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SERVOMOTOR RECORDING SYSTEM

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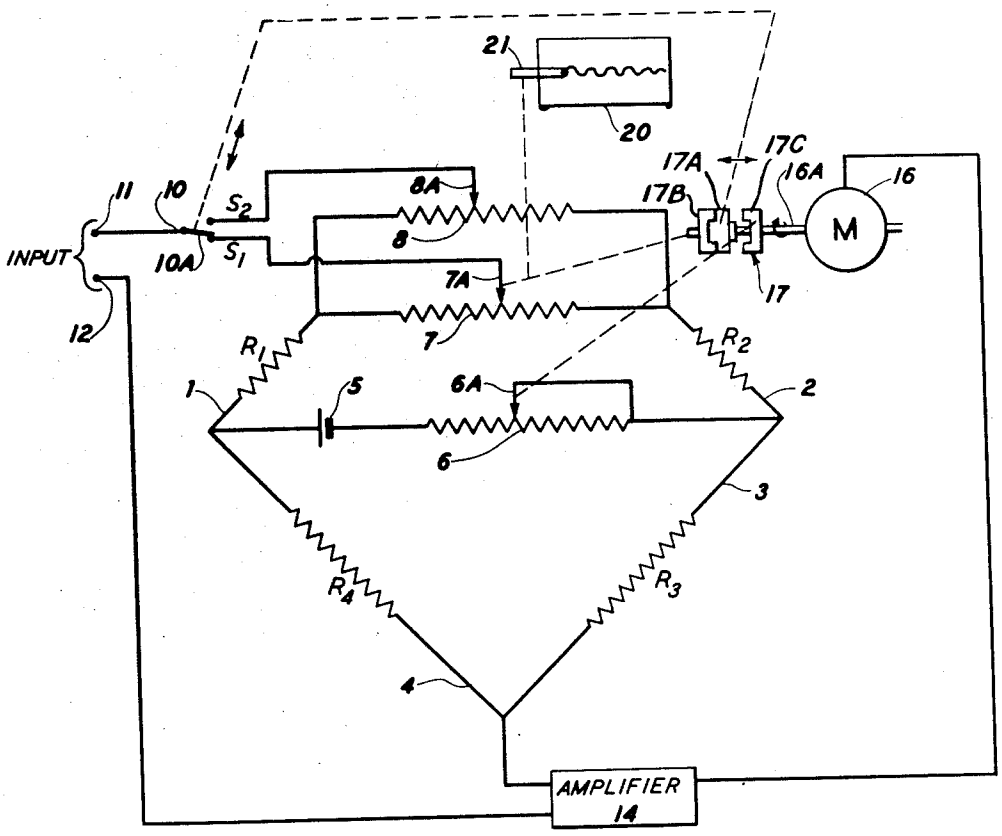

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SERVOMOTOR RECORDING SYSTEM

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This invention relates to a recording system and more particularly to a self-calibrating recording system adaptable to standardization at any desired predetermined level.

In many recording applications it is the overall sensitivity of the system with which the recorder is associated and not just that of the recorder alone which is of importance. Also, it is frequently desirable to standardize such systems to a predetermined level and to even vary the level of standardization from time to time. One example of such a system is a continuous monitoring mass spectrometer in which it is desired to compare the concentration of one or more components in a process stream with the known concentration of the same component or components in a standard sample.

This invention contemplates in a resistance bridge type recorder having a first potentiometer connected between adjacent bridge arms, and a variable resistor connected between opposite bridge terminals, the combination comprising a second potentiometer connected in parallel across the first potentiometer, and means for adjusting the setting of the variable resistor to balance the bridge at any desired setting of the second potentiometer.

More specifically the recording system of the invention comprises a resistance bridge, first and second parallel coupled adjustable tap potentiometers connected between adjacent bridge arms as one bridge terminal, a voltage source and a serially connected adjustable tap variable resistor connected across the bridge between second and third bridge terminals, a switch having a switch arm and separate contacts connected to each of the taps of the first and second potentiometers, an amplifier connected to the fourth bridge terminal, the input signal to be recorded being connected between the switch arm and the amplifier, a motor connected to be driven as a function of the output of the amplifier, a clutch connected to separately connect the motor to drive the taps of the first potentiometer and the variable resistor, and means operating the clutch responsive to the setting of the switch.

