United States Patent [19]
Krutz et al.

[11] 3,731,277
[45] May 1, 1973

[54] **DATA ACCUMULATION AND TRANSMISSION SYSTEM FOR USE BETWEEN REMOTE LOCATIONS AND A CENTRAL LOCATION**

[75] Inventors: **Ronald L. Krutz; Thomas J. Villella,** both of New Kensington, Pa.

[73] Assignee: **Gulf Research & Development Company,** Pittsburgh, Pa.

[22] Filed: **June 24, 1970**

[21] Appl. No.: **49,235**

[52] **U.S. Cl.**........**340/163 R,** 340/151 R, 340/147 LP
[51] **Int. Cl.**..........**H04q 3/00**
[58] **Field of Search**..........340/151 R, 163 R, 340/147 R, 147 LP

[56] **References Cited**

UNITED STATES PATENTS

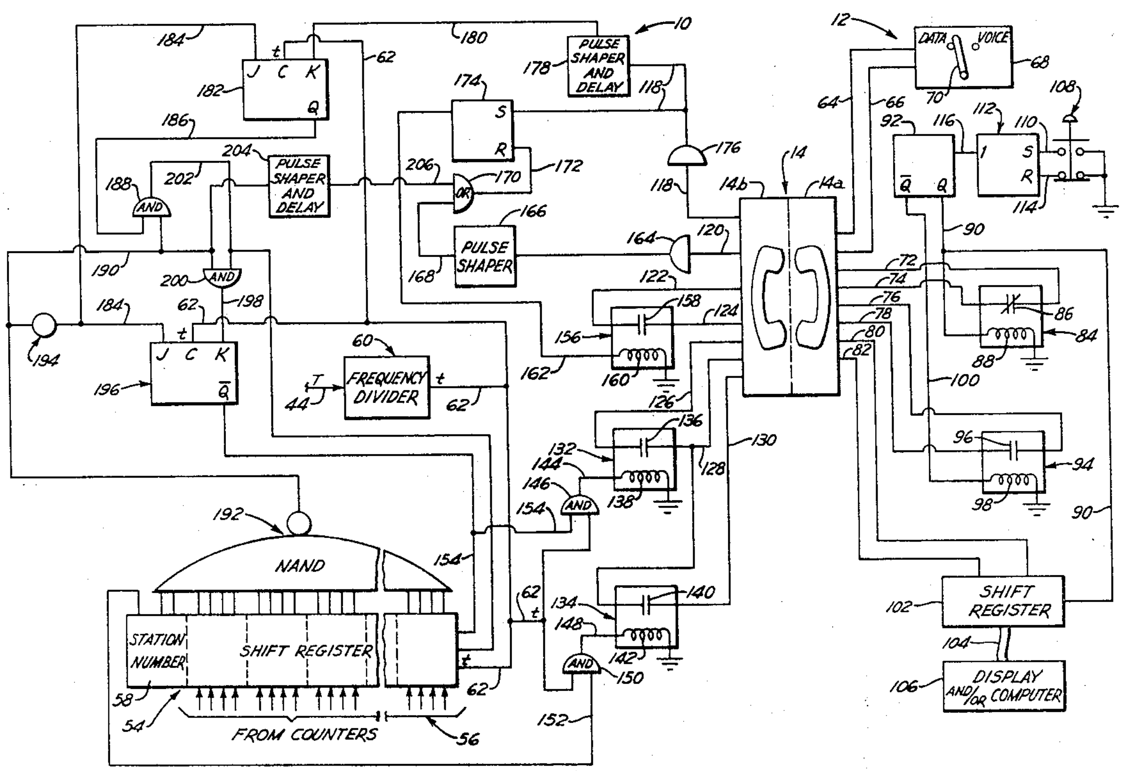
3,336,577	8/1967	Frielinghaus	340/163
3,384,874	5/1968	Morley	340/163
3,408,626	10/1968	Gabrielson	340/163
3,444,521	5/1969	Breese	340/163
3,445,815	5/1969	Saltzberg	340/163
3,529,293	9/1970	Sullivan	340/163
2,445,840	7/1948	Rauch	340/147 CN
2,840,705	6/1958	Scully	340/147 CN
3,016,516	1/1962	Doersam	340/147 C
3,150,374	9/1964	Sunstein	340/147 C
3,173,094	3/1965	Hoegeman	340/147 CN
3,397,386	8/1968	Bishup	340/163
3,435,416	3/1969	Kretsch	340/163
3,484,694	12/1969	Brothman	340/151 X
3,508,200	4/1970	Joel	340/151 X
3,532,827	10/1970	Ewin	340/151 X

Primary Examiner—Harold I. Pitts
Attorney—Meyer Neishloss, Deane E. Keith and William Kovensky

[57] **ABSTRACT**

A data accumulation and transmission system wherein a plurality of independent data generators are sequentially triggered in such a manner that the rate of speed of the triggering pulse is much greater than the rate of speed of data production. Double counting is prevented by utilizing the trailing edge of each data pulse to reset the device which the triggering pulse sets. The data is communicated, for example, across a telephonic connection in a highly reliable manner by utilizing a clock to drive the data out of a shift register and to simultaneously gate-in the clock pulses with the data at the sending telephone.

