Jan. 27, 1942.

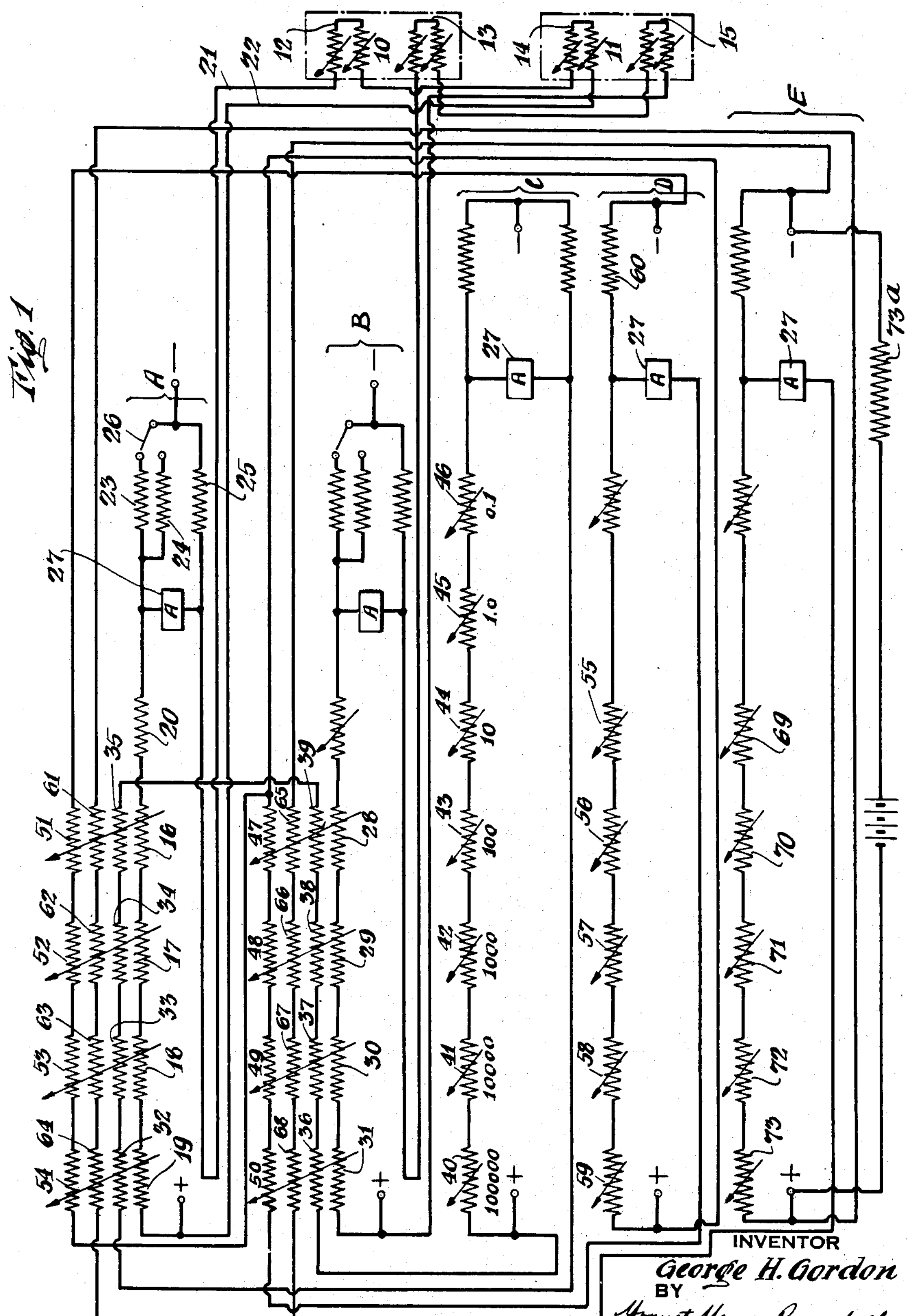
G. H. GORDON

2,271,508

CALCULATING DEVICE

Filed Aug. 4, 1939

4 Sheets-Sheet 1



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Jan. 27, 1942. G. H. GORDON 2,271,508

