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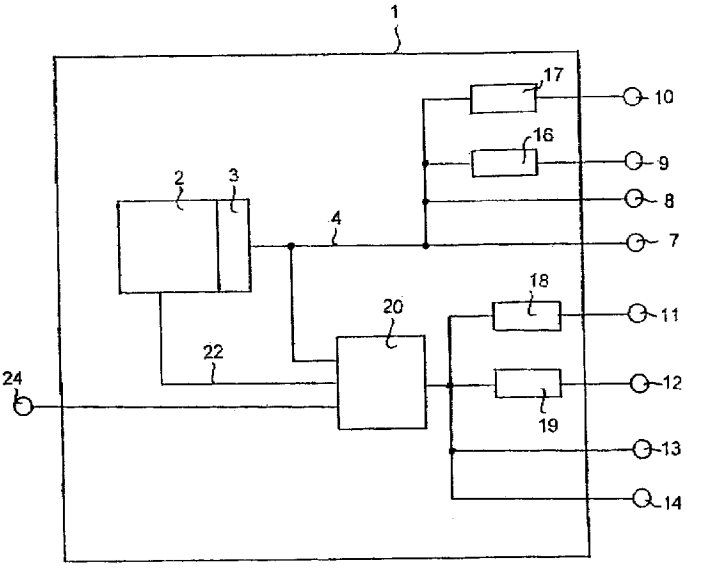
(54) **MONTAGE DE CIRCUITS ET METHODE PERMETTANT DE PRODUIRE UN CERTAIN NOMBRE DE SIGNAUX ANALOGIQUES**

(54) **CIRCUIT ARRANGEMENT FOR AND A METHOD OF PRODUCING A PLURALITY OF ANALOG SIGNALS**



(57) Montage de circuits et méthode de production d'un certain nombre de signaux analogiques variables selon la position de l'un de deux corps mobiles l'un par rapport à l'autre, un unique détecteur détectant au moyen de mesures la position à surveiller. La valeur de mesure déterminée au moyen du détecteur sert de base pour produire un signal numérique dont est tiré un signal analogique par conversion numérique-analogique pour chacun des récepteurs d'un groupe de récepteurs distincts aux fins de la commande d'unités subséquentes.

(57) In a circuit arrangement and a method for producing a plurality of analog signals which vary in dependence on the position of one of two mutually movable bodies relative to each other, a single sensor measuringly detects the position to be monitored. The measurement value ascertained by means of the sensor is used as the basis for producing a digital signal from which an analog signal is derived by digital/analog conversion for each of a plurality of separate receivers for controlling subsequently arranged units.

ABSTRACT OF THE INVENTION

In a circuit arrangement and a method for producing a plurality of analog signals which vary in dependence on the position of one of two mutually movable bodies relative to each other, a single sensor measuringly detects the position to be monitored. The measurement value ascertained by means of the sensor is used as the basis for producing a digital signal from which an analog signal is derived by digital/analog conversion for each of a plurality of separate receivers for controlling subsequently arranged units.

The invention concerns a circuit arrangement for and a method of producing a plurality of analog signals which vary in dependence on the position adopted by one of two mutually movable bodies with respect to the other.

In situations involving monitoring a position by means of linear or angular senders or pick-up sensors, a problem which frequently arises is that one and the same linear displacement or rotary movement has to be evaluated in different ways, for controlling different operating procedures.

Thus, for example, the instantaneous angular position of the rotary shaft of the accelerator pedal of a motor vehicle may be a parameter of significance simultaneously for controlling the fuel injection pump, the throttle valve and/or the ignition timing. In such a situation, in general quite different position measurement value ranges are detected for the individual units disposed downstream of the sensor which is sensing the accelerator pedal position, and the respective analog measurement signal produced thereby is fed to a receiver associated with the unit in question, in a form which is matched to the needs thereof and which differs greatly from the other analog signals.