The second potentiometer in the above described apparatus may be set at any value with the switch connected to the adjustable tap thereof, whereupon the motor drives the tap of the variable resistor through the clutch and responsize to any unbalance output of the amplifier to balance the bridge at the particular setting of the second potentiometer. When a signal representing an unknown parameter to be measured is applied through the switch to the tap of the first potentiometer, the resultant unbalance of the bridge again actuates the motor through the amplifier to adjust the tap of this first potentiometer, the clutch being selectively actuated for this purpose by the change in switch setting. The excursions of the tap of the first potentiometer are recorded as the value sought.

The invention will be more clearly understood with reference to the following detailed description taken in conjunction with the accompanying drawing which is a

schematic circuit diagram of a recorder in accordance with the invention.

Referring to the drawing, the recorder comprises the four element resistance bridge including arms **1**, **2**, **3**, **4**, each including respective resistance elements R_1, R_2, tR_3, R_4. A voltage source **5** and a variable resistor **6**, having an adjustable tap **6A** connected to tap off a variable portion of the total resistance, are connected between opposite terminals of the bridge formed respectively at the junction of bridge arms **1** and **4** and bridge arms **2** and **3**. A potentiometer **7** having an adjustable tap **7A** is connected between bridge arms **1** and **2**, the tap **7A** constituting one terminal of the bridge. A second potentiometer **8** having an adjustable tap **8A** is connected across the first potentiometer **7**, the two potentiometers being connected in parallel between the two identified bridge arms.

A switch **10** includes a switch arm **10A** connected to terminal **11** of a pair of input terminals **11**, **12** and selectively to one or the other of contacts S_1 and S_2, switch contacts S_1, S_2 are connected respectively to adjustable taps **7A**, **8A** of the potentiometers **7** and **8**. An amplifier **14** is connected at its input to the fourth bridge terminal formed by the junction of arms **3** and **4** and to the other input terminal **12**. A motor **16** is connected to the output of amplifier **14** and is driven responsive to the output of the amplifier.

Motor **16** includes a drive shaft **16A** connected to a double-clutch, indicated generally at **17**. The clutch includes a drive member **17A** keyed to the shaft **16A** and movable into engagement with one or the other of two driven members **17B** and **17C**, which are respectively connected to the tap **7A** of the potentiometer **7** and the tap **6A** of the variable resistor **6**. The drive member **17A** is linked to the switch arm **10A**, whereby the clutch drive member **17A** is shifted into engagement within one or the other of the driven members **17B** and **17C**. When the switch is connected through contact S_1 the clutch connects motor drive shaft **16A** to adjustable tap **7A** of potentiometer **7**, and when the switch is connected through contact S_2 the clutch is selectively controlled to connect motor drive shaft **16A** to tap **6A** of variable resistor **6**. A conventional strip chart recorder **20** including a pen **21** is mechanically coupled to adjustable tap **7A** of potentiometer **7** so that the pen records the excursions thereof.

The operation of the recorder as illustrated and described, as might be employed to sense and record the output of a process monitoring mass spectrometer, is as follows: With input switch **10** in the S_1 position, the signal to be measured is applied across the bridge between potentiometer tap **7A** and amplifier **14**. Any variation in the input signal varies the bridge balance producing an unbalance voltage at the amplifier input. This unbalance voltage, as amplified, drives motor **16**, which, in the indicated switch position, is connected through clutch **17** to tap **7A** to vary the setting of this tap to return the bridge to balance. Any variation in the setting of the tap **7A** is recorded on chart **20**. Bridge balance is, of course, a function of the setting of tap **6A** of the variable resistor **6**.

As is conventional in the operation of a process monitor mass spectrometer, a so-called standard gas containing the components of interest in known concentration is periodically admitted to the instrument. With the recording system of the invention, the input switch **10** is thrown to the S_2 position during such standardizing operation, whereby a mechanical linkage between clutch **17** and tap **6A** of variable resistor **6** is completed. Potentiometer **8** has been, or is, manually set at a point corresponding to the indication which the instrument is desired to show on the standard gas in question. The difference be-

tween the mass spectrometer signal developed with the standard gas and the output of potentiometer 8 appears across the amplifier 14 and through the servo motor linkage drives tap 6A to cause the difference between the two signals to be substantially zero. By this means the sensitivity of the recorder is adjusted to compensate for changes in sensitivity of the entire system including the mass spectrometer.