CALCULATING DEVICE

Filed Aug. 4, 1939 4 Sheets-Sheet 2

Fig. 4

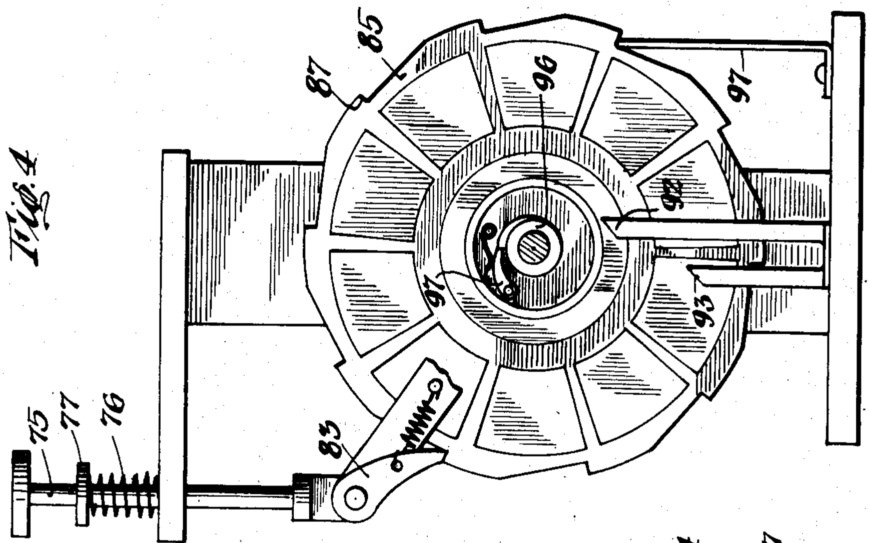


Fig. 3

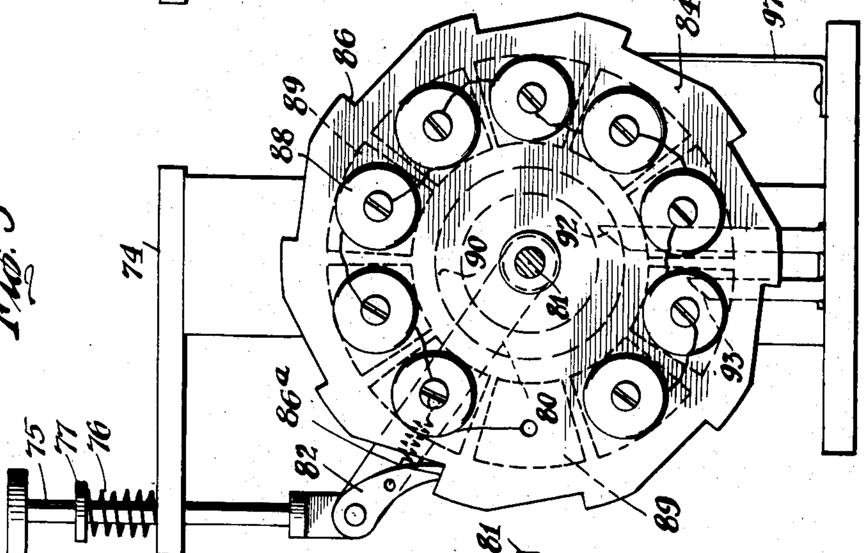
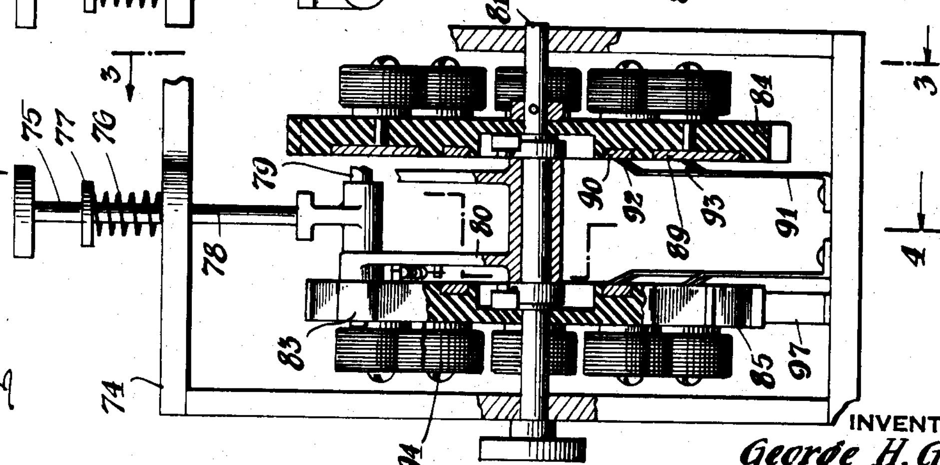


Fig. 2



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Jan. 27, 1942. G. H. GORDON 2,271,508

