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(54) DATA COMMUNICATION SYSTEM

(71) We, HONEYWELL INC., a Corporation organised and existing under the laws of the State of Delaware, United States of America, of Honeywell Plaza, Minneapolis, Minnesota 55048, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to data communication systems and more specifically, to a data communication system enabling a central station to communicate with remote stations by identifying and addressing remote stations having data to send to the central station.

In a conventional communication system a plurality of remote stations are located in consecutive positions in a serial arrangement on a data highway with a central station requesting a reply from each remote station desiring to use the data highway. In order to receive data from the remote stations, the central station is arranged to send a request to each remote station in turn. Upon receipt of the request, the remote station will respond with a data signal on the data highway if it has data to transmit to the central station. In one form of this known system, the remote stations are allotted respective time slots, and each measures a respective time interval from a primary timing pulse sent out by the central station; the measurement may be by means of a fixed time delay device or by counting synchronizing pulses. In another form of known system, each remote station is allotted a respective code (e.g. a binary sequence of pulses), and the central station transmits the codes for the remote stations one after another, leaving a suitable interval after each code signal for reception of any data which the just addressed remote station may have for transmission. Each remote station may include means for transmitting an identifying code as part of the data which it transmits, so that the central station can confirm that it is receiving data from the remote station which it has just addressed.

These prior art systems thus involve the serial interrogation of every remote station in turn whether or not it has data to transmit to the central station. This interrogation involves heavy usage of the data highway and is wasteful of time. The object of the present invention is to alleviate these disadvantages.

Accordingly the present invention provides a data communication system comprising a central station and a plurality of remote stations all coupled to a common highway, wherein in operation the central station:

transmits a poll command to which each remote station requiring service responds by transmitting a reply signal after a time delay unique to that station;

decodes the time delays of the reply signals to identify those remote stations requiring service and stores their identities; and

then services those remote stations.

It is thus evident that the polling of the remote stations can be carried out rapidly, since each remote station has only to transmit a single bit of information, and the time required for servicing the remote stations is also minimized, to that required for servicing by those remote stations which actually need servicing.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a timing diagram showing the relationships of the central station poll command and remote station reply signals, and

Figure 2 is a block diagram illustration of a data communication system embodying the invention.

Figure 1 is a timing diagram of the time related positions of the reply signals from a plurality of remote stations and the poll command from a central station. The poll command is issued by the central station and is applied to a bidirectional data highway having the remote stations arranged serially thereon. The time windows, or reply signal positions, occurring after the end of the poll command correspond in number to the number of remote stations. The length of each window is selected to allow an adequate response time for a remote station while maintaining the entire time used for the polling operation within the allotted specifications for the data highway system. A typical length for each time window would be eighty milliseconds for a system using twenty-eight remote stations and a polling operation every ten milliseconds. The length of each reply signal from the remote stations would, accordingly, be arranged to be compatible with the eight microsecond time slot, or reply window.

Referring to Figure 2, there is shown an overall block diagram of the pulse position to binary address conversion system. A central station controller 2 at a central station is arranged to transmit a poll command, i.e., a digital word, on a bidirectional data highway 3 and to concurrently enable a window counter 4 to count clock signals from a clock source 6. The poll command is applied to the data highway 3 on a regular basis as initiated by a timer in the controller 2 using the aforesaid ten millisecond timing. The clock signal for the window counter 4 is arranged to have a repetition frequency equal to the occurrence time of each reply signal time slot, or window, shown in Figure 1. The clock signal is applied to the window counter 4 following the end of the poll command signal from the central station controller. The counter output is connected to a memory 8 to enable the stored binary count in the window counter 4 to be stored in the memory 8, which is a conventional bipolar memory.

The poll command is applied to each of a plurality of remote stations 10A to 10D which interpret the digital word by means of respective code detectors. The output signal of the detectors representing the receipt of a poll command at each of the remote stations 10A to 10D is arranged to produce a reply pulse for transmission to the central controller 2 if the respective remote station requires servicing by the central controller 2. A signal delay at each of the remote stations is located in the respective reply pulse path and is initially adjusted when the remote station is attached to the data highway 3 to enable the reply pulse from a remote station to be delayed before being applied to the data highway 3 by a fixed delay following the receipt of the poll command. In a preferred embodiment, each of the remote stations 10A to 10D is arranged to reply in the time window corresponding to the serial physical position of the remote station along the data highway 3, e.g., the third remote station along the data highway 3 from the central controller 2 is arranged to reply in the third time window following the poll command. This adjustment of the signal delay at each of the remote stations 10A to 10D is retained until either the location of the remote station is altered to change its position along the data highway 3 or a new remote station is introduced into the system either as an addition or substitution. A typical remote station is shown in station 10A wherein a conventional detector 11A responsive to the coded poll command receives the signals from the data highway 3 and produces output signals to either a variable delay circuit 11C for transmission to the data highway as a reply signal or a terminal device 11B, e.g., a valve controller, arranged to use the detected commands from the central controller 2.

A reply pulse from each of the remote stations 10A, 10B, 10C, 10D is applied via the controller 2 to the memory 8 to enable the storage operation of the stored count in the window counter 4 and to an address counter 12 to increment the address counter 12 to the next storage address of the memory 8. The incrementation of the address counter 12 provides for the storing of successive transferred binary counts from the window counter 4 in consecutive memory locations. The memory locations can be subsequently sequentially read to detect the presence of stored binary counts which identify the remote stations signalling back along the data highway following the poll command. The stored information in the memory 8 is thus subsequently used as binary addresses for the remote stations to request data therefrom during a data gathering operation.