It is possible to equip systems of that kind with a number of position sensors, for example potentiometers, with such number corresponding to the number of associated receivers. The position sensors may be so arranged in terms of assembly and circuitry that they each detect a respective individually associated position range and, upon transiting same, output a voltage which varies between a minimum value corresponding to one end or limit of the range and a maximum value which represents the other end or limit of the range in question.

That operating procedure however involves a number of difficulties. Thus for example even if the same analog voltage is to be fed to each of the receivers, to represent the same measurement range, the system must include for each receiver its own specific potentiometer or sensor in order to ensure the required freedom from reaction or feedback.

If different measurement ranges have to be accurately related

to each other, then a high level of expenditure is necessary in order suitably accurately to establish or detect the zero positions or zero values of the potentiometer.

Furthermore, a potentiometer can only ever cover an angular range of less than 360° so that, in situations of use in which there is a requirement for measuringly monitoring larger angles than this, the arrangement must employ two potentiometers which accordingly have to be extremely accurately matched to each other and which in addition have to be very precisely positioned. In practice that is frequently not a viable option because of the high production and assembly costs that it involves.

In addition inexpensive potentiometers generally involve linear output characteristics so that additional electronic circuits are required if different characteristic configurations are necessary.

In accordance with the present invention in terms of the circuit arrangement aspect there is provided a circuit arrangement for producing a plurality of analog signals which are variable in dependence on the position adopted by one of first and second mutually movable bodies with respect to the other and which are adapted to be fed to receivers that are separate from each other, for the control of subsequent units, including

- a single sensor for measuringly detecting said position to be monitored,
- a circuit means having an output for outputting in the form of a digital signal the measurement value ascertained by means of the sensor, and
- a digital/analog converter means adapted to output for each of the receivers a suitably processed analog signal derived from the digital signal.

In regard to the method aspect there is provided a method of producing a plurality of analog signals which are variable in dependence on the position adopted by one of first and second mutually movable bodies with respect to the other,

wherein

- said position to be monitored is measuringly detected by means of a single sensor,

- a digital signal representing the measurement value ascertained by means of the sensor is produced, and

- a suitably processed analog signal is derived from the digital signal for feeding to respective ones of a plurality of receivers.

As will be seen in greater detail from preferred embodiments of the circuit arrangement and method the present invention can thus provide a circuit arrangement for producing a plurality of analog signals which are variable in dependence on the position of a movable body relative to another, which makes it possible to produce virtually any number of mutually independent position signals derived from a movement to be monitored, at a low level of circuitry expenditure, while being of a simplified design configuration using tried-and-tested components, and affording a high degree of accuracy and resolution. The method according to the invention is simple to implement while affording accurate results over a wide range of movement, insofar as one and the same digital signal can be readily fed to any number of processing channels, without any interaction or reaction effect, while on the other hand it can be transformed into the most widely varying analog signals by means of digital/analog converters which are wired or actuated in different ways, in order thereby to simulate correspondingly different analog position sender or pick-up devices.

As already indicated above, that simulation effect can be produced either by way of the specific wiring configuration of the digital/analog converters and possibly by means of downstream-disposed, simple electronic circuits or, preferably, by virtue of a procedure whereby the digitized measurement signal outputted by the sensor is modified by means of a computing and control circuit in such a way that only one digital/analog conversion operation is necessary to obtain the desired analog output signal. That modified digital signal can then be fed in a time multiplex procedure to a plurality of mutually parallel digital/analog converters, the outputs of which once again simulate the widely different analog sensors.

This last-mentioned mode of operation affords the advantage that different sensors can be successively simulated at one and the same output in dependence on a program which is predetermined by the computing circuit, or in dependence on a command signal which can be supplied from the exterior.

The most important parameters which in this respect are freely selectably variable are the measurement range, the output signal ranges (in respect of current or voltage), the association sign between those two ranges, the characteristic configuration, and so forth.

As the signals of all simulated outputs are derived from one and the same digital signal they are precisely related to each other at any time and it is readily possible to establish the common zero point thereof.

