

**unusual
patented
circuits
1944-1946**

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preface

DURING THE past few years, the U. S. Patent Office has issued an unprecedented number of basic patents in electronics and associated fields. Under the pressure of emergency, research was speeded up greatly and it accounted for much of this output. Many of these ideas now are incorporated into devices and instruments which are being used in connection with television, FM and electronic control.

The more interesting patents have been digested in this book. They are described and illustrated so that the reader may understand their principles and advantages in a minimum of time. For convenience, the book is divided into five sections. U. S. Patents are classified in four sections. A fifth section is devoted to foreign patents which were seized by the U. S. Government during the war and which are available now to individuals and firms which can make use of them.

Some of the patents described are relatively complicated and use a large number of components. However, many are innovations which use few parts, but perform the work better with a saving of time and money.

It is well to keep in mind that important inventions are not limited to workers who have direct access to a modern laboratory with precision instruments. Consideration of the patents described here will prove that this is so. Often a seemingly unimportant detail, useless in itself, may, in combination with other ideas or devices, form the basis of a fundamentally new development.

Note: If more data on a particular patent is desired, a copy of the patent may be secured for 25c from the *Commissioner of Patents*, Washington 25, D. C. Order by patent number. *Do not send stamps.* Another source of patents is the larger public libraries. Many (particularly in the big cities) maintain a complete file of U. S. Patents.

Section 1 . . .

CONTROL CIRCUITS

Remote Control

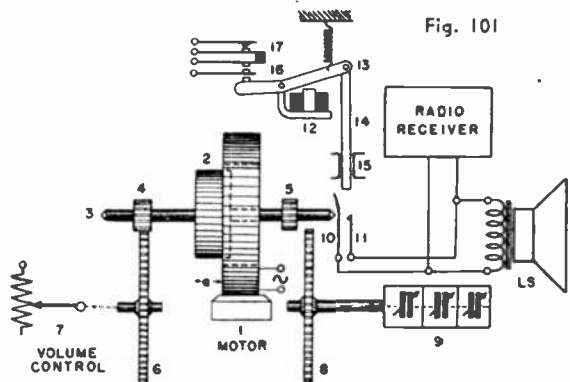
THIS is a device invented by J. A. Van Lammeron to control automatically more than one function of a radio receiver.

The two major adjustments in a radio receiver are the tuning adjustment and the volume adjustment. In sets to be operated at a distance it is usual for a remotely controlled motor to perform the tuning adjustment. Volume control is had at the receiver itself, or by means of another long lead.

This invention uses only one motor to accomplish both adjustments. As noted in Fig. 101, the shaft is movable axially. In the position shown, the volume control is being engaged by means of gears 4 and 6. If the shaft is displaced to the right, however, the tuning con-

denser would be engaged through gears 5 and 8. Note that for the latter engagement, contacts 10 and 11 close, shorting out the speaker during tuning.

Energization of the motor may take place by two different means.



One is direct, so that the armature is drawn into the motor and the tuning condensers are rotated. The other means involves energizing the relay 12 shown in the figure. In this case the armature 13 is attracted. lever 14 drops into the guide 15 and simultaneously the motor is

electrically connected by the closing of contacts 16 and 17. With this means of control, the lever 14 opposes the tendency of the shaft to be displaced to the right and tuning may be done.

The motor field has two distinct windings, either of which may be thrown into the circuit by proper push-button operation. Thus, the motor is reversible and may rotate in either direction.—*Patent No. 2,345,778*

Depth Indicator

THIS development by William A. Tolson makes it easier to measure the distance below the surface of water to some reflecting object. This should prove of great importance for detecting sunken objects, measuring river bottoms,

indicating approaching ships during fog and nighttime, etc.

Fig. 102 shows a simplification of the instrument schematic. Tube T1 is a self-quenched oscillator, such as is used in superregenera-

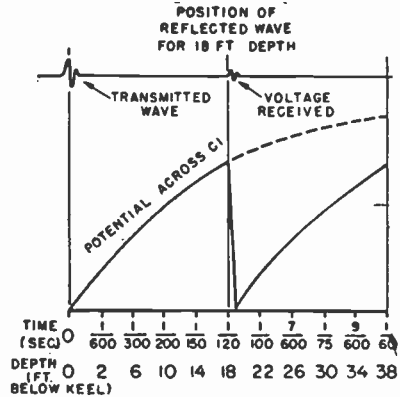


Fig. 103

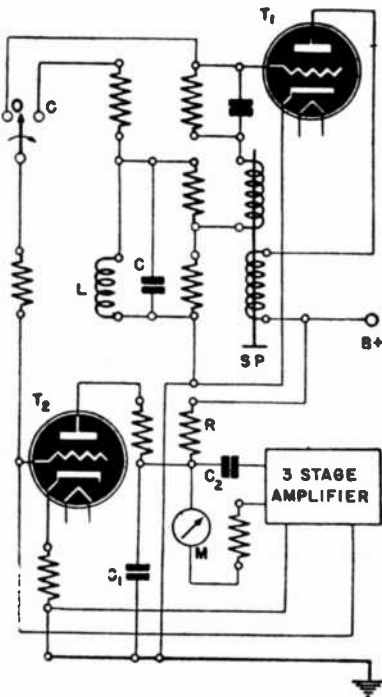


Fig. 102

tive receivers. This tube operates a sound projector, S.P., which may be attached to a hull of a vessel. To operate, the switch is thrown to O. The control tube T2 is normally operated at plate cutoff as is the final stage of the amplifier.

A pulse is generated by the oscillator, actuating the projector and simultaneously unblocking tube T2. Plate current flows through R causing C1 to discharge. It should be evident that while T2 was cut off, C1 was effectively across B plus and therefore fully charged.

At some time later, the reflected pulse returns and actuates the diaphragm of S.P. which is used as both projector and receiver. This reflection is much smaller than the original and insufficient to affect the control tube, but after a three-stage amplification is large enough to unblock the final tube. Current then flows through the meter M (by-

passed by C2) thus discharging C1 again.

Evidently the amplitude of current through the meter depends upon the state of charge of C1 at the moment, and this in turn depends upon the interval of time between projection and reception of the pulse. The meter may therefore be calibrated in units of distance. Fig. 103 shows how the potential across C1 varies. Note that at the instant of arrival of the reflected pulse the voltage drops. For a greater depth than shown, it would have followed the dotted line further before discharge and conversely.

Since varying circuit constants might have some effect upon the calibration, the circuit may first be checked for calibration. The switch is thrown to C. Tuned circuit LC has a definite time constant corresponding to some depth and the meter circuit may be adjusted until proper indication is shown. —*Patent No. 2,346,093*

Lighting Regulator

THIS is an automatic regulator operated by motor control. As described here it may be used in connection with the

automatic regulation of a lighting system as in a classroom or auditorium so that constant lighting is maintained. Two sources of illumination are used, such that when the primary source increases or decreases, the secondary source will automatically compensate.

A photoelectric cell (Fig. 104) is provided in series with a resistance across a voltage source. The grid voltage of the tube is determined by the amount of illumination falling on the cell, and adjustment of the resistor R1 determines cathode bias.

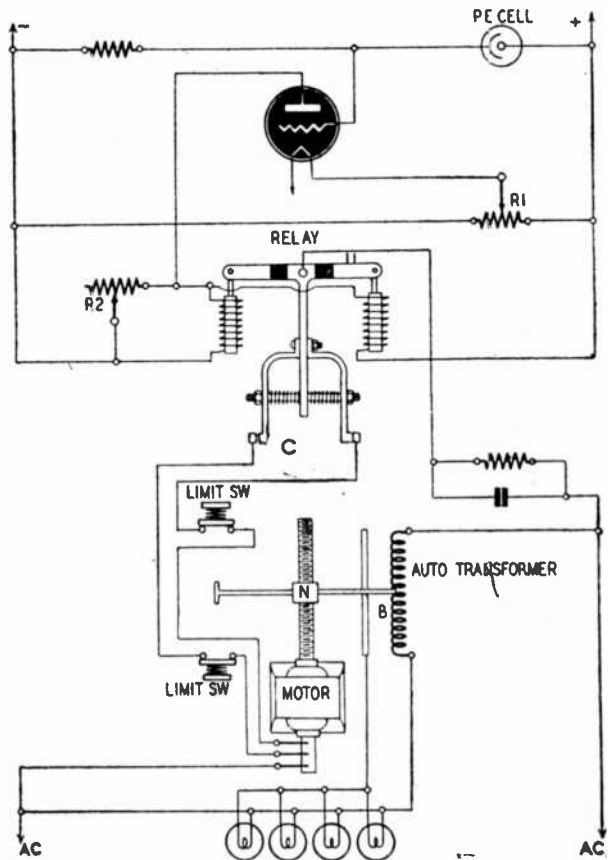


Fig. 104

The center-biased relay has two arms whose cores cooperate with coils which are connected across the d.c. supply. Resistor R2 may be used to balance the pull of the coils so as to balance the relay lever. When the relay is thrown off balance because of an excess of energization of one of the coils, one of the contacts C will be opened. Due to the spring arrangement, these contacts are normally both closed.

Each of the contacts C lead through limit switches to one winding of a reversible motor. When this motor rotates, the nut N travels up or down the screw, so that the brush B increases or decreases the voltage from the autotransformer. This in turn raises or reduces the brilliancy of a bank of lights.

With the entire device balanced at the normal illumination level, current flows through both motor windings, providing a powerful braking effect so that the motor is stationary. Should the normal illumination be decreased for some reason, the resistance of the photocell increases, causing the grid voltage to become more negative. Since plate current flows through one winding only, the relay arm on the left will be pulled downward, opening a contact and shutting off current through one motor winding. The motor rotates, pulling the nut upward and causing an increase of illumination from the bank of lights until normal lighting is again established. The system works in the opposite manner when illumination is increased.

The limit switches provide a stop in both directions should the nut

travel too far up or down. The corresponding motor winding will be opened, preventing further movement.—*Patent No. 2,346,794*

Electronic Control

It is often required to work with exceedingly small voltages which must be controlled or recorded. Direct electronic amplification is not possible because of the small magnitudes involved. The present device eliminates previous difficulties and results in a stable, rugged and instantaneous acting instrument. As shown in Fig. 105, it is used to control the temperature of a furnace. 1.

A thermocouple, 2, has its output connected to flexible contacts, 3, 4, on a revolving disc, 5. The contacts successively charge the various condensers on the disc. After the final condenser, 6, has been charged, contacts, 7, 8, touch terminals, 9, 10, and the sum of all the voltages on the individual condensers appears across them, since all condensers are in series. This sum voltage charges condenser, 11.

The difference between the latter voltage and that across the left side of the slide-wire, 12 (due to the battery) appears across resistor, 13, and is amplified by tubes, 14, 15. This is followed by two more stages, 16, 17 and 18, 19, the output of which is fed to the reversible motor windings, 20, 21. The direction of rotation depends upon whether the voltage across 11 is larger or smaller than that across the left-hand portion of the slide-wire.

This motor actuates the screw threaded shaft, 22, causing move-

ment of the contact, 23, until the two voltages are balanced. Movement of 23 not only records on the chart, 24, but also closes contact to either 25 or 26 to rotate another re-

cess (Fig. 106). The extremity of each cross-bar is connected to a diaphragm *d* supported peripherally at *e*. When a sound wave strikes the large sphere *I* the

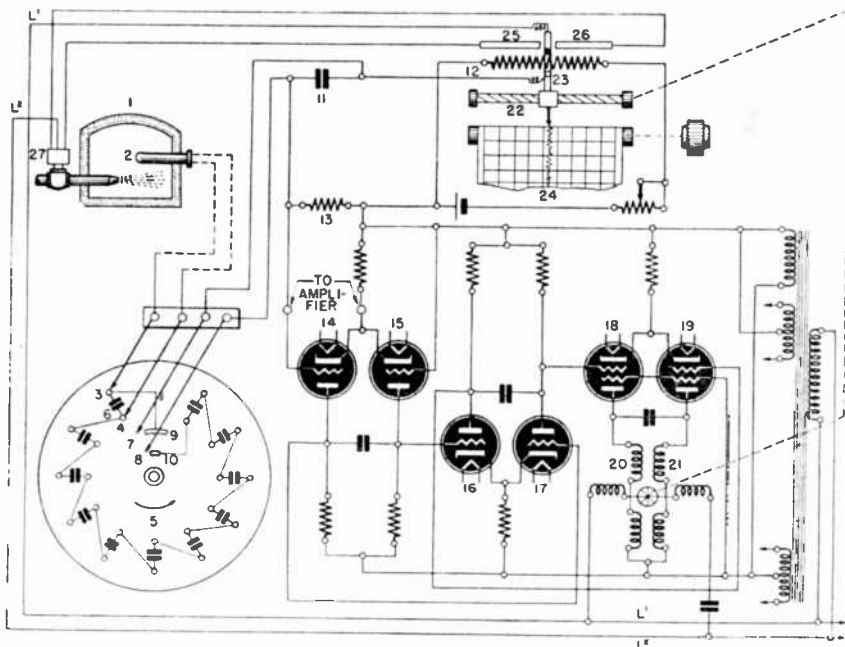


Fig. 105

versible motor, 27, at the furnace. The latter adjusts a fuel valve maintaining automatic furnace temperature. The inventor is Earl A. Keller.—*Patent No. 2,349,137*

Echo Sounding

THIS is a device to indicate the direction and magnitude of a wave disturbance, to be used in connection with echo soundings on board ship, for instance. It was invented by Donald O. Sproule.

As shown, four cross-bars *F* are mounted on an assembly containing a sphere *I* at the top, the pivot being a sphere in a conical

entire assembly vibrates, causing movement of the corresponding diaphragms in the fields of pot magnets. A lightweight coil which is

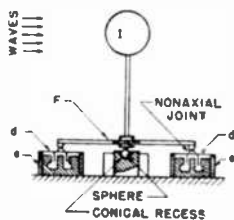


Fig. 106

part of the diaphragm assembly (in the gap between magnetic poles) generates an e.m.f., diagonally op-

posite coils being in series (Fig. 107) and led to amplifiers m and

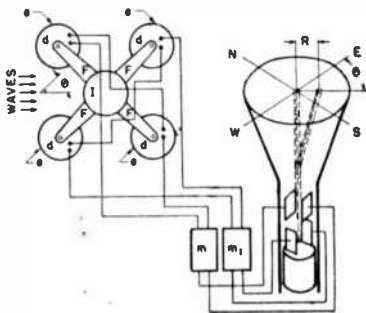


Fig. 107

m_1 and thence to oscilloscope deflecting plates. The screen of the scope is scaled so that the direction and intensity of the disturbance may be measured.

Displacement of the electron beam is thus the result of the vibration of sphere I, direction and magnitude depending upon the impinging sound wave. By noting the direction θ and length R of the line on the scope screen, the incoming wave is completely determined.—*Patent No. 2,350,080*

Meter Feedback

THE advantages of feedback in audio amplifiers are well known. Chief of these are better frequency response and decreased distortion. Application of feedback to a galvanometer also gives advantages, including better response and damping control. Inventor, Malcolm D. McCarty.

The feedback is obtained by mounting an additional coil on the same support as the usual galvanometer coil. While the regular coil acts as the motor which moves the pointer across the dial to the indi-

cated spot, the other acts as a generator, the motion in a magnetic field setting up a voltage across its terminals. Its output may be applied to a load for damping control, or to an inverse feedback circuit.

The principle, when used as a damping control, is that of the well-known dynamic brake. Output terminals of the inner coil shown in Fig. 108 may be shorted, or a low resistance placed across them. Fig.

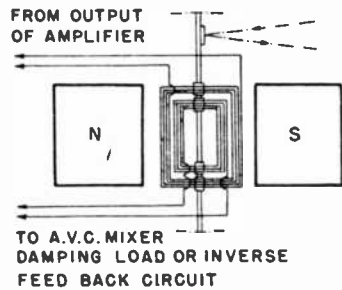


Fig. 108

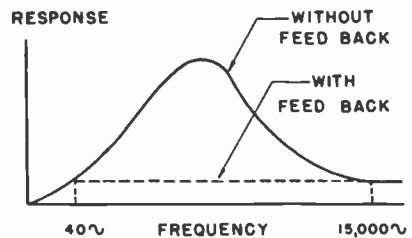


Fig. 109

109 indicates the response improvement when the output is applied to a feedback circuit.—*Patent No. 2,351,353*

Tone Control

A SIMPLE method is provided of boosting either bass or treble by means of one potentiometer adjustment, invented by Kirby B. Austin. When this control in

the 6J5 grid circuit (see Fig. 110) is at the upper point, curve C results (Fig. 111). Here the $.01 \mu\text{f}$ condenser, the cathode resistor and coil C shunt the potentiometer. When the slider is at the lower end, curve A results. Now bass is boosted because the condenser shunts cath-

ing circuit with a single control, invented by Howard M. Crosby.

As series resistors are cut into the plate circuit for power reduction, the other end of the switch arm shunts the secondary of the modulation transformer MT with the proper impedance to maintain

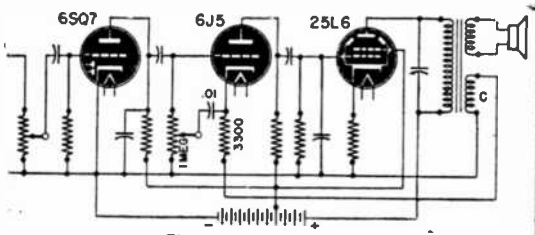


Fig. 110

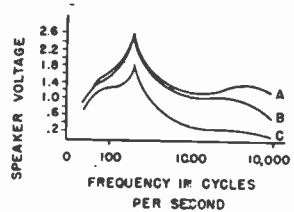


Fig. 111

ode resistor and feed-back coil C. Compare these two extreme curves with curve B when the $.01 \mu\text{f}$ capacitor is disconnected. The sharp peak at 200 cycles is due to mechanical characteristics of the particular speaker used.—*Patent No. 2,352,931*

the correct relation between modulator and oscillator, and always reflect the same impedance back into the modulator primary.—*Patent No. 2,355,422*

Impedance Regulator

BROADCAST stations are often required to vary power input at specified times.

These adjustments must not change impedance matching in any way. Fig. 112 shows a compensat-

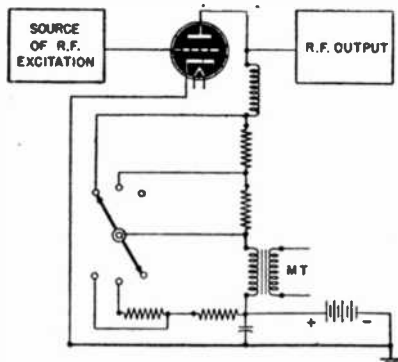


Fig. 112

Quick Response Meter

THIS idea patented by Theodore A. Rich speeds up the

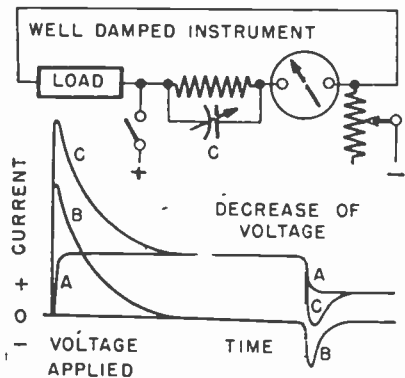


Fig. 113

indication of normally sluggish meters. A condenser of about $0.1 \mu\text{f}$ capacity is placed across the external series resistor (Fig. 113).

