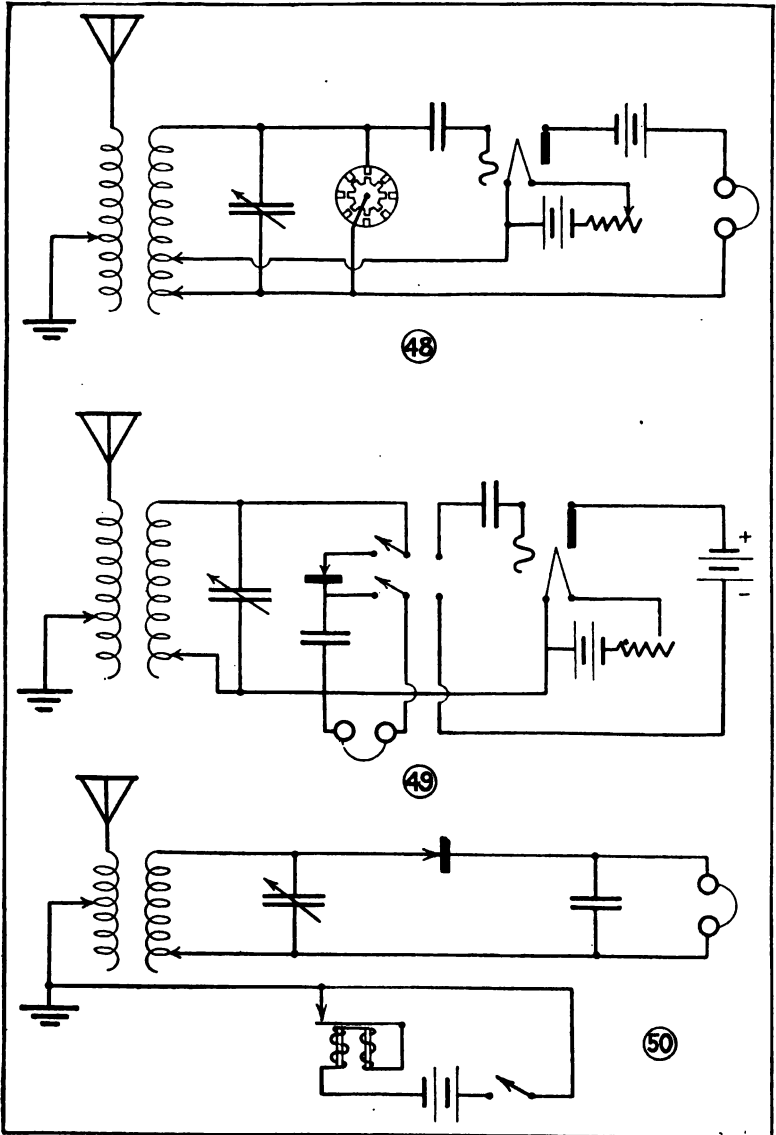
Notes:

49. By changing over the double pole and double throw circuit either audion detector or crystal can be cut into the receiving circuit.

Notes:

50. Diagram of a buzzer test for use with either a crystal or audion receiver. The buzzer is connected with a battery and switch, and a lead run from the vibrator screw of the buzzer to the receiving set ground.

Notes:



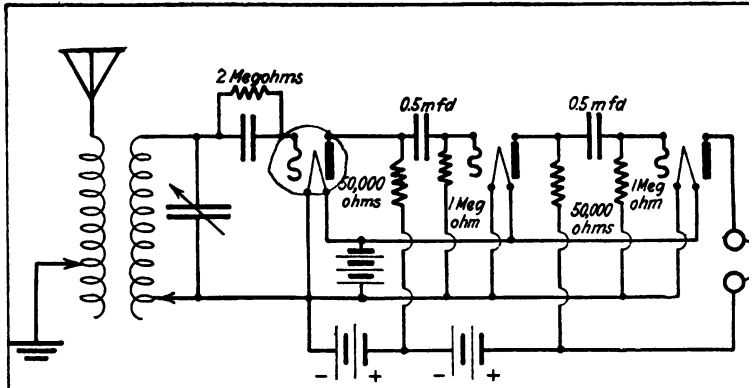
51. A resistance coupled amplifier is shown in this diagram. Dimensions for the condensers and resistances are shown. This circuit is for audio frequency amplification. Additional stages can be connected on in the same manner as is the last step.

For radio frequency amplification the grid condenser can be omitted from the first audion and the second audion connected as the first stage as shown in the diagram.

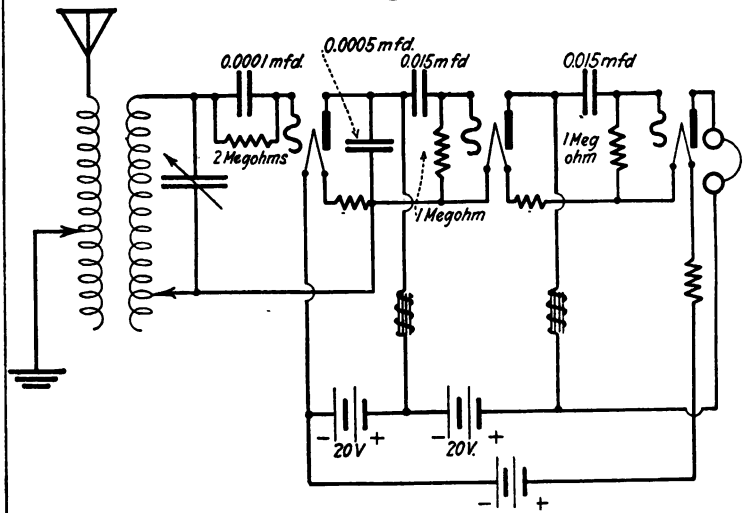
Notes :

52. This is an impedance coupled amplifier. The impedances should have a reactance value at 700 cycles equal to the impedance of the tube which is usually 50,000 ohms. Small variable resistances are inserted in the filament circuit to give a slight negative charge to the grid.