CALCULATING DEVICE

Filed Aug. 4, 1939 4 Sheets-Sheet 3

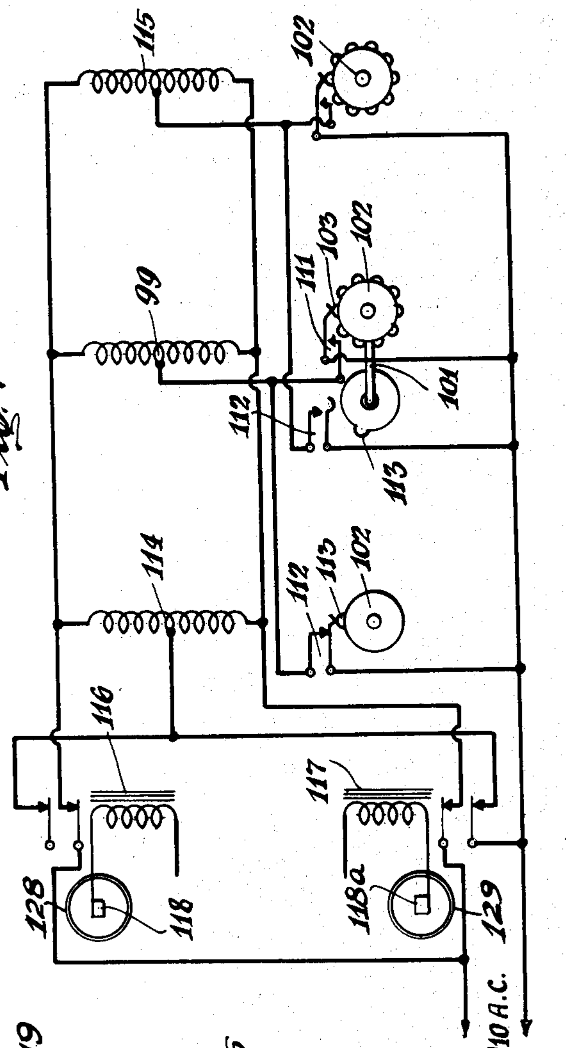

Fig. 7

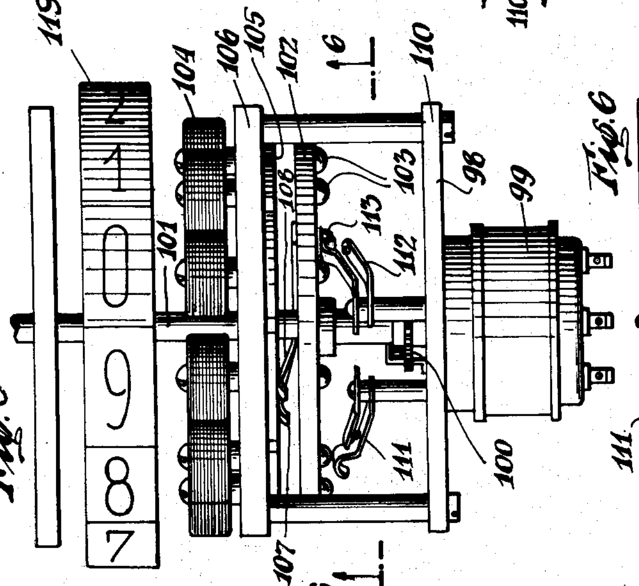

Fig. 5

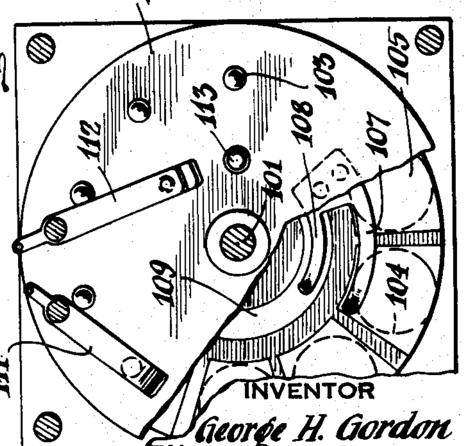

Fig. 6

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CALCULATING DEVICE

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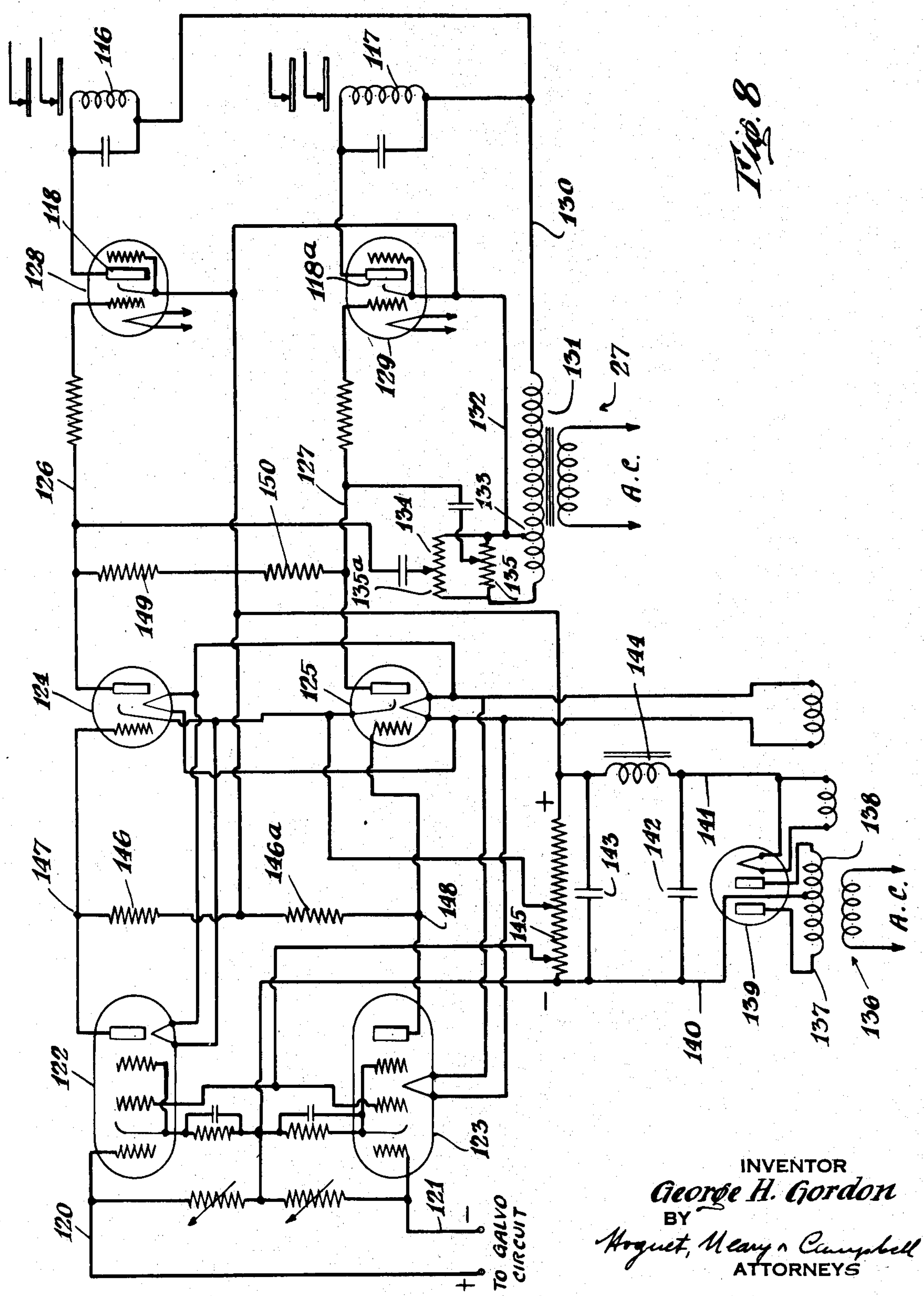

Fig. 8

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UNITED STATES PATENT OFFICE

2,271,508

CALCULATING DEVICE

George H. Gordon, New York, N. Y., assignor, by mesne assignments, to Carter R. Leidy

Application August 4, 1939, Serial No. 288,279

9 Claims. (Cl. 235—61)

This invention relates to calculating devices and has particular reference to devices for totalizing bets, calculating odds and displaying totals and odds at race tracks.

Race track totalizers which have been used heretofore are complicated mechanical and/or electrical mechanisms which include large numbers of selector devices of the type commonly used in automatic telephone circuits as well as relays, gears and the like which render them extremely expensive to manufacture and maintain in operating condition. Complex as these mechanisms are, they require a large personnel to operate them or maintain them in operating condition and to calculate from the totals obtained by the operation of the device the approximate odds on each horse.

The present invention has as an object the production of a calculating device by means of which the grand total of amounts bet on a race, the total amount bet on each horse and the odds on each horse may be calculated without recourse to any manal or mental calculation on the part of the operator of the device. The calculations are made automatically and during the period when the bets are being placed.

Another object of the invention is to provide calculating devices which are capable of adding, subtracting, multiplying and dividing, all of which functions are carried out substantially entirely electrically without the necessity for providing complicated arrangements of gears or other mechanical elements.

A further object of the invention is to provide electrical calculating devices which are accurate, rugged, unaffected by voltage variations and/or temperature change within comparatively wide limitations.

An additional object of the invention is to provide calculating devices which are particularly suitable for use in parimutuel betting and which are compact, portable and are capable of being used without modification at races in which the number of betting stations may be widely varied in accordance with the attendance at the track or the number of horses in the race.

A further object of the invention is to provide registering mechanisms for use with calculating machines which are actuated electrically.

A still further object of the invention is to provide control mechanisms whereby such registers may be operated in response to inequalities in voltages or resistance whereby substantially automatic operation of the registers may be obtained.

Other objects of the invention will be apparent from the following description of a typical form of the device embodying the features of the invention.