The initial rush of current through C brings the pointer quickly to its correct indication. Should the voltage decrease suddenly, C discharges at once and again the pointer follows quickly.

In each case, the pointer is initially speeded up and slows down as it approaches its final deflection.

The graphs show: A, resistor current; B, condenser current; C, their sum.—*Patent No. 2,356,617*

Frequency Meter

AN unknown frequency may be measured by its beat note with a known frequency. To adjust the first to equal the latter, it is therefore necessary to obtain zero beat. Very low frequencies are inaudible, however, so that an approximation only is possible. With this circuit, invented by Henry V. Hermansen, exact synchronism may be made through the use of a 6E5 or similar tuning eye tube.

A crystal of known frequency is used in a Pierce circuit between grid and plate (Fig. 114). The unknown frequency is adjusted until the fluctuations of the shadow sec-

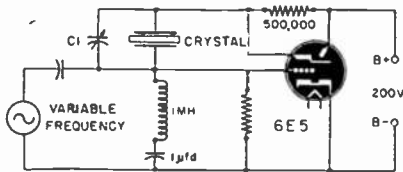


Fig. 114

tor of the 6E5 cease, at which point exact synchronism exists.—*Patent No. 2,358,127*

Gain Control

THIS circuit invented by George W. Fyler is suitable for ultra-high frequencies involving band

widths such as those used in television. In ordinary amplifiers it is found that changing the grid bias (for gain control) varies the input capacitance by one or two μf . A more negative grid decreases the capacitance and results in better

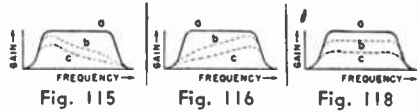


Fig. 115

Fig. 116

Fig. 118

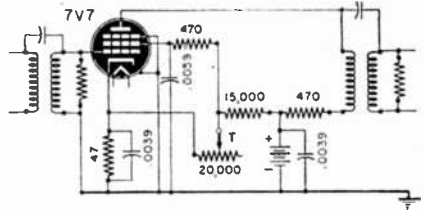


Fig. 117

low frequency response. Fig. 115 shows (a) normal bias, (b) slightly neg. bias and (c) still higher bias.

It is also found that variation of screen potential results in the opposite effect. Fig. 116 shows (a) normal, (b) and (c) progressively decreasing screen voltage. Fig. 117 provides a circuit where one effect balances the other. As the tap T on the voltage divider moves to the left, the screen voltage decreases. The increase of current through the bleeder circuit simultaneously increases grid bias. The final result is shown in Fig. 118 for (a) normal gain, (b) less gain, (c) minimum gain.—*Patent No. 2,358,325*

Temperature Indicator

THIS is a simple electronic temperature indicator by means of which temperature may be directly read on a millimeter as shown in Fig. 119. It is the in-

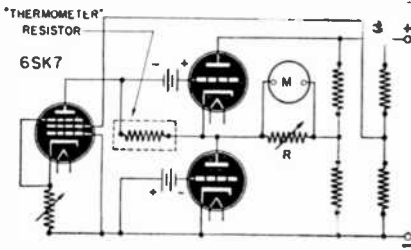


Fig. 119

vention of John William Smith.

The resistor is one having a constant temperature coefficient and is placed in the medium to be measured. The 6SK7 plate current is constant, so that the voltage drop across the resistor varies directly with temperature. A v.t. voltmeter circuit, composed of two triodes (one to balance out the steady meter current) measures the voltage drop. Since this reading is linear, only two points on the scale need be calibrated. The variable shunt resistance R adjusts the sensitivity, so that the maximum temperature to be measured may correspond to full scale.

The series-tube circuit in the vacuum-tube voltmeter should be interesting to designers of such instruments. The usual Wheatstone bridge effect is obtained with the two tubes in series with the voltage rather than in parallel, as is the more common case, where two tubes are used for a balanced v.t.v.m. circuit.—*Patent No. 2,359,334*

Ice Detector

This device (Fig. 120) detects ice formation upon a surface such as aircraft wings, and automatically operates ice-melting apparatus. A glass prism P is built into the wing-surface S , a bulb B

passing a light beam through it. John P. Boston and Henry M. Taylor are the inventors.

From Snell's law, a ray at the surface between two media is passed on unless its angle of incidence is greater than a given critical value. Without the ice layer I , the light is reflected as shown in the diagram, because the critical angle from the glass to air is $43^{\circ}2'$ and in this case the ray always strikes the top surface of the prism at a 45° angle.

The critical angle between glass and water is 70° , so when ice forms, the light ray passes through the prism and does not strike the photocell. In the latter case no bias potential is generated at the tube grid and a large plate current operates the relay, passing current from the generator G to the heating resistors.

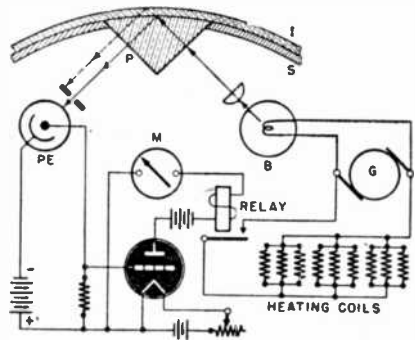


Fig. 120

The meter M may be used as an indication of ice. — *Patent No. 2,359,787*

Densitometer

In photographic work and film recording film emulsions are compared and studied by means of densitometers. This circuit plots an $H \& D$ curve directly on an oscil-

loscope screen permitting rapid determination of film characteristics. The inventor, Judd O. Baker.

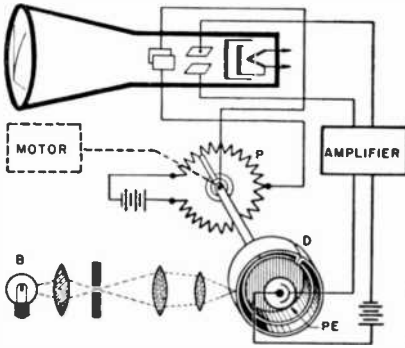


Fig. 121

The film is secured on a drum D inside of which is mounted a photocell. One film edge overhangs so that light from a bulb B may be focussed upon it. On the same shaft is mounted the movable contact of a potentiometer P (see Fig. 121).

The photocell output (determined by the film transmission) is amplified and connected to the oscilloscope vertical plates, while the potentiometer output goes to the horizontal plates. The horizontal beam displacement (sweep) is linear and depends upon the potentiometer arm, while the vertical displacement corresponds to the film transmission. As the motor rotates a density curve is traced out by the electron beam on the tube screen.

—Patent No. 2,361,477

Moisture Indicator

THIS circuit accurately measures the moisture content in soils, soaps, grains, paper, etc. Electrical conductivity methods fail where changes in salt concentration are present. L. D. Bever and B. T.

Shaw use a sensitive bridge to measure the heat conductivity which depends upon moisture content.

For soil measurements, X, the unknown arm of the bridge, is composed of No. 40 enameled copper wire wound on glass or bakelite tubing. Arm A may be of 7 ohms resistance, B a variable in shunt with 200 ohms, and C about 200 ohms (See Fig. 122).

Meter M1 measures battery current into the bridge and MA is used to indicate balance. Sufficient current is passed through the bridge to cause a slight temperature rise in Coil X. Only this resistance will increase with temperature, since the others are of manganin. If the moisture content of soil or other ma-

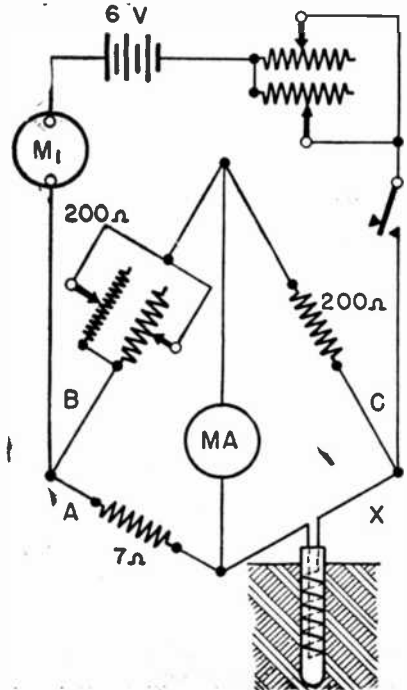


Fig. 122

terial is great, heat will be conducted away rapidly and only a

small unbalance will be present.

If only a small amount of moisture is contained in the medium, the temperature and resistance rise of the coil is correspondingly greater. MA therefore indicates directly the degree of moisture and may be calibrated.—*Patent No. 2,362,344*

Modulation Indicator

MODULATION measurement is essential in radio telephone and modulated signal generator work. This device invented by Halsey W. Kline indicates continuously.

The two diodes may be a single 6H6 tube. One rectifies the signal so that across C1 there appears the carrier component modulated by the audio. The d.c. milliammeter M1 in series with R1 measures only *average* voltage which is proportional to the carrier strength, *regardless of modulation* (Fig. 123).

The audio component is impressed on the second diode (through the r.f. filter) and the rectified and filtered voltage appears across R2. The high resistance d.c. voltmeter, M2, is connected

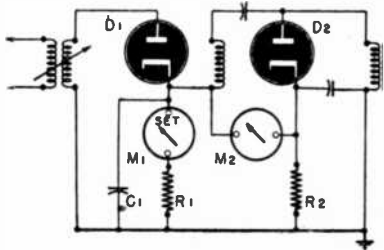


Fig. 123

so that it measures the *difference* of the voltages across the two cathodes, that is, the difference between the carrier and the modulation voltages.

At 100% modulation the two voltages are equal, so the meter reads zero. At smaller percentages the a.f. is less than the r.f., and M2 reads upscale. The coupling to the input must be adjusted so that M1 always reads the proper setting as determined by previous calibration.—*Patent No. 2,362,830*

Frequency Indicator

FREQUENCY meters for the audio range are often complicated and tend to instability. Many

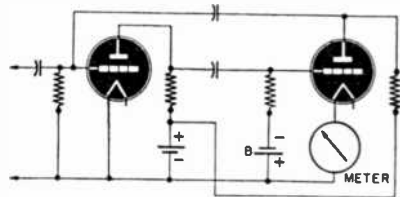


Fig. 124

use thyratron tubes which deteriorate rapidly at the higher frequencies. This circuit invented by Donald A. Wilbur uses high-vacuum tubes.

The indicator is shown in its simplest form (Fig. 124). It consists of an amplifier with positive feedback. When an input voltage of negative polarity is applied, the second grid (being out of phase) becomes positive, the meter then indicating.

It is obvious that the amplifier will tend to oscillation, but battery B cuts off the second tube after one complete oscillation. Each negative pulse applied therefore causes a single oscillation, and since the meter averages out the tube current, the reading will be directly proportional to the incoming frequency, regardless of the wave shape.—*Patent No. 2,366,076*

Volume Control

A BATTERY-SAVING volume control useful for the ultra-portable type of radio is disclosed in this patent issued to Winfield R. Koch. Volume is controlled by varying voltage on the final stage screen grid, so that low output is accompanied by low current drain (Fig. 125).

Note that the size of screen bypass is such that only the highs pass, resulting in negative feedback for the low frequencies at minimum volume. The lowered plate current at low volume raises the inductance of L so that the low frequencies are aided. This gives a *tone control* effect, the middle register volume

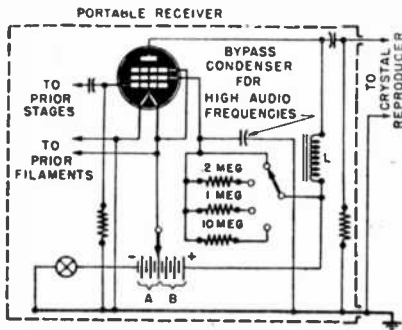


Fig. 125

dropping with lowered output.

A typical circuit may show, with an applied voltage of 45, only 10 on the screen at minimum volume.

Instead of a number of resistors and a switch, it is possible to use a single variable resistor instead of the three shown. This would result in a further saving of space and parts.—*Patent No. 2,367,357*

Pressure Indicator

A PATENT has been issued to Howard D. Warshaw for

this continuously reading pressure indicator. It is essentially a balanced oscillator with a pressure-

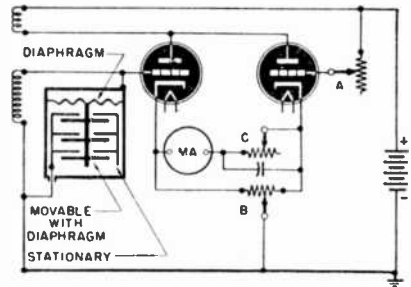


Fig. 126

operated condenser across its tank coil.

The tank condenser is shown (Fig. 126) to be made up of a pressure-sensitive diaphragm secured to a set of movable plates in capacitive relation to a set of fixed plates. Changes in pressure cause proportional changes of capacitance.

The use of two tubes allows a balancing out of the steady milliampere reading otherwise obtained. To operate, A is adjusted for the most critical oscillator point. B is then adjusted for zero meter reading. C is the sensitivity control. The meter itself may be located at some remote location.—*Patent No. 2,368,278*

Pulse Remote Control

PULSES are used to control the position of a movable object at a distance, timing rather than amplitude being used in order to eliminate interference in this patent issued to William A. Tolson. The received pulses are amplified in push-pull (Fig. 127) after phase inversion. Amplification is sufficient to cause plate cut-off on the nega-

tive halves, the bias on T2 and T3 being set at substantially the input peaks. The positive pulse loops are amplified by T3 and the negative loops by T2.

When the input signal (Fig. 128) consists of positive pulses shorter than the negative pulses T4 is conductive longer than T5, and vice versa, unbalancing the circuit.

Each output tube therefore operates alternately, the current being smoothed by condensers and applied to two differentially-wound armatures. For example, when average plate current from T4 is greater than from T5, one winding is excited more than the other and the motor rotates in the corresponding direction. The motor is stationary when the currents are equal.

The motor carries a control which increases one screen's voltage while decreasing that of the other. The connections are such that the plate current unbalance is decreased. The motor stops when full balance is restored.

The transmitter (Fig. 129) con-

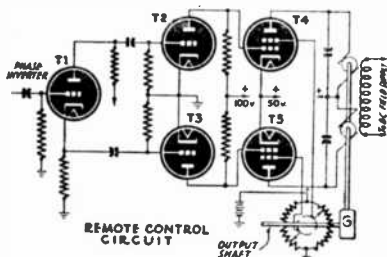


Fig. 127

sists of a revolving insulated drum carrying a triangular sheet of conducting material. When the movable control is normal as shown, positive and negative pulses (due to condenser charge and discharge)

are equal. Conditions are shown under "normal control" (Fig. 128).

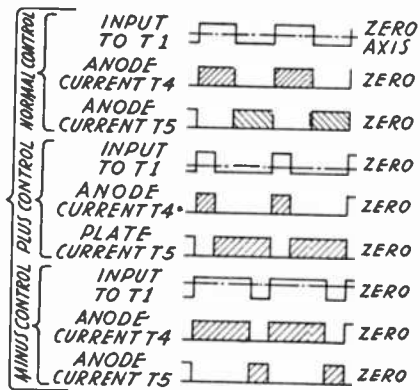


Fig. 128

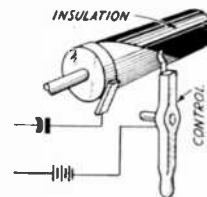


Fig. 129

Moving the control to one side or the other gives either "plus" or "minus" control, the motor rotating in the corresponding direction. The gear box G determines how long the motor runs before balance is obtained.—*Patent No. 2,371,415*

Condenser Tester

CONDENSERS are one of the most difficult components to test, since removal from the set is usually required. This circuit, devised by Oliver J. Morelock, permits testing a condenser for efficiency while it remains in the radio.

A conventional oscillator is coupled to an external circuit provided with test prods (Fig. 130).

An additional degenerative circuit composed of C1, C2 and R is adjusted so that negative feedback just prevents oscillation. Under this condition the meter reads zero or very slightly since no grid current flows. When the test prods are connected across a good condenser, effectively shorting the secondary, phase relationships are disturbed and oscillation permitted. The meter now reads upscale.

The indicating meter can preferably be a D'Arsonval microammeter with a "Good-Bad" scale. Coupling between the two windings of the oscillator coil is adjusted so that good condensers of .001 μf or higher read "Good." A third lead with condenser C3 (.00025 μf) in series with the secondary provides for testing condensers from .001 down to .0002 μf . The upper scale of the meter is read when the leads

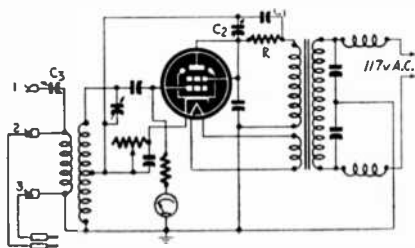


Fig. 130

are connected across 2 and 3, the lower scale when across 1 and 3. —Patent No. 2,373,079

Temperature Control

In the operation of any indicating instrument, there is a choice of making it quick-acting with probable overshooting or slow-acting with a gradual approach to the final mark. In this device invented by Walter P. Wills, which

is used to control and record oven temperature, an initial impulse is provided in addition to the normal force, resulting in rapid response while eliminating overshooting.

The voltage output of a thermocouple due to temperature variations is an alternating component superimposed over a direct current. As shown in Fig. 131 this is applied across a center-tapped 200-ohm resistor. The upper half, R1, is associated with an auxiliary circuit containing a condenser and potentiometer which can pass the a.c. component only.

While the temperature remains constant, the voltage across A and B equals that across R2. When a rise or drop occurs, the output is momentarily increased or decreased by the voltage across the potentiometer. As the condenser reaches its final state of charge this latter a.c. component disappears.

The swinging-mirror galvanometer G measures the voltage across A, B and R3 in series. The former is the thermocouple output and the latter is due to an external battery. R4 is adjusted so that at normal oven temperature the two voltages are equal and G does not deflect.

As the oven heats or cools, G swings in one direction or the other so that more light falls on one or the other of the photocells P. The unbalanced voltage is amplified in a d.c. amplifier and applied to a reversible motor.