Notes :



51



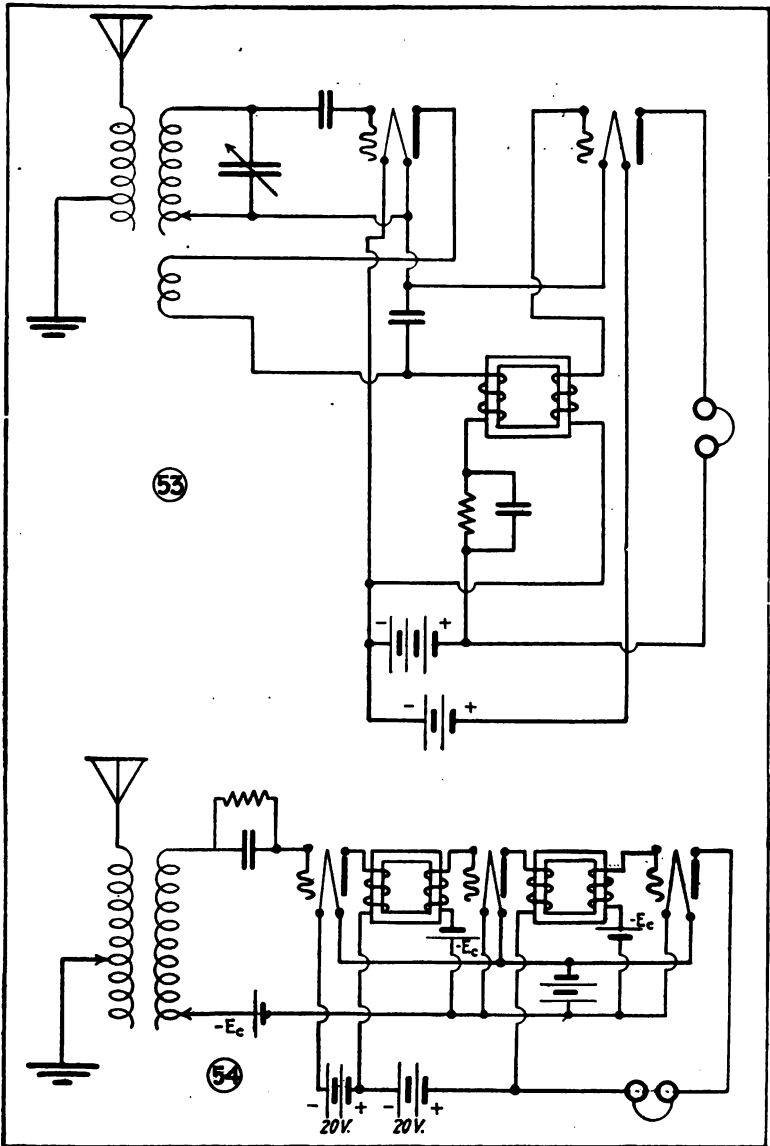
52

53. A one step transformer coupled amplifier with a tickler coil for undamped wave reception for the regeneration of spark signals. The fixed condensers in the amplifier circuit can be omitted, though they add to the efficiency of the circuit.

Notes :

54. A detector and two-stage transformer coupled amplifier. Small batteries marked $-E_c$ are inserted in the grid circuit to give clearer amplification. It is advisable to have these batteries adjustable so that the amount of negative grid voltage can be adjusted while the apparatus is in operation.

Notes :

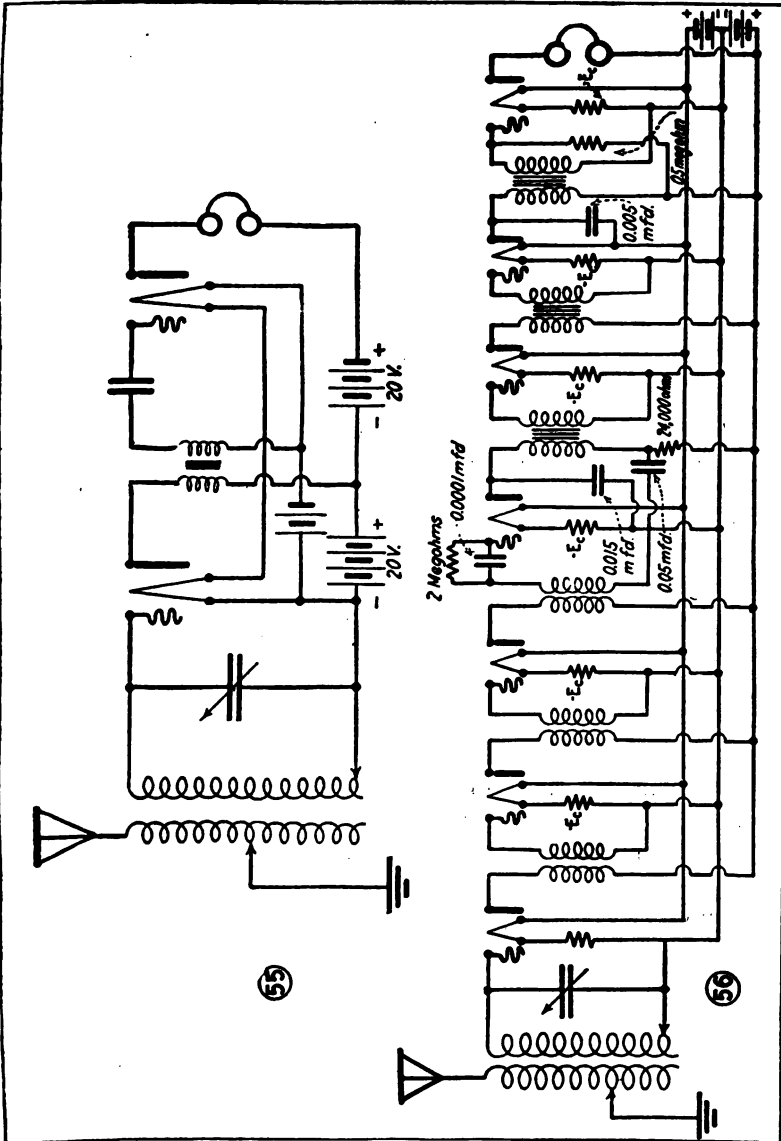


55. A radio frequency amplifier with an iron core transformer is shown in this diagram. The second audion acts as a detector for the radio frequency amplified by the first tube.

Notes:

56. Here are connections for a six-step amplifier having three stages of radio frequency amplification, a detector and three stages of audio frequency amplification. Adjustable resistances should be inserted in the grid circuits so that the amplification can be effected without distorting the incoming signals. This is particularly necessary for the reception of the radio telephone. Amplifiers connected in this manner have been carried out to fifteen or more stages.

