ANALOG TELEMETRY SYSTEM HAVING FREQUENCY SIGNAL TRANSMISSION

Inventor: Hugh V. Snively, Richmond, Va.
Assignee: Robertshaw Controls Company, Richmond, Va.
Filed: Feb. 16, 1970
Appl. No.: 11,761

Int. Cl. ...............G01k 5/00, G01k 5/18

References Cited
UNITED STATES PATENTS
3,194,067 7/1965 Grillo ................340/183 X
3,253,260 5/1966 Hawley ...............340/182 UX

Primary Examiner—Harold I. Pitts
Attorney—Auzville Jackson, Jr., Robert L. Marben and Anthony A. O'Brien

ABSTRACT
An analog telemetry system including a plurality of analog encoders at a plurality of remote stations for sensing a plurality of different conditions and providing analog signals corresponding thereto with matching electrical characteristics. Each of the remote stations has a transmitter for transmitting the analog signals to a central control station which includes an indicating meter having a temperature scale and a graduated 0–100 scale for visually representing all of the analog signals regardless of the conditions sensed.

3 Claims, 4 Drawing Figures
ANALOG TELEMETRY SYSTEM HAVING FREQUENCY SIGNAL TRANSMISSION

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention pertains to analog telemetry systems and more particularly to such systems utilizing a single indicating meter.

2. Description of the Prior Art
An operator at the central control station of a supervisory control system for a plurality of remote stations normally must view a plurality of indicating meters corresponding to all of the various conditions being monitored from the central control station. The use of a plurality of such meters is an inconvenience to the operator in that it is difficult to become familiar with and accurately obtain information from a plurality of meters, each of which has a different scale but the same general appearance.

One of the reasons for utilizing an indicating meter for each condition sensed in the field in conventional supervisory control systems is that the analog signals sensed in the field have varying ranges associated therewith, thereby requiring either range selection signals to be transmitted back to the central control station from the remote stations or separate wires or frequency channels for various conditions. When voice-grade telephone lines are utilized as a medium of communication between the remote stations and the central control station, the number of available frequency channels is limited; and, accordingly, it is disadvantageous to use a plurality of the frequency channels for analog signals. Similarly, the cost of wiring is expensive; and, therefore, the use of separate wires for each analog condition sensed is disadvantageous.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to utilize a single indicating meter to represent analog signals corresponding to conditions sensed at a plurality of remote stations.

The present invention is summarized in an analog telemetry system including a plurality of remote stations, each of the remote stations including first and second analog encoders generating first and second analog signals having matching electrical characteristics corresponding to first and second conditions, respectively; and a transmitter for transmitting the first and second analog signals to a central control station, the central control station including a single indicating meter to visually represent the first and second conditions in accordance with the first and second analog signals.

Another object of the present invention is to match the electrical characteristics of analog signals representing various conditions at remote stations prior to the communication of the analog signals to an indicating meter at a central control station.

A further object of the present invention is to utilize a single frequency channel to transmit analog signals representing various conditions to a central control station.

Some of the advantages of the present invention over prior art analog telemetry systems are that the number of frequency channels required for analog operations are reduced, a single-meter represents all field conditions, and circuitry for analog monitoring is reduced.

FURTHER OBJECTS AND ADVANTAGES
Further objects and advantages of the present invention will become apparent from the following description of the preferred embodiment taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an analog telemetry system according to the present invention.
FIG. 2 is a schematic diagram of the interfaces and field points of FIG. 1.
FIG. 3 is a schematic diagram of analog encoder circuitry at the local points of FIG. 1.
FIG. 4 is a schematic diagram of analog encoder circuitry at the remote points of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An analog telemetry system according to the present invention is illustrated in FIG. 1 and includes a central control station 10 and a plurality of remote stations RS1 and RS2. The remote stations are in communication with central control station 10 through a voice-grade telephone line 12 in a party-line manner such that each remote station receives signals from central control station 10, simultaneously. While only two remote stations are illustrated in FIG. 1, any number of remote stations may be utilized with the analog telemetry system of the present invention. Similarly, various means of communication may be utilized with the analog telemetry system of the present invention; for instance, individual voice-grade telephone lines may be utilized for each remote station with a pair of contacts selectively controlling communication between the remote stations and central control station 10. Similarly, any suitable communication medium such as electromagnetic transmission, may be utilized with the analog telemetry system of the present invention.