The motor is connected with the threaded shaft as well as the oven valve. The contact on R3 moves in the corresponding direction for making a permanent record, while the valve adjusts the fuel intake to

restore normal conditions. Another motor M runs the recording chart. Note the very large condenser

position of the rotor determines the ratio of voltage picked up by one stator to that of the other. The

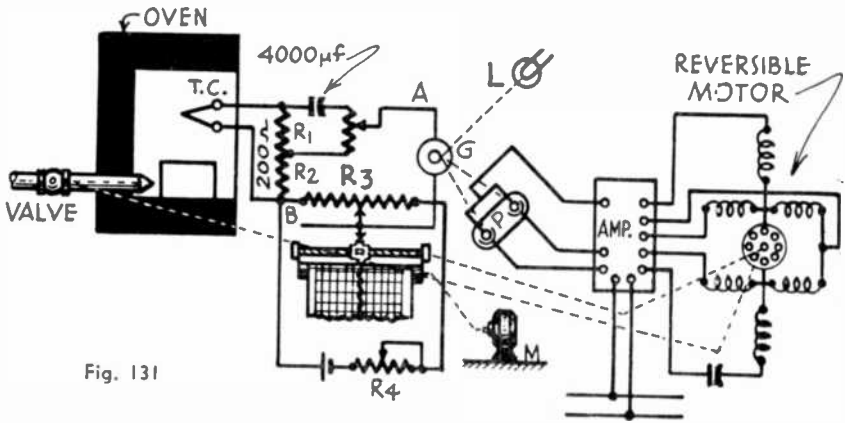


Fig. 131

which is designed to pass very low frequencies (gradual heat changes). —Patent No. 2,375,159

Wind Measurements

WIND has both magnitude and direction so that two measurements must be made for meteorological purposes. For accurate measurements, devices must usually be located in exposed and elevated positions. It is therefore desirable to transmit the information to other points.

The two wind indications are conveniently transmitted to and observed on an oscilloscope, according to the invention of Leon Hillman (Fig. 132). A rotating anemometer is coupled to a small a.c. generator G whose output is rectified by a copper oxide rectifier R giving pulses as shown. The wind velocity determines the amplitude of the pulses. An exposed wind vane is fixed to a rotor loop, through which these pulses pass, within two stator loops of a goniometer. The

goniometer output is applied to the oscilloscope, which may be located at some distance from the goniometer and associated apparatus.

Operation takes place as follows. Since the pulses are d.c. the oscilloscope screen will show a straight line on one side of the center point. Its amplitude depends upon the a.c. generator voltage and therefore upon the wind velocity. The straight line will have a direction depending upon the position of the rotor within the two stators of the goniometer. This is clearly shown in the

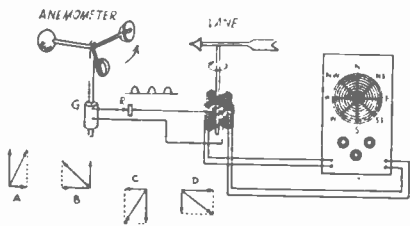


Fig. 132

smaller figure, the resultant in each case being the vector sum of the two component voltages picked up by each stator.

Other types of indicating devices might be used, but the oscilloscope is most suitable.—*Patent No. 2,375,227*

Tuning Indicator

A LAMP indicator is a simple and convenient means of showing the presence and power of an incoming signal, but usually requires relatively elaborate design to use. This circuit invented by Dermot Ambrose makes use of an

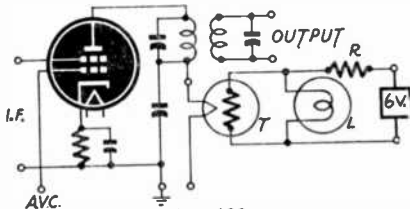


Fig. 133

indirectly heated, positive coefficient thermistor T to control the lamp L, so that the latter indicates the strength of a station.

Fig. 133 shows an i.f. amplifier using separate grids for the signal and for the a.v.c., but conventional design may be used. The a.v.c. is proportional to signal strength. As a station is tuned to resonance, a more negative potential is applied to the grid, thus decreasing the plate current. Since this current flows through the filament of the thermistor, the latter resistance decreases with signal strength, also.

The lamp circuit, which may be connected to a 6-volt transformer, is such that the lamp dims as the thermistor resistance lowers and vice versa. Therefore the system permits optimum tuning, and can be used to adjust for a station while the set is maintained in a quiet condition.—*Patent No. 2,377,475*

Peak Current Meter

MEASUREMENT of the peak current of a circuit is very important in some types of work, such as those involving mercury-vapor rectifier tubes.

A low resistance R is used in this circuit devised by Clarence W. Hansell and the peak voltage drop (proportional to the peak current) is rectified by a condenser-input rectifier circuit (Fig. 134). The output is measured by a high-resistance voltmeter V. Such a circuit indicates proportionally to the peak voltage stored on the filter condenser C.

To secure maximum accuracy the rectifier circuit is first calibrated as in Fig. 135. A standard ammeter A measures the current flowing, then the motor M is turned on, chopping up the current into on-off intervals. At the desired ratio of on-off, the meter V is calibrated in terms of the known current previously shown on A. Multiplying taps may be used on R.—*Patent No. 2,378,846*

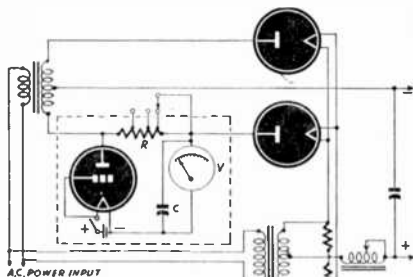


Fig. 134

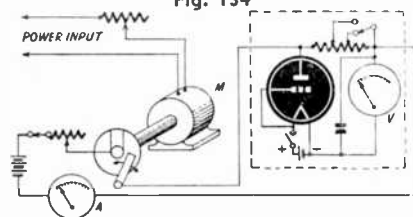


Fig. 135

FM Tuning Indicator

IN an FM detector, a frequency swing in one direction results in a positive potential. If

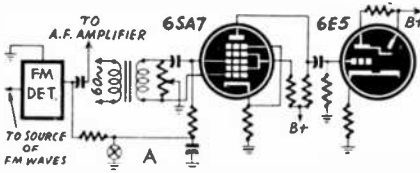


Fig. 136

the swing is in the other direction (from the carrier) there is a negative potential output. This simple indicator operates on these voltages (Fig. 136).

A low voltage a.c. is applied out of phase to the first and third control grids of a 6SA7 or similar type tube. With the switch closed, the potentiometer is originally adjusted to balance out the a.c. component in the plate circuit as shown by the pattern obtained on the 6E5.

With the switch open, a signal may now be tuned in. If it is properly resonated, the same pattern will remain because there is still no voltage at point A due to the signal. If the signal is off tune, however, point A will become either positive or negative and therefore unbalance the 6SA7 and an a.c. component will appear in its plate circuit. The electron-ray will then show a light green area, the result of the rapidly fluctuating a.c. at its input circuit. The size of this area indicates the degree of off-tuning. This circuit was patented by Berttram Trevor.—*Patent No. 2,379,765*

Resonance Indicator

THIS arrangement invented by C. A. Rosencrans can

be used to indicate unmodulated current resonance without taking excessive power from the source or causing variations in its frequency.

A motor simultaneously varies a small variable condenser and controls the sweep generator of an oscilloscope (Fig. 137). When the tuning condenser C is tuned to exact resonance with the r.f. source, the amplitude of the voltage E will vary as at a in Fig. 138 from B through resonance to D and back for each revolution of the motor. If the circuit is somewhat off resonance, the induced voltage will vary as at b from B' to D' and back. In the first case, the output after detection and audio amplification will be twice the frequency of that in the second case, since there are twice as many changes from minimum to maximum.

The filter is adjusted to pass only the fundamental frequency corresponding to the motor rotation

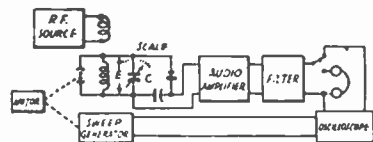


Fig. 137

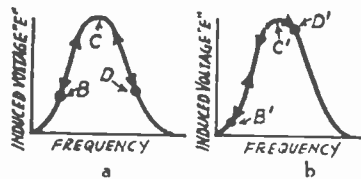


Fig. 138

speed. At resonance, a distinct null will result because there is no fundamental frequency output from the detector. Off resonance, the ratio of fundamental to harmonic output increases and is indicated either on

the phones or the oscilloscope.
—*Patent No. 2,380,791*

Indicating Relay

THIS patent covers certain improvements in the construction of instrument type relays, resulting in a more satisfactory device. It was invented by Anthony H. Lamb.

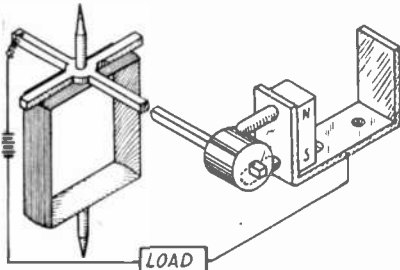


Fig. 139

tion of instrument type relays, resulting in a more satisfactory device. It was invented by Anthony H. Lamb.

In order to eliminate need for machining permanent magnet material, which is difficult, use is made of a small block of Alnico or similar material, but the actual pole pieces are of soft magnetic material which may be properly machined.

As shown in Fig. 139, a cylindrical rider of soft iron is mounted on a pointer which deflects in response to current through the coil which is mounted on pivots. At a predetermined current, attraction takes place thus closing the external circuit to the load.—*Patent No. 2,380,851*

Motor Control

THIS device devised by Murray G. Crosby controls the rotation of a motor in the required direction by the application of a small d.c. potential. As described here it is used in an automatic frequency control circuit of an FM receiver. The FM detector is shown at the left of Fig. 110.

A 60-cycle source of voltage is applied to two similar amplifying channels. The output of each channel is connected to one winding of a differential-wound motor. Therefore, the direction of rotation is controlled by the operation of the proper amplifying channel.

When lead A is positive, the

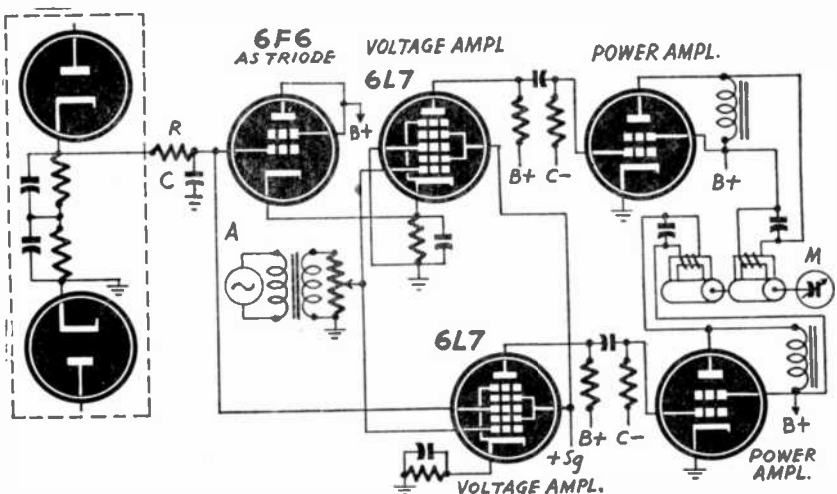


Fig. 140

lower channel operates, because of the positive voltage on the third grid of the 6L7. At the same time, the 6F6 tube changes the phase of this voltage and causes a negative potential to appear at the third grid of the upper 6L7, so that it is cut off. When A is negative the opposite state of affairs exists and the motor reverses.

It is found that 90 volts appears at the motor when a 5-volt d.c. change is made at A. The motor rotates in the proper direction until resonance occurs. At this point there is no d.c. and no rotation. —*Patent No. 2,380,918*

Displacement Indicator

MOTION or position is translated into electrical signals by means of an oscilloscope in this device, invented by Herbert Ziebolz. The electron stream of the tube is deflected by both static and magnetic fields. Therefore the position of a magnet will affect the direction of the electron beam and the point at which it strikes the plate. If only

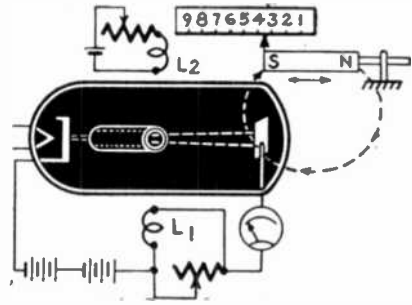


Fig. 141

part of the spot hits the plate, the meter will read lower than if the plate catches all the electrons (Fig. 141).

Coil L1, together with its variable shunt, is used to counteract the effect of the magnet and thus control the spot. L2 is used to position the spot initially so that it strikes the center of the plate.—*Patent No. 2,383,758*

Pulse Counter

THIS invention patented by Sydney B. Ingram, describes the use of vacuum tubes for counting rapidly-recurring positive pulses.

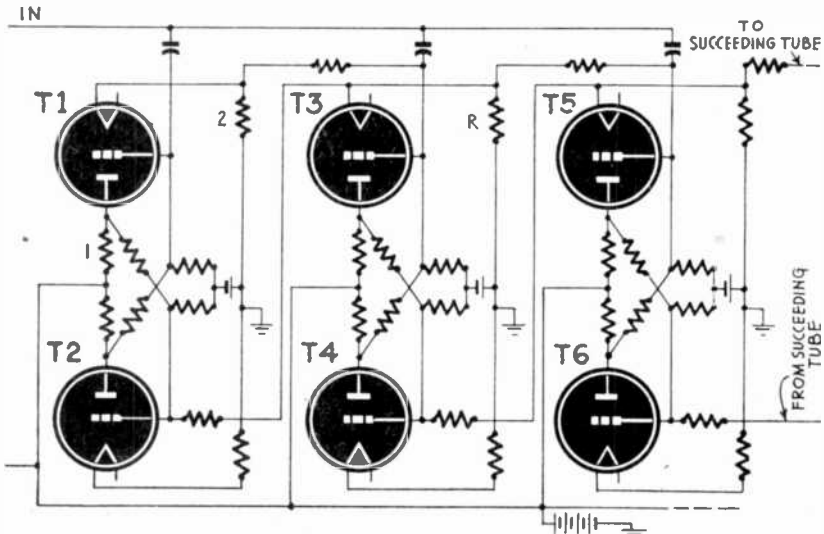


Fig. 142

The tubes are connected in pairs so that when one of a pair becomes conducting, the other is cut off, thus maintaining this condition.

In Fig. 142, assume that initially T1 and T5 are biased much beyond cut-off, while T3 is just below this condition, and note that all three are connected in parallel with reference to the input. Application of the first positive pulse then fires T3, and its plate current becomes relatively large. This current flows through R so that its upper end becomes positive.

The results are: (a) The grid of T5 is raised to a potential just below cut-off; (b) the grid of T2 becomes positive, firing the tube and therefore again cutting off T1. It is then evident that the second positive pulse will fire only T5, and that succeeding pulses will activate succeeding tube pairs, one after another, in the same way.

It is possible to connect the series of tube pairs in a closed ring (as by connecting the T5 output to the T1 input). Plate circuits may include devices for recording the pulses.—*Patent No. 2,384,379*

R.F. Indicator

R.F. TRANSMITTERS are tuned and modulation checked conventionally by thermocouples and

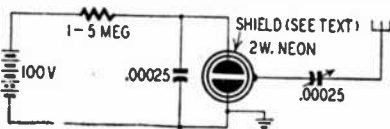


Fig. 143

meters, both of which are rather expensive and delicate. This new circuit, patented by G. F. Colman,

should be of interest to amateurs and others since it enables a circuit to be correctly tuned by using only an ordinary neon bulb (Fig. 143).

A conducting ring is placed around the neon bulb and is connected to a pickup device such as a small antenna which is introduced into the r.f. field. The small variable condenser controls the electrostatic excitation to the bulb. One of the bulb plates is grounded, and both are connected across a small condenser which equalizes the discharge so that each plate shows approximately the same glow.

An auxiliary d.c. circuit is connected and adjusted so that the neon is only slightly ionized. The added r.f. power causes a corresponding increase of ionization. Relative r.f. magnitude may be indicated by the variable condenser setting necessary to reach a given degree of ionization.

Typical circuit constants are given in the diagram.—*Patent No. 2,395,850*

Electronic Chronoscope

THE measurement of very small time intervals (of the order of 10 microseconds) is accomplished by this instrument devised by C. R. Nisewanger and Frederick W. Brown. One practical application is the measurement of rate of detonation. In explosive design, for example, it is often necessary to know the time interval between the instantaneous detonations at given points along an explosive.

The circuit (Fig. 144) uses two thyratron tubes connected to a switching tube. The latter tube, a

pentode, is adjusted as follows. The screen grid is biased below cut-off, but an applied positive pulse will restore the tube to a conducting condition. If a negative pulse is applied to the control grid immediately thereafter, the tube cuts off

charged is measured by a vacuum-tube voltmeter which includes the usual balancing-out circuit. This permits setting the meter G to some reference point before measurement. Voltage across C (and therefore time interval) is indicated by

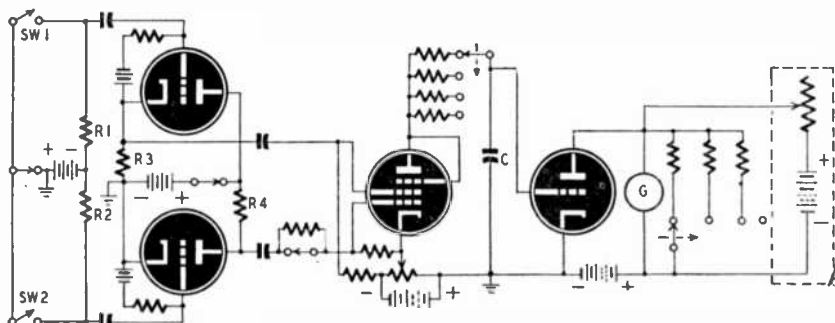


Fig. 144

again. The pentode circuit is equivalent to an R-C circuit which is closed and then opened. As a result the condenser C becomes charged to some value depending upon the time interval of conduction. A meter across C may therefore be calibrated in terms of that time interval.

Closing SW1 starts the interval being measured. The voltage drop across R1 transmits a positive pulse to the upper thyatron which breaks down. The voltage drop across R3 applies a positive pulse to the switching tube which begins to conduct and charge the condenser C. The completion of the interval is marked by closing SW2, which produces a voltage drop across R2. The resultant positive pulse fires the lower thyatron and there exists a voltage drop across R4. A negative pulse is therefore transmitted to the pentode control grid, cutting off the plate current.

The voltage to which C has been

a corresponding decrease of meter indication.

The circuit may be calibrated by closing the key switches mechanically at known small time intervals. To measure the rate of detonation of an explosive, each switch may consist of two fine wires placed close together. When the explosion reaches a switch, the released ions act to close it. With a slight change of circuit it is possible to utilize a circuit break to fire each thyatron.