Notes:



57. A buzzer transmitter in which the sending condenser and primary of the oscillation transformer are shunted across the break in the buzzer. Buzzers carrying up to 100 watts have been used in this way. A small buzzer with a 6 volt battery will transmit several miles if a good receiver is used.

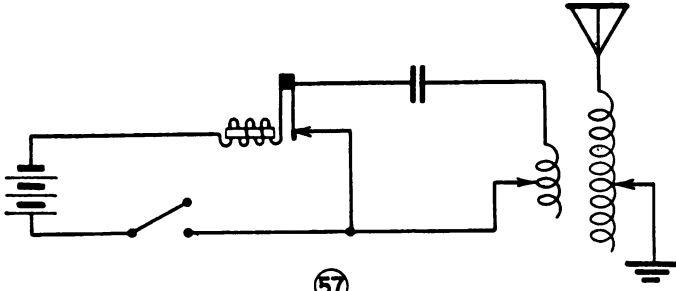
Notes:

58. A method for using higher currents is shown in this circuit. The vibrator carries a contact which closes the circuit across two separate contacts.

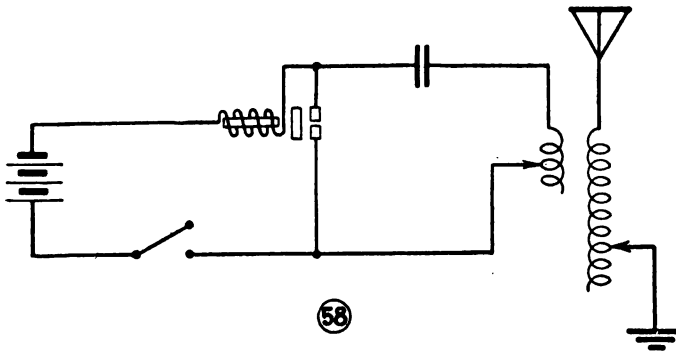
Notes:

59. This is a diagram of a spark coil transmitter. In order to comply with the radio law, it is almost essential to use an oscillation transformer instead of a helix.

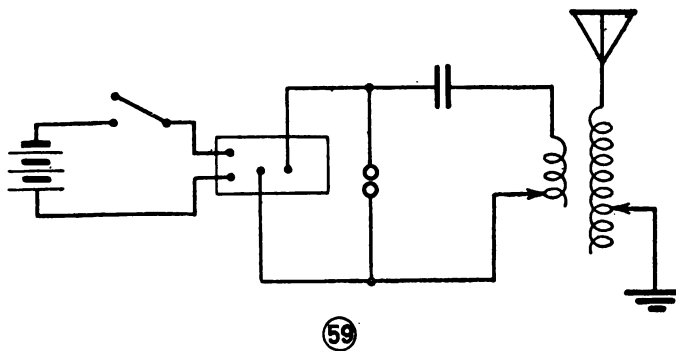
Notes:



57



58



59

60. A transformer set operating on 110 volts. A condenser is shunted around the contacts of the key to prevent sparking.

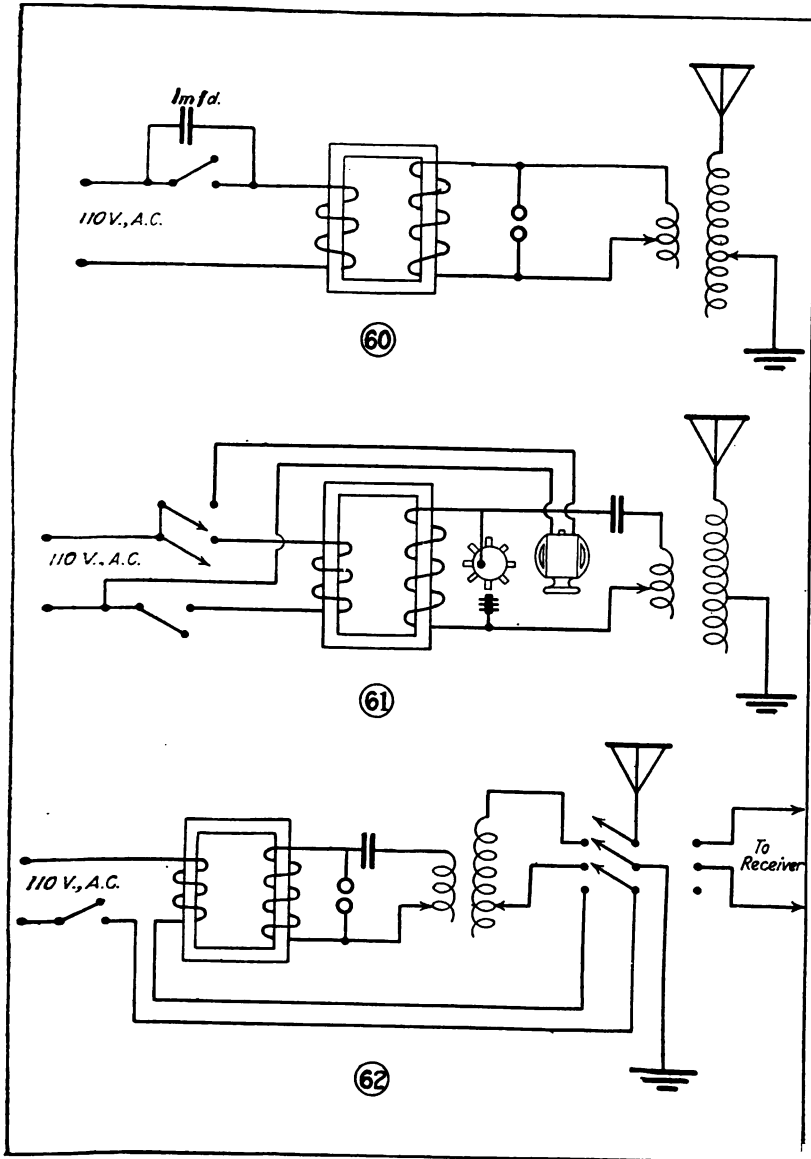
Notes:

61. This shows a switch to open the power circuit and the spark gap motor when the transmitter is not in use. Closing the switch starts the motor and closes the power supply to the transformer so that it is in readiness for the operation of the key.

Notes:

62. Here a triple pole double throw switch changes the antenna and ground from sending to receiving and closes or opens the power circuit so that no transmitting can be done when the switch is connected for receiving.