Central control station 10 includes point selection circuitry 14 for selecting a field point to be monitored. Point selection circuitry 14 is conventional and may include thumb wheels, toggle switches or the like. An output 16 from point selection circuitry 14 is supplied to an address generator 18 which provides field point signals at an output 20 to a frequency shift transmitter 22. Transmitter 22 has an output 24 supplying mark, space and carrier frequencies corresponding to the address signals to telephone line 12 for communication to the remote stations.

A frequency shift analog telemetry receiver 26 receives frequency shift signals from the remote stations corresponding to analog signals generated thereat, and supplies the analog signals to output leads 28 and 30. An output 32 from analog telemetry receiver 26 supplies a signal to a group of local field points 34 when a carrier frequency is received by analog telemetry receiver 26. Address signals are supplied to local points 34 from output 20 of address generator 18 via an output 36 of a local point interface 38. Analog encoder circuitry in local points 34 supplies analog signals to output leads 40 and 42 which are connected with output leads 28 and 30 from analog telemetry receiver 26, respectively. The analog outputs from analog telemetry receiver 26 and local points 34 are supplied to a record relay 44 and an indicate relay 46 for selective communication by a single-pole, dou-
ble-throw manual selector switch 48 to a recorder 50 or an indicating meter 52.

Record relay 44 includes a coil 54 connected between a source of negative potential and a contact of selector switch 48. A pair of contacts 56 are connected between output leads 28 and 40 and an input 58 to recorder 50. Another pair of contacts 60 are connected between output leads 30 and 42 and an input 62 to recorder 50. The analog signals from analog telemetry receiver 26 and local points 34 are supplied to recorder 50 on inputs 58 and 62 when record relay 44 is energized, and recorder 50 also receives an input on a lead 64 from address generator 18 indicating the field point being interrogated. Field point addresses may be stored by recorder 50 in program fashion and supplied to address generator 18 on a lead 65 to provide automatic interrogation of predetermined field points.

Indicate relay 46 includes a coil 66 connected between the source of negative potential and another contact of selector switch 48. A single-pole, double-throw switch 68 responsive to coil 66 has one contact connected with output leads 28 and 40, the other contact connected with an output 70 from a current source 72, and the pole connected with an input 74 to meter 52. A single-pole, double-throw switch 76 also responsive to coil 66 has one contact connected with output leads 30 and 42, the other contact connected with an output 78 from current source 72, and the pole connected with an input 80 to meter 52. The analog signals from analog telemetry receiver 26 and local points 34 are supplied to meter 52 on inputs 74 and 80 when indicate relay 46 is energized, and a constant current from current source 72 is supplied to meter 52 on inputs 74 and 80 when indicate relay 46 is deenergized.

Selector switch 48 is manually operable to exclusively supply the analog signals from analog telemetry receiver 26 and local points 34 to either recorder 50 or meter 52 by selectively connecting a source of positive potential to coils 54 and 66 to energize either record relay 44 or indicate relay 46. Of course, if it is desired, the selector switch may be designed to supply the analog signals to both recorder 50 and meter 52 simultaneously.

Meter 52 has a temperature scale, preferably with a range of −40°F. to +260°F., and a graduated 0–100 scale. A single pointer P is utilized as an indicator for both scales and is responsive to small current signals on inputs 74 and 80 to represent an analog value.

