United States Patent

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[54] **SYSTEMS RANGE CALCULATOR**

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[51] **Int. Cl.** **G06g 7/48,** G06g 7/32
[58] **Field of Search** 235/184, 193

[56] **References Cited**

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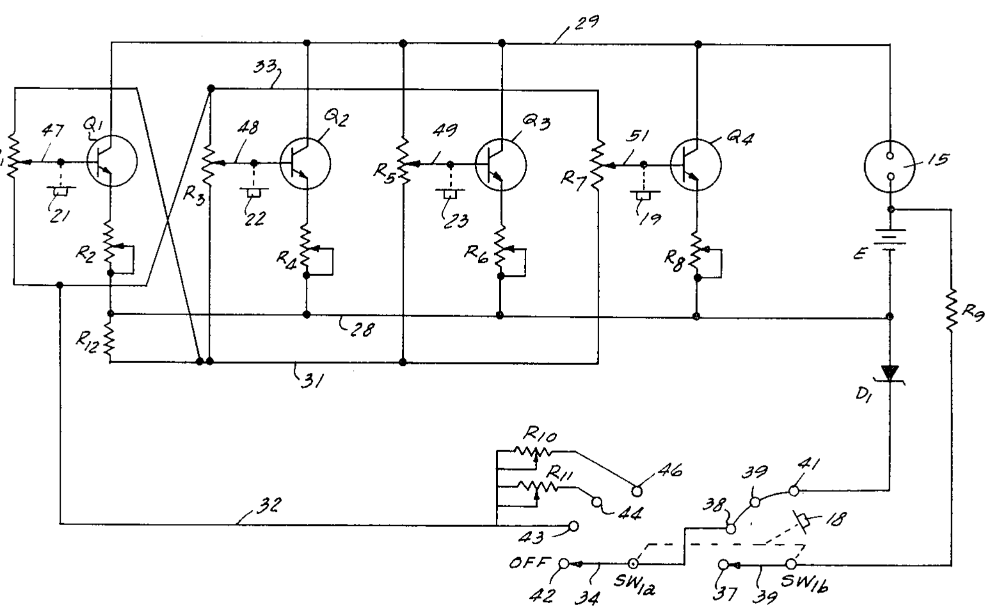
[57] **ABSTRACT**

An analog computer which is very accurate and is capable of calculating results dependent upon a number of independent variables. The independent variables are handled in separate portions of the computer and the outputs of each portion are combined to obtain a solution. The preferred embodiment of the computer disclosed comprises a systems range calculator in which receiver sensitivity, transmitter power, antenna gain, tower height and the frequency of the transmitter may be set to obtain the calculated range of the equipment.