If the single sensor used is an inductive measurement value sender, as is to be found for example in German patent specifications Nos 41 13 745 and 41 27 209 to which reference is therefore directed here, it is possible to detect angular ranges of virtually any magnitude, with a substantially higher degree of accuracy and resolution than is possible when using potentiometers.

In addition, in accordance with a preferred feature of the invention, the circuit arrangement of the invention may also have at least one further output at which the digital measurement signal itself or digital signals derived therefrom are available.

Therefore, not only is the number of sensors required reduced to a single sensor, but the arrangement and method according to the invention also eliminate the assembly complications and expenditure involved in positioning and adjusting relative to each other the plurality of sensors which were necessarily used hitherto.

An embodiment of the circuit arrangement and the method according to the present invention will now be described by way of example with reference to the single Figure of the accompanying drawing showing a diagrammatic view of the basic circuit diagram of the circuit arrangement in accordance with the invention.

Referring to the Figure, reference numeral 1 therein denotes a circuit arrangement for producing a plurality of analog signals which

are variable in dependence on the position adopted by one of first and second mutually movable bodies (not shown) with respect to the other, and which are adapted to be fed to receivers (also not shown) that are separate from each other, for the control of downstream-disposed or subsequent units. Reference numeral 2 in the Figure indicates a sensor which for example may be an inductive position pick-up device, in particular an inductive angular pick-up device.

Connected to the output side of the sensor 2 is an electronic circuit unit 3 which processes the analog signal firstly produced by the sensor 2 and fed to the unit 3, in digital form. A suitable circuit configuration of this kind, for such a purpose, can be found for example in European specification No 0 582 111 A.

The signal which is outputted by the circuit unit 3 on the data bus line 4 and which represents in digital form the measurement value respectively ascertained by the sensor 2 is fed directly to the outputs 7 and 8 of the circuit arrangement 1. The outputs 7 and 8 are each connected to a respective user circuit (not shown) which is designed for receiving and further processing of digital measurement signals of that nature.

In comparison, the further outputs indicated at 9 through 12 are connected to receivers or user circuits to which measurement signals have to be fed in analog form. In comparison once again, the further outputs 13 and 14 service receivers to which admittedly digital signals also have to be supplied, which signals however are not identical to the measurement signal delivered at the output of the circuit unit 3 but are derived therefrom in a manner which will be described in greater detail hereinafter.

The digital measurement signal which occurs on the data bus line 4 is also fed to first and second digital/analog converters 16, 17 which, in accordance with a respective specification predetermined by a fixed wiring configuration thereof, convert the signal into an analog signal which thus appears at the respective outputs 9 and 10.

It will be noted at this point that the foregoing term 'specification' is used to denote for example a given measurement value range, a voltage or current range corresponding to that measurement

value range, and so forth.

For example, if the sensor 2 is an angular pick-up device, voltage values of between -3 and +3V may occur at the output 9 when the angular position of a shaft which is being monitored by the sensor 2 varies between 45° and 65°, while the voltage appearing at the output 10 varies between +2 and +10V if the component being detected by the sensor 2 passes through an angular range of between 345° and 5° or -15° and +5°.

It will be appreciated that the foregoing numerical values are employed here only by way of example, and it is to be expressly pointed out that it is also possible for the digital/analog converters to be fixedly programmed in such a way that voltage values which are different, in terms of the maximum amplitude or sign, may be associated with the analog output signals of the digital/analog converters, when passing through equal measurement ranges, or equal voltage values are associated therewith when passing through equal or different measurement ranges. Instead of a voltage, it is also possible, by virtue of the digital/analog converters 16, 17 being of a suitable structure, to output an impressed current which varies with the position to be monitored.

It should also be expressly noted that the number of digital/analog converter units which can be connected in that way to the data bus line 4 is not limited to two but can be of virtually any number in order to produce the most widely varying output signals.

In comparison, the digital measurement signal outputted by the output of the circuit unit 3 is fed to the digital/analog converters 18, 19 servicing the outputs 11 and 12, not directly but by way of a control and computing unit as indicated at 20, which can be referred to as a processor, which processes that digital signal in accordance with the above-mentioned specifications which are predetermined by the fixed wiring configurations in respect of the digital/analog converters 16, 17, in such a way that it only has to be converted into analog form by the converters 18, 19.

