

1

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METERING MEANS

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This invention relates to metering means adapted for the metering of base and additive components of a motor fuel.

At the present time various grades of motor fuel are delivered from a single "pump" by supplying base and additive components in definite proportions from separate supply tanks. The grades are characterized by different anti-knock properties, the base being a grade of fuel having minimum anti-knock properties satisfactory for motor vehicle engines of relatively low compression ratio while the additive component may be of a type either having anti-knock properties which suffice for the most demanding requirements or properties in excess of this. In the former case the additive may be marketed alone to provide the motor fuel of highest grade, while in the latter case the highest grade motor fuel may consist of a mixture of base and additive having sufficient additive content to provide the highest grade fuel desired. A motorist may obtain that grade most satisfactory to him out of a number of offered selections in excess of two.

Heretofore, the proportioning of base and additive has been effected mechanically by the use of change speed gearing having inputs from individual meters for the base and additive and controlling valves so as to maintain the proportion of base and additive in given delivery substantially constant. Through the use of one or more gear type variators and/or other change speed gearing the proper price has been exhibited at the pump, the price being established either by assigning prices to the base and additive separately or by assigning a price per gallon arbitrarily for particular compositions. In the devices for this purpose heretofore provided mechanical drives are used throughout with the result that it is necessary to provide all of the mechanism in a "pump" at the point of delivery.

One of the objects of the present invention is the provision of blending means in which major parts of the apparatus are electronic rather than mechanical. Not only does this offer the advantage that expensive gear systems, including variators, may be eliminated, but there may also be eliminated the necessity for providing at the point of delivery of fuel to a vehicle the so-called "pumps," since the computing and control means may be located remote from the delivery hose.

A further object of the invention relates to the utilization of electrical pulses for control and computation in a fashion providing for the blending or mixture of liquids or other fluids, applicable to fluids other than motor fuel components. In particular, the use of pulses makes possible the provision of inputs to other computing or control devices which may be dependent for operation on fluid deliveries.

The foregoing and other objects of the invention particularly relating to details of construction and operation will become apparent from the following description, read in conjunction with the accompanying drawing, in which the figure is a mechanical and wiring diagram showing a preferred embodiment of the invention applied to the blending of motor fuel constituents.

While the invention is of broader applicability, it will be specifically described in its application to a blending and pricing system for motor fuels.

Referring to the drawing, and assuming, first, that the apparatus about to be described is enclosed in a unitary

2

housing forming a so-called "pump," the casing is indicated at 2. As will become apparent, various parts of the apparatus may be remote from other parts thereof and it will be understood that a number of housings may be provided for various groups of elements of the apparatus, these housings being suitably locked against unauthorized tampering.

For consistency of description, the term "base" will be used in the sense indicated above, i.e., to denote a fuel of minimum grade of quality. The term "additive" will be used in the sense of a high grade additive which in itself may be a fuel called for by certain customers. However, it will be evident that the additive may be a fuel having "grade" far exceeding what may be called for.

There is provided a base pump 4 driven by a motor in conventional fashion and arranged to receive through pipe 6 from a supply tank (not shown) the base fuel. In the usual fashion, the base pump 4 is provided with a by-pass 8 in which is located a loaded relief valve 10 so that if the delivery hose outlet is shut off the base pump may continue to operate, recirculating the base through the valve 10 from its outlet to its inlet. Delivery of base from the base pump 4 takes place through a pipe 12 which delivers the base through the meter 14 which meter may be of conventional type. Such meters record accurately the fluid delivered therethrough to the precision required by the authorities. It may be here noted that the base meter is only required to rotate a disc and therefore is not subject to the loading imposed by the mechanical devices driven by a meter in a conventional mechanical system. Thus greater accuracy of metering may be attained. From the meter 14 the base is delivered through a pipe 18 containing a check valve 16.

A pump 22 for the additive draws its supply of additive from a tank (not illustrated) through pipe connection 20. This pump 22 may be of the same type as the base pump 4 and has provided in association with it a by-pass 24 incorporating a loaded relief valve 26. The additive pump may be driven from the same motor which drives the base pump 4 or it may be driven by a separate motor, the separate motors for the two pumps being, in the latter case, individually operated when base alone is called for or additive alone is called for.

The additive pump 22 delivers additive through line 28 to the meter 30 which may be of the type serving to meter the base. Delivery from the meter 30 takes place through piping 32 which includes the check valve 34.