6 Claims, 2 Drawing Figures



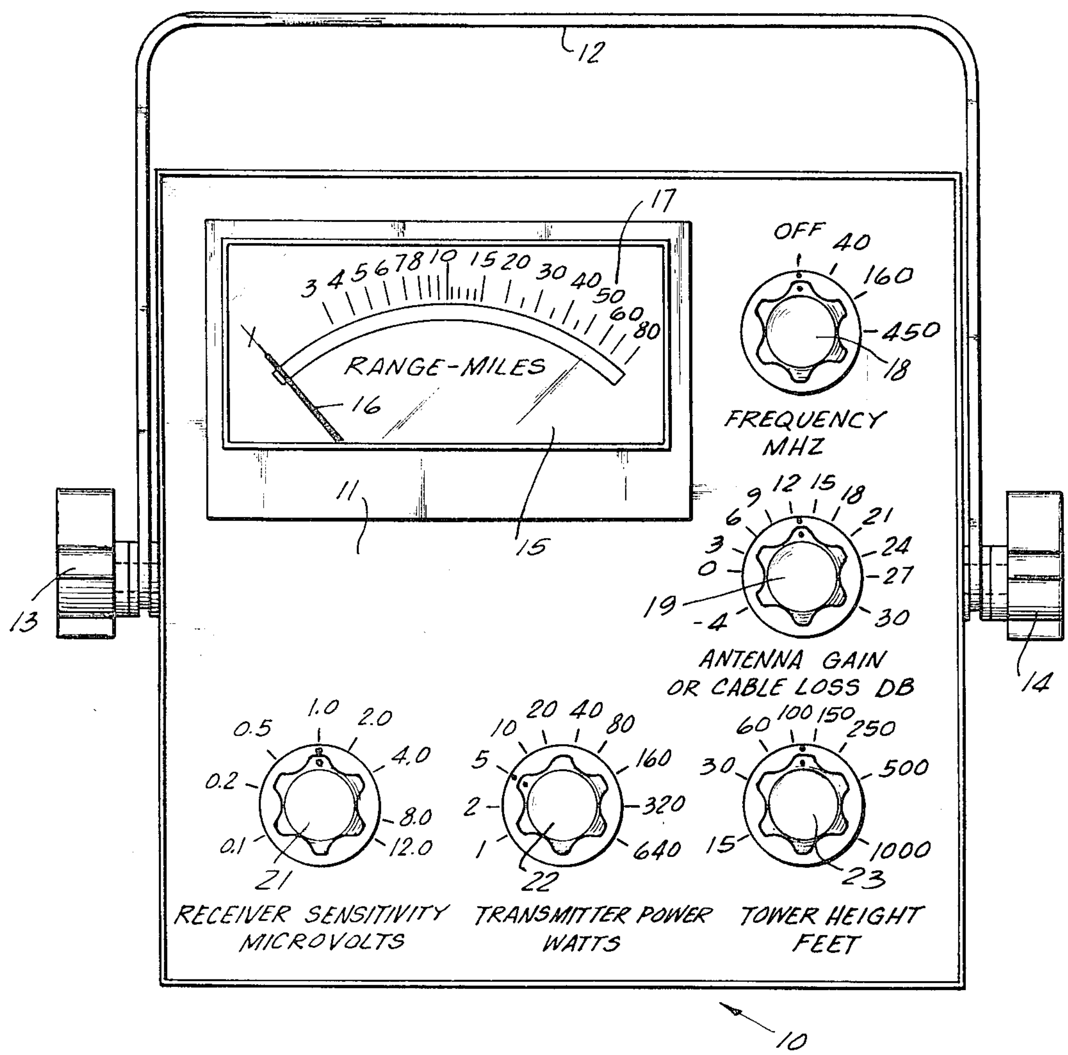


Fig. 1

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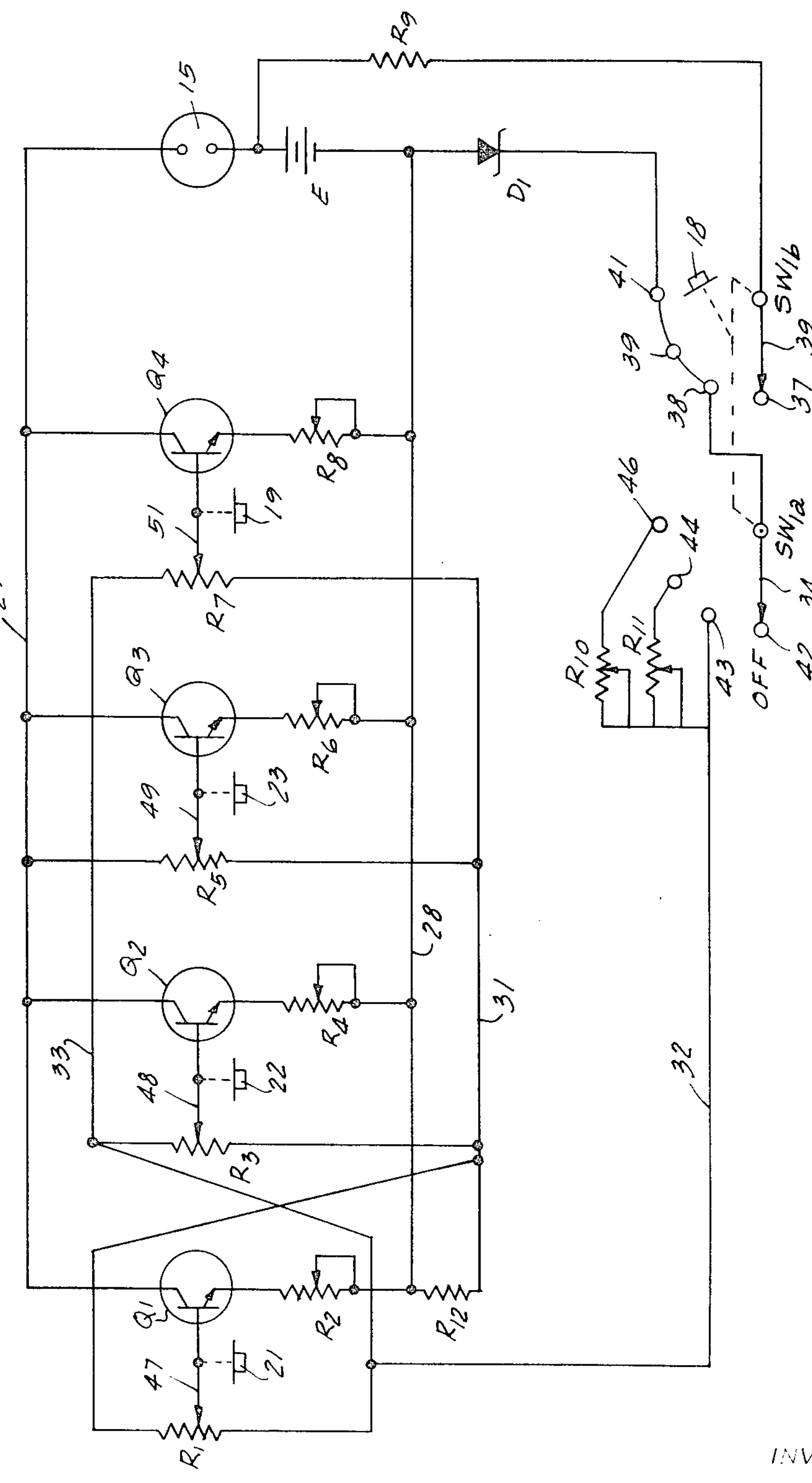