The circuit is adapted to measure over a wide range of values by providing several values of resistors in the condenser charging and galvanometer circuits. — *Patent No. 2,395,902*

Torsiograph

MANY types of machines require torsional vibration study, so that methods may be devised to eliminate non-uniform rotation of a shaft. This invention by Lawrence

E. Hope offers means of measuring and indicating the vibration present. It does not require direct access to the vibrating shaft.

A thin toothed wheel is mounted

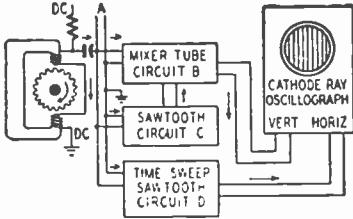
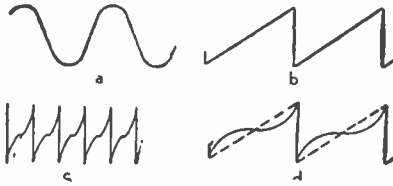


Fig. 145

on the shaft and an electromagnet mounted with its poles close to the wheel (Fig. 145). The magnet coils are supplied with direct current. As the teeth move between the poles.



a—Sine wave from mixer.
b—The horizontal sweep.
c, d, e—Flattened portions are brighter, due to shape of the sine wave.

Fig. 146

an alternating voltage is induced in the windings and is present across wires A. The voltage actuates two sawtooth circuits, C and D. The output of C combines with the induced voltage (in the mixer circuit B) and the result appears across the oscillograph vertical posts. The induced voltage may be taken as approximately a sine wave due to tooth shaping. The output of D is connected across the oscillograph horizontal binding posts. Its fre-

quency may be a submultiple of C.

Fig. 146-a shows sine wave from mixer; Fig. 146-b illustrates the horizontal sweep.

Combination of sine and sawtooth (Fig. 146-c) has a flattened central portion (Fig. 146-d). This point is at the horizontal part of the sine wave, so the ray dwells on it longer than any other part of the trace, making a bright spot. As the wave is compressed (Fig. 146-e) relative brightness increases.

If the shaft vibrates during rotation, the center of each wave will lag or lead the average value and will therefore appear either earlier or later. This means that it will be either lower or higher than normal and can be distinguished easily. This superimposed wave indicates the torsional vibration.—*Patent No. 2,399,635*

Radiotelegraph

A. G. C.

THE requirements for automatic gain control circuits are different for code reception than for phone. In the former case a sudden burst of static or increased signal strength may block the receiver and cause the loss of the first few characters of a high-speed code transmission. Also, the charge on the condensers of an a.g.c. system leaks off during spaces between signals so that the gain of the receiver varies during reception of these intermittent signals.

The difficulties are eliminated in R. Lee Hollingsworth's patented circuit, shown in Fig. 147. The signal is heterodyned, amplified and rectified in a conventional three-stage circuit. Note, however, that

the amplifier grids are isolated unless either tube A or B conducts.

The detector output flows through B and develops an a.g.c. voltage at

only when a *powerful* signal or surge of static appears. During these intervals the tube by-passes current and prevents the receiver

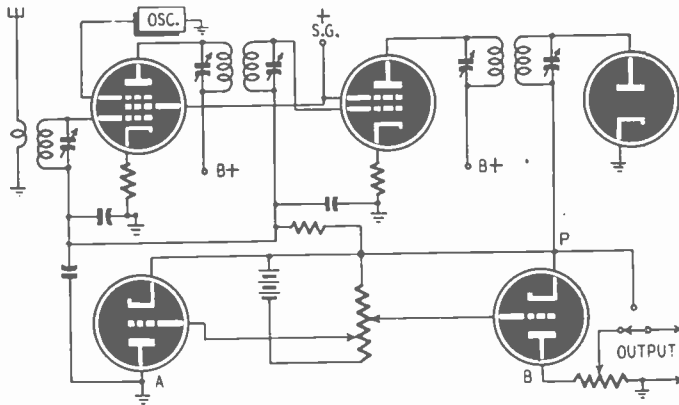


Fig. 147

point P. B conducts only during moments when a signal is received, in other words. It may be adjusted for delayed a.g.c. action, if desired. Tube A is adjusted to be cut off without signal input. It conducts

from blocking.

Due to amplifier grid isolation, this receiver maintains its sensitivity without regard to the length of spaces between signals.—*Patent No. 2,404,712*

INVENTED THE IMPOSSIBLE

WHEN Dr. E. F. W. Alexanderson was awarded the Cedergren gold medal by the Royal Technical Institute of Sweden, Harry Stockton of Harvard University stated, in introducing the recipient:

“One of the outstanding characteristics of Dr. Alexanderson is the fact he is unafraid of difficulties and frequently does the seemingly impossible.

“It was around 1904 that Reginald Fessenden requested General Electric to build an alternator for a frequency—not of 60 cycles per second, nor of a few hundred cycles per second—but 100,000 cycles per second,” Mr. Stockton said. “Everyone knew that such an alternator could not be designed, but Dr. Alexanderson seemed unaware of the fact, so he just went ahead and designed it. His alternator was tested in 1906 at Brant Rock in Massachusetts and became a great success. On Christmas eve of 1906 the Alexanderson alternator went on the air with voice transmission, and to those operators on ship and shore who happened to get this transmission in their earphones, it meant the advent of broadcasting.

“This must not lead us to believe that the alternator is the only invention credited to the genius of Dr. Alexanderson, for there are 300 General Electric patents taken out in his name, covering a vast field of electrical engineering applications. Roughly speaking Dr. Alexanderson has taken out a new patent every seventh week over a period of 40 years.”

Section 2 . . .

DETECTORS & AMPLIFIERS

Television Receiver

THIS invention simplifies the necessary apparatus at the receiving end through the use of a superregenerative stage. Characteristics of such an amplifier are extremely high sensitivity and broad tuning, so that several radio-frequency stages of amplification may be eliminated.

The signal is applied through a broadly tuned circuit across the control grid and cathode of the superregenerative amplifier (Fig.

applied to the oscilloscope tube as usual.

The horizontal deflection circuit determines the sweeping of the beam horizontally across the scope tube in saw-tooth fashion (lower right corner); that is, it is swept across and then suddenly snapped back to its starting place. This sweeping takes place at 15,750 c.p.s. ordinarily. Since this deflection circuit is coupled to the superregenerative stage, the two become synchronized.

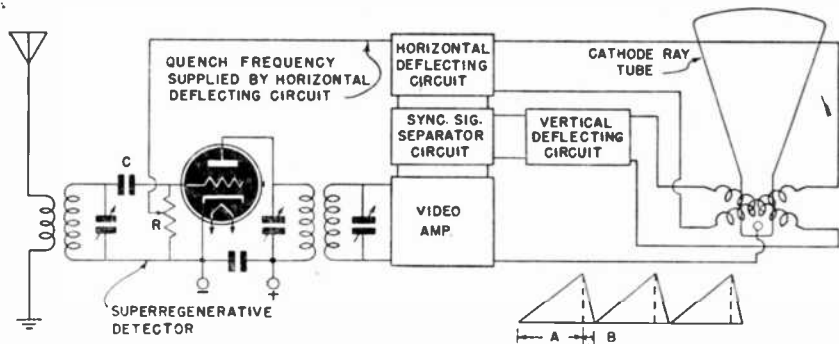


Fig. 201

201). The tube is self-quenched by means of R and C, which are designed to block at a frequency just under 15,750 cycles per second. The signal is then further amplified and

The signal is enormously amplified due to regenerative feedback while the beam is being swept across the scope tube (A). While being snapped back (B), however,

a high negative potential is applied to the center arm of the potentiometer, effectively blocking the tube. The quenching, therefore, has no effect on the beam seen on the television tube.—*Patent No. 2,346,499*

Push-Pull Circuit

In many circuits which use fixed bias, hum from the power supply becomes a problem. An im-

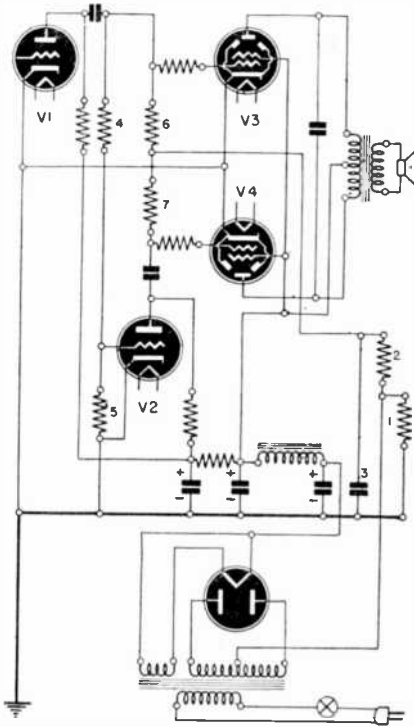


Fig. 202

proved arrangement to minimize such hum is the subject of this patent issued to Joseph A. Worcester, Jr.

The bias voltage (across resistance 1) is filtered by 2 and 3 (Fig. 202). The a.f. input is amplified by V1, and V2 is the phase inverter. Any hum at the V3 and V4 grids from the bias supply will

cancel, due to the push-pull action of the tubes. But hum at the V3 grid may be amplified through the phase changer, V2. The ratio of the resistances 4 plus 5 to resistance 5 is made equal to the amplification factor of V2. Therefore hum from the bias supply introduced to the V4 grid through the phase-changer is equal in strength and opposite in phase to that introduced directly, leaving only the hum present at the V3 grid.—*Patent No. 2,350,858*

Amplifier Circuit

USING the slightly unconventional audio amplifier circuit shown in Fig. 203, it is found that tube life can be greatly increased and better efficiency obtained with somewhat greater output.

The screens are grounded so that very little plate current ordinarily flows. This eliminates the need for grid bias, and up to twice normal plate voltages may be used. The input capacitance is also greatly lowered, so that a greater impedance in the grid circuit may be used, as compared with a normal class-B circuit.

The general operating characteristics are similar to those obtained in the operation of class-A triodes according to W. H. Cook and H. C. Dalrymple, the inventors.—*Patent No. 2,358,148*

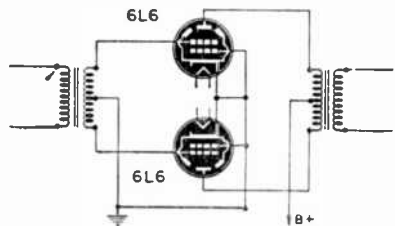


Fig. 203

Push-Pull Amplifier

THIS improved circuit (Fig. 204) invented by Walter E.

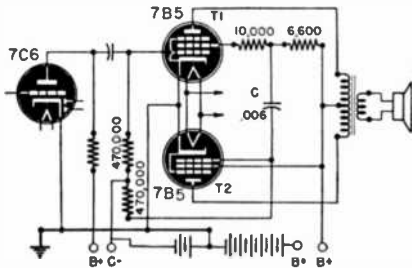


Fig. 204

Gilbert eliminates need for a transformer or phase-inverting stage in producing out-of-phase voltages. Screen voltage output from T1 is voltage-divided by the two resistors and passed through C to the control grid of T2 which is therefore 180° out of phase with that of T1. A push-pull voltage is thus delivered to a speaker or to further stages.

T1 may be any multi-grid tube, typical constants being shown. — Patent No. 2,361,282

Detector Circuit

THIS circuit overcomes previous limitations of diode detectors and provides greater sensitivity and selectivity. A diode usually loads the circuit while an infinite impedance type does not provide sufficient a.v.c.

Chief feature of the new detector, developed by Frederick C. Everett, is an inductance in the cathode circuit (Fig. 205). Signals on the grid cause the tube's space current to fluctuate, producing a varying voltage across the coil. Since the voltage between diode plates and ground is constant, the varying voltage of the cathode will cause

rectification in the cathode-diode circuit.

The input grid circuit is not loaded with current flowing in the diode circuit, as is the case where the diodes are attached directly to the input coil. Advantage is also taken of the tube's amplifying action.

The circuit may be hooked up in the fashion of a straight impedance detector, with one of the diodes leading to an audio amplifier, and the plate connected directly to B plus with a large bypass condenser to ground, as shown in Fig. 205 (right).

A more interesting circuit is the one shown in Fig. 205 (left). The rectified signal is reflexed back to

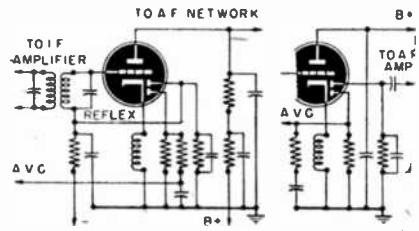


Fig. 205

the grid and amplified at audio frequency.—Patent No. 2,361,616

FM-AM Receiver

THE ordinary resonance curve of an i.f. amplifier introduces AM so that a limiter is required for FM reception. Here the usual discriminator is modified (Fig. 206) by adjustment of M, C, R1 and R2 to obtain excessive selectivity, its curve drooping near the carrier. The decrease near this frequency is compensated by the usual increase of the resonance curve,

resulting in a linear discriminator curve without a limiter stage.

AM may also be received as the

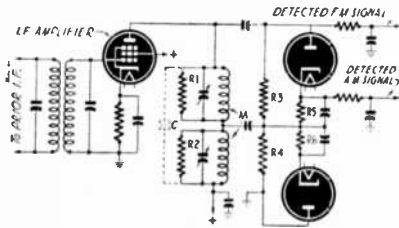


Fig. 206

sum of voltages across R5 and R4 which are *in phase*. The output will be a double-humped voltage of the same polarity on each side of the carrier. When combined with the above-mentioned resonance curve the result is a desired flat top. This patent was issued to Murray G. Crosby.—*Patent No. 2,363,650*

Two-Way Amplifier

WHERE two-way transmission must take place as in long distance telephony, special precautions must be taken to avoid feedback and oscillation because of interaction.

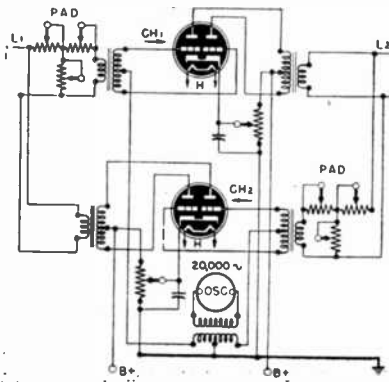


Fig. 207

A superaudible oscillation alternately biases each of the two am-

plifiers shown in this circuit devised by H. L. Donaldson (Fig. 207). In other words, channel 1 operates while channel 2 is cut off during one alternation of the 20,000-cycle oscillation, and vice versa during the next alternation. Thus no feedback can occur. The high frequency does not interfere with the audio frequencies being transmitted.

While intended for telephone use, in the manner of the familiar two-way repeaters, this circuit might well be adapted to a line or carrier office intercommunication system.—*Patent No. 2,366,011*

U. H. F. FM Detector

THE optical characteristics of ultra-high frequencies are

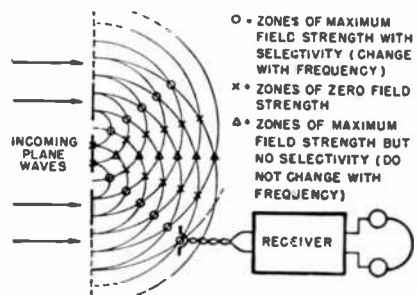


Fig. 208

made use of by Warren R. Ferris in this invention relating to FM signal reception.

Incoming waves (Fig. 208) strike a metal baffle containing slits. Their width may be equal to the wave length of the signals and their spacing several times greater. As a result of spreading, cylindrical waves are formed beyond the baffle, resulting in weakening and strengthening of energy at different points, as shown. Positions of maximum and minimum strength will vary with the frequency.

The system is described as it would be used with waves in the order of one centimeter long, but is adaptable to longer or shorter waves.

A dipole is placed at a point of maximum signal at a frequency representing maximum FM deviation. Then as the signal varies in frequency each side of the carrier, received signal amplitude changes and may be detected by any u.h.f. means. A large number of slits and dipoles may be used to increase sensitivity to the extent desired.—*Patent No. 2,367,764*

Frequency Modulation

THIS is an improved FM transmitter patented by Frederick E. Terman, which permits greater frequency swings at higher voltage levels with simple apparatus. A permanent magnet assembly and balanced armature is sealed into an evacuated bulb, the arma-

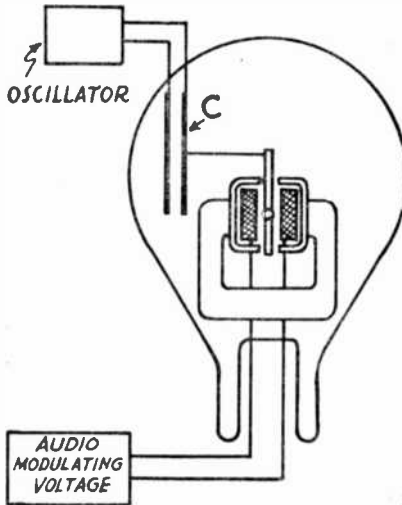


Fig. 209

ture being free to vibrate in accordance with the applied modu-

lating voltage (Fig. 209). One plate of a condenser is linked to the armature so that a change of capacitance results. Since the condenser is shunted across the r.f. oscillator tank, the carrier becomes frequency modulated.

Operation within the vacuum permits very high voltage to be modulated without breakdown. If the condenser forms all or most of the tank capacitance large swings are possible.—*Patent No. 2,372,231*

FM Detector

It has been discovered that a superregenerative circuit provides a very sensitive detector of

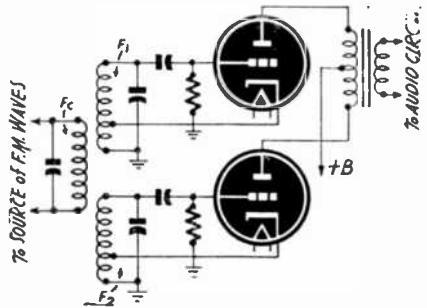


Fig. 210

FM energy and requires no limiter. Fig. 210 (from patent issued to George C. Sziklat) shows two such circuits with secondaries oppositely mistuned by a frequency exceeding the maximum frequency deviation of the carrier.

The time constant of each circuit is adjusted to some superaudible frequency between 30 and 200 kc, the smaller providing greater output. The superregenerative circuit characteristics provide a substantially straight portion between peaks. Since the tubes are run between cutoff and saturation, limiting

action is automatically provided for. High sensitivity is obtained whether the input is an antenna or an i.f. amplifier output.—*Patent No. 2,373,616*

Balancing System

WHEN an unbalanced load is coupled to a push-pull stage, the latter also becomes unbalanced. For example, a grounded antenna coupled to an output stage requires a decrease of one capacitance and an increase of the other to maintain balance. Since this must be done without disturbing resonance, it is a difficult procedure.