The remote stations are essentially identical and accordingly only remote station RS1 is described. Remote station RS1 includes a receiver RS which receives frequency shift signals corresponding to field point addresses from transmitter 22 at central control station 10, and receiver RS has an output 84 supplying the address signals to an interface 86. Interface 86 supplies outputs to a group of remote points 88 on multiconductor cables 90 and 91. Remote points 88 include analog encoder circuitry providing analog signals to an analog telemetry transmitter 92 on leads 94 and 96, and the analog encoder circuitry further controls the operation of analog telemetry transmitter 92 through 96 and 100. Analog telemetry transmitter 92 provides frequency shift signals on an output 102 corresponding to the analog signals on leads 94 and 96 for communication to analog telemetry receiver 26 at central control station 10 over telephone line 12.

Interface 86 and remote points 88 are illustrated schematically in FIG. 2 with the realization that the circuitry therein is also utilized for local point interface 38 and local points 34 at the central control station 10. Interface 86 receives address signals from receiver 82 on output 84, and the address signals are supplied to a remote station decoder 104 and an AND gate 106 which also receives an input from remote station decoder 104. Gate 106 is inhibited until the address of the remote station with which the interface is associated is received from central control station 10 at which time gate 106 is enabled to pass the address signals on to registers 108 and 110, each of which has ten outputs indicated generally at 112 and 114 corresponding to units and tens addresses of individual remote points in group 88, respectively.

The remote points include a plurality of coils arranged in a ten by ten matrix for receiving the outputs 112 and 114 from registers 108 and 110 on cables 90 and 91, respectively. If a point at remote station RS1 having an address of 73 is selected, that address will be presented to registers 108 and 110 in such a manner that the output at 112 will place a positive potential on the unit lead corresponding to 3 and the output at 114 will place a negative on the tens lead corresponding to 70. Thus, it may be seen that a complete current path can be traced from units lead 3 through the coil indicated at 73 to tens lead 70 thereby energizing coil 73. Each of the coils will have one or more sets of contacts associated therewith such that various conditions of an alarm or analog nature as well as control functions may be monitored at the remote stations.

While the present invention pertains to analog telemetry systems, it should be realized that such systems will normally be included in comprehensive supervisory control systems capable of performing alarm and status monitoring functions and control functions as well as analog telemetering. Accordingly, any suitable technique may be utilized to address individual field points; and, the skeletal circuitry of FIG. 2 is shown and described only for purposes of completeness.

Analog encoder circuitry for local points 34 is illustrated in FIG. 3. A temperature encoder 116 includes a coil 118 corresponding to one of the matrix coils illustrated in FIG. 2 and normally open contacts 120, 122 and 124. Contacts 120 are connected between a source of positive potential and a wire 126 which is included in a trunk 128 along with wires 130 and 132. Wires 130 and 132 are connected with a thermocouple 134 through contacts 122 and 124, respectively. Trunk 128 extends to all thermocouple temperature sensing local points such that when any of the thermocouple, temperature sensing local points are addressed, a positive potential will be placed on wire 126 and analog voltage signals will be placed on leads 130 and 132 by thermocouple 134. A relay 136 has a coil 138 connected between wire 126 and a source of negative potential, normally open contacts 140 and 142, and normally closed contacts 144 and 146. The analog signals on wires 130 and 132 are supplied to a converter 148 which supplies the analog signals after conversion to a common form to output leads 40 and 42 through contacts 140 and 142, respectively, when relay 136 is energized. Contacts 144 and 146 are connected with output leads 40 and 42 through normally closed contacts 149 and 150 which are controlled by a coil 152 which is...
energized by a positive potential on lead 32 when analog telemetry receiver 26 receives a carrier signal from any of the analog telemetry transmitters 93 at the remote stations.