41 Claims, 5 Drawing Figures



Patented May 1, 1973 3,731,277

3 Sheets-Sheet 1

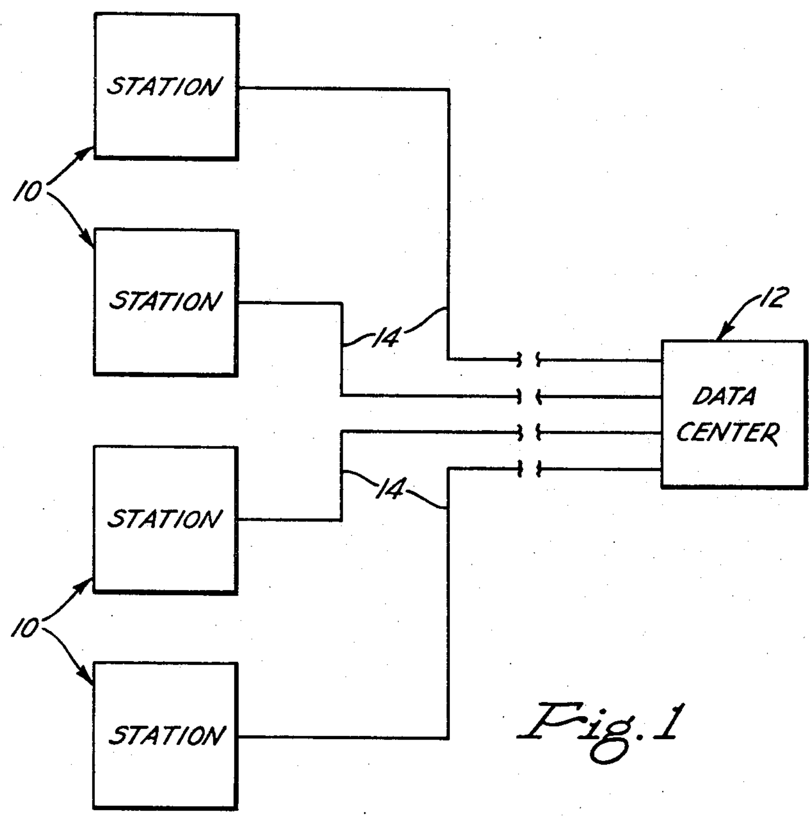


Fig. 1

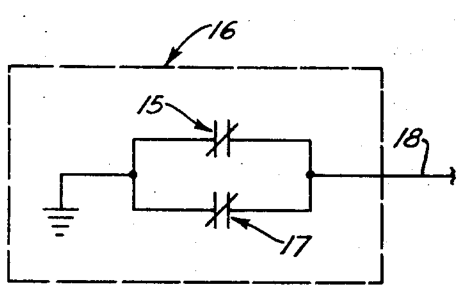


Fig. 3

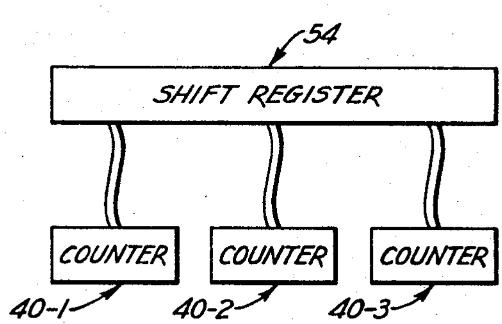


Fig. 5

INVENTORS.
RONALD L. KRUTZ
THOMAS J. VILLELLA

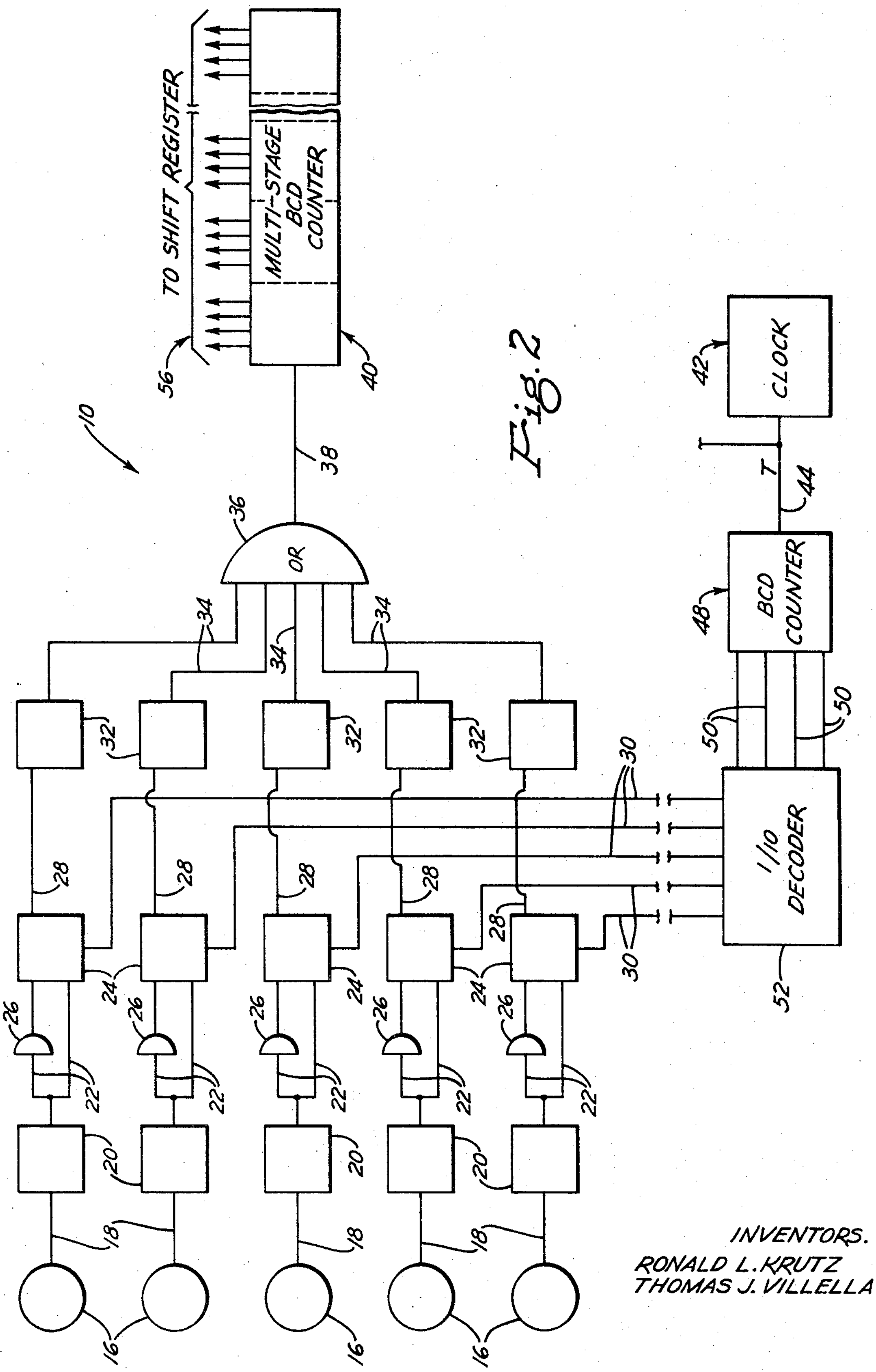


Fig. 2

INVENTORS.
RONALD L. KRUTZ
THOMAS J. VILLELLA

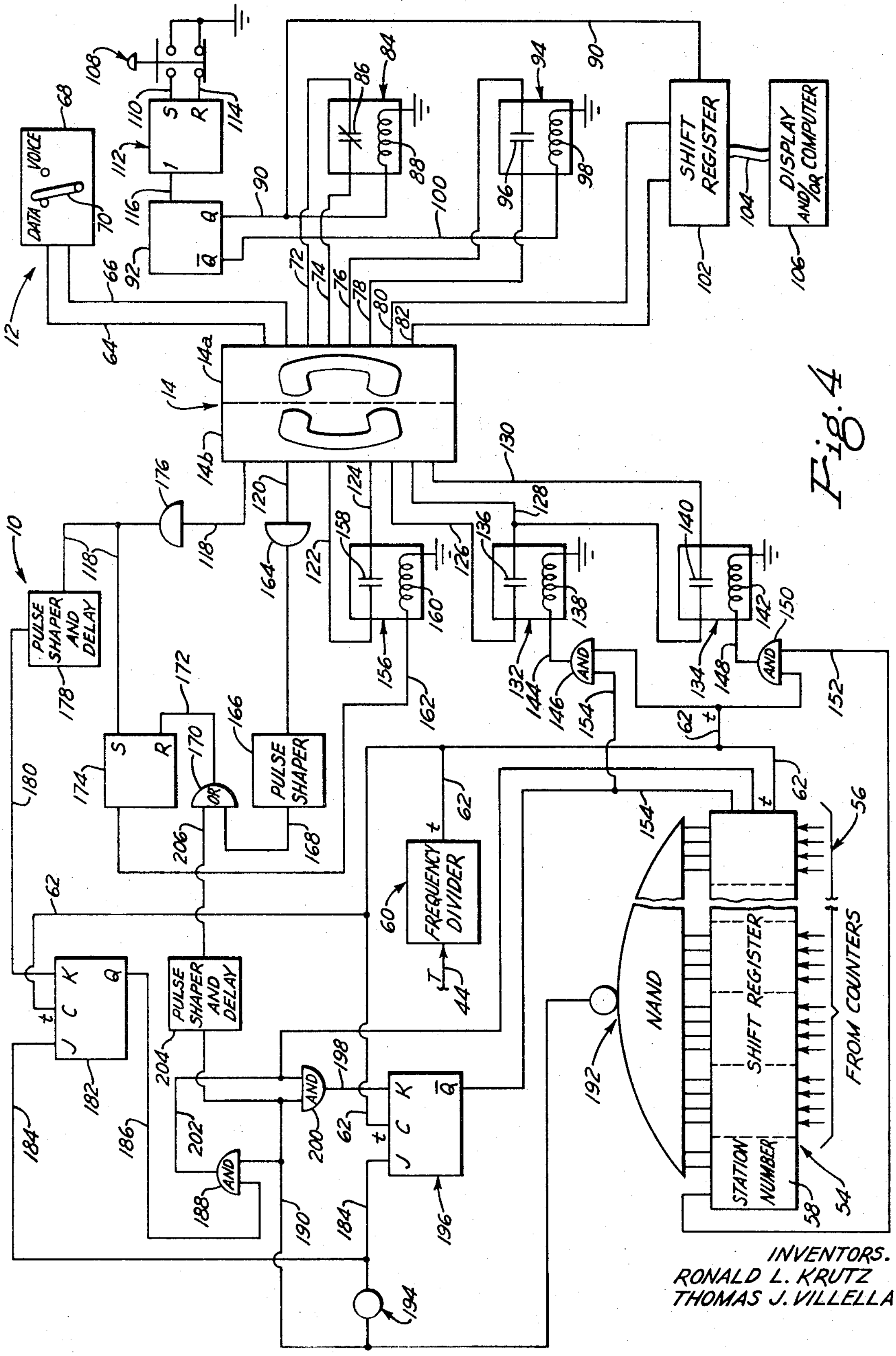


Fig. 4

INVENTORS.
RONALD L. KRUTZ
THOMAS J. VILLELLA

DATA ACCUMULATION AND TRANSMISSION SYSTEM FOR USE BETWEEN REMOTE LOCATIONS AND A CENTRAL LOCATION

This invention relates to data gathering and transmission systems, and more in particular pertains to such a system for use between a plurality of separated locations and a central point, such as a computer center. The data is generated at each of the separate locations by a plurality of separate and independent devices or data generators. The central location, by means of a telephonic hook-up or other communication means, may interrogate each of the remote locations to gather the data from all of the data generators at that location.