Rotor position in degrees	Capacity of one section	Capacity of other section
0	6.0	30.0
45	6.7	20.0
90	10.0	10.0
135	20.0	6.7
180	30.0	6.0

A special dual-condenser is used in the invention of Paul D. Andrews to simplify adjustment (Fig. 211). One section increases while the other decreases in such a manner that the effective capacitance of the two in series is a constant. The table illustrates how this may be accomplished for an effective capacitance of $5 \mu\text{mf}$. An additional condenser may be connected across

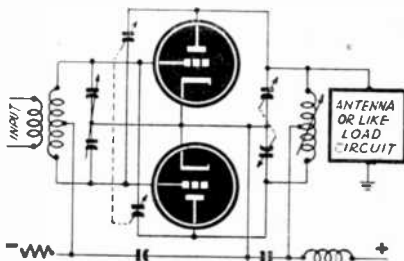


Fig. 211

the tuning coil which is independent of the balancing adjustment.—*Patent No. 2,380,389*

Carrier System

WHEN it is desired that each transmitter of a carrier cur-

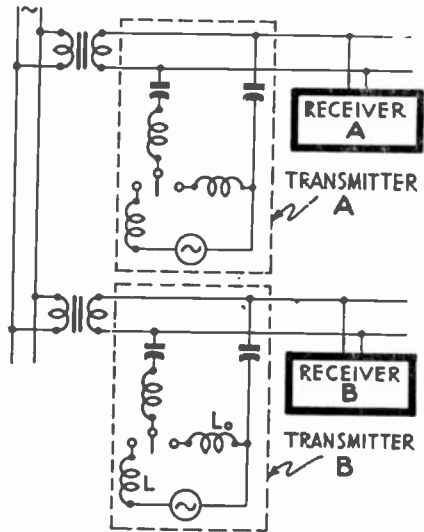


Fig. 212

rent system cause response only in its associated receiver some means is necessary to exclude signals from the other transmitters.

In Fig. 212 (from patent of John L. Woodworth), transmitter A should not operate receiver B. To accomplish this, transmitter B is placed between the two and a series resonant circuit is connected. This circuit is composed of two condensers and two coils and is tuned to transmitter A frequency. Receiver B therefore does not respond to transmitter A. L indicates the inductance of the carrier current generator and is made equal to L_0 so that the wave trap operates whether the transmitter is on or off.

The same procedure is followed for transmitter B.—*Patent No. 2,385,673*

U. H. F. Modulation

U.H.F. workers are well aware that at very high frequencies it becomes more difficult to secure amplitude modulation without simultaneous frequency modulation. In some cases the latter is not detrimental to communication, except that as the proportion of FM increases, a smaller proportion of AM is effective. In the microwave region, the FM may form an appreciable portion of the total modulation.

To overcome the difficulty, this invention by Walter Van Roberts makes use of a wave guide. It is known that any given wave guide has a sharp cut-off at some frequency which is related to its physical dimensions. As the critical frequency is approached, the attenuation rises rapidly.

The wave guide is used between the generator and radiator, its dimensions being such that it operates almost at cut-off. As an example, such a guide operating at about 500 mc might consist of a pipe 15 inches in diameter extending to a height of several hundred feet. The upper end would terminate in a horn radiator and the lower in the u.h.f. generator (Figs. 213 and 214).

In the microwave region, modulation generally consists of a relatively low r.f. (or intermediate frequency), which, in turn, is modulated by an a.f. When such modulation is applied, the carrier is shifted. When it moves in the direction of cut-off, the wave guide attenuation rises, and vice versa, thus effectively amplitude-modulating the carrier as its frequency varies. Thus otherwise undesirable

frequency modulation of the transmitted wave is transformed into and made to reinforce the ampli-



Fig. 213

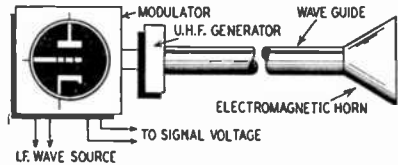


Fig. 214

tude modulation applied to the carrier.

An equivalent system may be utilized where a radio system is to receive an FM transmission. The latter does not appreciably affect a crystal detector, but a wave guide may be incorporated as shown. The FM carrier becomes essentially amplitude-modulated by the attenuation effect of the wave guide, and may therefore be detected.—*Patent No. 2,393,414*

Resonant Lines

USE of transmission line segments for tuning a u.h.f. receiver is made by George E. Pray in his invention as illustrated, Figs. 215 and 216. High stability and

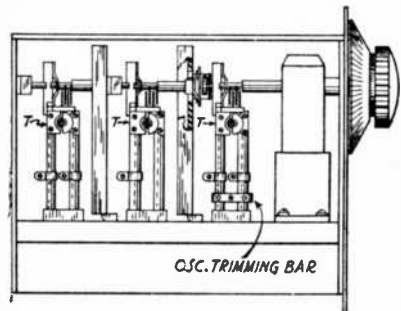


Fig. 215

accurate gang tuning are obtainable.

A length of line, shorted at one end and slightly less than a quarter-

circuit. The charging current flowing through R1 puts a negative voltage on the grid which opposes

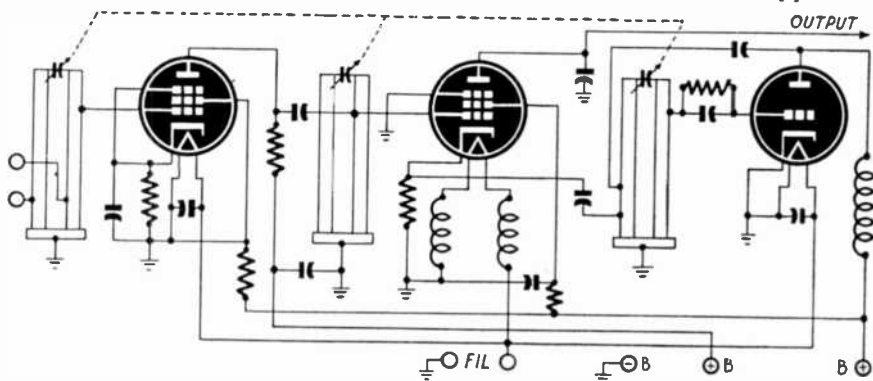


Fig. 216

wave in length, is used as an inductance, tuned by a small condenser. Adjustable taps are provided, the grids being tapped down to match the tube input impedances. The first stage is an r.f. amplifier, the second a mixer, and the last is the oscillator. The grid of the latter is connected to a suitable tap on one leg, the plate to a point on the other leg, and the cathode to ground. Another tapped connection (through a condenser) leads to the mixer cathode for heterodyning.

The physical construction of such a receiver is shown in Fig. 215.—

Patent No. 2,366,750

Pulse Modulator

THIS circuit, invented by J. E. Gorham and A. W. Frevert, is designed to shape as well as time the pulses used to modulate an r.f. amplifier. An alternating current is rectified and applied to a thyratron control circuit (Fig. 217). This voltage charges the condenser at a rate determined by the resistance and capacitance in the

the existing positive voltage, and as it dies down, two effects tend to break down the tube: (a) the rising plate voltage; (b) the rising grid voltage. The variable resistor is adjusted to fire the tube at the moment of peak condenser voltage.

When the tube fires it permits the condenser to discharge through it (L prevents sudden current flow), the resulting oscillatory flow reversing the condenser voltage and quickly extinguishing the tube.

With the rectified voltage shown, the pulse rate will be twice that of

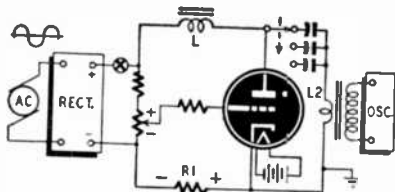


Fig. 217

the applied a.c. frequency. If pure d.c. is used this rate may be adjusted to any value by changing values of C and L (the transformer primary). The width of the pulse depends upon the size of condenser C.—Patent No. 2,391,894

High Fidelity Amplifier

THIS 2-tube amplifier, patented by J. B. Crawley, shows

D.C. Amplifier

ORDINARY R-C coupling cannot be used in very low-fre-

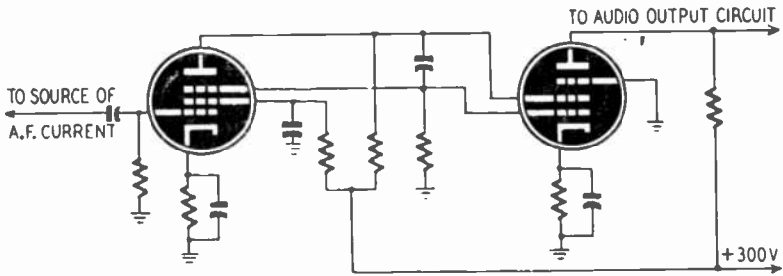


Fig. 218

excellent fidelity to almost 15,000 cycles.

The first tube is direct coupled to the screen-grid of the second in

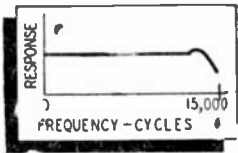


Fig. 219

addition to capacitance coupling to the control-grid as shown in Fig. 218. Degenerative feedback is accomplished through the same condenser by coupling the plate and suppressor of the first tube. Further negative feedback results because the screen of the second tube is not bypassed to ground.

A typical response curve is shown in Fig. 219.—*Patent No. 2,400,919*

quency and d.c. amplifiers. Instead it is required that the grid of one tube connect directly to the plate of the previous tube. Because of the relatively high potential on the grid, the corresponding cathode must also be raised to a high positive voltage. Where a number of stages are used, the total power-supply voltage must be very high because each stage operates at one or more hundreds of volts higher than the preceding stage.

This circuit (Fig. 220) requires two tubes, a pentode amplifier and a triode repeater, for each stage of amplification. The plate voltage variations in the amplifier are transferred to the repeater in parallel with it, as disclosed in patent issued to John R. Beckwith. The repeater operates as a cathode follower and requires no capacitance coupling.

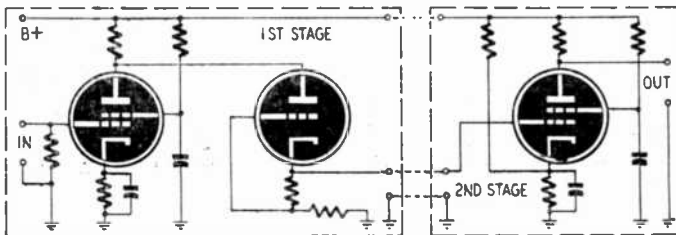


Fig. 220

The succeeding grid is operated at a low voltage relative to ground. Therefore the circuit does not need the very high voltage supply characteristic of earlier d.c. amplifiers.

This great advantage is accompanied by several disadvantages, which in most cases are less important. The repeater tube, like any other, is non-linear and degeneration is added to compensate for it. The gain of this tube is only approximately .35 and therefore more stages are required than usual. In addition, the grid of the second stage operates at a slightly positive voltage, which must be compensated.—*Patent No. 2,400,734*

Modulation Step-Up

THIS invention by Frank H. Slaymaker greatly increases the

transmitters must operate at very low percentages of modulation due to requirements of portability.

In this invention, (See Fig. 221) the r.f. amplifier is biased so that the modulated portion of the carrier coincides with the lower portion of the r.f. tube characteristic. In this way only the modulated portion is present in the output circuit as shown. This corresponds to 100 percent modulation. The steeper the E_g - I_p curve, the greater the modulated output. Due to flywheel action in the plate tank, the half waves become symmetrical as shown in (b).

It is evident that the distortion creates harmonics of the original r.f. oscillation. This is an advantage since it is possible to produce 100 percent modulation and multiply the frequency in the same stage

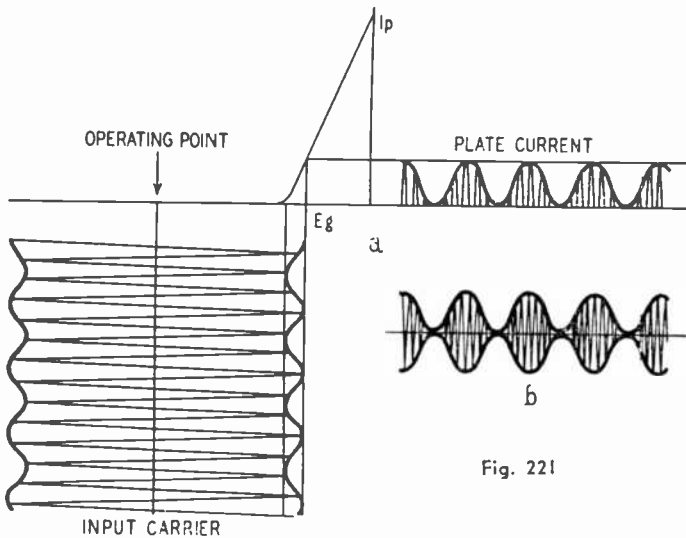


Fig. 221

percentage of modulation of an r.f. carrier. Mobile units such as tank

to reach the desired high frequency.—*Patent No. 2,403,245*

Section 3 . . .

POWER SUPPLIES

Multi-Volt Vibrator

THIS is a device to produce two different high voltages from one synchronous type vibrator, patented by R. J. Aust. It may thus be used to supply plate voltage and screen voltage without the inconvenience and power loss of a voltage divider.

The essentials are shown in Fig. 301. A 6-volt battery may be applied through a typical filter system. The vibrating reed is originally at rest on contacts T, U. Current therefore flows from the positive battery terminal through P1, the electromagnet, and back to the negative terminal. P1 is thus supplied with a weak voltage.

The reed is pulled away from T, U and it contacts R, S instead. This shorts out EM and applies the full battery voltage across P1, so that an e.m.f. is induced in the secondary windings. Simultaneously, S1 is connected through contact R across B1+ and B— (ground).

The electromagnet having been shorted out, the reed falls back on T, U, and the full battery voltage is now applied across P2 with current now flowing in the *opposite*

direction through the primary. Again voltages are induced in the secondaries, this time of *opposite* polarity. S1 is disconnected from

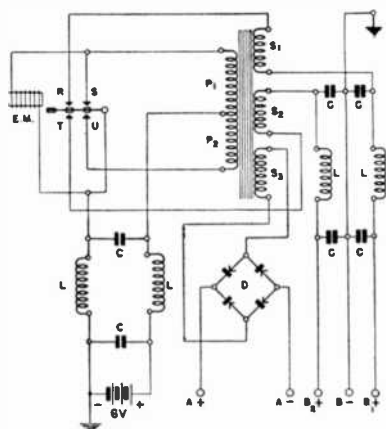


Fig. 301

the external terminals, however, so that this reversed e.m.f. is not present at B1+. The latter thus only shows *rectified* voltage which may be filtered as shown.

During this moment, also, S2 is connected through T to the terminals B2+ and B—, so that this voltage (of different magnitude than the first) is available. The cycle, as outlined above, then starts all over again.

A third secondary S3, a low voltage, is rectified by D and led to the A terminals, where it is available for filament heating of d.c. tubes.

This circuit presents two advantages over conventional vibrator power packs. Possibly most important is the fact that the filaments of the tubes—of whatever voltage—may be directly supplied from the vibrator transformer. It is unimportant whether they are of the a.c. or d.c. type. Second is the opportunity of obtaining two separate B voltages; with, of course, the possibility of combining them should that be expedient. These features might be useless in many standard applications (as where a 6-volt battery is used with a device employing 6-volt-filament tubes) but in special applications might prove extremely useful. It would also have application for special arrangements such as a power supply for a receiver and a separate supply for a transmitter to facilitate break-in use.—*Patent No. 2,347,165*

Electronic Vibrator

THIS device uses only a single pentode type tube to pro-

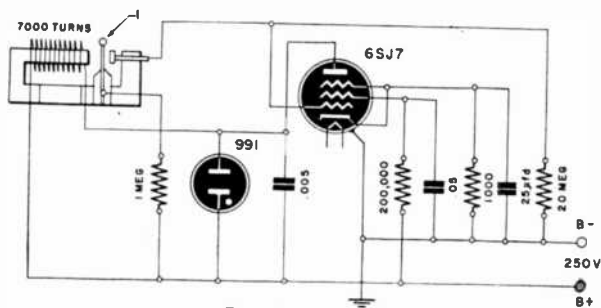


Fig. 302

vide an extremely accurate, simple and rugged vibrator system (Fig.

302). The vibrator coil in the output circuit of the pentode is tuned by a $.005 \mu\text{f}$ condenser to its resonant frequency.

Reed and electrode (1) form a varying capacitance in the input circuit. Note the 20 megohm resistor between control grid and ground to protect against possible shorting of the reed and electrode.

Initial movement of the reed at the vibrator resonant frequency applies an input potential to the 6SJ7, its output being fed back to the vibrator coil. An extremely stable oscillation results.—*Patent No. 2,349,125*

D.C. To A.C. Converter

WORN contacts and poor wave form result from vibrator sparking. These difficulties are

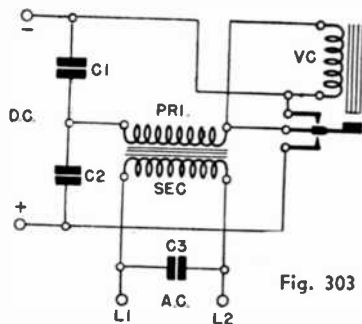


Fig. 303

eliminated by closing and opening contacts only while no current flows, as is done in this circuit invented by Alec. H. E. Walker (Fig. 303). When the bottom contact is made,

C2 discharges (through transformer primary), and the d.c. source

charges C1. The vibrator coil, now being across the d.c., attracts the armature, whence C1 discharges and C2 charges. Contacts are therefore made only while condensers are fully charged or discharged. C3 aids the wave form.—*Patent No. 2,352,299*

Overload Protection

RELAYS are often used for protection of vacuum tube circuits, but they have the disadvantage of throwing the circuit out of operation even on slight, temporary overload. This method, devised by G. L. Graveson and C. R. Keith, uses a thermistor, which operates only when the tube plates reach a predetermined temperature (Fig. 301). It is especially useful in connection with such circuits as class-C oscillators.