Fig. 2

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SYSTEMS RANGE CALCULATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to analog computers and in particular to an analog computer of inexpensive and simple construction.

2. Description of the Prior Art

In engineering applications it is very often necessary to calculate various results dependent upon various functions. In recent times the trend has been more and more to digital computers which convert all inputs into digital format before processing the information. Most digital computers are relatively expensive in that they contain many components. Although analog computers of various forms have been known for some time, recently there has been a tendency to replace them with digital computers.

SUMMARY OF THE INVENTION

The present invention comprises an analog computer which may be adapted to solve specific problems by setting inputs into certain portions of the computer to obtain desired answers. A reasonably flexible analog computer for desk top applications, for example, and desk top calculation is provided which may be set to solve a number of problems quickly and inexpensively. The computer may be adapted to rapidly calculate any solution having two or more independent and dependent variables and includes a plurality of dials that may be calibrated to set in the various variables of the problem. The preferred embodiment disclosed in this application comprises an analog computer in which the range in miles, for example, of a communications system may be determined. Four emitter-follower transistor stages are provided which are interconnected with potentiometers that may be set to the following input factors: receiver sensitivity, transmitter power, tower height, and antenna gain. The current from the various emitter-follower stages is supplied to a meter which indicates the range of the system. A biasing voltage for the emitter-follower stages may be adjusted by a switch which is calibrated in frequency of the system. The analog computer thus formed will allow personnel to quickly determine the range of a communication system by adjusting the various factors of the system under consideration and then directly read the range of the system on the meter. Although the computer is illustrated as a system range analyzer it is to be realized that many other problems may be solved by this invention.

Other objects, features and advantages of the invention will be readily apparent from the following description of a certain preferred embodiment thereof taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the analog computer of this invention, and

FIG. 2 is a schematic view of the computer of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a preferred embodiment of the analog computer of this invention comprising a systems range analyzer **10** having a case with a front panel **11** and a supporting generally U-shaped handle **12** which may be locked to various angular positions relative to the case by knobs **13** and **14**. A meter **15** has a movable needle **16** which may be read against indicia **17** to indicate the range in miles, for example, of a communication system for which the computer has been set. A knob **18** has an off position and may be set to the frequency in megahertz of the communication system. A knob **19** may be set to indicate antenna gain for the particular antenna of the communication system. A knob **21** may be set to the receiver sensitivity. A knob **22** may be set to the transmitter power and a knob **23** may be set to the tower height.

The radio systems range analyzer of this invention comprises an analog computer for calculating the range of a communications system as a function of many independent variables such as tower height, receiver sensitivity, antenna gain, transmitter power, and the frequency of the communication system. In the present invention the meter **15** may be calibrated in miles and will indicate the range of the communication system under consideration when the knobs **18, 19, 21, 22** and **23** are set to the correct parameters of the system.

FIG. 2 comprises a schematic diagram and illustrates four emitter-follower transistor stages which allow input factors to be set into the computer. Stage Q1 may set in the receiver sensitivity which is controlled by knob **21**. Stage Q2 sets in the transmitter power and is controlled by the knob **22**. Transistor stage Q3 allows the height of the antenna tower to be set in and is controlled by knob **23**. Transistor stage Q4 allows the antenna gain to be set by knob **19**.