A humidity encoder 154 includes a coil 156 corresponding to one of the matrix coils illustrated in FIG. 2 and normally open contacts 158, 160 and 162. Contacts 158 are connected between a source of positive potential and a wire 164 which is included in a trunk 166 along with wires 168 and 170. Wires 168 and 170 are connected with a humidity sensor 172 through contacts 160 and 162, respectively. Trunk 166 extends to all humidity sensing local points such that when any of the humidity sensing local points are addressed, a positive potential will be placed on wire 164 and analog current or voltage signals will be placed on wires 168 and 170 by humidity sensor 172. A relay 174 has a coil 176 connected between wire 164 and the source of negative potential, normally open contacts 178 and 180, and normally closed contacts 182 and 184. The analog signals on wires 168 and 170 are supplied to a converter 186 which supplies the analog signals after conversion to a common form to output leads 40 and 42 through contacts 178 and 180 when relay 174 is energized. Contacts 182 and 184 are connected in series with contacts 146 and 144, respectively, of relay 136.

A process variable encoder 188 includes a coil 190 corresponding to one of the matrix coils illustrated in FIG. 2 and normally open contacts 192, 194 and 196. Contacts 192 are connected between a source of positive potential and a wire 198 which is included in a trunk 200 along with wires 202 and 204. Wires 202 and 204 are connected with a process variable sensor 206 through contacts 194 and 196, respectively. Trunk 200 extends to all process variable local points such that when any of the process variable local points are addressed, a positive potential will be placed on wire 198 and analog current or voltage signals will be placed on wires 202 and 204 by process variable sensor 206. A relay 208 has a coil 210 connected between wire 198 and the source of negative potential, normally open contacts 212 and 214, and normally closed contacts 216 and 218. The analog signals on wires 202 and 204 are supplied to output leads 40 and 42 through contacts 212 and 214 when relay 208 is energized. Contacts 216 and 218 are connected in series with contacts 194 and 182, respectively, of relay 174.

A feedback encoder 220 includes a coil 222 corresponding to one of the matrix coils illustrated in FIG. 2 and normally open contacts 224, 226 and 228. Contacts 224 are connected between a source of positive potential and a wire 230 which is included in a trunk 232 along with wires 234 and 236. Wire 234 is connected with a slider 238 through contacts 226, and wire 236 is connected with one end of a potentiometer 240 through contacts 228. Slider 238 is movable on potentiometer 240 in accordance with movement of a control device to provide an analog feedback signal. Trunk 232 extends to all feedback local points such that when any of the feedback local points are addressed, a positive potential will be placed on wire 230 and analog voltage signals will be placed on wires 234 and 236 by slider 238. A relay 242 has a coil 248 connected between wire 230 and the source of negative potential, normally open contacts 250 and 252, and normally closed contacts 254 and 256. The analog signals on wires 234 and 236 are supplied to a converter 258 which supplies the analog signals after conversion to a common form to output leads 40 and 42 through contacts 250 and 252 when relay 242 is energized. Contacts 254 and 256 are connected in series between the outputs of a constant current source 260 and contacts 218 and 216, respectively, of relay 208.

Analog encoder circuitry for remote points 88 is illustrated in FIG. 4 and is similar to the analog encoder circuitry of FIG. 3. Accordingly, the components of FIG. 4 which are identical to components of FIG. 3 are given identical reference numbers with primes and are not described again.

Relay 136 for temperature encoder 116 includes normally open contacts 262 which are connected between a source of positive potential and a coil 264 in a relay 266. Relay 266 includes normally open contacts 268 which are connected with analog telemetry transmitter 92 through leads 98 and 100. Relay 174 includes normally open contacts 270 connected between the source of positive potential and coil 264, and relay 208' includes normally open contacts 272 connected between the source of positive potential and coil 264. Similarly, relay 242 includes normally open contacts 274 connected between the source and positive potential and coil 264.

When any remote point corresponding to an analog encoder in group 88 is addressed, the relay associated with the condition being sensed will be energized to turn energize coil 264 of relay 266 through either of contacts 262, 270, 272 or 274. When relay 266 is energized, the closure of contacts 268 keys analog telemetry transmitter 92 to provide a carrier frequency prior to the transmitting of analog signals on leads 94 and 96.