As is obvious, such a system is useful in a varied and large number of different kinds of applications, such as transmission of credit card sales data, inventory control, credit verification, remote reading of metering devices generally, and the like. However, the invention was developed specifically for and will be described primarily in connection with such a system for use between a data center connected to a plurality of otherwise conventional retail gasoline outlets or service stations.

For ease of description, the invention may be thought of as comprising two portions, which are in fact integrated together, but which lend themselves to functional separation. These two portions are a data gathering system having a part in operative cooperation with each of the pumps in the station or other pulse data generators, and secondly a data transmission system which includes commercially available telephonic data transmission equipment, for example, data transmission equipment as supplied by the Bell Telephone Companies. Of course, the invention is not limited to any particular model of such telephonic equipment or even to the telephone per se, since other means, such as telegraph lines, radio systems, or the like, could be used, with suitable changes in the apparatus of the invention. However, as mentioned above, this division into sections is a matter of convenience only, since, in fact, a single circuit or "black box" could be provided at each service station with the data pulses from each pump brought to a single piece of electronic hardware in the station, or perhaps with satellite parts thereof at each pump. Thus, each piece of apparatus at each station would include virtually the entire invention, namely, the entire data gathering "section" and all of the data sending part of the data transmission "section". The remainder of the apparatus of the invention, one piece of equipment to service all of the remote locations, would comprise merely the remainder of the data transmission section and some sort of data receiving means such as a shift register and/or display. This is the form the prototype apparatus built to test the invention has taken.

The utility of the invention in the gasoline business is manifest, and includes the capability of automated inventory control, automated dispatching of tank trucks to the stations, stock loss control, automated money accounting including service station billing, remote meter reading, and the like. Further, starting from the system of the invention as a base, still more sophisticated uses are possible, such as automated credit card retailing which would include automatic billing of the customer, checking for expired or otherwise invalid credit cards, and automated and more rapid customer billing which is worth substantial monies to a major oil company by holding customer accounts receivable at a lower level.

Referring again to the artificial but convenient separation of the invention into sections above, the data gathering section comprises a highly versatile circuit adapted for use with virtually any number of pumps in a conventional service station. In the specific form of apparatus disclosed below, maximum capacity is ten pumps for one grade of gasoline, but this number can be increased, almost without limit, for an exceptionally large station, or in other applications to which the invention might be applied. More than ten pumps is somewhat unlikely because each grade of gasoline is handled separately, and it would be an exceptionally large station which would have more than ten pumps for one grade.

One problem, overcome by the invention, flows from the fact that each pump is a completely independent input device, that is, each pump operates or does not operate without regard to the others, and, when operating, can operate at an infinity of different speeds. In the specific apparatus described below, five pumps for one grade are shown as a more or less arbitrary example of a typical installation. Each of the five pumps can operate or not operate without regard to the other four, and each can operate at many different speeds, although the most typical speed will be top speed as when the pump is operated under the control of the automatic shut-off nozzle. Thus, given the above as the environment of the invention and given that transducer means are provided at each pump to transform the flow of gasoline into a stream of electrical pulses proportional to the liquid flow, as will appear in the detailed description below, then the circuitry must be able to accommodate, within one station, the possibility of simultaneous creation of two or more pulses generated by two or more separate pumps. Further, the circuitry must never lose a pulse and must never create spurious or additional pulses. This high degree of reliability is needed for proper inventory control and for proper financial control.

In overcoming these problems and achieving these goals, the invention utilizes the fact that each of the random data pulse generators, each pump, has a known maximum speed. The circuitry provides a continuously "circulating" triggering pulse which is used to pass the raw data pulses through intermediate stages of the circuitry. The speed of this "circulating" triggering or gating pulse is caused to be much greater than the highest possible speed of data pulse generation, and this speed relationship is utilized, as will be described in detail below, to solve the simultaneous data pulse generation problem as well as to assure correct accumulation of the data.

The invention solves the potential problem of usage of the pump creating false pulses by providing means to ground the input end of the circuit at all times except when the pump motor is operating.

The data transmission section of the invention is partly located at the service station and operates in conjunction with the means utilized to accumulate the data from one of the pumps, with some communication means such as a data telephone hook-up, and finally with interrogation means and data receiving means including a display, a computer, and/or the like, at the central location or data center. An essential here, again with an eye to one of the prime pre-requisites of high reliability, is the provision of means to provide a fiducial, clock, or control pulse which is transmitted with the data by the communication means from the station to the data center, and, as will appear below, in the opposite direction as well, so as to assure that only the data is counted, no data is lost, and that no spurious or additional pulses are included.

Another problem is accommodating for the nature of the environment, e.g., the constant presence of automobiles having high voltage ignition circuits which could severely disrupt the intended operation of electronic pulse handling circuitry. The invention corrects for this potential problem by providing suitable noise depressant means, such as grounding the pump data generator after each sale, as will appear in detail below, using relatively noise immune logic components at the input end, and using suitable RC protecting networks (loss pass filters) between each pump and the circuit of the invention.

The invention provides means to simplify the process of interrogation of each station by the central location while at the same time holding the cost of equipment required at each remote location to a minimum. Referring again to the artificial division of the invention into "sections" a unique interface is provided so that one data sending apparatus at the station can accommodate as many separate data gathering systems as are present, for example, each grade of gasoline will require its own data gathering "section".

The above and other advantages of the invention will be pointed out or will become evident in the following detailed description and claims, and in the accompanying drawing also forming a part of the disclosure, in which:

FIG. 1 is a schematic diagram of one type of environment in which the invention may be used;

FIG. 2 is an electrical schematic diagram of the data accumulation section;

FIG. 3 is a detailed view of part of FIG. 2;

FIG. 4 is an electrical schematic diagram of the remainder of the apparatus of the invention which includes part of the data transmission section, the communication means, and the apparatus required at the central location or data center; and

FIG. 5 is a simplified sketch showing the manner of operation of a part of the apparatus of FIGS. 2 and 4.

Referring in detail to the drawing, in FIG. 1 there is shown a plurality of remote locations 10, which may be conventional retail gasoline service stations. A central location 12, which may be a data center or computer center is joined to each of the stations 10 by separate communication means such as separate telephonic hook-ups, which communication means are indicated by the lines 14. Referring to FIG. 2, there is shown part of the installation at each of the stations 10, and referring to FIG. 4, there is shown the remainder of each of the installations at each service station 10, the communication means 14, and the entire installation at the computer center or central location 12.

Referring now in detail to FIG. 2, each service station 10 includes a separate plurality of gasoline dispensing pumps 16 for each of the various grades of

gasoline. In FIG. 2 there are shown five pumps 16 for one particular grade, it being understood that there will be approximately five for each of the other grades sold by that station, and that the circuitry up to counter 40, as described below, will be duplicated for such other groups of pumps.