A corresponding consideration also applies in regard to the digital signals which occur at the outputs 13, 14 and which are derived

from the output signal on the data bus line 4 by the processor 20 in a freely selectable manner, for example in such a way that a single data pulse always appears at the output 13 when one of the mutually movable bodies reaches or passes a given, preselected position. If that position is an angular position, a revolution counter can be connected to the output 13. The position signal delivered thereby can also be used to simulate a limit position switch.

At its output, the computing and control circuit or processor 20 includes a multiplexer (not shown) which feeds the suitably processed digital signals to the downstream-disposed digital/analog converters 18, 19 and to the outputs 13, 14 in a time-multiplex mode. The arrangement may include buffer circuits (also not shown) which provide for intermediate storage of the respective value for the digital/analog converter units 18, 19 and the outputs 13, 14 respectively, for the periods of time in which they are not directly actuated by the processor 20.

The processor 20 is connected by way of a line indicated at 22 to the sensor 2 or the circuit unit 3 thereof, so that it can also influence the form of the digital signal outputted by the circuit unit 3 on the data bus line 4. For example, it can provide that only the incremental variation values of the measurement signal, a measurement signal which is reduced in respect of its bit length by the least significant bit, or only the direction of variation of the signal, are outputted on the bus line 4.

Reference numeral 24 in the Figure denotes an input terminal 24 from which the processor 20 can be controlled from the exterior in such a way that it varies the digital signals for the individual downstream-disposed units or outputs, which signals are outputted at the output of the processor 20 and are derived from the digital measurement signal on the data bus line 4, not only in accordance with a fixedly stored program but also in dependence on a control signal which is supplied therefore by way of the input terminal 24.

The described arrangement thus makes it possible, by means of the digitized measurement signal that is produced by a single position pick-up or sensor, to service a plurality of digital and analog

channels to which the measurement signal can be fed either directly or in the widely varying analog variants. The circuit arrangement thus permits computer simulation of a widely varying range of kinds of measurement value sensors which are adapted in the optimum manner to the requirements of the respective downstream-connected receiver. As all signals supplied to such receivers originate from a single sensor, there is no need for mutual adjustment upon assembly of the system.

Instead of an inductive position sensor 2, it is in principle also possible to use a potentiometer or any other kind of position sensor which produces an analog measurement signal which is firstly digitized in the circuit unit 3. Potentiometers used as rotary sensors however suffer from the disadvantage that they can only cover an angular range of less than 360°. If the system is required to measuringly detect and track a larger angular range or any number of revolutions, the above-mentioned inductive sensors are accordingly to be preferred.

It will be appreciated that a circuit arrangement according to the invention can also include only fixedly wired digital/analog converters or only converters which are controlled by way of a processor as indicated at 20.

It will be further appreciated that the above-described circuit arrangement and the method of producing a plurality of analog signals implemented therein have been set forth only by way of example and illustration of the principles of the present invention and that various other modifications and alterations may be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed, are defined as follows:

1. A circuit arrangement for producing a plurality of analog signals which are variable in dependence on the position adopted by one of first and second mutually movable bodies with respect to the other and which are adapted to be fed to receivers that are separate from each other, for the control of subsequent units, including

- a single sensor for measuringly detecting said position to be monitored,

- a circuit means having an output for outputting in the form of a digital signal the measurement value ascertained by means of the sensor, and

- a digital/analog converter means adapted to output for each of the receivers a suitably processed analog signal derived from the digital signal.

2. A circuit arrangement as set forth in claim 1

wherein the digital/analog converter means is adapted to output analog signals derived from the digital signal and associated with different position measurement ranges.

3. A circuit arrangement as set forth in claim 2

wherein the digital/analog converter means is adapted to output analog signals which are derived from the digital signal and which pass through different voltage ranges when the position measurement range associated with the said analog signals is transited.