In its broadest aspects the present invention utilizes the principles of the well-known Wheatstone bridge in that the calculating system for adding, subtracting, multiplying and dividing is a resistance circuit in which numerical values are represented by resistances of predetermined value. By increasing or decreasing the resistance in the circuit or circuits proportionately to the numerical values, one or more automatic resistance measuring devices located at near or remote points determine the total numerical value represented by the resistances at any instance.

More particularly the invention includes a counting mechanism by means of which the resistance in one arm of a resistance bridge circuit is increased in proportion to the sum or difference of numerical values that are to be determined while in another arm of the bridge the resistance is automatically varied in order to maintain it equal to the resistance in the first arm of the bridge. In response to this equalizing operation, indicators which represent the total value of the resistance in the second arm are actuated and which upon proper calibration may indicate directly the numerical value corresponding to the resistance in the first arm of the bridge or a value proportional to the exact resistance. This principle of operation may be readily utilized in such devices as adding machines and is particularly suitable for use in calculating machines for determining the amounts bet at race tracks and the odds of the various bets.

In a typical form of device, each betting station or booth is provided with one or more devices which can, in step by step relationship and in accordance with the amounts bet, vary the resistance in one arm of a resistance bridge circuit. The resistance bridge is initially balanced with respect to line contact or other inherent resistance in the circuit. As the resistance in the first arm of the bridge is varied, the amounts of current flowing in each arm become unequal and this inequality is utilized to actuate through a thermionic valve circuit an electrically driven mechanism which tends to increase or decrease the resistance in the second arm of the bridge and thereby again bring the bridge into balance.

The balancing means in turn may be utilized to actuate conventional indicating drums or to control circuits whereby indicating means may be displayed to indicate at each instant or at any predetermined time or interval, the values such as, for example, dollars or cents, or any other unit, represented by the resistances in the arms of the bridge.

Resistance bridge circuits similar to that described generally above may be likewise used to determine the ratios between the values of the resistances at each betting station or the amount bet upon each horse whereby the odds may be accurately calculated on each horse.

Likewise, by selectively unbalancing the bridge, ratios, for example, to effect a tax deduction on the total may be obtained.

Similar principles as will be pointed out hereinafter may be utilized in order to provide adding machines or other forms of calculating devices whereby ordinary commercial adding, subtracting, multiplying and dividing can readily be accomplished.

The invention further includes an electrically actuated registering or indicating mechanism which is responsive to variations in the resistance in the bridge circuit and thus can provide a visual indication of the values represented by the resistances in or ratios between the resistances in the bridge circuit. Additionally, the invention includes a novel resistance varying device or counting mechanism whereby resistances representing numerical values may be varied in the circuit.

For a better understanding of the present invention, reference may be had to the accompanying drawings, in which:

Figure 1 is a wiring diagram of a typical form of calculating machine utilizing two adding or betting units;

Figure 2 is a front view partly broken away of a typical form of device for varying the resistance in the bridge circuit in accordance with the amount to be added;

Figure 3 is a sectional view taken on line 3—3 of Figure 2;

Figure 4 is a sectional view taken on line 4—4 of Figure 2;

Figure 5 is a plan view of a combined resistance varying and indicating device which may be used in conjunction with the circuit;

Figure 6 is a side view partly broken away of the device disclosed in Figure 5;

Figure 7 is a diagrammatic circuit showing a circuit of a typical resistance varying and indicating device; and

Figure 8 is a wiring diagram of the electrical control for actuating the resistance varying and indicating device.

The electrical circuit disclosed in Figure 1 of the drawings illustrates a typical two-stage or two-booth betting totalizer in which bets may be placed upon two horses. In each of the booths 10 and 11 is provided resistance varying devices 12, 13, 14 and 15 with the resistance varying devices 12 and 14 being connected in series and forming one arm of a Wheatstone bridge A. The resistance increasing devices 13 and 15 likewise are connected in series and form one arm of a resistance bridge B. Each of the resistance varying devices 12, 13, 14 and 15 is adapted to have the resistance increased therein in steps in which each step may be considered equal, for example, to two dollars. Thus, for each two dollars bet at each of the stations the resistance can be increased by a predetermined fixed amount, for example 5 ohms, or any other predetermined amount, as may be desired, but in any event the value of each dollar is represented by a definite resistance value.

Another opposed arm of the bridge A is formed by a series of variable resistances 16, 17, 18 and 19 which are adapted to be automatically varied to maintain their total resistances equal to the resistances in the devices 12 and 14. An additional resistance 20 is connected in series with the resistances 16, 17, 18 and 19 in order to balance out the resistances of the lines 21 and 22 which connect the resistance devices 12 and 14 in the bridge circuit. In the third arm of the bridge are provided the parallel resistances 23 and 24 which are opposed in turn by a resistance 25 in the fourth arm of the bridge to equalize and balance the bridge. The resistance 24 may have a greater value than the resistance 23 so that when connected in the circuit by means of the switch 26 it effects a deduction from the total resistance required in resistances 16, 17, 18 and 19 to balance up the circuit. Therefore, by means of the resistance 24 it is possible to effect a deduction on the total resistance corresponding to, for example, taxes on the betting or percentage deduction taken by the race track establishment. Current is supplied to the bridge circuit at opposite ends thereof and instead of a galvanometer for determining whether or not the bridge is in balance, a thermionic valve circuit 27, which will be described in detail hereinafter, is provided for controlling electrical means for automatically varying the values of the resistances 16, 17, 18 and 19.

Resistances 16, 17, 18 and 19 may vary in value to correspond to tenths of a dollar, dollars, tens and hundreds of dollars, respectively, so that if actuated sequentially, and step by step, any value can be produced ranging from 10¢ to $999.90, thus giving the device great flexibility and rendering it capable of responding equally to variations in the resistance at the resistance varying devices 12 and 14. It should be understood that while only four such variable resistances 16, 17, 18 and 19 are disclosed that a greater number may be provided in accordance with the top numerical value that may be desired. Accordingly, sufficient number of banks of resistances may be used to provide a reading as high as may be desired, for example, one hundred thousand or one million dollars.

The resistance varying devices 13 and 15 are connected in the bridge circuit B in an identical way and in this circuit the various tenths, units, tens and hundreds banks of resistances 28, 29, 30 and 31 are provided for equalizing the resistances in the arms of the bridge.