In operation, if no field point has been addressed at central control station 19, the analog telemetry transmitters 92 at the remote stations will be passive. Accordingly, analog telemetry receiver 26 will receive no input signals, and coil 152 which is responsive to output 33 of analog telemetry receiver 26 will be deenergized. Since no local points have been addressed, relays 136, 174, 208 and 242 will also be deenergized, and a path for current from current source 260 is completed to record relay 44 and indicate relay 46.

If selector switch 48 is in the record position illustrated in FIG. 1, record relay 44 will be energized to close contacts 50 and 60 to permit current flow to recorder 50. Indicate relay 46 will be deenergized at this time; and, accordingly, switches 68 and 76 will be in a position to provide current from source 72 to meter 52 to assure the continuous supply of current required by the meter. If selector switch 48 is placed in the indicate position, indicate relay 46 will be energized to permit current from current source 260 to be supplied to meter 52 through switches 68 and 76 to provide continuous current to the meter.

When it is desired to monitor a field point, point selection circuit 14 or recorder 50 is operated to provide address generator 18 with information corresponding to the field point and the remote station at which it is located. Address signals corresponding to the selected field point are communicated from the
transmitter 22 to all of the remote stations and directly from output 20 of address generator 18 to local point interface 38 simultaneously.

When the decoder 104 at interface 86 or local point interface 38 is actuated, gate 106 is enabled to supply address signals corresponding to the individual field points to registers 108 and 110. The outputs 112 and 114 from the registers select the desired field point in the matrix to enable the analog encoder associated therewith.

If the desired field point is located within local points 34, one of the relays 136, 174, 208 or 242 will be energized to interrupt current flow from current source 260. Assuming that coil 118 of temperature encoder 116 has been energized in the matrix the closure of contacts 120 will energize coil 138 to close contacts 140 and 142 and open contacts 144 and 146. A small analog voltage from thermocouple 134 will be supplied on wires 130 and 132 to converter 148. Converter 148 converts the analog voltage signal from thermocouple 134 to an analog current signal compatible with meter 52 and having the same electrical characteristics as analog signals from the other analog encoders. The analog current signals are supplied to meter 52 through contacts 140 and 142, leads 40 and 42 and switches 68 and 76 if indicate relay 46 is energized. The temperature sensed by thermocouple 134 will be visually indicated to the operator at central control station 20 by movement of pointer P over the temperature scale. If record relay 44 is energized, the analog current signals will be recorded at recorder 50 along with the field point address on output 64 from address generator 18.

If the selected field point corresponds to coil 222 of feedback encoder 220 at local points 34, the voltage across potentiometer 240 will be supplied to converter 258 on wires 234 and 236. Converter 258 will convert the analog voltage signals from potentiometer 240 into analog current signals compatible with meter 52 and having the same electrical characteristics as the analog signals from the other analog encoders. The analog signals from feedback encoder 220 are supplied to meter 52 when indicate relay 46 is energized, and the movement of the control device which controls the position of slider 238 on potentiometer 240 will be visually indicated by movement of pointer P over the graduated 0-100 scale.

In a similar manner, humidity conditions and process variable conditions such as pressure or flow are supplied to either recorder 50 or meter 52. The analog signals from process variable sensor 206 are applied directly to meter 52 without conversion in order to illustrate that the system may be designed around a specific set of analog signals thereby reducing the equipment required; that is, the common form and electrical characteristics of the analog signals are defined by the analog signals from process variable encoder 188.

The operation of analog encoders at remote points in groups 88 at the remote stations is similar to that described with respect to the analog encoders at local points 34. However, when either of relays 136', 174', 208' or 242' are energized, coil 264 of relay 266 is energized to close contacts 268 and cause analog telemetry transmitter 92 to transmit a carrier frequency to analog telemetry receiver 26 at the central control station. Upon receiving the carrier frequency, analog telemetry receiver 26 energizes relay 152 to interrupt the current from current source 260. The analog signals on leads 94 and 96 all have a common form and matched electrical characteristics and are supplied to analog telemetry transmitter 92 to cause the transmitting of mark and space signals having a frequency of alternation corresponding to the analog signals. The mark and space alternations are received at analog telemetry receiver 26 which supplies analog signals on output leads 28 and 30 corresponding to the analog signals on leads 94 and 96 from field points at the remote stations.