The thermistor (T) resistance varies with temperature. It is placed in shunt with a leg of a phase-shifting bridge, and is positioned adjacent to the tube plates. Radiation from the latter causes an out-of-phase voltage to be applied to the rectifier grids, decreasing the voltage output. As soon as normal

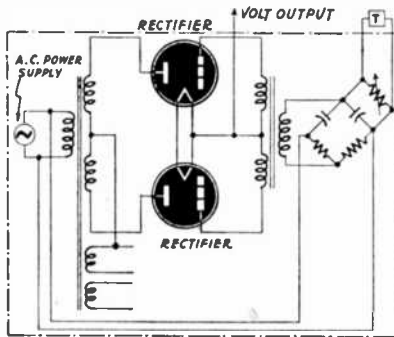


Fig. 304

conditions return, the grids are in phase with the plates (of the recti-

fier tubes) and a normal voltage output is again available—*Patent No. 2,364,136*

Harmonic Generator

A SYSTEM which requires transmission on harmonically related wave lengths (such as amateur radio) has heretofore used

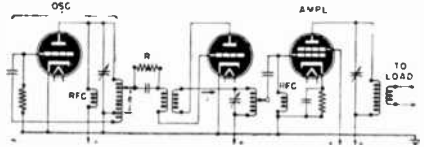


Fig. 305



Fig. 306

multiplier stages to reach the desired harmonic. This results in tuning complications and multi-stage doublers.

If a momentary pulse is delivered to an amplifier, the same excitation is available regardless of the order of harmonic. Walter Van B. Roberts has discovered. By using one pulse per cycle of fundamental the same power is applied at the amplifier grid at all harmonics.

The pulse generator (Fig. 305) functions as follows: A high value grid-leak, R, periodically blocks the tube, but when plate current finally flows, regenerative action induces a high positive potential on the grid so that saturation is reached. When the plate current levels off it produces a high negative potential on the grid, rapidly cutting off plate current, thereby producing pulses. The triggering effect of the pulses is shown in Fig. 306.

These pulses of current flow in

the plate circuit of the second tube keeping it in oscillation and supplying excitation to the grid circuit of the final amplifier, which may thus be operated at any multiple of the fundamental oscillator frequency.—*Patent No. 2,364,756*

Variable Load Supply

IN some cases of extreme load variation, it is desirable that a power pack supply either a high voltage at low current or a low voltage at high current. O. H. Schade has devised such a power supply system (Fig. 307).

Here two power supplies are in series: E1 which has, for example, an output of 150 volts at 100 ma and E2 which supplies about 150 volts at 1 ma. At light loads E2 is mainly effective in supplying the high voltage. As the load increases, E2 drops quickly until it becomes smaller than E1 so that the diode D conducts, shorting out E2. E1 then

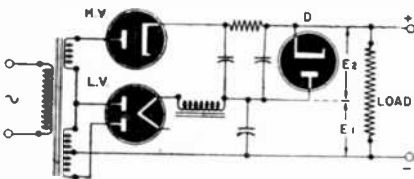


Fig. 307

supplies the low voltage at high current.—*Patent No. 2,364,761*

Electronic Regulator

VOLTAGE regulators usually include high current triodes, which act as variable resistors, in addition to the usual rectifiers. This circuit devised by C. W. Faulkner uses triode rectifiers, thus combining the two functions (Fig. 308).

A bleeder is formed by the plate-cathode resistance of the pentode and the resistor R, to the junction of which the triode grids are attached. Effective resistance of the

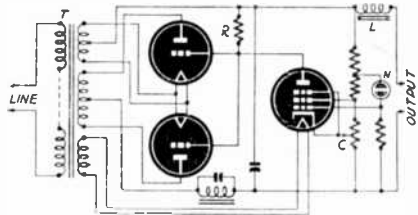


Fig. 308

pentode is set by the potentiometer C, which varies cathode potential of the pentode with respect to the negative side of the line, and is also controlled by the No. 1 grid, attached to a point on a bleeder across the output.

As the load changes, the pentode grid voltage also varies with respect to its cathode. The neon bulb N tends to keep the voltage between grid and the positive power lead constant. A change of pentode plate current is thus produced, and this, flowing through R, varies the grid voltage of the rectifiers, thus controlling the voltage output. The triodes may be capable of delivering 0-150 ma, with a maximum voltage variation of one-half percent. C is the voltage adjustment.—*Patent No. 2,373,750*

Sawtooth Generator

THIS novel electron tube invented by Thomas W. Cunniff simplifies and improves the generation of sawtooth wave forms. It consists of an electron gun A, a beam deflecting system B and a target C. The latter is an annular

coating of resistance material (such as carbon sprayed on a mica disc) with a small gap (Fig. 309).

A sine wave of desired frequency is applied to the tube. A phase-changing circuit applies voltage to the two sets of plates 90° out of phase with each other, causing the beam to travel in a circle along the target.

The output voltage at DE is in series with a portion of the target PD (P being the point at which the electron beam strikes the target at the moment). The greater the length PD, the smaller the output voltage becomes. Therefore, when P is in the gap, the output voltage is zero and it becomes progressively greater as P moves in the direction of the arrows. The small figure shows the wave form. Note that no time is wasted since the voltage

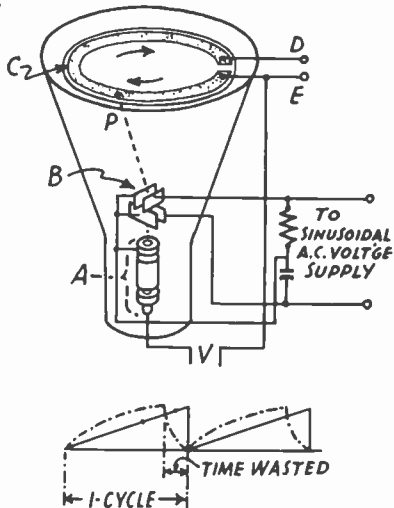


Fig. 309

drops immediately to zero at the gap. Broken lines show ordinary sawtooth waves. — Patent No. 2,374,666

High-Voltage Generator

WHERE high voltages at low currents are required, as in television circuits, it is desirable to eliminate transformers because of their great weight and bulk. An r.f.

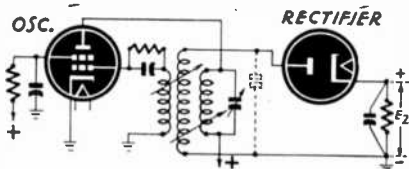


Fig. 310

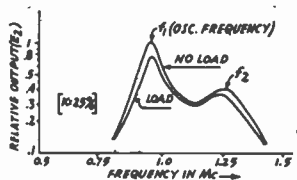


Fig. 311

oscillator and rectifier system can be used not only for the above reasons but also because of its greater safety, since it has a current-limiting characteristic (Fig. 310).

A voltage step-up r.f. transformer, having a Q of about 150-300, steps up the high frequency (about 1 mc) to a high voltage (up to 75,000). A 6Y6 oscillator, for example, can generate about 15 watts at 75% efficiency using 300 volts on its plate. By using tight coupling, and tuning the oscillator to the lower of the two resulting peaks, a voltage regulation of between 5 and 15% may be obtained (Fig. 311). Patent issued to Otto H. Schade.—Patent No. 2,374,781

Voltage Regulator

IN certain applications such as welding it is necessary that the voltage be kept within definite limits.

This circuit devised by Hans Klemperer uses three VR tubes and a gas-filled triode (Fig. 312). Alternating current is applied through a transformer and the triode to the condenser C. The latter voltage, for example 3,000, is to be con-

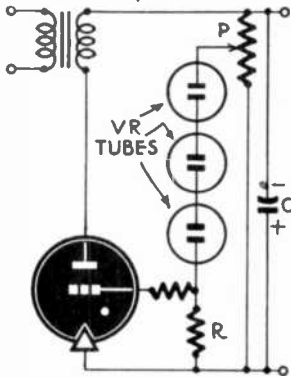


Fig. 312

trolled. The VR tubes may operate at 105 volts and fire at 110 volts. The potentiometer is adjusted so that the VR tubes fire when the desired voltage across C is reached. At this instant a voltage of 15 appears across R $[3 \times (110-105)]$. Any additional voltage at point P is then simply added to the voltage across R by the VR tube action.

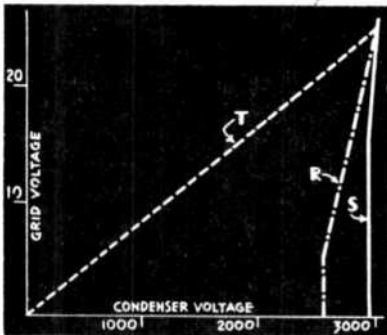


Fig. 313

The voltage across R constitutes a negative bias for the triode.

Therefore, the current through the tube is sharply controlled. In Fig. 313, curve R shows the characteristic when a single VR tube is used, S when three tubes are used, and T when only a potentiometer is used —*Patent No. 2,383,492*

Thyratron Inverter

THIS invention by Henry Carleton inverts power without the use of moving parts, requires only few components, and provides an adjustable frequency (Fig. 314).

The d.c. source is connected across R1, R2 and C. R2 is much greater than the other resistor. With the switch closed, the condenser C begins to charge and the current flow gradually decreases to zero.

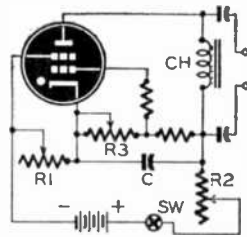


Fig. 314

As a result of this current a high negative bias appears at the screen grid, but this quickly drops to zero. Simultaneously, the control grid and anode voltages rise rapidly in a positive sense. These three changes all tend to break down the thyratron tube at some instant before complete condenser charge.

When the tube ionizes, the condenser discharges through coil CH, resulting in an oscillatory pulse, until the condenser charges to a sufficiently high reverse potential which cuts off the tube. The output appears across the coil and is taken off through fixed condensers.

R2 adjusts the frequency, while R1 and R3 determine the optimum instant for tube breakdown. — *Patent No. 2,390,508*

Generator Regulator

THIS electronic regulator invented by William C. Grabau limits the voltage fluctuations of a.c. generators. Use is made of two full-wave rectifiers and a gas-discharge tube V3. The latter shunts the field resistance and thus controls the alternator excitation (Fig. 315).

V1 rectifies part of the voltage output and R1 constitutes its load. V2 acts in a similar way except that its efficiency is determined by its grid bias, which is made up of

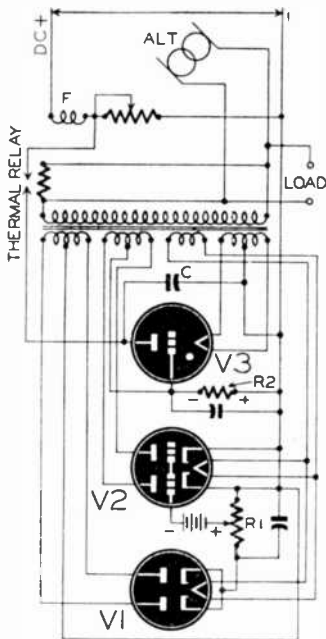


Fig. 315

a negative battery potential in series with a portion of the positive voltage developed across R1.

Assume an increase in generator output. All secondary voltages increase slightly. As a result, the grids of V2 become more positive, and in turn the voltage across R2 increases. This grid bias determines the length of time during which V3 conducts, which in this case will be shorter. A smaller total average current thus flows through F, causing the generator voltage to return to normal. The reverse takes place when the a.c. voltage tends to decrease.—*Patent No. 2,390,214*

Voltage Doubler

THIS vibrator devised by W. W. Garstang uses two sets of contacts which enable it to double the voltage of the battery which energizes it (Fig. 316).

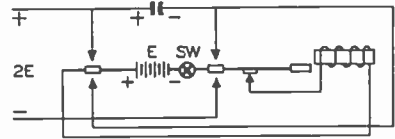


Fig. 316

Initially the armature rests on the three lower contacts and when the battery is switched on current flows through the magnet winding. This attracts the armature which therefore touches the upper contacts and interrupts the magnet winding. In this position the battery charges the condenser to its full voltage.

As the magnet is no longer energized the armature falls back upon the lower contacts again. This puts the condenser in series with the battery with the proper polarity so that a total voltage of 2E exists across the output terminals. An interrupted voltage of this peak value exists as long as the vibration takes place.—*Patent No. 2,392,472*

Section 4 . . .

MISCELLANEOUS

Thyratron Ignition

THIS device eliminates pitted contacts, cam shaft wear and

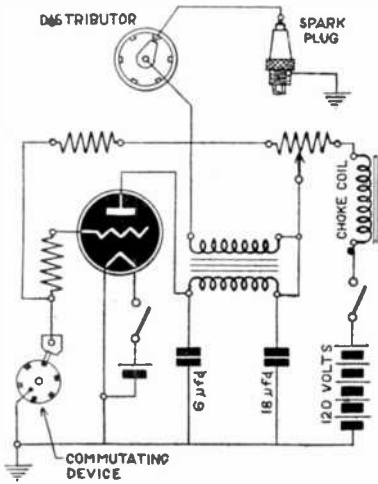


Fig. 401

other disadvantages which attend the usual mechanical ignition system. Using a thyratron tube as shown in Fig. 401 only a very weak current need be made and broken.

The distributor and commutating device are synchronized. The latter has conducting and insulating segments contacted by a brush. When a conducting segment is contacted the grid is grounded and no current

flows. When contact is made with an insulating segment the grid is connected to the plus side of the battery, firing the tube, so that a heavy plate current flows through the transformer primary. The large condensers store a charge and aid in causing a heavy spark plug current.—*Patent No. 2,353,527*

Electronic Alarm

THIS simple, efficient means of indicating changes in an external load was invented by Joseph T. Repking.

The load circuit is completed through the filament of an ordinary

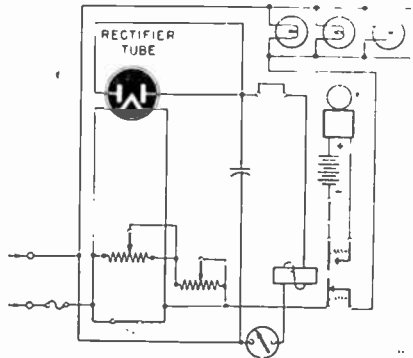


Fig. 402

rectifier tube, such as an 80 (Fig. 402). A shunt by-passes such a

proportion of the current that the tube filament receives its normal amount, and a high- and low-current relay is in its plate circuit.

If the current in the external circuit decreases greatly, for example by the burning out of a number of lamps, current flow through the power rectifier filament decreases, reducing the emission. The underload relay contact falls back, ringing the alarm. Should abnormal input voltage, or a short in the load, increase the filament current, the increased emission sends more current through the tube plate circuit, operating the overload relays and opening the circuit. — Patent No. 2,355,752

Television Projection

DIRECT television projection requires expensive and rel-

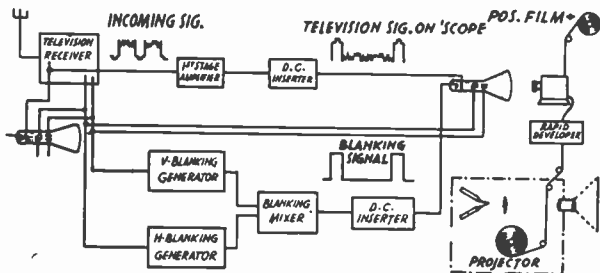


Fig. 403

atively short-life equipment. Here the incoming signals are passed through an additional video stage, producing a negative image on a high-brilliance, blue-screen oscilloscope using about 10,000 volts. Additional blanking circuits eliminate the return traces which would otherwise be visible (Fig. 403). Inventor is T. T. Goldsmith.

The images are photographed on ordinary positive movie film, resulting in a good contrast, positive image. The film is processed and is

then ready for a regular theatre size projection machine. The time interval is not great, and among the advantages are large images with inexpensive equipment and the fact that the pictures may be repeated and duplicated.—Patent No. 2,373,114

Tuned Loop Antenna

LOOP aerials provide compact sources of energy pickup, but heretofore there has been no effective way of tuning the loop to fully cover the broadcast band. An inductance tuning ratio of 10-1 would be required for this purpose. The elimination of tuning condensers would permit a more compact and economical input circuit, as disclosed by Harry E. Thomas.

Fig. 404 illustrates a new means

of tuning a loop with an inductance change ratio of about 10-1. Four similar loops are wound in the same direction and mounted on a collapsible, hinged body. For clarity only a single turn is shown on each side. When fully open (full lines) the total inductance is due to the self-inductance of each side plus the mutual inductance effects of *opposite* sides which are seen to *aid*. As the sides collapse (dotted lines), note that *adjacent* sides approach. Since the latter effects *oppose*, the

resultant inductance approaches a very small value.

The quadruple loop is in effect

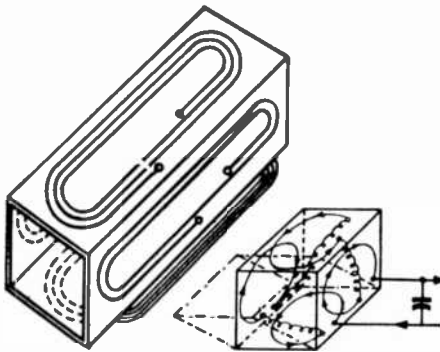


Fig. 404

a special application of the variometer principle used in the tuning circuits of many early broadcast radio receivers.

Any gear system which eliminates backlash may be used as a control.—*Patent No. 2,373,206*

Interference Elimination

THE use of r.f. generators for industrial and therapeutic purposes has resulted in a serious interference with communication cir-

their radiations may wander in and out of important frequency bands.

To eliminate this type of interference, Clarence W. Hansell suggests in this patent that the r.f. generator be frequency modulated rapidly through a wide range. Preferably this modulation may take the form of a triangular wave, at the rate of 1,000 megacycles per second for example, in which case any radiated energy will remain in a 10-kc band only 10 microseconds! This is found to be equal to an interference reduction of 50 db.

A general circuit for an r.f. oscillator is shown in Fig. 405. A push-pull stage is frequency modulated by a rotating condenser connected across a portion of the tuning tank. The same motor may be used to operate a blower for cooling the tubes.—*Patent No. 2,381,496*

Relay Circuit

ALTHOUGH operated from on-off signals, this polarized relay shows push-pull characteristics; current can flow through it in both directions (Fig. 406).

When a signal is received the full-wave rectifier delivers a negative voltage to the triode grid, biasing the tube to cut-off. The rectifier load includes resistor R and the relay winding. Polarity of the latter is as marked. When the signal stops, the rectifier output disappears. The triode then conducts and plate current flows through the relay winding in the reverse direction so that its polarity is opposite to that which is marked. The armature is attracted to one pole or the other depending upon current direction.