The transistor Q1 has a variable resistor R2 connected in its emitter circuit and the other side of the resistor R2 is connected to a lead **28**. The base of transistor Q1 is connected to a wiper contact **47** of a potentiometer R1 which is controlled by knob **21**. One side of potentiometer R1 is connected to lead **32** and the other side is connected to lead **31**. The collectors of all the transistors Q1 through Q4 are connected together and to lead **29** which is connected to one terminal of meter **15**. The other terminal of meter **15** is connected to a voltage source E which has its other terminal connected to lead **28**. A zener diode D1 has its anode connected to lead **28** and its cathode connected to the contact **41** of a switch SW1*b*. Contact **34** of a switch SW1*a* is connected to stationary contact **38** of switch SW1*b*. Switch SW1*b* has a movable contact **39** which can engage any one of the stationary contacts **37, 38, 39** or **41**. Movable contact **34** of switch SW1*a* may engage any of the stationary contacts **42, 43, 44** or **46**. Contact **43** is connected to lead **32**. Contact **44** is connected to a variable resistor R11 which has its other side connected to lead **32**. Contact **46** is connected to a variable resistor R10 which has its other side connected to lead **32**. Lead **32** is connected to lead **33**. Lead **33** is connected to first sides of potentiometers R3, R5 and R7 which have their opposite sides connected to lead **31**.

Potentiometer R3 has a movable contact **48** which is controllable by knob **22**. Potentiometer R5 has a movable contact **49** which is controllable by knob **23**. Potentiometer R7 has a movable contact **51** which is controllable by knob **19**. The wiper contacts **48, 49** and **51**, respectively, are connected to the bases of transistors Q2, Q3 and Q4.

The emitter of transistor Q2 is connected to a variable resistor R4 which has its other side connected to lead **28**. The emitter of transistor Q3 is connected to variable resistor R6 which has its other side connected to lead **28**. The emitter of transistor Q4 is connected to a variable resistor R8 which has its other side connected to lead **28**. A resistor R12 is connected between leads **28** and **31**.

A resistor R9 is connected from the junction point between meter **15** and battery E and the movable contact **39** of switch SW1*b*. The movable contacts **34** and **39** of switches SW1*a* and SW1*b* are controlled by knob **18**.

The meter may be scaled logarithmically with the zero point in the vicinity of 2 miles and the upper limit may represent 80 miles in a 200-microampere meter, for example. This scale would be based on a 15-decibel-per-octave factor for a range which means that each time the range is doubled the signal strength decreases by 15 decibels. On the other hand, each time systems energy factors are increased by 15 decibels such as by increasing the power output or increasing the antenna gain or receiver sensitivity the range would be doubled. When using a 15-db.-per-octave figure, 1 db. represents 2.33 microamperes, or stated differently, 2.33-microampere movement of the meter represents 1 db. increase or decrease in system energy factors.

The four emitter-follower transistor stages represent, respectively, receiver sensitivity, transmitter power in watts, tower height in feet, and antenna gain. Emitter-follower transistors operate so that the applied voltage at the base is duplicated (less the fermi level voltage) across a series resistor in the emitter lead. The potentiometers R1, R3, R5 and R7 are connected across a stable voltage source from the battery E which is stabilized by the zener diode D1 across the resistor R9. The advantages of the present system are that input currents in the microampere range will control hundreds of microamperes of output current. The arrangement of the potentiometers R1, R3, R5 and R7 in the base circuit of the transistors allows zero values to be achieved which is an advantage over a simple series potentiometer in the transistor circuit which would have to be infinite in range in order to achieve zero and current limiting would have to be accomplished with additional resistors in such a system. The emitter-follower system of the present invention allows stable and repeatable performance to be obtained. Each of the emitter-follower systems are placed in parallel with the battery source stabilized by the zener diode D1 and all draw current through the meter **15**.

Transmitter power stage Q2, the tower height stage Q3 and the antenna gain stage Q4 have controls which respond in a positive manner such that increased transmitter output, increased tower height and increased antenna gain each produce increased current in the meter **15** so as to indicate an increased range as the knobs **22, 23** and **19** are rotated in a clockwise direction.

The receiver sensitivity control Q1 when rotated clockwise produces a decrease in receiver sensitivity and therefore this control will be at its maximum setting when rotated counterclockwise to its limit. This is because 1/10-microvolt sensitivity is more sensitive than 1-microvolt sensitivity. For this reason the leads connecting the potentiometer R1 are reversed relative to the potentiometers R3, R5 and R7.