By converting the analog signals to the encoders to a common form with the same electrical characteristics, a single frequency channel can be utilized to transmit the analog signals from the remote stations to the central control stations and a single meter can be utilized to visually represent conditions sensed at the field points. Thus, the analog telemetry system of the present invention permits greater use of the limited frequency channels available with communication mediums such as telephone lines.

Meter 52 may, for example, receive analog current signals in an operating range from 4-20 ma; and, accordingly, the converters will provide analog signal outputs having electrical characteristics compatible with meter 52. That is, the converters will provide analog current signals within the 4-20 ma range. For instance, potentiometer 240 may have a maximum voltage of 24 v. and the analog signals on wires 234 and 236 will have a range of 0-20 v. Converter 258 will convert the analog voltage signals to a 4-20 ma range to thereby match the electrical characteristics of the analog signals from the other analog encoders.

For illustrative purposes examples of equipment and signal ranges are provided for each of the different field points shown, as used to provide 4-20 ma analog current signals. Thermocouple 134 may be copper-constantan and provide a -3 to 7 mv. output for a 350° F. range, and converter 148 may be a Robertshaw Series 12 Transmitting Potentiometer which converts the -3 to +7 mv. signal to the 4-20 ma analog range. Humidity sensor 172 may provide a pneumatic pressure from 3 to 15 lbs. which is supplied to a Penn Controls P-80 transducer to provide a resistance between 0-135 ohms in accordance with the pressure, and converter 186 may be a Rochester Instrument Model SC370 which utilizes a voltage to sense the resistance of the transducer and provides an output corresponding thereto in the 4-20 ma analog range. Process variable sensor 206 may be a Robertshaw Model 115 which senses pressure and provides an output in the 4 to 20 ma range. The converter 258 for potentiometer 240 may be a Rochester Instrument Model SC300X which receives a 0-20 v. input from the potentiometer and provides an output corresponding thereto in the 4-20 ma range.

An example of a commercially, available, single meter that may be utilized for meter 52 of the present invention is the Westronics Model 11. Analog telemetry receiver 26 and analog telemetry transmitters 92 are commercially available as Models QATR-20 and QATT-20, respectively, manufactured by Quindar Electronics.
Inasmuch as the present invention is subject to many variations, modifications and changes in detail, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An analog telemetry system comprising
   a plurality of remote stations, each of said remote stations comprising
   a plurality of analog encoder means each sensing a separate condition and generating an analog signal corresponding to said sensed condition,
   each analog encoder means having conversion means for converting the electrical characteristics of each said analog signal to match the electrical characteristics of the other analog signals and lying within a predetermined analog signal range,
   means adapted to selectively enable one of said analog encoder means, and
   transmitter means connected with each of said analog encoder means to transmit signals from said analog encoder means having said matched electrical characteristics and lying within said analog signal range over a single frequency channel; and
   a central control station communicating with said plurality of remote stations, said central control station comprising
   means to select one of said analog encoder means at one of said plurality of remote stations,
   receiver means for receiving said analog signals from said transmitter means over said single frequency channel, and
   a single indicating meter means connected with said receiving means and having an operating range corresponding to said predetermined analog signal range to visually represent any of said sensed conditions in accordance with said received analog signal.

2. The invention as recited in claim 1 wherein said central control station further comprises current source means, switch means connecting said current source means with said meter, and means in said receiver means responsive to transmission of said analog signals by said transmitter means to open said switch means to interrupt the supply of current from said current source means to said meter.

3. The invention as recited in claim 1 wherein said central control station further comprises a plurality of local points having analog encoder means each sensing a separate local condition and generating an analog signal corresponding to said sensed condition, each local analog encoder means having electrical characteristics matching the electrical characteristics of said remote analog signals, said local analog encoder means having input means connected with said meter to enable visual representation of said local conditions in accordance with said local analog signals.

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