Notes:



63. Connections for a break-in system. A very small spark gap is put in the ground circuit. When the key is pressed, the antenna connection of the receiver is open, but when the key is up the receiver is connected for operation.

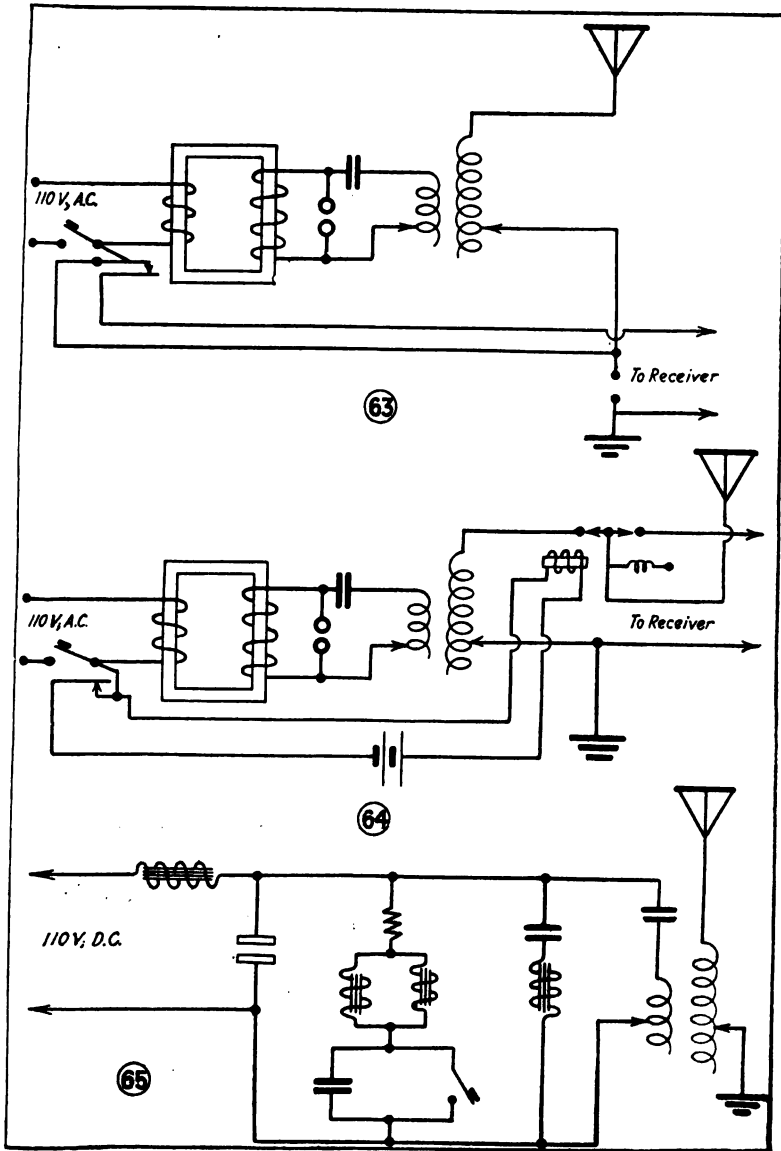
Notes:

64. In this circuit a relay is used to change the antenna from the transmitting to the receiving set. Ordinarily, the spring on the armature of the relay connects the antenna to the receiving set, but when the key is pressed the contact is closed by which the relay magnet is energized and the armature thrown over to join the antenna to the transmitter.

Notes:

65. The Chaffee gap operating on 110 volts, direct current with a tone circuit and starter. If the set is operated on alternating current the starter and tone circuit can be omitted. In this diagram a small resistance is connected in series with two impedances and a key shunted to a condenser across the gap. Another parallel circuit composed of a condenser and impedance, the natural period of which is within the audible range, are connected across the gap. Operating the key stops and starts the gap.

Notes:



66. A loop antenna used for undamped wave transmission. A tap is taken from the center of the loop and connected to the filament of the audion. For higher power several bulbs can be connected in parallel.

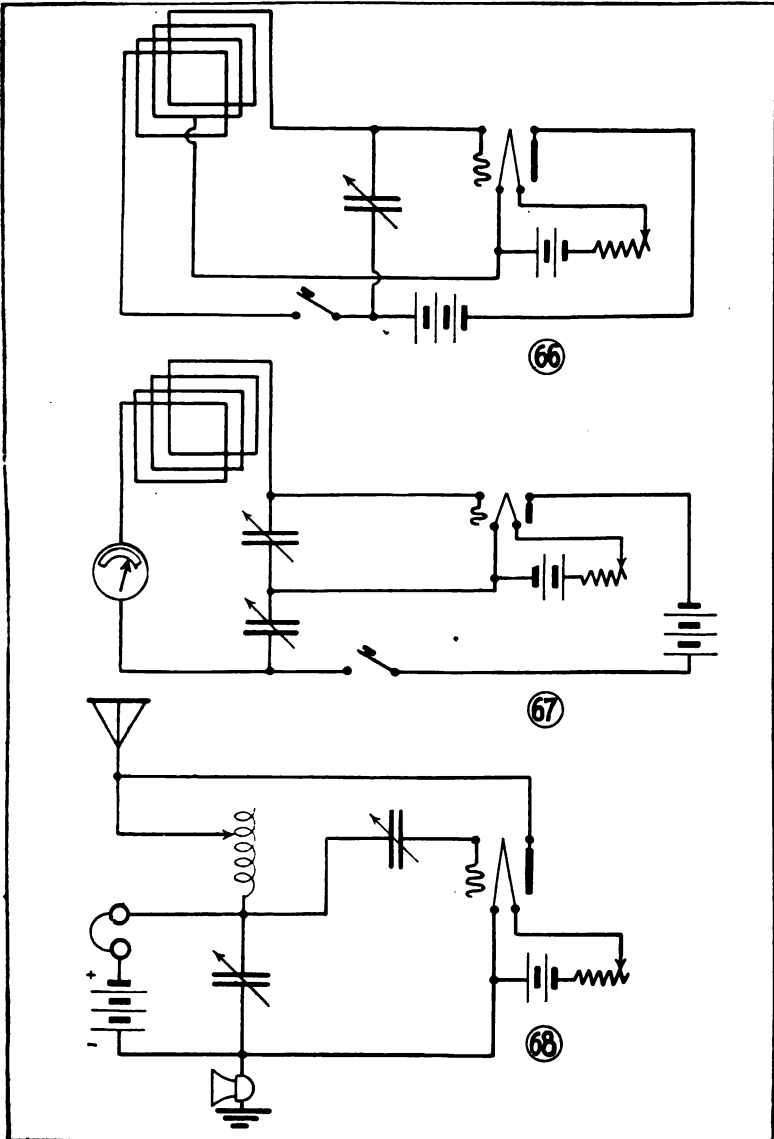
Notes:

67. Another way of connecting a loop antenna for undamped wave transmission. A hot wire ammeter is inserted in the lead to the loop to indicate the adjustment for maximum power. A telephone transmitter can be put in this circuit for telephonic transmission.