4. A circuit arrangement as set forth in claim 2

wherein the digital/analog converter means is adapted to output analog signals which are derived from the digital signal and of which at least one, within a said position measurement range associated therewith, represents said measurement value in the form of an impressed current.

5. A circuit arrangement as set forth in claim 3

wherein the digital/analog converter means is adapted to output analog signals whicha re derived from the digital signal and which have a different characteristic configuration.

6. A circuit arrangement as set forth in claim 4

wherein the digital/analog converter means is adapted to output analog signals which are derived from the digital signal and which have a different characteristic configuration.

7. A circuit arrangement as set forth in claim 1

which further includes at least one output for outputting a digital measurement signal to a receiver.

8. A circuit arrangement as set forth in claim 1

which includes a multiplexer adapted to make available at least first and second ones of said analog signals in succession in respect of time at one and the same analog output of the circuit arrangement.

9. A circuit arrangement as set forth in claim 1

which includes at least first and second analog outputs at which at least first and second ones of said analog signals are available at the same time.

10. A circuit arrangement as set forth in claim 1

wherein the sensor is an inductive angle sensor.

11. A circuit arrangement as set forth in claim 1

wherein the sensor is an inductive linear sensor.

12. A circuit arrangement as set forth in claim 1

wherein the digital/analog converter means is operable to derive the analog signal for at least one of the receivers from the digital signal in accordance with a specification which is predetermined by a fixed wiring configuration.

13. A circuit arrangement as set forth in claim 1

which includes a control and computing unit which is operable to feed variably in respect of time the digital/analog converter means with digital signals which are derived from the digital signal and which are modified for the production of the desired analog signals.

14. A circuit arrangement as set forth in claim 13

wherein the control and computing unit comprises a control input by way of which the modified digital signals fed to the digital/analog converter means by the control and computing unit are variable from the exterior.

15. A method of producing a plurality of analog signals which are variable in dependence on the position adopted by one of first and second mutually movable bodies with respect to the other,

wherein

- said position to be monitored is measuringly detected by means of a single sensor,
- a digital signal representing the measurement value ascertained by means of the sensor is produced, and
- a suitably processed analog signal is derived from the digital signal for feeding to respective ones of a plurality of receivers.

16. A method as set forth in claim 15

wherein different position measurement ranges are associated with the analog signals derived from the digital signal.

17. A method as set forth in claim 15

wherein analog signals derived from the digital signal pass through different voltage ranges when the position measurement range associated with said analog signals is transited.

18. A method as set forth in claim 15

wherein at least one of the analog signals derived from the digital signal represents the measurement value in the form of an impressed current.

19. A method as set forth in claim 17

wherein the analog signals derived from the digital signal have different characteristics.

20. A method as set forth in claim 18

wherein the analog signals derived from the digital signal have different characteristics.

21. A method as set forth in claim 15

wherein a said digital signal is outputted to at least one receiver.

22. A method as set forth in claim 15

wherein at least first and second ones of said analog signals are made available in succession in respect of time at one and the same analog output.

23. A method as set forth in claim 15

wherein at least first and second ones of said analog signals are simultaneously made available at first and second separate analog outputs.

24. A method as set forth in claim 15

wherein the analog signal for at least one of said receivers is derived from the digital signal in accordance with a specification which is predetermined by a fixed wiring configuration.

25. A method as set forth in claim 15

wherein a modified digital signal derived from said digital signal representing the measurement value is fed to digital/analog converter means for producing the analog signal for at least one of

said receivers.

26. A method as set forth in claim 15

wherein a plurality of modified digital signals derived from said digital signal representing the measurement value are fed in a time multiplex process to a digital/analog converter means for producing a plurality of different analog signals.

27. A method as set forth in claim 26

wherein the sequence of said modified digital signals is controllable from the exterior.

28. A method as set forth in claim 21

wherein the digital signal for at least one of said receivers includes individual pulses, each of which characterises the attainment of at least one predetermined position.