More specifically, during the data gathering operation a series of call signals is generated. Each call signal is fed to the address counter 12 to address the next consecutive location in the memory 8 (starting with the address counter being reset to the first location), and this causes the address stored in that location to be read out. This is fed as a 5-bit number to a multiplexer 74. The outputs of the window counter 4, which is still being driven by the clock source 6, are used to control the multiplexer 74 to select each of the 5 input bits in turn. Thus the stored address is read out from the memory 8 and converted into a 5-bit serial form by the multiplexer 74. This serial address passes through the controller 2 and is used to address the corresponding remote station to call for the information which that remote station has. When that information has been received by the controller 2, the next call signal is generated, to produce the coded address of the next remote station to be called. Thus the relevant information is gathered from all the remote stations having such information to send, but only those stations are communicated with during this operation.

WHAT WE CLAIM IS:—

1. A data communication system comprising a central station and a plurality of remote stations all coupled to a common highway, wherein in operation the central station:

transmits a poll command to which each remote station requiring service responds by transmitting a reply signal after a time delay unique to that station;

decodes the time delays of the reply signals to identify those remote stations requiring service and stores their identities; and

then services those remote stations.

2. A system according to claim 1 wherein the central station decodes the time delays into binary coded form by means of a counter driven by a clock signal the period of which is such that all time delays are different multiples thereof.

3. A system according to claim 2 wherein the central station includes a memory having a plurality of locations in each of which a respective binary coded form can be stored, and a counter which counts the reply signals and produces an address for the memory.

4. A system according to claim 3 wherein the central station includes a multiplexer which, in operation, converts the output of the memory into serial form.

5. A system according to any previous claim wherein each remote station includes a poll signal detector and an adjustable delay driven by the poll signal detector.

6. A data communication system substantially as herein described with reference to the accompanying drawings.

7. The central station of any previous claim.

8. A remote station of any previous claim.

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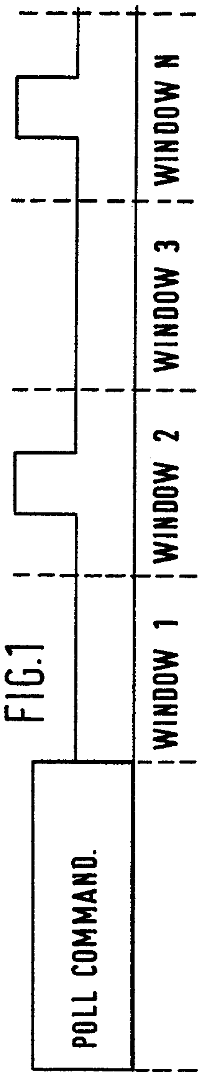
POLL COMMAND.
WINDOW 1
WINDOW 2
WINDOW 3
WINDOW N

FIG.1

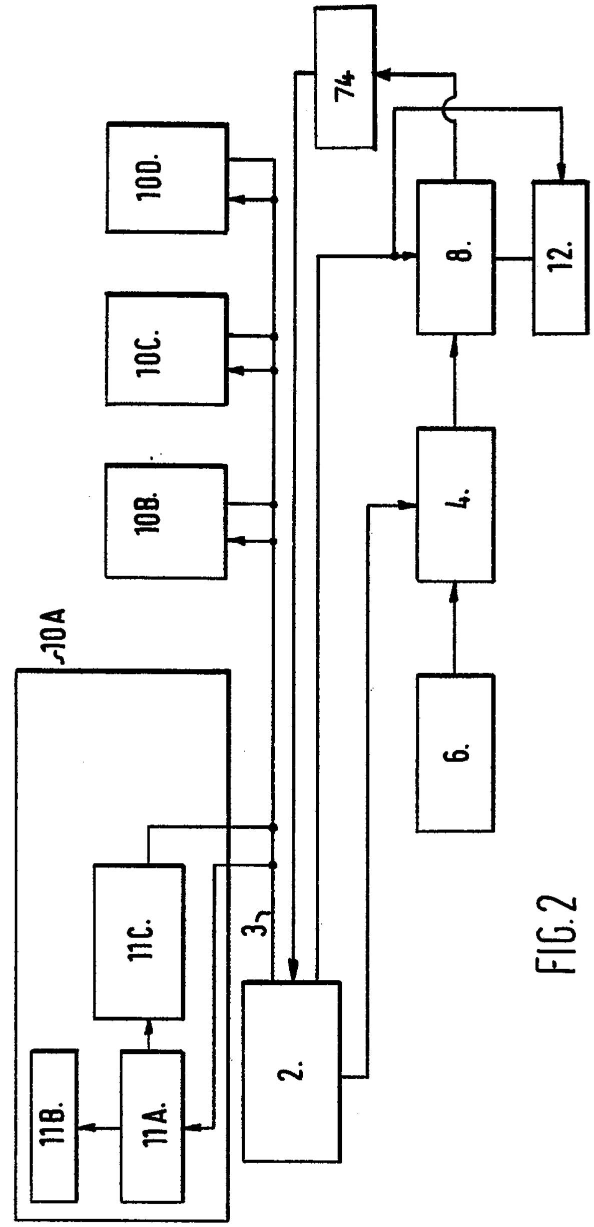
10A
11A.
11B.
11C.
10B.
10C.
10D.
3
2.
4.
6.
8.
12.
74

FIG.2