By means of the parallel coupled potentiometer 8, standardization can be effectuated to any predesired level whereby the recorded trace can be made to fall at any desired place on the chart for any given value of the parameter to be measured.

Although described in its operation in conjunction with a mass spectrometer, the system is applicable to any recordable situation in which it is desired to standardize to a present level including temperature measurement, rate of flow, gravity, an the like, and has the very important feature of compensating for sensitivity changes in the recorder as well as in the system sensing the parameter under investigation.

This system of recording can be extended to a multiple channel instrument if desired by the inclusion of additional parallel coupled potentiometers, i. e. further duplications of potentiometer 8, and by parallel connection of a plurality of variable resistors replacing the single resistor 6 as illustrated. Such multi-channel operation requires a clutch operable to make the selective interconnections necessary. Duplication of the identified elements and as requiring a clutch of increased versatility is an obvious expedient from the illustrated and described single channel embodiment.

As an example of the relative resistance values of the variable elements of the illustrated recorder, potentiometers 7 and 8 may each have a resistance of about 5 ohms, and variable resistor 6 may have a total resistance of about 500 ohms. These values are exemplary only, and are in no way limiting.

I claim:

1. In a resistance bridge circuit having a first adjustable tap potentiometer connected between adjacent bridge arms with the tap of the potentiometer forming one bridge terminal, an adjustable source of potential connected between second and third opposite bridge terminals, an input circuit, am amplifier coupled to receive the difference between the signal applied to the input circuit and the output signal provided by the bridge circuit, and motor means coupled to the output of the amplifier for controlling the position of the tap of the first potentiometer to cause the difference between the signal applied to the input circuit and the output signal provided by the bridge circuit to be substantially zero, the improvement which comprises a second adjustable tap potentiometer connected in shunt with the first potentiometer, means for disconnecting the tap of the first potentiometer and for connecting the tap of the second potentiometer to the input circuit, and means for coupling the output of the motor means to control the potential provided by the adjustable source of potential when the tap of the second potentiometer is connected to the input circuit, to cause the difference between the signal applied to the input circuit and the output signal provided by the bridge circuit to be substantially zero when the tap of the second potentiometer is connected to the input circuit.

2. In a resistance bridge type recording system having a first adjustable tap potentiometer connected between adjacent bridge arms with the tap of the potentiometer forming one bridge terminal, an adjustable source of potential connected between second and third opposite bridge terminals, an input circuit having first and second terminals for receiving an input signal, an amplifier have one input connection coupled to the second terminal of the input circuit and having its other input connection coupled to the fourth bridge terminal, and a motor coupled to the output of the amplifier, the improvement which comprises a second adjustable tap potentiometer connected in shunt with the first potentiometer, switching means for selectively connecting the first terminal of the input circuit to the tap of the first potentiometer or to the tap of the second potentiometer, and means for coupling the output of the motor to control the position of the tap of the first potentiometer when that tap is connected to the first terminal of the input circuit and for coupling the output of the motor to control the potential provided by the adjustable source of potential when the tap of the second potentiometer is connected to the first terminal of the input circuit.

3. In a resistance bridge type recording system having a first adjustable tap potentiometer connected in series between adjacent bridge arms with the tap of the potentiometer forming one bridge terminal, a voltage source and an adjustable resistor connected in series across the bridge between second and third bridge terminals, an input circuit having first and second terminals for receiving an input signal, an amplifier having one input connection coupled to the second terminal of the input circuit and having its other input connection coupled to the fourth bridge terminal, and a motor coupled to the output of the amplifier, the improvement which comprises a second adjustable tap potentiometer connected in shunt with the first potentiometer, switching means for selectively connecting the first terminal of the input circuit to the tap of the first potentiometer or to the tap of the second potentiometer, and means coupled to the switching means for coupling the output of the motor to control the position of the tap of the first potentiometer when that tap is connected to the first terminal of the input circuit and for coupling the output of the motor to control the resistance of the adjustable resistor when the tap of the second potentiometer is connected to the first terminal of the input circuit.

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