29. A method as set forth in claim 21

wherein the digital signal for at least one of said receivers includes individual pulses, each of which characterises the passage through at least one predetermined position.

30. Each and every novel feature or novel combination of features herein disclosed.

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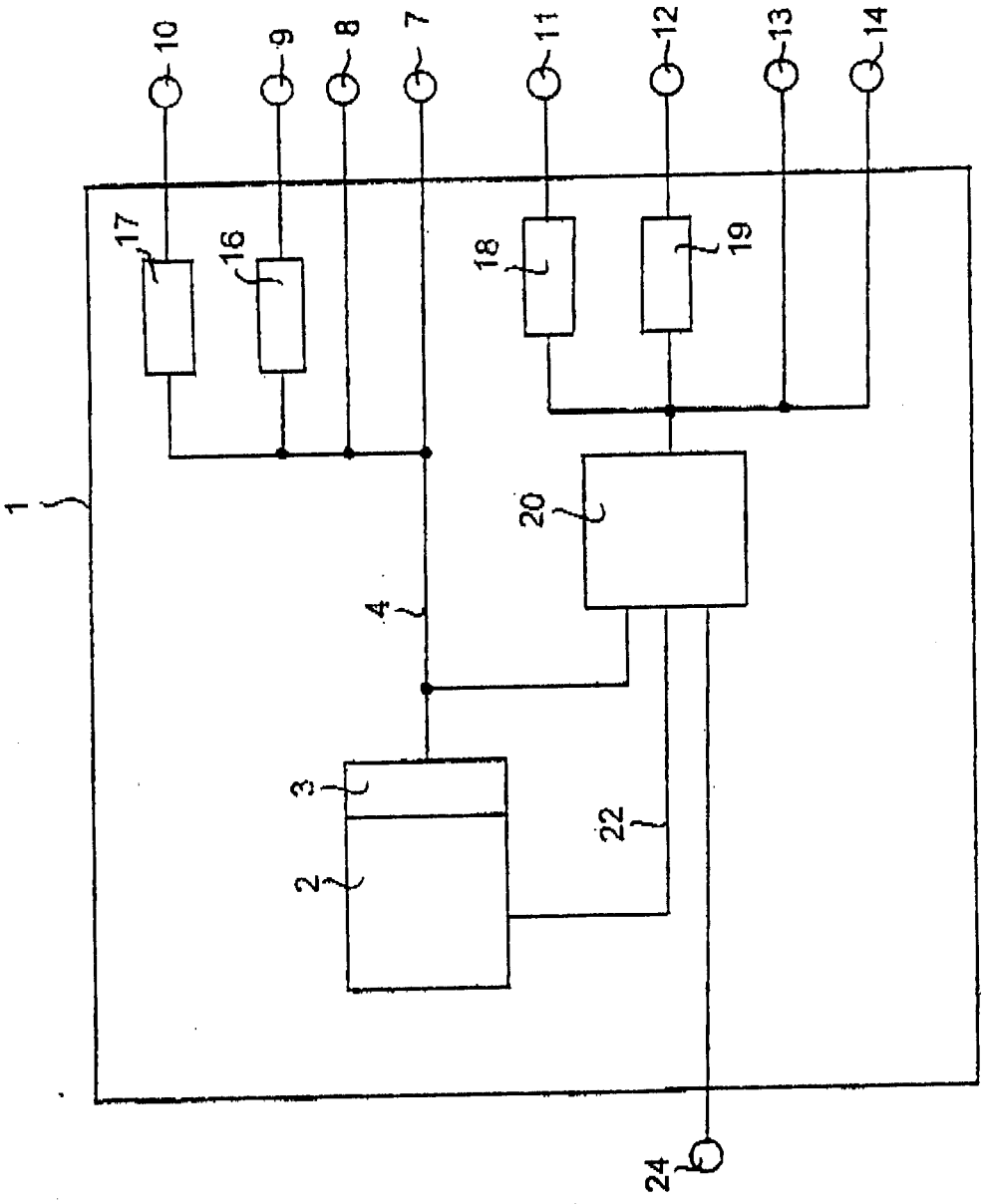
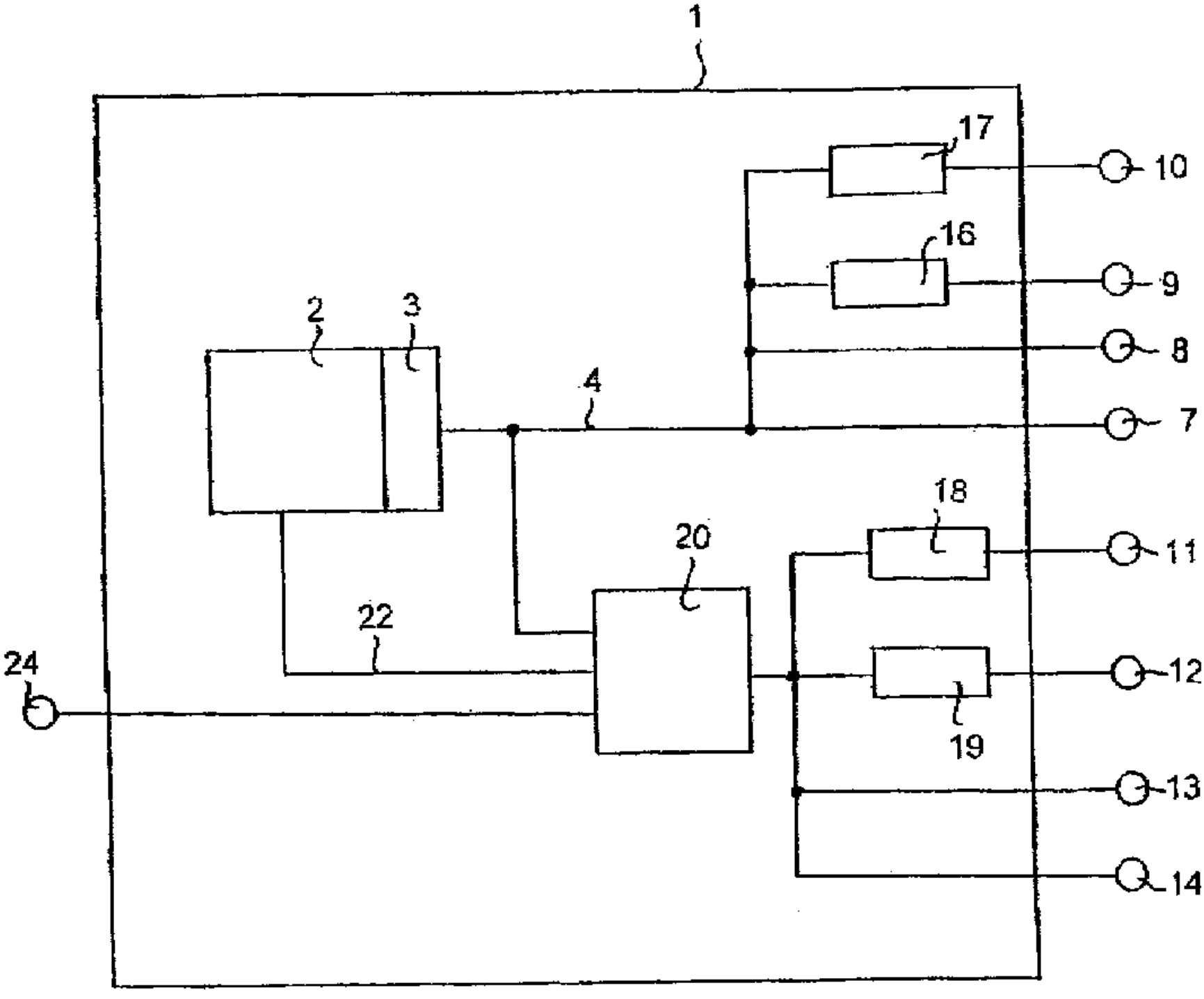


Fig. 1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