In order to obtain a registration of the total amount bet upon each horse, a second bridge circuit is provided in which resistances of equal value to the resistances 16, 17, 18, 19, 28, 29, 30 and 31 are provided and connected in series to form one arm of a bridge circuit C. The resistances 32, 33, 34, 35, 36, 37, 38 and 39 are varied simultaneously and equally with the resistances 16—19 and 28—31, inclusive, and introduce the same resistance into the third bridge circuit C. A plurality of variable resistances 40, 41, 42, 43, 44, 45 and 46 are connected in series to form the opposed arm of the resistance bridge circuit C and are adapted to be varied sequentially in order to provide a total resistance in this arm of the bridge equal to the total resistance as introduced by the resistances 32—39, inclusive. The resistances 46 to 40, respectively.

correspond to tenths, units, hundreds, thousands and one hundred thousands and are adapted to be varied sequentially to represent from zero to 999,999.9. A device 27 which is responsive to voltage variation due to inequality in resistance of the bridge circuit C described above is also provided for actuating electrically driven means to vary the resistance in the bridge and thereby maintain it balanced. Thus, the bridge circuit C is capable of being adjusted into equality with the sum of the resistances interposed in the circuits A and B by varying the resistance in the betting booths by the devices 12, 13, 14 and 15.

In order to obtain the odds on the two horses represented in the booths 12 and 14 and 13 and 15, respectively, additional bridges D and E are provided. In the resistance bridge D one arm of the bridge is represented by resistances 47, 48, 49 and 50 which correspond in value, at any instant, to the resistances 28, 29, 30 and 31. In the same arm of the bridge, but on opposite side of the voltage responsive device 27, are the resistances 51, 52, 53 and 54 which correspond in value, at any instant, to the value of the resistances 16, 17, 18 and 19. In the opposite arm of the bridge D are a series of automatically actuated resistances 55, 56, 57, 58 and 59 which may be varied under the control of the voltage responsive device 27 to indicate the ratio of the value of the resistances 47 to 50, inclusive, to the ratio of the resistances 51 to 54, inclusive, thereby giving directly the profit to be obtained upon a one dollar bet. If it is desired to cause the resistances 55–59, inclusive, to represent the rate on, for example, a two dollar bet the resistance 60 may be given an appropriate value in accordance with the well-known formula for Wheatstone bridges in order to double or double and add the amount bet to the odds indication.

The bridge E is similar to the bridge D with the exception that the relationship of the resistances 61, 62, 63 and 64 are reversed to the resistances 65, 66, 67 and 68 so that the odds on the second horse will be determined by the amount of resistance interposed in the circuit by the variable resistances 69, 70, 71, 72 and 73 in the other adjustable arm of the bridge.

It should be noted that each of the odds and grand totals, bridges C, D and E are controlled by dummy banks of resistors which are separate and distinct from the resistors 16–19, inclusive, or 28, 29, 30 and 31 which are associated with the bridges A and B. Therefore, there is no necessity for providing switches or other means which might result in inaccuracy in operation of the bridge since each bridge operates independently of every other bridge.

In order to assure the accuracy of the various bridge circuits and maintain the desired sensitivity, the bridge circuits may be supplied with current which remains constant despite variation of the resistance in the bridge. This may be accomplished by connecting a ballast resistance 73a in series with the source of current supply, as illustrated in Figure 1 in bridge circuit E. Other equivalent means, such as a thermionic valve circuit may be used, if desired.

While the device has been described with reference to a betting device with two booths for betting on two horses, it will be understood that additional stations may be provided by merely increasing the number of resistance bridge circuits in the device. Likewise, this mechanism can be utilized quite readily as an adding machine by eliminating the odds circuit and by providing a plurality of resistance varying devices similar to devices 12, 13, 14 and 15 which vary in the resistance steps from one through nine and are provided with appropriate resistance values from those corresponding to 1¢ or a fraction thereof to 10, 100, 1000, and so forth. Likewise, when large resistance values may accumulate in the bridge, it is possible to start with a high resistance value in the bridge circuit and deduct resistance so that at the end of an accumulating operation, the total resistance is lowered and the sensitivity of the bridge increased.

With devices of the type described above and at races in which a greater number of horses than three are entered, it is possible to calculate the odds for the horses to show. Means may be provided in the bridge circuits, corresponding to A and B bridge circuits, for reducing the total to one-third of their value, by introducing a resistance of suitable value into the bridge circuits. For example, if there were six horses in the race, three horses would be represented in the show odds. The total values on the remaining horses may be reduced to one-third value and the total bet on each of the winning horses is separately balanced against one-third of the total of the amount bet on the horses which have not won. The resulting ratio gives the show odds on each of the winning horses.

The resistance varying or betting devices may take various forms, one of which, the preferred form, is disclosed in Figures 2 to 4. As shown in Figure 4, each device 12 to 15 includes a framework 74 through which projects a key 75 that is normally retained in an upward position by means of a spring 76 interposed between the top of the framework 74 and a collar 77 on the key stem 78. The key stem is pivotally connected to a shaft 79 which is rotatably mounted in a yoke 80. The yoke 80 is pivotally supported on a shaft 81 which projects through the side elements of the frame 74 and is rotatable therein. On opposite ends of the shaft 79 are fixed pawl members 82 and 83 which are adapted to cooperate with disc elements 84 and 85 which are rotatably mounted on the shaft 81. Each of the discs 84 and 85 is provided with ratchet teeth. The disc 84 is of somewhat greater diameter than the disc 85 and is provided with a series of ratchet teeth 86, all of which are of equal depth, except one, 86a, which is of greater depth. The disc 85 is likewise provided with ratchet teeth 87 which are of lesser height than the base of the ratchet teeth 86 on disc 84 but are of the same depth or distance from the shaft 81 as the bottom of the ratchet tooth 86a on disc 84. Therefore, upon depression of the key 75, the pawl 82 will engage behind a tooth 86 on the disc 84 and rotate it one step. However, because the teeth 87 on disc 85 are of lesser height than the teeth 86, disc 85 will not be rotated until the tooth 86a is engaged by the pawl 82. When this occurs, the pawl 83 can move into engagement with one of the teeth 87 and rotate the disc 85 one step. Thus, if there are ten teeth on disc 84 and an equal number of teeth on disc 85, it will require ten complete revolutions of disc 84 to rotate disc 85 one complete revolution.