Means are provided within each pump in the station to convert the flow of gasoline through the pump into a stream of data pulses the rate of which is proportional to the amount of liquid passing through the pump. Such pulse generating transducers are commercially available, or alternatively the apparatus disclosed in our copending patent application Ser. No. 815,838, filed Apr. 14, 1969, and entitled "Gasoline Pump Computer", now U. S. Pat. No. 3,598,283, assigned to the same assignee as the present invention, may be advantageously used. A line 18 delivers the raw data pulses produced by such means in the pump 16 to filter-like means 20 which serve to suppress noise produced by the proximity of high voltage automotive ignition systems, and to protect the remainder of the circuitry. Filter means 20 include a low pass filter such as an RC network, and a relatively noise immune logic gage, or other suitable means well known to those skilled in the art. After filters 20, the "cleaned-up" pulses are present on a pair of lines 22 which feed the pulses to pulse passing means which may be a bistable multivibrator or flip-flop 24. A signal inverting device 26 is included in one line 22 of each pair. Each pulse is reproduced and supplied by the lines 22 to the flip-flop 24 as both a negative-going and as a positive-going pulse, because such pulse treatment is required by the nature of the flip-flop, as is known.

Means are provided to assure that no spurious pulses are supplied to filter means 20 and the remainder of the circuitry because of the manner of usage of the pumps 16. Virtually all retail gasoline dispensing pumps in use today have two manual controls; a switch or push-button which resets the counting mechanism, and a switch which turns the pump motor on and off. The pump motor switch activator is usually a relatively heavy piece of metal which includes a flange or other means to hold the gasoline dispensing nozzle, but only when the pump switch is in the off position. The pump includes an interlock between these two controls which prohibits turning on the pump motor unless the counters are first reset to zero, and which also prohibits resetting the counting mechanism unless the pump motor is off.

The potential problem which is overcome by the switch arrangement of the invention shown in FIG. 3 is that if the circuit is not grounded while the pump counting mechanism is being reset, then the circuitry of the invention may "see" the resetting motion of the counter mechanism as pulses. This potential source of error is eliminated by the provision of a normally closed switch 15 wired between line 18 and a suitable ground in the pump and mechanically or otherwise connected to the manual pump motor control switch. The addition of such a switch is a simple matter for a skilled mechanic. Since the pump's own interlock assures that the pump motor switch must be off in order to reset, thereby placing switch 15 in its normally closed position, the FIG. 3 circuitry assures that line 18 will be grounded during the act of resetting the pump's counting mechanism. The second switch **17**, wired in parallel with switch **15**, represents that part of the pulse generating transducer in the pump used to produce the raw data pulses. Whatever such means **17** are used, they are preferably arranged so that switch **17** is closed when the pump's counting mechanism is at the zero position, thus assuring that the circuitry is grounded after resetting is complete and before the next pumping operation begins.

Thus, the FIG. **3** circuit assures that raw data pulses will be produced only during the act of dispensing gasoline.

Referring back to FIG. **2**, the flip-flops **24** require a triggering pulse to permit passage of signals from their input side, the lines **22**, across to their output side, lines **28**. The required triggering pulses are separately supplied to each flip-flop on a line **30** running from the timing means described further below. Flip-flop output line **28** delivers pulses to data pulse conditioning means which may be a one-shot multivibrator **32**, and a line **34** from each one-shot **32** delivers the pulses to data pulse accumulating means which may be an "or" gate **36**.

Before proceeding deeper into the detailed description of the circuit, it should be understood that the schematic drawings forming part of this disclosure have been distilled from substantially more complex working drawings. Thus, this description is at least partly in functional terms, leaving much of the detail to the expertise of the worker skilled in the art. For example, in the successfully constructed and operating prototype apparatus, the "lines" **30** are not literally a single electrical conductor but each is a pair of such conductors, and may be conventional wiring and internal circuitry of purchased components. Thus, the term "line" as used herein will be understood to mean one or more electrical conductors. Similarly, "or" gate **36** is in fact a NAND gate, but it is functionally equivalent to an "or" gate. Many such simplifications have been made, but no additional ones will be pointed out, unless necessary for an understanding of the functioning of the circuit, since such equipment, its capabilities, the interchangeability of such components, an such techniques, are well within the skill of the ordinary worker in the art.

The output signals from "or" gate **36** are fed on a line **38** to suitable counting means, which may be a multi-stage binary coded decimal (BCD) counter **40**. A counter **40**, see FIG. **5**, is required for each grade of gasoline, and all the circuitry of FIG. **2**, with the exception of the timing means, is provided for each different set of pumps **16**. The lines **30** are shown broken to indicate that the timing means are shared. As will appear in detail in the "Operation" section below, the essential timing required for operation of the invention is provided by a device **42** which may be thought of as a clock in that it continuously produces pulses at a regular frequency. Such clocks are commercially available with means to vary the period of the pulses. In any particular installation, one clock frequency will usually be sufficient, but the adjustable feature may be desired for more versatility or where the invention is used in some other environment. The timing pulses produced by clock **42** at a frequency of T pulses per unit time are present on a line **44**. The pulses on line **44** may be either positive-going or negative-going, depending upon the required interaction with the other components used in constructing any specific apparatus in accordance with the invention. In the successfully constructed embodiment of the invention these pulses are positive-going.

As is known, the description "positive-going" or "-negative-going" refers to the nature of the pulse. That is, assuming the pulse is of square shaped, then in the direction of the progression of time the first leg of the square either rises from whatever the base value is being used to some higher positive value (positive-going), or conversely, falls from the base value to some less positive value, (negative-going). The concept of zero as a base should be avoided since the base itself could have a positive or a negative value.

The clock pulses on line **44** feed the input side of a single stage BCD counter **48**. As is known, and as is explained in detail in our previous patent referred to above, device **48** is a commercially available item which counts the pulses received on input line **44** and produces coded pulses on a set of lines **50** representative of the numbers **0** through **9**. Counter **48** has the capacity to count as high as **15**, but it is constrained, by simple alteration, to count up to **9** only. The coded signals on lines **50** feed the input side of a decoding device **52**, which changes the binary code decimal signals to true decimal signals supplied on the output lines **30** described below. Thus, components **48** and **52** operating together may be thought of as a single decimal counter, and are used for all the sets of pumps in the station.

The circuitry of FIG. **2**, with the exception of the data pulse generators in the pumps **16**, is advantageously all solid-state, rather than vacuum tube, so as to yield the advantages of lower power and voltage requirements, smaller size, and rugged, reliable and relatively inexpensive construction.

As is now evident, each remote location will have a number of counters **40** equal to the number of different grades of gasoline sold at that station. Typically, there are three grades. Referring to FIG. **5**, the three counters are indicated as **40–1**, **40–2** and **40–3**, and the manner of their connection to the shift register **54** of FIG. **4** is diagrammatically shown. The concept underlying FIG. **5** is that the three data accumulation circuits, each like FIG. **2**, are interfaced with the single data transmission circuit, FIG. **4**, by providing one shift register **54** large enough to accommodate all the counters **40**. Thus, when the central location interrogates a station all the data as to all three grades of gasoline will be sent out in one continuous stream, thereby eliminating the need to make a separate interrogation in regard to each grade of gasoline. The data for each grade can be separated at the central location **12** in a variety of ways, such as by providing means to insert a "dummy" between the data for each grade, or some symbol other than a number between grades, or by simply physically separating the three displays at the data center, the number of digits per grade being known. Other ways of achieving data separation will be obvious to those skilled in the art.

Thus, the arrangement of FIG. **5** allows parallel data accumulation from independent counters, and sequential data transmission of the composite data count.

Referring now to FIG. 4, there is shown the remainder of the circuitry at remote location 10, all of the circuitry at the central location 12, and the telephonic communication means interconnecting the two locations. The FIGS. 2 and 4 circuitry are connected together between the counters 40 and a shift register 54. The connection is indicated by the sets of lines 56 which interconnect the respective stages of all the counters 40 and shift register 54. These two components, 40 and 54, are shown broken in the drawing to indicate that any number of counting stages could be utilized. The shift register 54, however, will have at least one more stage 58 than the sum of all the stages of counters 40. The additional stage 58 comprises means to manually set a number thereon, not shown, which number will identify the particular station 10, the first location, to the data center 12, the second or central location. If required, of course, the extra stage 58 could comprise more than one stage, dependent upon the number of remote locations being serviced. The shift register may require two or more additional stages to accommodate the intradata "dummies," symbols, or the like, if such are used.