This circuit, William E. Simpson discloses, has been found useful in

circuits at times. The former are usually unstable in frequency and

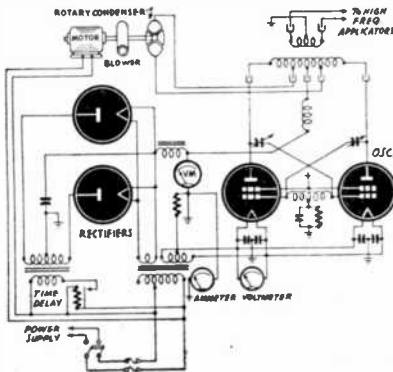


Fig. 405

connection with printer code signals transmitted over long lines or radio channels. Such signals may

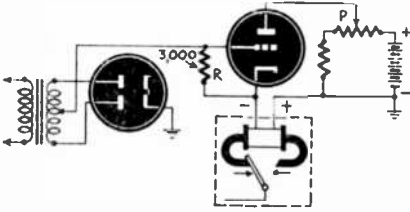


Fig. 406

be distorted and will not easily affect a teletype printer. If the present circuit is adjusted so that weak signals cut off the triode and if the reverse current is properly adjusted by means of the potentiometer, it will be actuated by such signals.—*Patent No. 2,387,536*

Microphonic Tube

ORDINARILY a microphonic tube is a lamentable component, to be discarded at the earliest moment a replacement can be located. In this case, a microphonic tube is deliberately designed for particularly useful electronic applications.

The vacuum tube is shown in Fig. 407 with cathode, control grid and anode, but auxiliary elements could be added. A circular flexible diaphragm D is welded at its periphery to a metal ring R which in turn is sealed to the edge of a large aperture in the glass envelope. The center of the diaphragm is connected to a large glass bead which supports the control grid. The grid lead from the base is flexible to permit movement.

Vibration or displacement at the diaphragm is transmitted to the control grid. Therefore, corresponding changes of amplification factor

occur and may be indicated or recorded in the plate circuit.

This new tube, suggested by Jerome Rothstein in his patent, can be used to measure wind velocity, liquid pressure, faint sounds and mechanical stresses. The center of

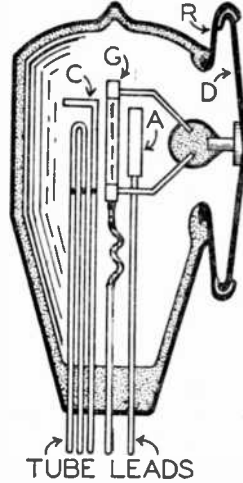


Fig. 407

the diaphragm may be connected to a distant object by a taut wire if desired.—*Patent No. 2,389,935*

Talking Book

THIS patent covers a basic idea rather than actual mechanism employed. Printed on the book pages are variable area recordings with means to guide a reproducer along its tracks, such as perforations at beginning and end of each line.

The printed word and its sound track could be printed on the same line, so that it might be seen and listened to simultaneously. Such a book would be of great value for foreign language study, dictionary purposes, code practice, etc. — *Patent No. 2,369,572*

Energy Reflector

FOR radar and similar applications of microwaves, radio energy is emitted through wave

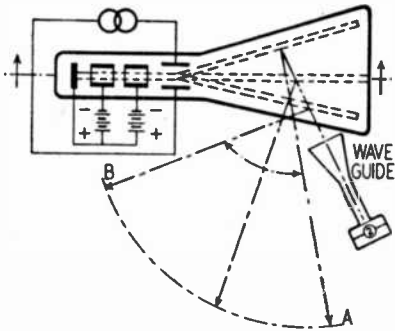


Fig. 408

guides and caused to scan a given area. This usually requires a mechanical motion. This invention, by R. J. McElhannon, uses electronic means to direct radio waves.

An elongated oscilloscope tube is used to provide a sheet of electrons (Fig. 408). This tube is much wider than its height. Starting from the base end, the tube contains a cathode or filament, two focussing electrodes and a set of deflecting plates. An electron sheet is thus emitted by the filament and is deflected between the two extreme positions noted by the dotted lines.

The energy output of a wave guide is directed against the electron sheet and since the latter has the properties of a conductor, reflection takes place as shown, between the extreme positions A and B. A more complicated set-up may be used if it is required that reflection of the energy take place in more than one plane.—*Patent No. 2,391,914*

Pilot Lamp

THIS device invented by Chalmers Morehead combines the

features of fluorescent and glow lamps in one bulb. It can be used either for decorative purposes or as a pilot bulb. Its advantages are low power dissipation, cool operation and long life (Fig. 409).

The bulb is filled with an inert gas such as argon at low pressure. The leads are mounted through a glass seal, and at their inner ends are spot welded two filament coils. The junction of these coils is further supported by the seal.

When a low voltage is applied to the bulb, the filament becomes heated. At about 10 volts a discharge also takes place between the main lead ends, and the bulb then glows brightly. The full current of the bulb is .15 ampere.

Fluorescent material may be coated on the inside of the bulb in order to obtain any desired color including ultra-violet radiation. If a string of these bulbs are connected in series and one becomes

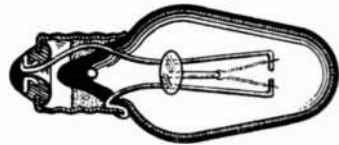


Fig. 409

defective by reason of failure to glow, the other bulbs will continue to function.—*Patent No. 2,392,333*

Tube Tester

COMMON types of tube testers measure emission or mutual conductance. While much information about the tube is given, these types cannot indicate the quality of the tube as an oscillator.

The accompanying diagram (Fig. 410) illustrates a versatile circuit perfected by James B. Crawley in

which the tested tube is operated under actual oscillator circuit conditions. The filament is connected

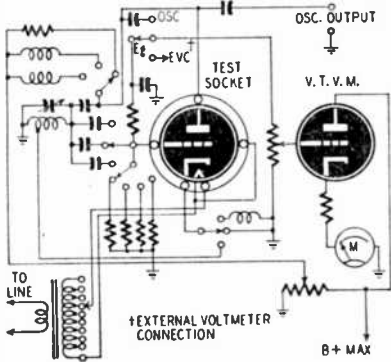


Fig. 410

to a tapped transformer secondary. The B supply is adjustable for various plate potentials. The grid and cathode of the tube is connected to the desired value of components as shown. Shunt feed is used, a resistor or suitable coils being switched in for connection to the plate. Note that the oscillator output is available as a generator signal for other purposes.

A v.t.v.m. tube is added so that the efficiency of the oscillator tube can be measured under the several conditions. The voltmeter may be connected either to the oscillator plate (through a condenser), or to the grid (through a resistor), or to an external voltage.—*Patent No. 2,399,859*

Antenna System

A RHOMBIC antenna is known as an excellent wide-band system. However, it requires a resistance termination for optimum results. This resistor must dissipate sufficient energy to prevent reflection along the antenna.

Instead of a resistor, this rhombic

uses a transformer as a termination, for the purpose of transmitting some of the antenna energy back into the transmitter input (Fig. 411). Therefore two effects are accomplished; oscillations are eliminated; oscillations are maintained.

The inventor, George T. Royden, suggests the use of this system in connection with radar or radio jamming facilities. For these purposes the tuning condenser is rotated continuously through the desired band of frequencies. On the same shaft is connected a rotary arm contacting a metal band (Fig. 412). This constitutes the B-minus return. At one position an interruption on the metal band is provided, so that during this moment (corresponding to the desired frequency) no jamming takes place. This frequency, which may be set at any desired point in the band covered by the apparatus, is used for communication transmission. — *Patent No. 2,393,656*

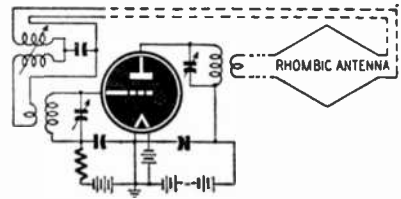


Fig. 411

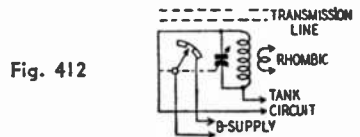


Fig. 412

Television Sweep Circuit

THIS invention is an improvement over existing circuits which govern the deflection of an

electron beam by electromagnetism, and has been patented by Millard W. Baldwin, Jr. Since the special features are associated with the vertical sweep circuit, it need only be mentioned that the horizontal sweep is controlled by a suitable oscillator and deflection coils.

The vertical sweep circuit uses three tubes, the last two in push-pull for second-harmonic reduction. The input triode is triggered by periodic pulses which cause the tube to conduct and therefore dis-

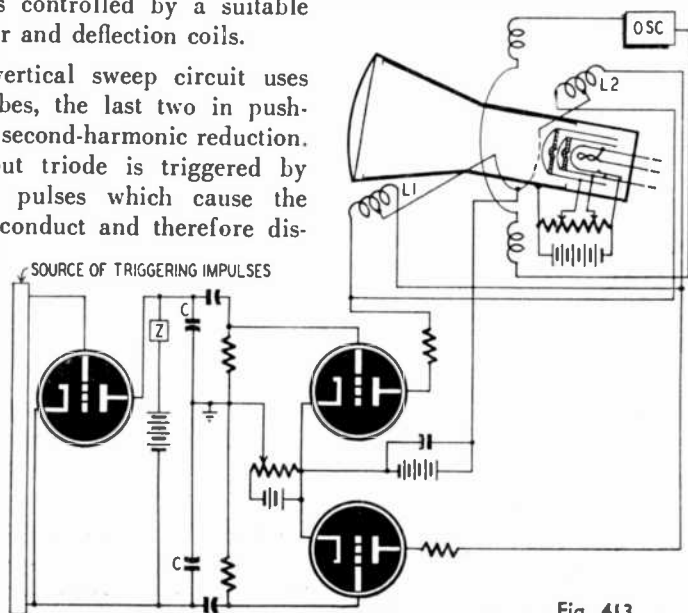


Fig. 413

charge the condensers C. These charge again and the cycle repeats.

The output of the push-pull stage flows through the coils L1 and L2 (Fig. 413) and it consists in general of a residual d.c. component and the signal a.c. component. For convenience consider the first portion alone, that is, in the absence of a signal. During these intervals there should be no vertical deflection of the beam. The deflection coils ordinarily carry the current of only one of the push-pull plate currents, and as a result the two equal and opposite currents balance out only near the center of the scope tube. This means that when an electron is near the end of its

travel (along a horizontal line), one or the other of the magnetic fields will predominate and cause the beam to be deflected even though no signal is coming through. Therefore the television picture will

be distorted along the two sides. In this circuit, each deflection coil is center-tapped and each half carries the current from one tube. As a result, the two opposite and equal fields cancel out in each coil. Under this condition there is practically no magnetic field due to the d.c. component of the push-pull tubes and therefore no vertical deflection without signal input.—*Patent No. 2,393,601*

U. H. F. Measurement

THE measurement of u.h.f. voltage is a very difficult process. At the microwave frequencies, an accurate measurement is not generally possible with conven-

tional apparatus. The invention of Ralph W. George, described here, requires only a special wire element and an ordinary bridge circuit and power supply. It is effective up to several thousand megacycles.

One arm of the bridge is a platinum or wollaston wire only $\frac{1}{8}$ " long and .1 mil in diameter, having an approximate resistance of 73 ohms at room temperature. The arms 1 and 2 are fixed resistors and R2 is adjustable. (Fig. 414) the condenser C serves to by-pass the r.f. currents so that they do not enter other parts of the bridge. A regulated power supply is desirable to energize the bridge.

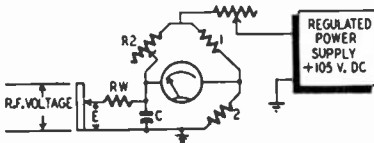


Fig. 414

To operate the circuit, the bridge is first balanced with no r.f. through RW. When the current is turned on, it heats the small platinum wire and therefore causes its resistance to increase, unbalancing the bridge. In order to determine the exact value of voltage, a known source of d.c. is substituted for the r.f. and its potential is adjusted until the same deflection is obtained on the microammeter. The two voltages are then equal.—*Patent No. 2,399,481*

Standing Wave Indication

THE most important measurement which concerns antenna design is that of standing wave ratios. An impedance mismatch results in the existence of

standing waves along the transmission line. Therefore, it is necessary to reduce them for maximum power output. One possible method consists of using a v.t.v.m. arranged

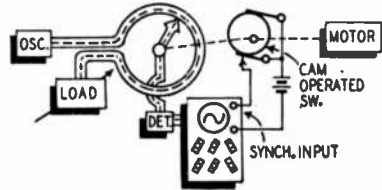


Fig. 415

to slide along the line while the ratio of maximum to minimum voltage is noted. This is a very inconvenient method, especially with coaxial line.

To simplify the process, a portion of the coaxial line is arranged in circular form, as described in Donald W. Peterson's patent. A movable arm containing a probe contacts the internal conductor and feeds the voltage to a detector, whose output is indicated as a vertical deflection on an oscilloscope. The variable arm is operated by a motor which also controls a switching cam as shown in Fig. 415.

During each revolution of the arm, the same switch is closed once. This provides the horizontal synchronizing pulse which starts the

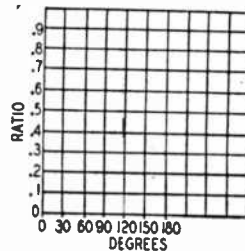


Fig. 416

horizontal deflection. As a result, the pattern shows the relative voltage at each point of the circular

coaxial line. A celluloid screen marked off in angles as shown in Fig. 416 makes it convenient to interpret the standing waves. Gain and deflection controls are adjusted until a full wave covers 180°. The pattern may be observed while necessary adjustments are made.—*Patent No. 2,400,597*

High-Fi Disc Recording

NEGATIVE feedback is widely used in electrical and mechanical systems for the reduction of distortion. Greatly increased fidelity can be obtained from a disc recording system by the use of negative feedback. For best results it should include not only the amplifier but the vibrating stylus as well.

One possible connection uses a coil in which the stylus induces a voltage to be fed back to the amplifier in proper phase. This has a

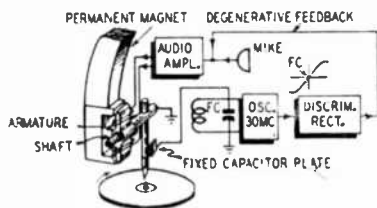


Fig. 417

tendency to cause undesired coupling with the recording coil besides adding mass to the vibrating system, another undesirable feature.

An effective solution is the use of FM to derive the negative feedback voltage. In the patent issued to Henry E. Roys a small capacitor plate is used in conjunction (but not in contact) with the stylus (Fig. 417). Vibration of the latter modulates the frequency of a high frequency oscillator (for example 30

mc). The modulated output is applied to a discriminator and this audio voltage can be used as negative feedback.—*Patent No. 2,400,953*

Frequency Multiplier

THIS device, patented by Ernest G. Linder, can multi-

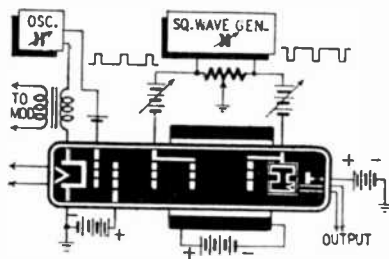


Fig. 418

ply an ultra-high frequency in any whole number. It makes use of a special elongated tube containing a cathode, a number of grids and a cavity resonator.

The uniform electron flow from the cathode is pulsed by the first grid. Electrons pass when this grid is positive and are cut off when the electrode is negative. Therefore the electrons proceed in pulses after this grid. The second grid is an accelerating element (Fig. 418).

The third and fourth grids are connected to a square wave voltage as shown. This voltage causes the uniform pulses to be bunched. When the grids are positive, approaching electrons are accelerated and those which have just passed are slowed up. When the grids are negative, approaching electrons are retarded and those which have just passed are accelerated. Both effects tend to bunch up the electrons. Between these bunches the electrons are more or less separated accord-

ing to their position between the bunches. While the total number of bunches is exactly equal to the total number of original pulses, they simply exist closer together or further apart. The number of pulses per second corresponds to a definite frequency. This frequency is uniform at first but the action of the third and fourth grids causes it to be frequency modulated.

The fifth and last grid's voltage is also supplied by the square wave generator but out of phase. When it is positive, the entire bunch is accelerated and, upon passing through the cavity resonator, causes oscillation. The frequency of this oscillation corresponds to the density of pulses in the bunch and to the velocity of the bunch. If the bunches are highly compressed by a high voltage on the third and fourth grids, the frequency will be higher. This can also be obtained by high voltages on the last grid.

Magnetic focussing is provided by a solenoid around the tube. The target electrode at the right end collects electrons. The loop coupled to the cavity resonator extracts energy of the multiplied frequency. —*Patent No. 2,401,945*

FM Phono Pickup

AN improved push-pull phonograph pickup is the invention of Alexis Badmaieff. Not only does

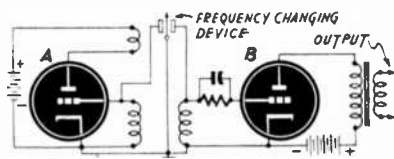


Fig. 419

this instrument completely cover the audio range and far beyond, but

its output is much higher than usual.

The basic circuit is given in

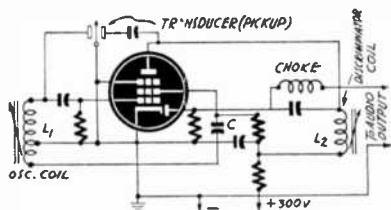


Fig. 420

Fig. 419. Tube A is a high frequency oscillator. B is a discriminator tube whose peak frequency is displaced somewhat as shown in Fig. 421. The oscillator frequency F_c is adjusted to the steep portion of the discriminator's frequency characteristic. The pickup is shown as a dual capacitance, the stylus being grounded. Vibration of the latter in response to a recording causes

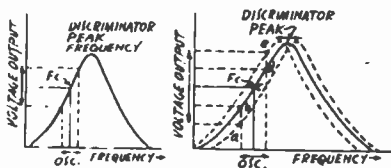


Fig. 421 and 422

it to alternately increase and decrease the frequency of the oscillator and discriminator in opposite phase.

The result appears in Fig. 422. When the stylus moves to the left it decreases the oscillator frequency and simultaneously increases the discriminator resonant frequency. The first changes the operating point from c to b, while the second shifts the entire discriminator curve to the right, therefore fixing the operating point at a. Likewise, when the stylus moves to the right, the operating point will be found at e.

Not only is the output doubled as a result of this double change, but the push-pull effect also cancels out even-harmonic distortion which might otherwise occur.

A still more simplified circuit is that of Fig. 420, where only a single tube (6SF7 or similar type) is used. L1 is a tapped oscillator coil for the tube, which is electron coupled. L2 is the discriminator coil. The output of the latter is applied to a diode plate through a fixed condenser. It is rectified, filtered and applied to an audio amplifier. The tube suppressor is used as an electrostatic shield.

Typical design of such an instrument may follow Fig. 423, where several views are shown. The sapphire stylus is mounted at the end of a steel wire bent as shown and mounted on a brass block. The side view shows only one fixed plate, but of course there are two, one on each side of the steel wire and mounted on a bakelite block. The

stylus support wire.