The disc 84, as illustrated, is provided with a series of nine fixed resistances, each of a value corresponding to some numerical value. Thus, each of the resistances 88 may have a value of 5 ohms and may represent two dollars or one dollar, as desired, and inasmuch as they are connected in series, the total value of the resistance that may be interposed by rotation of the disc will be 45 ohms. Each of the resistances 88 is electrically connected to a commutator segment 89 which is disposed on the inner face of the disc 84. An annular commutator segment 90 is disposed concentrically within the commutator segments 89 and is connected at all times with one of the commutator segments 89 by means of a commutator brush 91 of split form having one finger 92 continuously engaging the commutator ring 90 and another finger 93 engaging one of the commutator segments 89. The disc member 85 is similarly constructed with the exception that the resistances 94 have a value of ten times the value of the resistances 88. Thus, assuming that the value of the resistances 88 is 5 ohms, as the disc 85 is rotated step by step, each step will introduce an additional 50 ohms into the circuit so that with this construction a total of 99 steps introducing a total of 495 ohms into the circuit may be taken before both of the devices are rotated to zero position, when the brush finger 93 contacts the blank segment 95 which introduces no resistance into the circuit. With this construction, it is thus possible to start with an initial resistance equivalent to zero in so far as the bridge circuit is concerned and vary it through ninety-nine steps to a maximum resistance. It will be understood that the number of commutator segments may be varied widely and that a greater or lesser number of resistances may be provided as may be desired and that the number of discs like 84 and 85 may also be varied to permit a greater or lesser number of steps to be introduced by actuation of a single key. Thus, this construction may be widely varied without departing from the basic construction.

In order to return the discs to zero resistance position, the shaft 81 may be provided with a cam element 96 which upon rotation in counter-clockwise direction, as viewed in Figure 4, will engage a pawl 97 pivotally mounted on the inner face of each of the discs 84 and 85, thus permitting rotation of the discs back to the starting or initial position.

Retrograde turning of the discs 84 and 85 is avoided by means of spring fingers 97 which engage the teeth 87 and 86 of the discs 85 and 84, respectively.

As indicated above, the resistances 16, 17, 18 and 19 as well as the associated resistances in the bridge circuits C, D and E, the resistances in the bridge circuit B and associated resistance are varied electrically in order to maintain the various bridge circuits in balance. In Figures 5 to 7 are disclosed a typical form of device and a circuit for varying these resistances as well as indicating numerical values corresponding to the resistances or the ratios of the resistances in the bridge circuits.

In Figure 5 is disclosed a resistance varying device which consists of a frame 98 on which is mounted a reversing motor 99 which through reduction gears 100 drives a main drive shaft 101 which is rotatably mounted in the sides of the frame 98. Fixed to the shaft 101 is a disc member 102 which is provided with a plurality of protuberances 103 exceeding by one the number of fixed resistances 104 which are mounted on one side of the frame 98. The resistances 104 are connected in series and their individual and total values may correspond to the value of any of the variable resistances in the bridge circuits A, B, C, D and E, for example, the individual and total resistances of the variable resistance 17 in bridge circuit A. Each of these resistances is electrically connected to a commutator segment 105 on the inner face of the face plate 106, which is engaged by a switching brush 107 carried by the disc 102. The brush 107 is provided with a finger 108 which engages a commutator ring 109 also carried by the disc 102 and thus affords an electrical connection between these two elements. A suitable contact brush, not shown, may also form an electrical connection between the commutator segment 95, so that upon rotation of the disc 84 the resistances 104 are successively connected in series. The switching brushes 107 may be connected in series so that the resistances interposed by rotation of the discs 84 and 85 are accumulative. Thus, as the disc 102 rotates, it progressively increases the resistance in the bridge circuit in a step by step fashion and in proportion to the value of the resistances 104.

Mounted on the back plate 110 of the frame 98 are the switches 111 and 112. The switch 112 cooperates with a protuberance 113 on the disc 102 so that the switch 112 is closed once during a short interval as the protuberance 13 passes from 9 to 0 position for each complete revolution of the disc 102. The switch 111 is normally closed but is adapted to be opened to break the circuit when one of the protuberances 103 comes in contact with one of the elements of the switch 111 as the disc moves from one portion to the next. Thus the switch 111 is adapted to be opened, in the form of the invention illustrated, ten times during each revolution of the disc 102. Referring now to Figure 7 which illustrates the electrical connections between three of the devices shown in Figures 5 and 6, it will be noted that the motor 99 and the other two motors 114 and 115 are adapted to be energized to rotate in one direction or the other by means of a relay 116 or a relay 117 which is energized in response to discharge of electronic valve tubes, the plates 118 and 118a of which are shown. Assuming that the relay 117 is actuated in response to discharge of the electronic valve tube, a circuit is closed through the winding of the motor 114 which corresponds to motor 99 and the disc 102 is driven. Upon one complete rotation of this disc the normally open switch 112 is closed, thus completing a circuit through the winding of the motor 99 and driving the shaft 101. At the position corresponding to zero position or no resistance of the disc 102 which is driven by motor 99 the switch 111 will be open. Momentary closing of switch 112 which bridges across the contacts of switch 111 as the disc 102 moves from 9 to 0 position, energizes the motor 99 and causes it to rotate while the protuberance 113 on the disc 102 which is driven by motor 114 opens the circuit. However, by this time the switch 111 has closed since the protuberance 103 on disc 102 is driven by motor 99 has moved out of engagement with the switch 111 and thus the motor 99 continues to run until the switch 111 is again opened by the succeeding protuberance 103. This step by step rotation of the disc 102 by motor 99 continues without operation of motor 115 until the protuberance 113 which is driven by motor 99 closes the switch 112 associated therewith. Upon closing of the switch 112 the motor 115 is energized and the disc 102 driven thereby is moved forward one step. Thus this arrangement of the motor and switches acts similarly to a Geneva movement in a mechanical register in that the lowest valve disc may rotate intermittently or continuously while the higher value discs are rotated one step for each complete revolution of each successively lower value disc. Reversal of the motors 114, 99 and 115, by actuation of the relay 116, permits deductions to be made.

This operation of the switching mechanism for varying the resistances in the arms of the bridge to maintain the bridges in balance may likewise be utilized to indicate the various totals or odds at any instant. In its simplest form, the indicating means may consist of an indicating drum or wheel 119 bearing numerals from 0 to 9 which is mounted on the shaft 101 and rotates with the disc 102.