The showing of a shift register is exemplitive only, and, as will appear more clearly in the Operation section below, the term shall be understood to include any sort of device in which data is stored and moved in a sequential fashion, rather than along parallel lines or in any other manner. As is now clear, the two "artificial" portions of the invention, the circuitry of FIGS. 2 and 4 is artificial in the sense that in the intended use of the invention they are integrated together. The two sections have separate utility. For example, the FIG. 2 circuitry could end at the counter 40, with perhaps the addition of some display means, where it is desired to only accumulate the total count of the data pulse generators at a single location and not to transmit the data to some other location. Similarly, the data transmission means of FIG. 4 can be used in any environment where it is desired to transmit a data count from a shift register at one location to some data receiving means at some other location, where the two locations are physically separated from each other but connected together by some communication means.

As is known, each set of lines in the sets 56 consists of four lines, as four is the number of signals needed to represent any single digit number in the BCD code.

The timing of the operation of several components in the FIG. 4 circuitry is critical, and all of these portions are connected to a single timing or control source, which may comprise the clock 42 of FIG. 2. Referring to FIG. 4, a tap from line 44 feeds a frequency divider circuit 60, which circuit may be any one of a wide variety of such commercially available items. The output of divider 60 is present on a line 62, and comprises a chain of control or timing pulses having a frequency t. Suitable frequency divider circuits are commercially available, or may be easily built according to circuits found in handbooks. For example, Motorola Integrated Circuit Data Book, Aug. 1968. Line 62 feeds various parts of the FIG. 4 circuitry, as described below.

Communication means 14 will advantageously comprise equipment intended to work in conjunction with the commercial telephone network. In the form of the invention constructed to date, a Bell Telephone Company 401 H data transmitter and 401 J data receiver were used. These instruments have a number of connecting points or terminals on each side to which the user may attach whatever equipment he desires so long as his equipment will perform the function required by the special telephone at those terminals. Referring to the right side of FIG. 4, which corresponds to the data center, a pair of lines 64 and 66 connect the appropriate terminals on the data center special telephone 14*a* to a switching device 68. Device 68 is not supplied by the telephone company. A switching member 70 on device 68, in conjunction with data set 14*a*, renders the data set in condition to transmit and receive either data or normal voice.

The overall manner of using data set 14*a* and the sending data set 14b at the remote location is first to send a signal from the data center to the station which may be thought of as the "transmit command." This command signal enables the transmitting station, or remote location, to begin sending data. When the data center's telephone must be rendered into a different configuration in order to receive the data, and a corresponding change of configuration must take place at the sending location. The above sequence of events is a result of the fact that the particular telephones used are capable of unidirectional transmission only. The telephone company and others do have equipment available which can transmit data in both directions simultaneously, but such equipment is considerably more expensive, to either purchase or rent, than the simpler equipment around which this portion of the invention has been built. The simpler, less expensive equipment was used because no substantial loss of speed is suffered, and substantial economies are realized.

In addition to the lines 64 and 66 described above, six additional contacts on receiving equipment 14*a* are utilized and these are connected to lines 72, 74, 76, 78, 80 and 82 respectively. There are other terminals on the particular equipment 14a used to provide a second channel, but a second channel is not utilized in the invention and therefore is not shown. The lines 72 and 74 connect to the opposite sides of a pair of normally closed contacts 86 on a relay 84. When contacts 86 are closed, receiver 14*a* is in condition to receive data, and when the contacts 86 are open, equipment 14*a* is in condition to send the transmit command to the data sending equipment 14*b*. The coil 88 of relay 84 is connected by a line 90 to the Q terminal of a one-shot multivibrator 92.

The next pair of lines 76 and 78 are used to send the transmit command, and these lines run to the opposite sides of the normally open contacts 96 of a relay 94, the coil 98 of which is connected by a line 100 to the $\bar{Q}$ terminal of one-shot 92. As mentioned above, the schematic of FIG. 4 is simplified, and certain parts, such as current amplifiers or buffers in the lines 90 and 100 and suitable diodes or other suitable protection means for the coils 88 and 98 have been omitted.

The remaining two lines 80 and 82 are used to receive data and gated clock or control pulses from the remote location 10 via the communication means 14. These lines terminate at a receiving shift register 102. An extension of line 90 extends to the reset terminal on shift register 102. A cable 104 interconnects shift register **102** with means **106** which may comprise a data display device, and/or a suitable computer for handling the data received. In the event means **106** includes a computer, this machine may be used to automatically and cyclically interrogate all of the remote locations and to operate the data receiving means and circuitry on the right hand side of FIG. **4**. Thus, the term "data receiving means" as used herein shall be understood to denote means such as a shift register, a data display device, and/or a computer, and the like.

Completing the right hand side of FIG. **4** there is provided switch means such as a manually or mechanically operated switch **108**, the normally open terminal of which is connected by a line **110** to the set (S) terminal of a flip-flop **112**, and the normally closed terminal of which is connected by a line **114** to the reset (R) terminal of flip-flop **112**. A line **116** interconnects the output of the flip-flop **112** and the input of one-shot **92**.

Referring to the left side of FIG. **4**, the transmitting data set comprises seven lines, **118, 120, 122, 124, 126, 128** and **130**. Lines **126, 128** and **130** service the contacts on a pair of relays **132** and **134**. Relay **132** comprises a pair of normally open contacts **136** and a coil **138**, and relay **134** comprises a pair of normally open contacts **140** and a coil **142**. Line **128**, known as the "phone-common", is connected to one side of each of the contacts **136** and **140**. Line **126** connects to the other side of contacts **136** and line **130** connects to the other side of contacts **140**. One side of coil **138** is suitably grounded, and the other side of said coil is connected to a line **144** which connects to the output side of an "and" gate **146**. Similarly, a line **148** extends from coil **142** to the output side of an "and" gate **150**. Extensions of line **62**, carrying the control pulses at frequency *t*, comprise one of the two inputs to each of "and" gates **146** and **150**. A line **152** extending from the output of shift register **54** comprises the second input to "and" gate **150**, and a line **154** comprises the second input to "and" gate **146**. As will appear below, the array of components **132** through **154** are used to simultaneously deliver each control pulse and each data bit for transmission across communication means **14** and reception by the shift register **102** at the receiving side.

The normally open contacts **158** on a relay **156** are serviced by the lines **122** and **124**, and the coil **160** of said relay is suitably grounded on one side and connected to a line **162** on the other side. Relay **156** controls the condition of receiving portion **14*b*** as to whether it will send or receive signals, as will appear in the Operation section below.

Line **120**, which includes a suitable amplifier **164**, feeds pulses from transmitter **14*b*** to a pulse shaper **166** the output of which is fed on a line **168** to an "or" gate **170**. The output line **172** from "or" gate **170** feeds the R terminal of bistable multivibrator **174** which is called the transmit enable flip-flop. Line **162**, feeding coil **160** of relay **156**, is the output line of flip-flop **174**. Line **118** from the communication means includes a suitable amplifier **176**, and thereafter breaks into two branch lines, one of which feeds the set or S terminal of flip-flop **174**, and the other one of which feeds the pulse shaping and time delay means **178**. A line **180** connects the output of means **178** to the K terminal of a shift enable flip-flop **182**. The other inputs to flip-flop **182** are a line **184** at its J terminal, and the control pulses at frequency t on line **62** at its C terminal. A line **186** is connected to the output of shift enable flip-flop **182**.

Line **186** is one of the inputs to an "and" gate **188**, the other input of which is delivered on a line **190**. Line **190** connects to the output of a NAND gate **192**. As is known, a NAND gate is an "and" gate plus an inverter, so that the output will be high at all times except when all of its inputs are high. Line **184**, described above, including an inverter **194**, branches off from line **190**, and also branches off to the J terminal of another flip-flop **196**. The K terminal of flip-flop **196** is connected by a line **198** to the output of an "and" gate **200**. The output of flip-flop **196** is carried on line **154**, described above, which also connects to shift register **54**. A three-way branching line **202** interconnects the output of "and" gate **188**, one of the inputs to "and" gate **200**, and shift register **54**. Line **190** from NAND gate **192** interconnects the second input of "and" gate **200**, one of the inputs to "and" gate **188**, as described above, and the input of a second pulse shaper and delay circuit, similar to circuitry **178** described above. A line **206** interconnects the output of circuitry **204** and the second input terminal of "or" gate **170**.