The pickup head is connected to the main tone arm by means of two spring plates which permit mount-

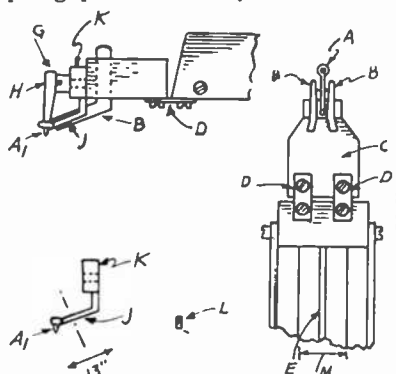


Fig. 423

ing in the proper vertical direction and also prevent damage to the unit should it be dropped on a record. Two transmission lines, one from each fixed plate, are placed in channels in the tone arm which is mounted directly on the chassis of the circuit by means of a pivot.

By way of illustration, several dimensions of the parts are given. With a device of this general con-

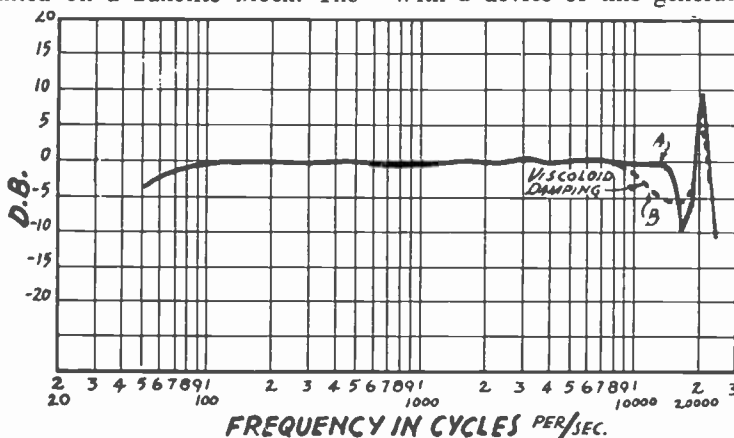


Fig. 424

use of a viscoloid strip between the stylus and mounting screws is necessary to suppress resonance in the

construction an unusually good response is obtained (Fig. 424).

This circuit also may be used for

cutting records or as a push-pull condenser microphone. Since it operates on a principle of small displacements, it can likewise find application in measuring vibration, pressure, etc.—*Patent No. 2,371,373*

DESIGN AND PERFORMANCE DATA

Oscillator frequency	between 30 and 60 mc
Frequency deviation	120 kc
Stylus pressure	.33 ounce
His output	7 db below ordinary pickups
Resonant frequency	21,000 cycles

Improved Electron Lens

THIS device is an invention of Charles H. Bachman of GE suitcase electron microscope fame. It is designed to minimize the possibility of voltage breakdown between different elements.

along the microscopic axis.

The lens system L is shown composed of solid material except for an appropriately shaped opening to influence the electronic beam which then passes on and strikes the fluorescent screen 5.

In the ordinary electron microscope, a possibility of voltage breakdown exists between the different elements so that sharp corners must be avoided, and surfaces must be highly polished. In the type of electron lens shown, however, the metallic electrode—seen at 6—is imbedded in a solid possessing high insulating strength. Then by proper shaping of this material, as well as the electrodes themselves, it is possible to minimize aberrational effects with less danger of breakdown.

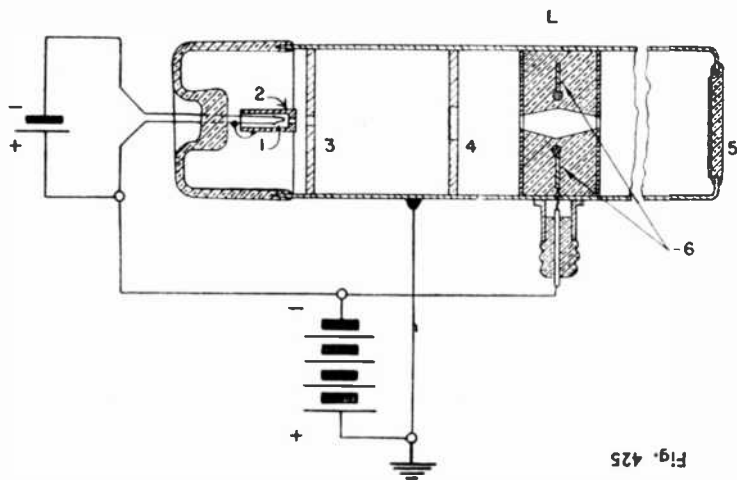


Fig. 425

In Fig. 425 a cathode 1 is surrounded by an apertured element 2 through which a narrow electronic beam moves. Element 3 is at a high positive potential compared with the cathode and accelerates the electrons. The object to be investigated is at the center of the screen 4,

A typical shaping of the lens is shown. Materials which may be used are glass for the solid dielectric and platinum for the electrode, which may be in the form of an annular disk or washer having at its inner edge a ring of circular cross-section.

Section 5 . . .

FOREIGN PATENTS

The following are interesting alien patents. Some were filed by residents of this country and many were filed by German nationals living abroad.

Some of the ideas are ingenious, but it is to be noted that although under pressure far longer than citizens of most non-Axis countries, the Axis scientists were unable to discover really essential ideas such as the cavity magnetron, high-power radar jamming, etc.

Superregenerator

It is usual in a superregenerative receiver to provide a separate oscillating circuit at a super-audible frequency using an electron tube. The disadvantage of another tube and its filament power is overcome by making use of a glow tube, such as a neon bulb, shown at N in Fig. 501. R and C are chosen to provide a blocking frequency which is transferred to the oscillating circuit by the transformer.—*Patent No. 1,931,950*

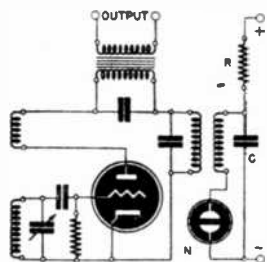


Fig. 501

Influencing Radiation

SINCE waves may be reflected or refracted by either a solid

metallic wall or a closely spaced system of wires, their direction may

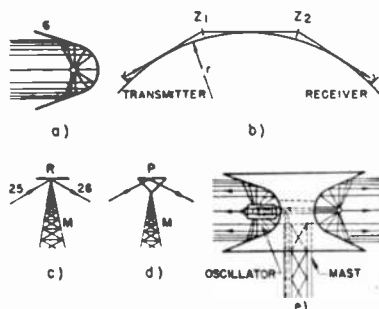


Fig. 502

be varied in a similar manner to that of a light beam.

Original transmission of the u.h.f. beam may be made by placing the antenna at the focus of a circular parabolic reflector, the beam taking the form of a plane surface (Fig. 502-a). Now due to earth curvature, this plane finally rises to a height beyond reach. By placing reflecting surfaces at regular intervals (Z in Fig. 502-b) the original beam may be transmitted to any required distance. Reflection (Fig. 502-c) or refraction due to a

prism effect (Fig. 502-d) may be utilized, or the beam may be simply transferred by a conductor from the focus of one parabolic surface to another. In this way u.h.f. carrying television or FM may be relayed from one city to another.

—*Patent No. 1,939,345*

Superregeneration

SUPERREGENERATION provides the most sensitive circuit thus far devised. Theoretically unlimited amplification is available at the proper point of operation. In most cases the blocking frequency is the result of impedance changes in the circuit, resulting in broad tuning and noise.

This invention makes use of periodic detuning at about 15 kc. A condenser microphone M is connected to a generator and its vibrating diaphragm influences the total capacitance of the tuning system T thus detuning it at a super-audible rate (Fig. 503). Normally

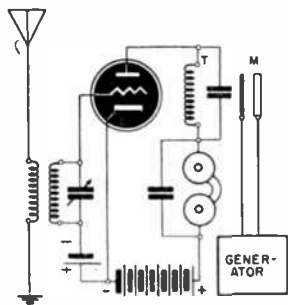


Fig. 503

both tuning circuits are resonated thus causing oscillation.—*Patent No. 2,010,978*

Multi-Range Receiver

It is sometimes difficult to design a regenerative receiver to

respond to ranges widely separated, since switching must usually be made in the tickler coils. In Fig.

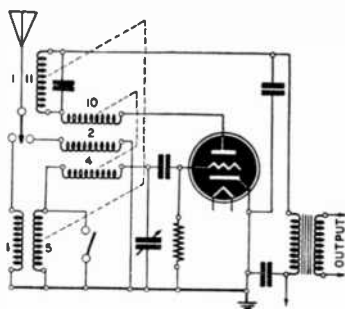


Fig. 504

504 coils 5 and 11 are coupled, as are coils 2, 4 and 10, also 3 and 5. For short waves coil 5 is shorted out and the antenna connected to coil 2. Therefore, 2 is the antenna coil, 4 the grid coil and 10 the plate coil. For long waves coil 3 is the antenna coil, 5 and 4 the grid inductance and 10 plus 11 are the plate coils, the antenna having been switched to coil 3. Plate coil switching is thus entirely eliminated.—*Patent No. 2,052,686*

Object Detector

HERE is a very sensitive device for detection of objects. A gas discharge tube is used in conjunction with an external "antenna" (Fig. 505). The tube should have a diameter of about 1/5 the length for most sensitive results. Argon at about .6 mm pressure is used and a voltage of about 30 impressed between anode and cathode. The external electrode is supplied with 1,000 volts, causing about 1 ampere to flow in the anode circuit, in the discharge state. Spacing between external electrode and tube is decreased until the discharge just

stops. Now any object coming into the field especially between antenna and tube causes discharge to return.

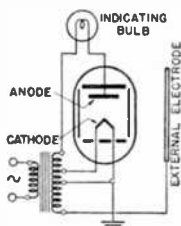


Fig. 505

It is possible to detect objects about 6 ft. away.—*Patent No. 2,089,677*

Space-Charge Receiver

A SPECIAL tube is used in this receiver to operate a speaker, either on radio or records. It is necessary to use a tube whose plate current varies about 20 ma per grid volt. This requires very close grid-cathode spacing, which normally results in difficulties. The tube used (Fig. 506) employs additional grids interposed between cathode and control grid. The inner grid regulates the emission of electrons, the outer grid accelerating them. The screen grid between them is for shielding. The result is a

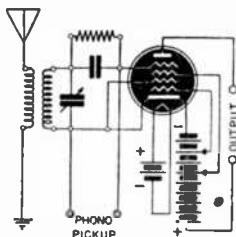


Fig. 506

combined voltage amplifier and power tube.—*Patent No. 2,090,051*

U. H. F. Radio

FOR either receiving or transmitting this circuit (Fig. 507) provides simplicity and efficiency.

The loop is a combined antenna and tuning coil, a sliding contact arm serving as regeneration (or oscillation) control. Z is either headphones, modulating device or

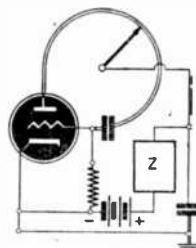


Fig. 507

keyer, depending upon circuit function.—*Patent No. 2,092,069*

U. H. F. Reflector

THIS is an ingenious idea for providing more sharp and efficient radio beam reflection. In Fig. 508 the antenna is placed at the focus F of a parabolic reflector. Note that all radiation within angle AFB does not strike the reflector, destroying the beam effectiveness. Therefore, a reflector, circular in shape, is built in front. Now in order to handle the latter reflections another circular reflec-



Fig. 508

tor is built at the rear replacing the corresponding parabolic section (dotted). Radii of the two circular sections are some odd number of quarter wavelengths so that reflections due to them are reflected back to the antenna. — *Patent No. 2,118,419*

Relaxation Oscillator

GAS discharge oscillators provide great output while vacuum discharge oscillators permit

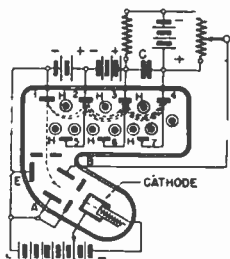


Fig. 509

reaching very high frequencies. This invention combines the advantages of each (Fig. 509). It consists of an electron multiplier device with heated cathode. Normally the beam travels in a straight line striking electrode E, while electrodes A and B deflect it when a suitable e.m.f. is impressed across them.

When condenser C becomes charged, its high voltage causes these plates to deflect the beam which strikes electrode 1, from which secondary electrons are emitted to strike electrode 2, etc. The stream of electrons, greatly multiplied in the last stage (between 3 and 4), causes condenser discharge and the cycle repeats. Magnetic fields at H and static fields at 5, 6, 7 deflect electrons from one electrode to the next.—*Patent No. 2,157,529*

Wide-Band Amplifier

In the u.h.f. bands used for television and FM one of the great difficulties is that of providing wide range amplifiers. In Fig. 510 a wide band of frequencies may be received by using damping

resistors. An r.f. coil and an a.f. coil are in series in the plate circuit. However, the resonant point of each is broadened by the damping parallel resistors, so that a range of 16 cycles to 1 megacycle

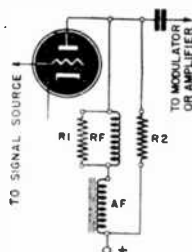


Fig. 510

may be covered.—*Patent No. 2,164,899*

U. H. F. Detection

FOR detection of very feeble u.h.f. voltages it is necessary that even slight changes of capacitance, resistance or inductance in the circuit be avoided, which limits the methods which may be used. In Fig. 511 the r.f. is led directly to a very high resistance filament sealed in a vacuum tube. The slightly heated filament changes the gas pressure and in turn this changes the conductivity of the large filament at the other end of the tube. The resistance of the latter filament may be measured by bridge means.

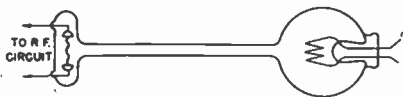


Fig. 511

Note that no disturbing influences react on the r.f. source.—*Patent No. 2,165,726*

Automatic Band Width

WHEN weak stations are being tuned in it is desirable that

the response curve be sharp and of as great amplitude as possible. In this way greater sensitivity and less response to noise is obtained. On the contrary it is better that the curve be broad and of lesser amplitude for reception of powerful signals so that high fidelity and less likelihood of overloading results. In Fig. 512 is an ingenious yet simple scheme for providing these adjustments automatically. Drum D operates on the same shaft as the tuning condenser C. The a.v.c. potential passes through this drum which is made of a semi-conducting material such as agate or marble.

When a certain strength of signal is received the a.v.c. voltage with respect to ground is such that an attractive force is exerted between drum and the belt passing over it, creating friction. Therefore the belt will move one way or the other (against spring action) when the tuning condenser approaches the vicinity of a powerful station. Coil K1 is pivoted at M1 and the shaft A1 is fastened to the belt so that any belt movement will decrease coupling between L1 and K1. Therefore as a strong station comes in the response curve becomes broad and

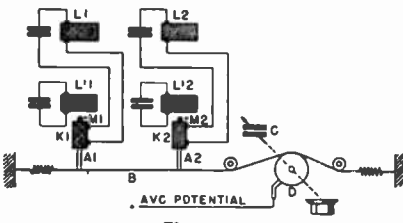


Fig. 512

low, returning automatically to a high, sharp curve as the station is passed. The L1 coils determine a

band-pass circuit, two of which are shown.—*Patent No. 2,245,731*

Modern Coherer

CONVENTIONAL apparatus cannot be used for reception in the centimeter and millimeter

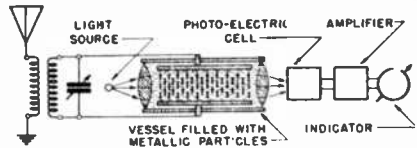


Fig. 513

bands. Here a novel arrangement becomes effective in these ranges. A vessel is filled with tiny metallic particles of high conductivity. They may be kept in suspension either by means of a feeble air current or may float in a suitable medium. The particles are preferably of flat shape and ordinarily assume haphazard directions. However, under the influence of u.h.f. they become dipoles and assume positions as shown in Fig. 513. Their deflection toward the vertical depends upon strength of signal. A source of constant light passes through the tube on to a photocell. Therefore the light is modulated at a rate equal to the modulations of the u.h.f. and the device is a u.h.f. detector. — *Patent No. 2,228,064*

Wide-Range Amplifier

IN resistance-coupled amplifiers the limit of high frequency response is reached due to shunting capacitances of the load and succeeding tube. As shown in Fig. 514, these are C_a due to the tube anode, C_s due to the load, C_e the grid-cathode capacitance of the next tube, and C_z the equivalent capacitance due to the plate-grid

capacitance and load of the following tube. As can be seen, the first three have a certain irreducible

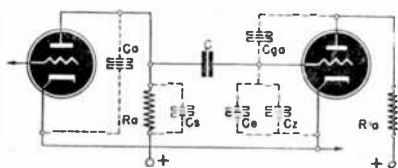


Fig. 514

minimum. The last can, however, be varied and is, in fact, equal to $C_z = C_{ga} (A + 1)$ where A is the amplification of the second tube. By using a negative resistance circuit such as a dynatron or transistor the fourth capacitance can actually be made negative and used to reduce the total of the four. It must be remembered that a negative resistance circuit will serve to make the second tube output voltage in phase with the input.—*Patent No. 2,248,476*

Radio Beam

TRANSMISSION of a course beam may be greatly simplified by the use of the set-up in Fig. 515. Use is made of a high frequency beam which may be reflected by the motor-driven bowl.

Two modulation frequencies are synchronously transmitted so that

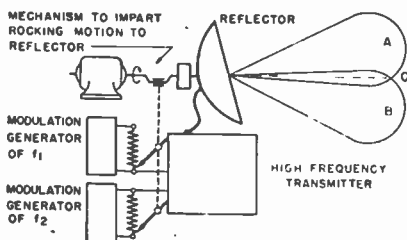


Fig. 515

when the beam is pointing, say at A , one of these tones is transmitted, while the other tone is transmitted

when the beam is in its other extreme position, B . A synchronous potentiometer moves simultaneously with the reflector motor. An aircraft coming in from point A hears one tone, while one coming in from B would hear the other. From the neutral position C , it would pick up an equal amount of each modulation frequency. Direction of flight is thus easily determined.—*Patent No. 2,283,054*

Radio Beam Reception

THE usual loop method of radio signal reception has the disadvantage of difficulty in indicating maximum and minimum. A maximum is not sharp and a null often does not exist due to disturb-

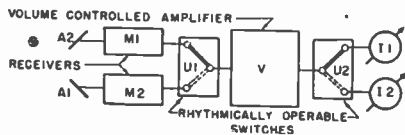


Fig. 516

ing influences. Fig. 516 shows a synchronized switch $U1$ and $U2$ which alternately connects one loop to one indicator and the other loop to the other indicator, the loops being at right angles.

The volume-controlled amplifier is of the usual a.v.c. design except that the time constant is chosen to be equal to the time interval of the switching arrangement. Now assuming the loops operated so that one receives more energy than the other, the a.v.c. will lag by the timing of the switch. Therefore when the weaker signal is received, the gain of the amplifier will be low and vice versa, giving a sharper indication of loop position with respect to the incoming station.—*Patent No. 2,169,742*

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