The shaft 101 may be extended in order to include a series of commutator and resistance devices similar to the elements 104, 105 and 109 which are disclosed in Figures 5 and 6 in order to provide for switching of the various resistances in the dummy banks of resistances in the bridges A and B to correspond to the values of the resistances 16—19 and 28—31 and common source of power and thus assuring that each of these banks of resistors and associated switching arrangements are maintained at equal value at all times.

The resistance varying and indicating device described above is actuated by the thermionic valve circuit 27 which is responsive to voltage variations in the opposed arms of the bridge. A typical circuit 27 for controlling the resistance varying and indicating device is disclosed in Figure 8. In this circuit the signals from the bridge are fed to the input terminals 120 and 121 of a balanced two stage direct current amplifier of conventional type, comprising the first stage tubes 122 and 123, the second stage tubes 124 and 125 and their associated circuits, as shown in Figure 8. The output of the amplifier is supplied from the output terminals 126 and 127 to the control grids of a pair of thyratron tubes 128 and 129, respectively, in the plate circuits of which are located the relays 116 and 117, respectively, for operating the bridge motors.

Alternating current is supplied through a conductor 130 to the plate circuits of the thyratron tubes 128 and 129 from a transformer 131, the primary of which is connected to an alternating current source. The cathodes of the thyratrons 128 and 129 are tied together and are connected through a conductor 132 to a tap 133 on the secondary winding of the transformer 131, thus completing the circuit.

The grid of thyratron tube 129 is provided with bias voltage from a voltage divider 134, one end of which is connected to the secondary terminal 135 of the transformer 131, the other end being connected to the tap 133. Likewise, bias voltage for the thyratron tube 128 is provided by a voltage divider 135a which is connected in parallel with voltage divider 135.

Direct current voltage for the amplifier may be obtained from a conventional rectifier-filter circuit which includes a transformer 136, the primary of which is connected to an alternating current source. The secondary terminals 137 and 138 of the transformer 136 are connected to the plates of a full-wave rectifier tube 139, providing a pulsating D. C. voltage across the conductors 140 and 141. The pulsating D. C. voltage is filtered in the conventional manner by a filter circuit including the shunt condensers 142 and 143 and a series inductance 144 providing a continuous D. C. voltage across the bleeder resistor 145, which is tapped to supply the necessary grid bias and plate voltages for the amplifier tubes 122, 123, 124 and 125.

When the bridge is balanced, zero voltage exists across the amplifier input terminals 120 and 121, and the currents flowing in the plate circuits of the input tubes 122 and 123 are of equal magnitude. Since these plate currents flow through the plate resistors 146 and 146a, respectively, the votlage drops across these resistors are also of equal magnitude, but they are opposite, so that no signal is applied to the grids of the tubes 124 and 125, and both of the relays 116 and 117 are inoperative.

However, if the bridge is unbalanced, and the signal voltage impressed across the input terminals 120 and 121 of the amplifier is of such polarity that terminal 120 is positive and terminal 121 is negative the following operation will take place. It will be apparent on inspection of the amplifier circuit that this will decrease the negative bias on the tube 122 so that the current flowing in its plate circuit will increase. Inasmuch as the plate current flows through the plate resistor 146, the voltage drop across the resistor will increase.

Meanwhile, the tube 123 is biased more negatively by the voltage impressed on the terminals 120 and 121, so that the current in its plate circuit is reduced, and the voltage drop across its plate resistor 146a is correspondingly reduced. Thus a D. C. voltage now exists across the terminals 147 and 148 which is the algebraic sum of the voltages across the plate resistors 146 and 146a.

This voltage is impressed across the grids of the tubes 124 and 125, producing similar changes in the voltage drops across the plate resistors 149 and 150 with the result that the voltage output at the amplifier terminals 126 and 127 is substantially greater than the voltage impressed on the input terminals 120 and 121.

The polarity of the amplified voltage is such that the output terminal 126 is positive and terminal 127 is negative. The application of this amplified voltage from the output terminals 126 and 127 to the grids of the thyratron tubes 128 and 129 causes the tube 128 to ignite, permitting current to flow through the relay 116 and operating the bridge motor 99 for inserting resistance in the bridge. When the bridge has been restored to balance, the voltage at the input terminals 120 and 121 of the amplifier will be brought to zero, thus extinguishing the thyratron tube 128, deenergizing its relay 116, and stopping the bridge motor 99.

It will be readily apparent on inspection of the amplifier circuit, that if the polarity of the voltage impressed on the amplifier input terminals 120 and 121 is such that terminal 121 is positive and terminal 122 is negative, thyratron tube 129 will be ignited, causing plate current to flow through relay 117 and energizing motor 99 for subtracting resistance from the bridge. When the bridge is again balanced, the thyratron tube 129 will be extinguished, thus deenergizing the relay 117 and stopping the motor 99.

Summarizing the operation of the device briefly, when a key at one of the stations 10 or 11 is depressed, controlling for example the resistance of device 12, the resistance in one arm of the bridge A is increased by rotation of the disc 85. Similarly, if one of the resistance devices, for example device 13, is actuated to increase the resistance in the bridge B, this bridge is rendered unbalanced. When the bridges A and B are rendered unbalanced, the signal voltages impressed upon the amplifiers A associated with each bridge at the input terminals 120 and 121 thereof are varied from equality and the voltage will be rendered positive at terminal 120 and negative at terminal 121. This unequal or voltage condition causes the thyratron tube 128 to ignite, actuating the relay 116 and causing the motors 99 to operate, thereby increasing the value of one or more of the resistances 16 to 19 of bridge A and one or more of the resistances 28 to 31 of bridge B. The corresponding indicating drums are rotated at the same time to indicate the numerical value represented by the resistances in the bridges A and B.

The members 99 also drive variable resistances in the arms of bridges C, D and E and these bridges will become unbalanced.

In the bridge C, the resistances 32 to 39 in one arm thereof are connected in series and inasmuch as they correspond to the resistances 16 to 19 and 28 to 31, the increase in value of the resistances 32 to 39 corresponds to the total increase in resistance of the resistance devices 12, 13, 14 and 15. The bridge C, therefore, is the grand totals bridge and being unbalanced, will actuate the amplifier relay A to cause the motor driven register disclosed in Figs. 5, 6 and 7 to increase the value of the resistances 40 to 46, thereby bringing the bridge C into balance and indicating the grand total.