OPERATION

Referring back to FIG. 2, each of the pumps **16** is free to operate independently of all the others. The clock **42** operates continuously, continuously driving the counter **48** and the decoder **52**. Thus, a circulating triggering pulse is sequentially present on the lines **30** to the data pulse passing flip-flops **24**. It is an important aspect of the present invention that the frequency of the triggering pulse on any one of the lines **30** be greater than the data pulse frequency produced by the pumps **16** at their maximum speed. A specific example may be helpful in explaining this point. It is a fair assumption that commercial gasoline vending pumps have a maximum speed of **12** gallons a minute. As disclosed and explained in our previous patent mentioned above, it is sufficient to use a transducer which will produce 10 data pulses per gallon of gasoline. 100 pulses per gallon could be used if more resolution is required. Thus, at the pump's top speed, 120 pulses a minute or two data pulses a second will be produced. In the operating prototype of the invention, clock **42** produces pulses at the rate of 1,000 per second. Counter **48** keeps counting these and supplies signals corresponding to the digits zero through nine on its output lines **50**. Therefore, there is a signal on any one line **30** corresponding to one of the digits zero to nine at the rate of 100 times a second. Thus, the triggering pulse is present at any one flip-flop **24** at 50 times the maximum rate of speed of the production of data pulses by the pump **16** associated with that flip-flop.

Because there happened to be five pumps in this example, it is possible to double the rate of speed of the circulation of triggering pulses around the flip-flops **24** by using two digits for each flip-flop. That is, zero and five to control one flip-flop, one and six to control the next, etc. Not all the digits need be used, which might be necessary in certain situations, e.g., if between six and eight pumps are to be included. Other arrangements will present themselves to those skilled in the art since the timing means are shared by all the sets of pumps in the station, only one set being shown.

The data pulses, after being "cleaned-up" by the filter means **20**, pass through the parallel lines **22** and inverter **26** to the input terminals of flip-flop **24**. Since the circulating triggering pulse is so much faster than the data pulses, the invention assures that no data pulses will be lost because even if two pumps should produce a data pulse simultaneously, one will in effect "wait" at the input to its flip-flop until the triggering pulse circulates around to allow it through. However, by so providing the speed difference to assure that no pulses are lost, the equipment has the potential of counting the same data pulse more than one time. This potential problem is overcome by providing a one-shot multivibrator **32** of such a character that it responds to only a falling edge of the output of flip-flop **24**. Subsequent triggering pulses on the line **30** do not cause multiple counting, and the circuit is independent of the width of the data pulse, because once a flip-flop **24** is "-set" by the simultaneous presence of a raw data pulse on line **22** and a timing pulse on line **30**, it remains "-set" and insensitive to additional timing pulses until it senses the tail and falling edge of the raw data pulse. The flip-flop resets after the falling edge occurs and after the next timing pulse occurs, thereby rendering it ready to receive the next data pulse while simultaneously driving multivibrator **32** to put out a pulse to counter **40** via gate **36**.

The outputs of the one-shots **32** then pass through the lines **34**, the "or" gate **36** and line **38** to the counter **40**. Because the firing of the one-shots corresponds to the movement of the circulating triggering pulse on the line **30**, and because of the extremely high response speed of the solid state components used, there is virtually no possibility of a data pulse being lost in its passage through the "or" gate **36**.

Referring now to FIG. **4**, the sets of lines **56** cause shift register **58** to virtually instantaneously follow the count as it proceeds on all the counters **40**. Each section of the shift register **58** associated with each counter operates independently of the other parts of the shift register during this operation. Nothing further occurs in the circuitry of FIG. **4** until the data center interrogates the remote location to request its count. The sequence of events, thereafter, is:

1. Device **68** must be put in the data mode.
2. The number of the transmitting data set 14b is dialed from the data receiver 14a (either manually or by computer), connection is completed, and the receiver data set put in the data mode.
3. Switch **108** is operated momentarily and the transmit command is generated.
4. Upon receipt of the transmit command from the receiving circuitry, shift register **54** at the transmitter is isolated from all counters **40** so that the counters are free to continue operating, and the shift register holds the one composite number which will be transmitted.
5. The data is transmitted across the communication means to the shift register **102**.
6. FIG. **4** circuitry is returned to the ready condition.
7. Shift register **54** is reconnected to the counters **40**.

Developing these steps in detail, the operation of switch **108** causes flip-flop **112** to change states, and produces a signal on line **116** feeding one-shot **92**. Prior to this occurrence, a signal was present at terminal $\overline{Q}$ and line **100**, holding contacts **96** of relay **94** closed. When the one-shot **92** fires, contact Q becomes activated and contact $\overline{Q}$ becomes deactivated. Thus, line **90** becomes conducting, resetting shift register **102** and activating coil **88** of relay **84**. Contacts **86** on said relay open, thus rendering receiver **14*a*** in condition to send the transmit command. Simultaneously, coil **98** of relay **94** becomes deactivated, opening contacts **96**, and the transmit command is sent out across the communication means from **14*a*** to **14*b***. One-shot **92** then completes its timing cycle, reactivating terminal $\overline{Q}$, deactivating terminal Q, thus deactivating coil **88**, thus allowing contacts **86** to return to their normally closed position, thus rendering receiving side **14**a ready to receive data.

The above chain of events cause certain corresponding occurrences on the **14*b*** sending side. Prior to any transmit command, a signal was automatically generated and was present on line **120**. This signal is produced by transmitter **14*b*** when connection between it and receiver **14*a*** was completed. The automatically generated signal is then fed to buffer **164**, shaped by device **166**, and fed through "or" gate **170** and through line **172** to reset flip-flop **174**. No signal is thus assured on line **162**, rendering coil **160** deactivated and contacts **158** in their normally open condition. When contacts **158** are open, transmitter portion **14*b*** is ready to receive the transmit command signal. Upon receipt of the transmit command signal from **14*a*** at **14*b***, that signal is present on line **118**, is fed through gate **176**, and proceeds to perform two functions along the parallel branch lines **118**. Firstly, the transmit command changes the state of flip-flop **174** to its set condition, creating a holding voltage on line **162**, and closing contacts **158** by the chain of events described above. Lines **122** and **124** are thus shorted rendering transmitter **14b** in condition to transmit data. Simultaneously, the transmit command signal is sent to pulse shaping and time delay circuitry **178**. A delay is required because the remaining equipment described below is all solid state, whereas the enabling equipment described above includes mechanical relays which require longer periods of time to operate. After the delay, the transmit command proceeds on line **180** to the K terminal of the shift enable flip-flop **182**, thus causing output line **186** to conduct. "And" gate **200**, when activated by signals on its two input lines **202** and **190**, provides a signal on its output line **198** to isolate shift register **54** from the counters **40** via flip-flop **196** prior to data transmission from **14*b*** to **14*a***. As will appear below, the same components operate to reconnect shift register **54** to the counters **40** at the end of data transmission. "And" gate **188**, which is actually a NAND gate, is needed for a signal inversion, and in other embodiments it could be omitted if such an inversion is not required.

NAND gate **192** is high at all times except at the end of the shift when it momentarily goes low. This is so because the input to gate **192** is the binary coded numbers corresponding to the count it is desired to transmit. Since each stage is limited to a count of nine, and since all the inputs from any stage could be conducting only if that one stage were thereby producing a set of signals corresponding to the number **15**, then it is certain that there will always be at least one signal in each set of four from each stage which will be low or a "-zero" in binary jargon. So long as even one input to gate **192** is low, then the output of the gate will be high. To insure this desideratum, by means described below, there is inserted a binary zero behind the data prior to transmission. Since there is a signal on line **190** there is a signal to one of the inputs to each of "and" gates **188** and **200**. When flip-flop **182** receives an input on its K terminal, the second input to "and" gate **188** is present causing it to produce an output on line **202**, causing the second input to be present on "and" gate **200**, causing flip-flop **196** to receive an input on its K terminal. A signal is then present on line **154** from the output of flip-flop **196**, causing two different chain of events in the circuitry. First, the output of **196** on the vertical leg of line **154** to the shift register **54** provides an initial 0 followed by a series of 1s which follow the data through shift register **54** during data transmission. The other branch of line **154** provides a 1 gating signal to "and" gate **146** which allows fiducial, control, or clock pulses to flow into the data set **14***b*.