Notes:

68. This circuit will operate over a short range as a telephone transmitter or receiver. The grid condenser should have a maximum capacity of 0.0005 mfd. and the tuning condenser 0.001 mfd.

Notes:

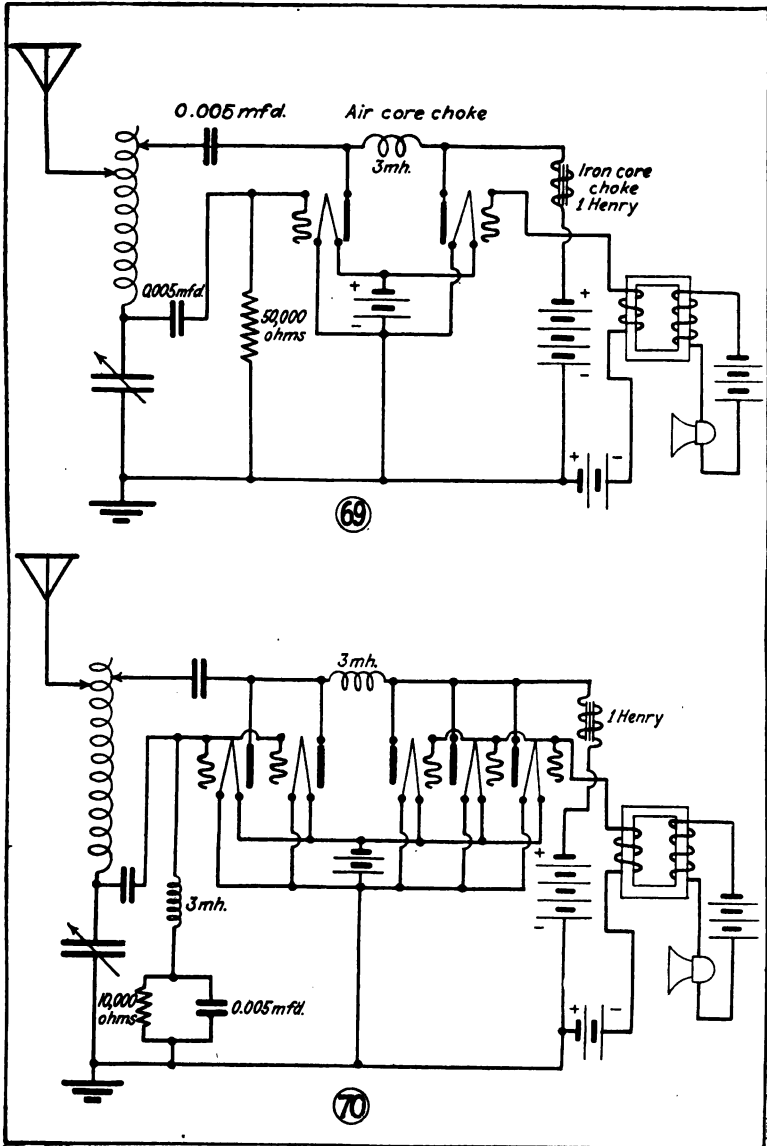


69. Telephone transmission can be carried on by connecting apparatus, as shown in this diagram. Very little explanation is needed, since the sizes of the coils and condensers are given. In place of the B battery a direct current generator of 100 to 350 volts can be used for long distance transmission. A battery is inserted in the grid of the modulator tube. The value of this negative voltage must be determined experimentally. A modulation transformer is needed. It is advisable to buy this instrument, as it is a difficult matter to make one at home.

Notes:

70. A high powered telephone transmitter is shown here connected in a manner similar to the set in 69. It is necessary ordinarily to use as many or more tubes in the modulator circuit as in the oscillator circuit. Considerable distances can be covered by a set of this kind if a high voltage is used in the plate circuits. When the values of the coils or condensers are not given they are the same as in 69.

Notes:

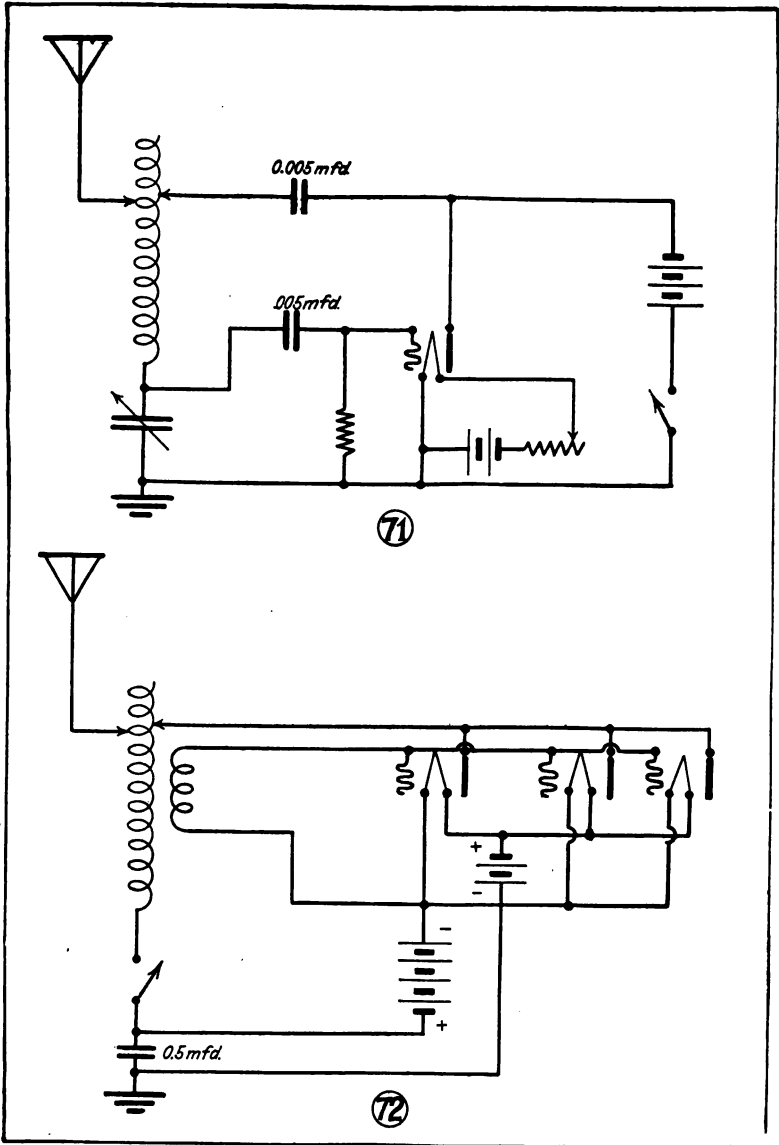


71. This circuit is suitable for short distance undamped wave telegraph transmission. It is also suitable for receiving if a pair of telephones is connected in the plate circuit. Telegraphic operation is carried on by means of the key inserted in the plate circuit.

Notes:

72. This is a high-powered undamped wave telegraph transmitter using three tubes in parallel. It is possible to have only two tubes or a number greater than three, depending upon the distance to be covered. The unique feature of this circuit is that no variable condensers are used, the capacity of the antenna providing all the capacity in the oscillating circuit. A small coil across the grid and filament, coupled to the tuning inductance provides the feed back coupling to maintain the circuit in oscillation.

Notes:

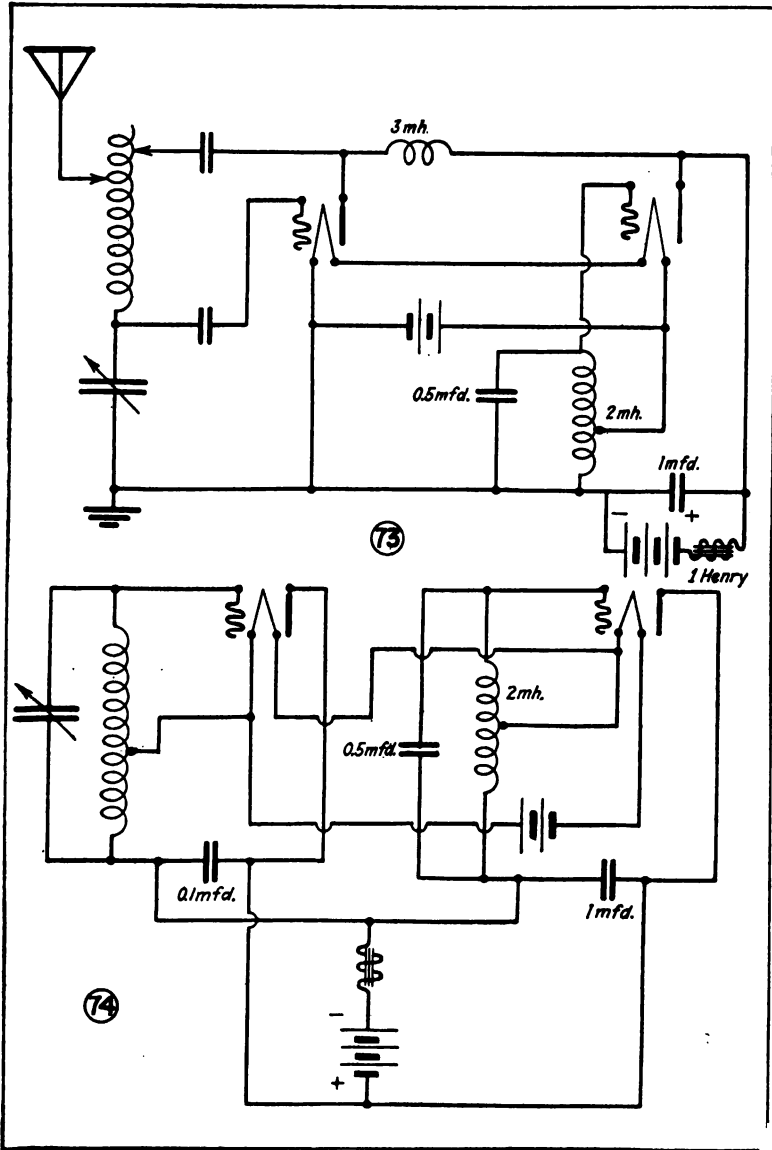


73. Connections for a modulated undamped wave transmitter are given in this diagram. The tube at the left operates as a radio frequency oscillator, while the tube at the right with the inductance and capacity provides an audio frequency oscillator which makes it possible to transmit on undamped waves, though they can be received with a crystal detector.

Notes:

74. A laboratory oscillator modulated by an audio frequency oscillator. This circuit is used for various kinds of experimental work. If the modulator is not required, it can be disconnected, in which case the circuit at the left will operate as a radio frequency undamped wave generator.

Notes:



75. This illustrates the method of measuring the wavelength of the primary of a radio transmitter. The antenna and ground are disconnected from the secondary of the oscillation transformer and a wavemeter coupled loosely to the primary. When the key is pressed a note will be heard in the wavemeter when it is adjusted to the wavelength of the primary circuit. This method can be used for either transformer or spark coil sets.