In use, the knob **18** is moved to move the switches SW1*a* and SW1*b* from the off position so that the movable contacts **34** and **39** engage, respectively, one of the contacts **43, 44, 46** or **38, 39** or **41**. It is to be noted that the contacts **38, 39** and **41** and electrically connected together. The movable contact **34** is connected to lead **32** directly or through the resistors R10 and R11. The three contacts **43, 44** and **46** correspond to the frequency of the communication system and might, for example, correspond to 40, 160 or 450 megahertz.

The receiver sensitivity in microvolts is set by knob **21** which may be calibrated, for example, between 0.1 to 12.0. The transmitter power in watts is set with knob **22** which may be calibrated between 1 to 1,000 watts, for example. Knob **23** is set to the tower height in feet which in a particular computer might vary from 15 to 1,000 feet. The antenna gain is set by knob **19** which might vary from –4 to 30 db.

With the settings for the particular system under consideration the needle **16** will indicate on the scale **17** the range in miles of the particular system being considered. It is to be observed as the knobs **22, 23** and **19** are moved clockwise the current through the meter **15** will increase correspondingly respective to increase in transmitter power, tower height or antenna gain. Thus, in use an engineer or salesman can rapidly calculate the range of a particular communication system for a customer by merely setting in the correct parameters of the system and directly reading the system range on the meter **15**.

Although the preferred embodiment is disclosed as a system range analyzer for a communication system it is to be realized that an analog computer in which each dial is calibrated from 0 to 100 could be provided and the data could be set in such a manner that the analog computer could make calculations much faster than some of the standard digital computers presently on the market. Such a computer could be mounted on the desk top and could be very inexpensive. The present embodiment utilizes a current system wherein current from each of the parameters are added before passing through the meter **15**. It would also be possible to utilize a single emmiter-follower having a voltage system to produce an analog computer.

In an actual embodiment constructed in accordance with this invention the following components were used:

Meter	0 to 200 microampere Honeywell-type No. 208 70448–121
Resistors R1, R3, R5, and R7	100K, ½-watt, 20% linear taper CTS No. UH 4817
Resistors R2, R4, R6, and R8	250K-254 L1 Mallory
Resistor R9	820-ohm ½-watt 10% carbon
Resistors R10 and R11	10K-14 L1 Mallory
Resistor R12	2.2K, ½-watt, 10% carbon
Transistors Q1, Q2, Q3 and Q4	Type 2N3393
Zener Diode D1	Type 1N5236
Battery	9-Volt

Although the invention has been described with respect to preferred embodiments it is not to be so limited as changes and modifications may be made therein which are within the full intended scope as defined by the appended claims.

What I claim is:

1. An analog computer for solving functions comprising:
   a first stage having first gain-controlling means which may be set to a particular value of a first variable of a function;
   a second stage having second gain-controlling means which may be set to a particular value of a second variable of said function;
   combining means receiving outputs from said first and said second stages and producing an output which is the solution of said function for the particular values of said variable; and
   wherein said first stage comprises an emitter-follower transistor stage connected in circuit with said combining means and said first gain-controlling means comprises a first potentiometer which has a first variable contact connected to the base electrode of said emitter-follower transistor, and a standard voltage source connected in circuit with said first potentiometer.

2. An analog computer according to claim **1** wherein said voltage source is also connected to said combining means and said first emitter-follower transistor stage.

3. An analog computer according to claim **1**, wherein said second stage comprises a second emitter-follower transistor stage connected in circuit with said combining means and said second gain-controlling means comprises a second potentiometer which has a second variable contact connected to the base electrode of said second emitter-follower transistor, and said standard voltage source connected in circuit with said second potentiometer.

4. An analog computer according to claim **3** wherein said voltage source is also connected to said second emitter-follower stage.

5. An analog computer according to claim **4** comprising first adjusting means connected to the first variable contact and movable in a first direction to increase the gain of the first stage and movable in a second direction to decrease the gain of the first stage and a second adjusting means connected to the second variable contact and movable in the first direction to decrease the gain of the second stage and movable in the second direction to increase the gain of the second stage.

6. An analog computer for solving functions comprising:
   a plurality of stages each having gain-controlling means which may be set to particular values of a plurality of variables of said functions;
   combining means receiving outputs from said plurality of stages and producing an output which is the solution of said function for the particular values of said variables; and
   wherein said plurality of stages each comprise emitter-follower transistor stages and said gain-controlling means comprise a plurality of potentiometers with variable contacts which are respectively connected to the base electrodes of said plurality of emitter-follower transistor stages.

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