Now the continuously supplied control pulses on line **62** at frequency *t* feeding shift register **54** and "and" gates **146** and **150**, and relays **132** and **134** causes the data and a train of fiducial or gated control pulses to be transmitted from **14***b* to **14***a* and on to lines **80** and **82** to the shift register **102** at the data center.

A shift register is well known in the art. However, the following analogy may be helpful to illustrate its operation and to better explain the manner of operation of the invention. The shift register may be thought of as a corridor in which a line of soldiers of no more than a certain number can stand single file. The soldiers correspond to the data bits which may be either high or low, one or zero in binary nomenclature. If another soldier pushes in at one end of the line then one soldier will be forced out at the opposite end of the line. Applying this analogy in the present invention, the control pulses, all high, feeding in at the right hand side on line **62** one by one push the data pulses out the left hand end on line **52** feeding "and" gate **150**. The first data pulses will be the station identification number. When all the data bits have been replaced by control pulses, all high or 1s, then the circuitry will reset, as will be explained below.

Each data bit, or absence of a data bit, is transmitted by operating or not operating coil **142** of relay **134**. Simultaneously, at the rate of speed determined by the control pulse frequency *t* a fiducial will definitely be transmitted by operating the coil **138** relay **132**. Each control pulse on line **62** is one input to both "and" gates **146** and **150**, since a steady signal is present on line **154**, relay **132** will operate to send out a fiducial on line **126** corresponding to each control pulse. In the event there is a high data bit on line **152**, the communication means **14** will simultaneously transmit it since relay **134** will operate to send that high data bit out on line **130**.

After all the data is thus shifted out, NAND gate **192** momentarily goes low since all its inputs are high, the shift register is full of 1s, and line **190** momentarily stops conducting. Inverter **194** activates the two branch lines **184** to cause the two flip-flops **182** and **196** to change back to their "set" or ready states. Line **186** thus stops conducting, thus deactivating "and" gates **188** and **200**, as well as reconnecting the shift register **54** to the counter **40** by means of the absence of a signal on line **202**.

Line **190** deactivating provides a pulse to component **204**, and after the delay thereof, puts transmitter **14***b* into a state ready to receive the next transmit command to initiate the next transmission cycle. This resetting occurs via line **206**, gate **170**, line **172**, flip-flop **174**, line **162**, and to relay **156** to open the connection between lines **122** and **124**. The delay of component **204** is provided to assure that the last data bit is sent out by relays **132** and **134** before the transmitter is reset as described above.

In the particular application of retail gasoline marketing described herein, relatively slow timing (in the milliseconds to microseconds range) is all that is required, thus permitting the use of relatively inexpensive logic circuitry. Another associated advantage is that the embodiment of the invention described lends itself to implementation by large scale integrated circuitry, which yields the advantages of still smaller size, high reliability and low power consumption.

While the invention has been described in detail above, it is to be understood that this detailed description is by way of example only, and the protection granted is to be limited only within the spirit of the invention and the scope of the following claims.

We claim:

1. A method for accumulating data pulses produced by a plurality of data pulse generators, wherein each data pulse generator is capable of producing a stream of data pulses independently of all of the other data pulse generators of said plurality, comprising the steps of supplying each data pulse of each stream of data pulse from each data pulse generator to a separate data pulse passing means, sequentially supplying a triggering pulse to each of the data pulse passing means at a frequency greater than the maximum frequency of data pulse generation by each of said data pulse generators, causing each data pulse passing means to produce an output when said data pulse passing means simultaneously senses a data pulse and a triggering pulse on its input side, and causing said data pulse passing means to be insensitive to additional triggering pulses to produce an additional output after it has so simultaneously sensed a data pulse and a triggering pulse until after said data pulse passing means has sensed the falling edge of said last mentioned data pulse, thereafter causing said data pulse passing means to be ready to produce another output upon the simultaneous presence of another data pulse and another triggering pulse at its input side after it has sensed said falling edge of said last mentioned data pulse, whereby said data pulse passing means produces only one output for each data pulse regardless of any additional triggering pulse supplied to said data pulse passing means while each data pulse is present at the input side of said data pulse passing means.

2. The method of claim **1**, and filtering each data pulse from a data pulse generator before it is passed to its associated data pulse passing means.

3. The method of claim **1**, wherein said triggering pulses are produced by decimal counting means, and said sequential operation is achieved by directing triggering pulses from successive decimal numeral locations on said counting means to each of said data pulse passing means sequentially.

4. The method of claim **1**, wherein said data pulse generators comprising a plurality of retail gasoline dispensing pumps, and each of said pumps includes transducer means for transforming the flow of gasoline therethrough into said steam of data pulses.

5. The method of claim 1, each of said data pulse passing means comprising a bistable multivibrator.

6. A method of communicating a data count from a first location across communication means having at least two channels to a second location, comprising the steps of causing the data count to be present on a shift register at said first location, producing a continuous stream of control pulses at a predetermined frequency, and simultaneously supplying said stream of control pulses to said shift register and to the portion of said communication means at said first location to simultaneously transmit each data bit from said shift register across one of said at least two channels of said communication means together with a control pulse across another of said at least two channels of said communication means to said second location.

7. The method of claim 6, wherein aid communication means comprises a telephonic connection between said first and second locations, wherein each data bit is simultaneously transmitted across said communication means together with a control pulse by causing each control pulse by itself to activate the coil of a first relay of a pair of relays, and to simultaneously activate the coil of the second of said pair of relays only if a "high" data bit from said shift register is also present at the input of the coil of said second relay.

8. The method of claim 6, additionally comprising the step of supplying a number on said shift register in addition to the data count thereon to identify said first location to said second location.

9. The method of claim 6, wherein said data count is made up of the data counts on a plurality of independent data counters, and wherein said shift register is large enough to simultaneously follow the data counts on all of said plurality of data counters, whereby the data is supplied to said shift register from said counters independently and in parallel and is moved out of said shift register all together and sequentially.

10. A circuit for accumulating data pulses produced by a plurality of data pulse generators, each of said data pulse generators being operable to produce a stream of data pulses independently of all of the other data pulse generators of said plurality, said circuit comprising a data pulse passing means connected to each of said data pulse generators, said circuit comprising timing means which includes clock means for producing a continuous stream of timing pulses at a predetermined frequency, said timing means comprising triggering means driven by said timing pulses for sequentially directing a triggering pulse to each of said data pulse passing means, wherein said predetermined frequency of timing pulse production by said clock means divided by the number of said data pulse generators is greater than the maximum frequency of data pulse generation by each of said data pulse generators; each of said data pulse passing means being of such a nature that it produces an output upon simultaneously sensing a data pulse and a triggering pulse on its input side, that is is insensitive to additional triggering pulses to produce additional outputs after it has so simultaneously sensed a data pulse and a triggering pulse until after it has sensed the falling edge of said last mentioned data pulse, and that it will be rendered ready to produce another output after it has so sensed the falling edge of said last mentioned data pulse and upon the simultaneous presence thereafter of another data pulse and another triggering pulse; whereby, said data pulse passing means produces only one output for each data pulse regardless of any additional triggering pulse supplied to said data pulse passing means while each data pulse is present at the input side of said data pulse passing means, and said circuit further comprising means for counting all of the data pulses passing all of said data pulse passing means.

11. The method of claim 10, said clock means including means to produce said timing pulses at different predetermined frequencies.

12. The combination of claim 10, said circuit, with the exclusion of said data pulse generators, comprising solely solid-state electronic components.

13. The combination of claim 10, said data pulse generators comprising a plurality of retail gasoline dispensing pumps, and each of said pumps including transducer means for transforming the flow of gasoline therethrough into said stream of data pulses.