The odds bridges D and E are rendered unbalanced by the balancing of bridges A and B unless equal amounts are bet at stations 10 and 11, for the reason that the resistances 51 to 54 correspond to the resistances 16 to 19 and the resistances 47 to 50 correspond to the resistances 28 to 31. The bridges D and E, being ratio bridges, are brought into balance, if unbalanced, by the resistances 55 to 59 and 69 to 73 respectively, which are varied in resistance by means of the amplifier relays A and the motor controlled register disclosed in Figs. 5 to 7, as described previously. The indicating drums 119 of the motor registers will indicate the ratios of the amount bet on the horses, thus providing odds, or if desired the profit on each dollar bet on a horse, depending upon the presence and value of the resistances 60 in bridges D and E.

Thus, the device is capable of indicating grand totals, horse totals and odds or profits on each bet.

From the foregoing it will be apparent that devices of the type described above are capable of automatic operation to add, subtract, divide or multiply and that a simple construction has been provided which is particularly suitable for pari-mutuel betting.

It will be understood, that other equivalent devices may be substituted, in part or wholly, for the indicating and resistance varying devices and that other variations may be made in the device without departing from the invention. Accordingly, the above described embodiments of the invention should be considered as illustrative, only, and not as limiting the scope of the following claims.

I claim:

1. A calculating device comprising a resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said bridge circuit in equal amounts corresponding to a unit of numerical value, means for varying the resistance in another opposed arm in amounts corresponding to said unit of numerical value, a second resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said second bridge circuit in equal amounts corresponding to said unit of numerical value, means for varying the resistance in another opposed arm of the second bridge circuit in amounts corresponding to said unit of numerical value, means responsive to inequalities in each of said bridge circuits for actuating the means for varying the resistance in the said another arms of said first and second bridge circuit to equalize the resistances in the arms of said bridge circuits; a third bridge circuit having opposed arms, means actuated by the means responsive to inequalities in each of said first and second bridge circuits for varying the resistance in one arm of the third bridge circuit to maintain it equal to the sum of the resistances in said other arms of said first and second bridge circuits, means for varying the resistance in another opposed arm of said third bridge circuit, means responsive to inequalities in resistance in the arms of the third bridge circuit for actuating the means for varying the resistance in said another arm to equalize the resistances in said arms.

2. The devices set forth in claim 1 comprising indicating means associated with each of said bridge circuits actuated in response to variation in the resistance in said other arms of said bridges for indicating the units of numerical value corresponding to said resistance.

3. A calculating device comprising a first resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said bridge circuit in progressively equal amounts corresponding to a predetermined unit of numerical value, means connected between said opposed arms responsive to inequalities in the resistance in the arms of said bridge circuit for varying the resistance in another arm of said bridge circuit to equalize the resistance in said arms; a second resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said second bridge circuit in amounts corresponding to said unit of numerical value, means connected between said opposed arms of said second bridge circuit responsive to inequalities in the arms of said second bridge circuit for varying the resistance in another arm to equalize the resistance in the arms of said second bridge circuit; a third resistance bridge circuit having opposed arms, means including the means for varying the resistances in said another arms of said first and second bridge circuits for varying the resistance in one arm of said third bridge circuit to equal the sum of the resistances in said other arms of said third bridge circuit and means for equalizing the resistances in said one and said another arms of said third bridge circuit.

4. The device set forth in claim 3 comprising separate indicating means associated with each bridge circuit, and actuated in response to operation of the means for varying the resistances of said other arms for indicating the corresponding numerical value of the resistance in said one arm of each bridge.

5. The calculating device set forth in claim 3 comprising a fourth resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said bridge circuit to render it equal to the resistance in said another arm of said first bridge circuit, means for varying the resistance in the other arm of said fourth bridge circuit to render it equal to the resistance

in said another arm of said second bridge circuit, and means for determining the ratio of the resistances in the arms of said third bridge circuit.

6. A calculating device comprising a first resistance bridge circuit having opposed arms, means for varying the resistance in one arm of said circuit in amounts corresponding to units of numerical value, means for varying the resistance in an opposed arm of said circuit to equalize the resistances in said opposed arms, a motor for actuating the last-named means, a relay circuit responsive to inequalities in resistance in said circuit for actuating said motor; a second bridge circuit having opposed arms, means for varying the resistance in one arm of said second circuit in amounts corresponding to units of numerical value, means for varying the resistance in an opposed arm of said second circuit to equalize the resistances in said opposed arms, a motor for actuating the last-named means, a relay circuit responsive to inequalities in resistance in said second circuit for actuating said motor, and a third bridge circuit having opposed arms, means connected in series actuated by said motors for varying the resistance in one arm of said third circuit to correspond to the sum of the resistances in said another arm of said first and second circuits, means for varying the resistance in another arm of said third circuit, a motor for actuating the last-named means, and a relay circuit responsive to inequalities in the resistances in the opposed arms of said third circuit for controlling said third circuit motor to equalize the resistances in said arms, and separate indicating means actuated by each of said motors for displaying the numerical values corresponding to the resistances in the arms of said bridges.

7. A calculating device comprising a first Wheatstone bridge circuit, means for increasing the resistance in one arm of said bridge circuit step by step, means including a motor responsive to the increase of the resistance in said one arm for increasing the resistance in an opposed arm of the bridge circuit step by step to equalize the resistances in said arms; a second Wheatstone bridge circuit, including means for increasing the resistance in one arm of said second circuit step by step, means including a motor responsive to the increase of resistance in said one arm of said second circuit for increasing the resistance in an opposed arm of said second circuit; and a third bridge circuit including means actuated by said motor for increasing the resistance in one arm of said third circuit proportionately to the increases in resistances in said one arms of said first and second bridge circuits and means including a motor responsive to the increase in resistance in said one arm of said third circuit for equalizing resistances in said arms.

8. The calculating device set forth in claim 7 in which the means including a motor responsive to the increase in resistance in said one arm comprises thermionic amplifying means, and a relay circuit for starting and stopping said motor controlled by said amplifying means.

9. The calculating device set forth in claim 7 comprising a separate indicator calibrated in numerical values corresponding to the resistances in said another arms of said bridge circuits actuated by each of said motors.

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