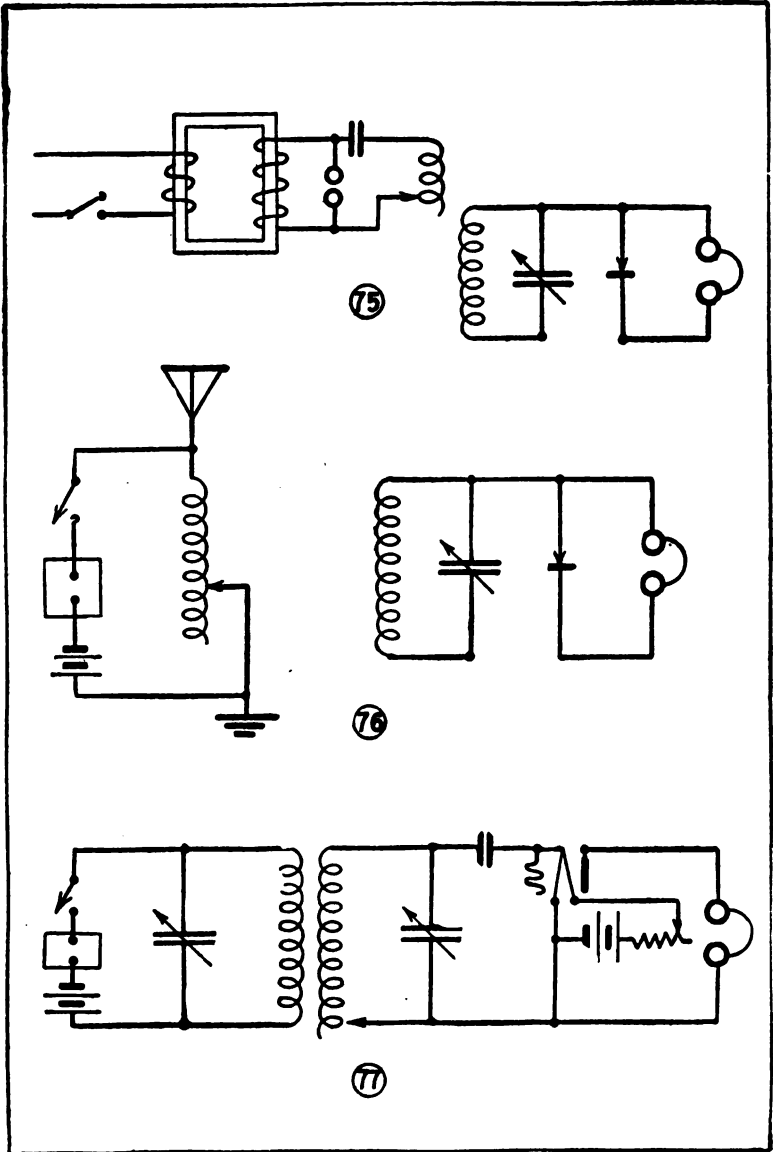
Notes:

76. To measure the wavelength of the secondary of a transmitter or primary of a loose coupler the other circuits should be disconnected and the buzzer and battery connected around the inductance. With the wavemeter coupled loosely to the coil a note will be heard when the two circuits are in resonance, that is, they have the same wavelength.

Notes:

77. The wavelength of the secondary of a receiving circuit can be measured by disconnecting the antenna and ground from the primary coil and coupling the wavemeter to the secondary. A buzzer is shunted around the inductance of the wavemeter. When the two circuits are in resonance a sound will be heard in the telephones of the receiving circuit.

Notes:



78. This circuit shows the manner in which the capacity of an antenna is measured. The switch is thrown to the right, the buzzer set in operation and the wavelength measured by means of the wavemeter. Then, without changing the adjustment of the wavemeter the switch is thrown to the left and the condenser adjusted until signals are again heard in the wavemeter. The capacity of the condenser at this point will be equal very closely, neglecting the inductance of the antenna, to the capacity of the antenna.

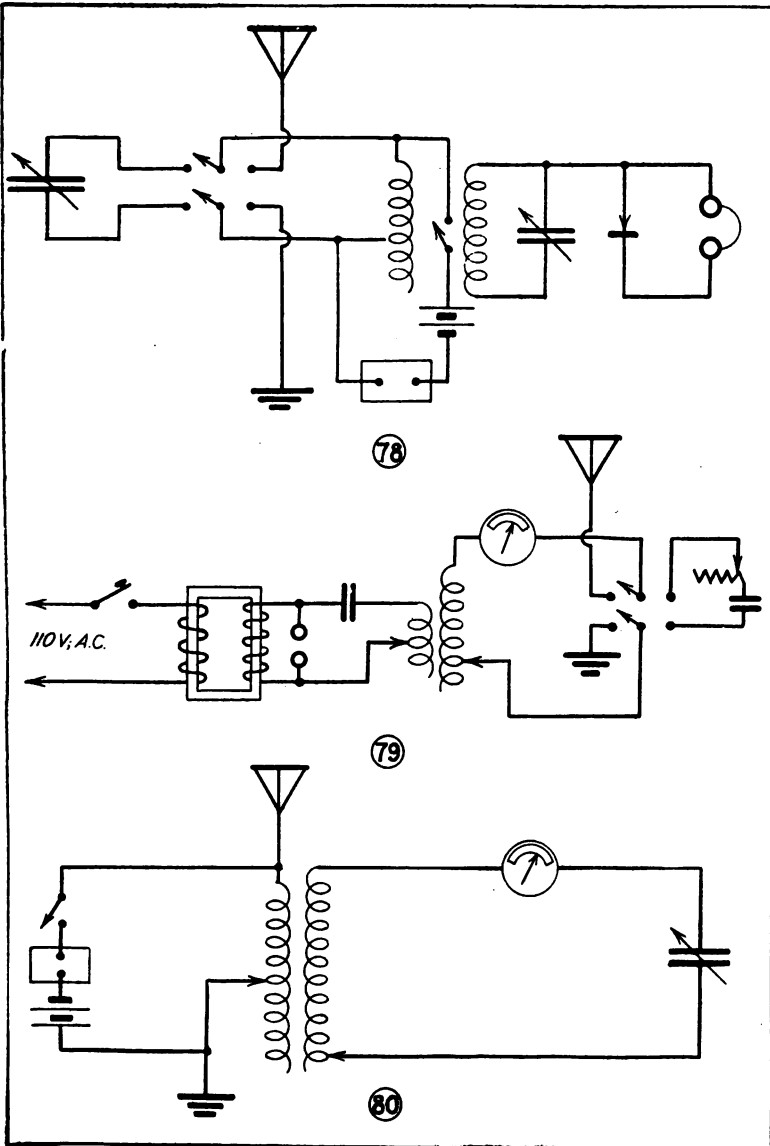
Notes:

79. The resistance of an antenna can be measured by using this circuit. The transmitter is first adjusted with the antenna and ground connected for maximum radiation as indicated by the hot wire ammeter. Then the switch is thrown to the right. This cuts in a variable non-inductive resistance and a condenser equal to the capacity of the antenna and ground. When the resistance is set at a value which gives the same reading of the ammeter as found ordinarily, the resistance in the circuit is equal to the resistance of the antenna.

Notes:

80. Another method for measuring the wavelength of an antenna circuit. In place of the telephones and detector connected with the wavemeter, a hot wire ammeter is inserted in the wavemeter circuit. When the antenna and wavemeter are in resonance the maximum indication will be given by the hot wire ammeter.