14. The combination of claim 10, each of said data pulse passing means comprising a bistable multivibrator.

15. The combination of claim 14, said circuit comprising a filter interposed between each of said data pulse generators and its associated bistable multivibrator.

16. The combination of claim 10, said triggering means comprising decimal counter means for counting the timing pulses produced by said clock means, said decimal counter sequentially operating each of said data pulses passing means by directing triggering pulses from successive decimal numeral locations thereon to each of said data pulse passing means sequentially.

17. The combination of claim 16, said decimal counter means comprising a BCD counter having its input side connected to said clock means and a one-of-ten decoder having its input side connected to the output side of said BCD counter.

18. The combination of claim 10, data pulse counting means including data pulse conditioning means which comprises a oneshot multivibrator.

19. The combination of claim 10, said data pulse counting means including data pulse accumulating means which comprises an "or" gate having its input side operatively cooperable with the outputs of all of the data pulse passing means.

20. The combination of claim 10, said data pulse counting means comprising a multi-stage BCD counter operatively cooperable with the output sides of all of said data pulse passing means.

21. The combination of claim 10, said data pulse counting means comprising a one-shot multivibrator connected to the output of each of said data pulse passing means, an "or" gate having its input connected to the outputs of all of said one-shot multivibrators, and a multi-stage BCD counter connected to the output of said "or" gate.

22. A system for communicating a data count present on a shift register at a first location across communication means having at least two channels to data receiving means at a second location which is remote

from the first location, switch means at said second location for transmitting a transmit command from said second location to said first location across said communication means, clock means at said first location for producing a continuous stream of control pulses at a predetermined frequency, and said first location comprising circuit means for simultaneously supplying said control pulses to both said shift register and said communication means and for interconnecting said shift register and said communication means to simultaneously transmit each bit of data in said shift register across one channel of said communication means and one control pulse across another channel of said communication means to said second location.

23. The combination of claim **22**, said circuit means comprising an array of a pair of relays and an "and" gate associated with the coil of each of said relays, each of said relays comprising a pair of normally open contacts connected to said communication means in such a manner that closing of said contacts causes a pulse to be transmitted across a separate channel of said communication means, each of said "and" gates having a pair of inputs, one of the inputs of each of said "and" gates comprising said continuous stream of control pulses, the second input of one of said "and" gates comprising a steady signal, the other of said inputs of the "and" gates comprising the output of said shift register, circuit means interconnecting the output of each of said "and" gates with the coil of a respective one of said relays in such a manner as to close the contacts of each of said relays when each of said "and" gates produces an output pulse, whereby one of said channels of said communication means will transmit one pulse for each control pulse and the other of said channels will simultaneously transmit a pulse only when a high data bit pulse is present at the output of said shift register, and whereby said stream of control pulses also controls the progression of the data bits in said shift register corresponding to the data count on said shift register out of said shift register.

24. The combination of claim **22**, said communication means comprising a telephonic connection between said first and second locations.

25. The combination of claim **22**, and said shift register further comprising manually controllable means for permitting creation of an additional number on said shift register in addition to the numbers corresponding to said data count, whereby said additional number may be used for purposes of identifying said first location to said second location.

26. The combination of claim **22**, said data receiving means comprising a second shift register and means to display the data count received thereon from said first location.

27. The combination of claim **26**, said data receiving means further comprising a computer, and means interconnecting said computer and said switch means for causing automatic operation of said switch means.

28. The combination of claim **22**, wherein said data count is made up of the data counts on a plurality of independent data counters, and wherein said shift register is large enough to simultaneously follow the data counts on all of said plurality of data counters, whereby the data is supplied to said shift register from said counters independently and in parallel and is moved out of said shift register all together and sequentially.

29. A system for accumulating data pulses produced by a plurality of data generators and for communicating the accumulated data count from a first location across communication means to a second location remote from said first location, each of said data pulse generators being operable to produce a stream of data pulses independently of all of the other data pulse generators of said plurality, a data pulse passing means connected to each of said data pulse generators, timing means including clock means for producing a continuous stream of timing pulses at a predetermined frequency, said timing means comprising triggering means for sequentially directing a triggering pulse to each of said data pulse passing means, wherein said predetermined frequency of timing pulse production by said clock means divided by the number of said data pulse generators is greater than the maximum frequency of data pulse generation by each of said data pulse generators, each of said data pulse passing means being of such a nature that it is rendered operative to pass a data pulse from its associated data pulse generator therethrough and onto subsequent portions of the system upon receipt of a triggering pulse and of such a nature that is rendered inoperative to so pass a data pulse upon passage therethrough of a selected portion of each data pulse, circuit means for directing all of the data pulses passing all of said data pulse passing means to a shift register to thereby create a data count on said shift register, said shift register being located at said first location, data receiving means at said second location, switch means at said second location for transmitting a transmit command from said second location to said first location across said communication means, said first location comprising said circuit means for supplying said continuous stream of timing pulses to both said shift register and said communication means simultaneously and for interconnecting said shift register and said communication means, whereby said communication means simultaneously transmits each data bit in said shift register together with one timing pulse to said second location.

30. The combination of claim **29**, frequency divider means at said first location for changing the predetermined frequency of the timing pulses supplied to said shift register and said communication means, whereby the timing of the data accumulation may be different from the timing of the data transmission.

31. The combination of claim **29**, said data pulse generators comprising a plurality of retail gasoline dispensing pumps, and each of said pumps including transducer means for transforming the flow of gasoline therethrough into said stream of data pulses.

32. The combination of claim **29**, each of said data pulse passing means comprising a bistable multivibrator.

33. The combination of claim **32**, said circuit comprising a filter interposed between each of said data pulse generators and its associated bistable multivibrator.

34. The combination of claim **29**, said triggering means comprising decimal counter means for counting the timing pulses produced by said clock means, said decimal counter sequentially operating each of said data pulses passing means by directing triggering pulses from successive decimal numeral locations thereon to each of said data pulse passing means sequentially.

35. The combination of claim 29, and data pulse counting means, said data pulse counting means comprising a one-shot multivibrator connected to the output of each of said data pulse passing means, an "or" gate having its input connected to the outputs of all of said one-shot multivibrators, and a multi-stage BCD counter connected to the output of said "or" gate.

36. The combination of claim 29, said circuit means comprising an array of a pair of relays and an "and" gate associated with the coil of each of said relays, each of said relays comprising a pair of normally open contacts connected to said communication means in such a manner that closing of said contacts causes a pulse to be transmitted across a separate channel of said communication means, each of said "and" gates having a pair of inputs, one of the inputs of each of said "and" gates comprising said continuous stream of control pulses, the second input of one of said "and" gates comprising a steady signal, the other of said inputs of the "and" gates comprising the output of said shift register, circuit means interconnecting the output of each of said "and" gates with the coil of a respective one of said relays in such a manner as to close the contacts of each of said relays when each of said "and" gates produces an output pulse, whereby one of said channels of said communication means will transmit one pulse for each control pulse and the other of said channels will simultaneously transmit a pulse only when a high data bit pulse is present at the output of said shift register, and whereby said stream of control pulses also controls the progression of the data bits in said shift register corresponding to the data count on said shift register out of said shift register.

37. The combination of claim 29, said communication means comprising a telephonic connection between said first and second locations.

38. The combination of claim 29, and said shift register further comprising manually controllable means for permitting creation of an additional number on said shift register in addition to the numbers corresponding to said data count, whereby said additional number may be used for purposes of identifying said first location to said second location.

39. The combination of claim 29, said data receiving means comprising a second shift register and means to display the data count received thereon from said first location.

40. The combination of claim 39, said data receiving means further comprising a computer, and means interconnecting said computer and said switch means for causing automatic operation of said switch means.

41. The combination of claim 29, said plurality of data pulse generators consisting of a plurality of groups of data pulse generators, said circuit including a separate and independent data counter for each group of data pulse generators, wherein said data count is made up of the data counts of said plurality of independent data counters, and wherein said shift register is large enough to simultaneously follow the data counts on all of said plurality of data counters, whereby the data is supplied to said shift register from said counters independently and in parallel and is moved out of said shift register all together and sequentially.

* * * * *