Notes:



81. This circuit is used for measuring either inductance or capacity by the use of a standard coil or condenser and a wavemeter. The capacity or inductance to be measured is put in the circuit at the left and a buzzer connected around the coil for excitation. When the wavelength has been found by means of

the wavemeter the inductance is $L = \frac{\lambda^2}{3552 C}$ or the

capacity is $C = \frac{\lambda^2}{3552 L}$

Where C = capacity in mfd.

L = inductance in cms.

λ = wavelength in meters.

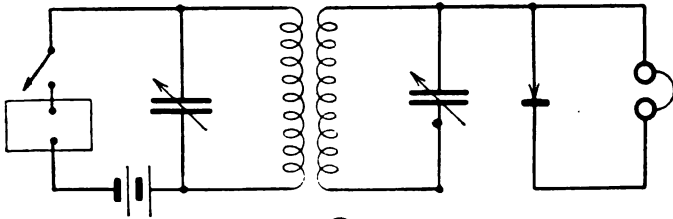
Notes:

82. A circuit for measuring the variation of plate current with changes of filament current in an audion detector. The meter marked I_a is an ammeter measuring up to 2 amperes and I_b a milliammeter or microammeter measuring up to 50 milliamperes.

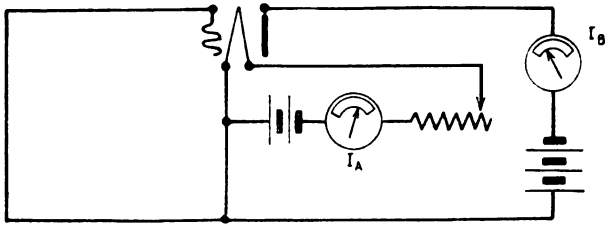
Notes:

83. By means of this circuit the variations of plate current with changes of plate voltage at various filament currents can be determined. The meters marked I_a and I_b are the same as in 82, while the E_b voltmeter should have a range up to the maximum voltage applied to the tube.

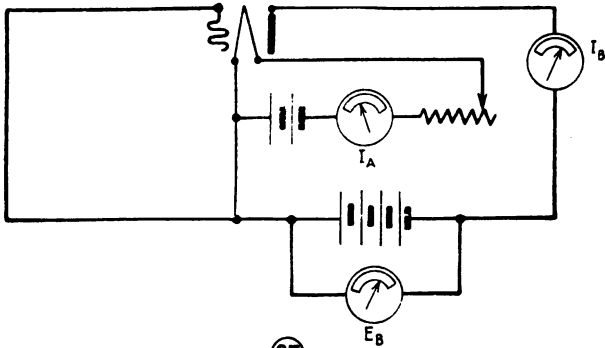
Notes:



81



82



83

84. The addition of a variable grid battery and voltmeter makes it possible to determine the plate current at different values of positive and negative grid voltage. Curves obtained in this manner are called the characteristic curves of the tubes.

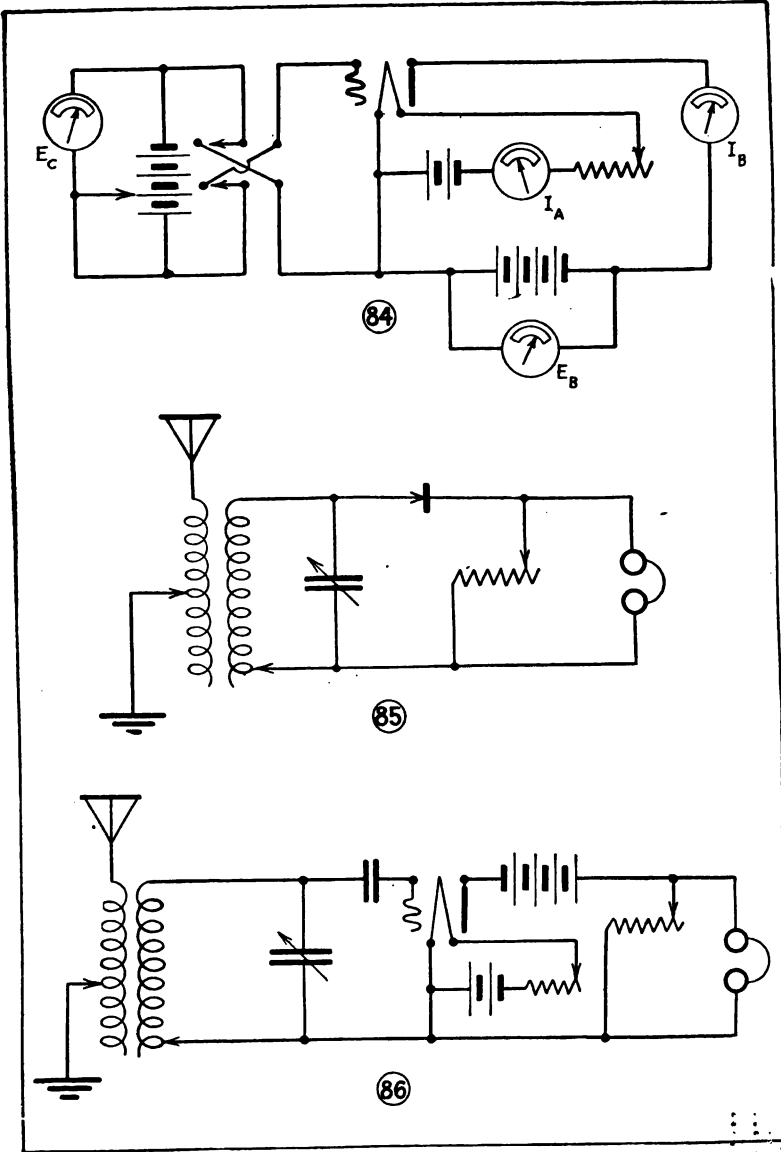
Notes:

85. This circuit is for measuring the audibility of signals using a crystal detector. A variable resistance is connected across the telephones. When the value of the resistance has been decreased until dots and dashes can just be distinguished the audibility is equal to the resistance of the telephones plus the resistance of the shunt divided by the resistance of the shunt.

Notes:

86. In this circuit the audibility meter is used with an audion receiver. The shunt resistance is operated in the same manner as described in 85, and the audibility factor determined in the same manner.

Notes:



Additional Circuits