The base and additive delivered respectively, through lines 18 and 32, are respectively controlled by the valves 36 and 38 from which they are delivered through conduits 48 and 50 to concentric hoses terminating in a manually operable valved nozzle at which admixture occurs. The two valves 36 and 38 are concurrently operated through mechanical connections indicated at 40 by a reversible motor 42 which has suitable windings 44 and 46 for drive of the motor. For simplicity, a direct current motor is illustrated which may have a field 44 connected between positive and negative current supply terminals, the armature winding 46 receiving current in one direction to drive the motor in one direction, and receiving current in the opposite direction to drive the motor in the reverse direction. The valves 36 and 38 are so arranged that as one opens the other closes, with both open simultaneously except at the ends of their travel when one will close entirely with the other fully open and vice versa. This arrangement is such as to provide throttling of the flows to achieve proportioning as will become more apparent hereafter. The valves may take various well known forms and, accordingly, are not described in mechanical detail. The base meter 14 drives through shaft 52 a drum or disc 54 containing at its periphery magnet-

izable material for the temporary recording of pulses magnetically. The additive meter 30 drives through connection 56 a similar drum or disc 58. Depending upon the characteristics of operation of the meters and the accuracy required, the meters may drive their respective discs through gearing so that a disc may take a number of revolutions for each revolution of the corresponding meter output shaft.

About the periphery of disc or drum 54 (which will, for simplicity, be hereafter referred to as a drum) there are located a magnetic recording head 60, a magnetic pickup head 68, an erasing head 64. In similar fashion, the drum 58 has disposed about its periphery a recording head 62, a pickup head 70 and an erasing head 66. The drums 54 and 58 rotate counterclockwise and the erasing heads 64 and 66 precede the recording heads 60 and 62, operating with conventional high frequency input to erase pulses from the drums. The recording heads 60 and 62 are located in fixed positions. The reproducing heads 68 and 70 are respectively connected to pinions 72 and 74 so as to be adjustable about the drum axis to provide adjustable arcs A and A' between the recording locations and the reproducing locations. While various adjusting arrangements for the pinions 72 and 74 may be used, depending on the particular type of operation desired, consistently with what will be described the pinions 72 and 74 are herein shown as respectively engaged by racks 76 and 78. A screw 80 rotatable by a handle 82 available to an attendant drives through a worm 84, a wheel 86 which may be provided with markings readable against an index 88 for setting of desired ratios of additive and base. A nut 90 is moved lengthwise of screw 80 by rotation of the screw and carries at pivot 92 a lever 94 on which slide cross-heads 96 and 98 pivoted to the racks 76 and 78 which are guided by means, not shown, for movement in the direction of their lengths. A price dial 100 having markings readable against an index 102 is provided with a pinion 104 engaging teeth on the rack 76. With proper initial adjustments it will be evident that the displacement A of reproducing head 68 from recording head 60 will bear a ratio to the spacing A' between reproducing head 70 and recording head 62 which is determined by the position of nut 90 along screw 80. At the same time, the magnitude of displacement A is fixed by the adjustment of dial 100. As will more clearly appear hereafter, these adjustments take care of the proportioning of both the components and the establishment of price. Pulses picked up by the reproducing heads 68 and 70 are respectively fed at 106 and 108 to amplifiers 110 and 112 which may be of conventional type, amplifying and reshaping pulses for delivery to other elements. The output from amplifier 110 is fed through connection 114 to the input of a pulse former 116, the output 118 of which delivers pulses to the recording heads 60 and 62 through the respective connections 120 and 122. A switch 124 connected to a potential source terminal 126 is arranged to provide an initiating pulse to and through the pulse former 116, which pulse former is provided primarily to secure a sharp pulse originating at this switch, since pulses received at 114 may well be properly shaped in the amplifiers.

The output of amplifier 110 is also delivered at 128 to a pulse counter 130 of electronic type arranged to divide the number of received pulses by a predetermined factor to emit a proportional number of pulses to an electromagnetically operated mechanical price counter 132 suitable for total price display. (It will be assumed that during operation pulses at 128 may be emitted at a rate higher than may be acceptable to an electromagnetic counter, and hence the dividing counter 130 is provided.)

Proper control depends upon an output of signals dependent upon the order of arrival of related pulses from the lines 106 and 108. While various systems may take care of this, there is illustrated a simple arrangement involving a monostable multivibrator 134 and a bistable

multivibrator 136, to which respective inputs are provided at 135 and 137 from the amplifiers 110 and 112. Monostable multivibrator 134 is of conventional type triggered by receipt of a pulse at 135 to its astable state. In the usual fashion this multivibrator will return to its stable state after a predetermined interval of time less than the shortest expected period between successive pulses emitted on line 106. Describing the bistable multivibrator 136 as having first and second states, it may be considered to be normally in its first state, being triggered to its second state by a pulse input at 137. A connection at 139 between the two multivibrators is arranged to trigger the bistable multivibrator 136 back to its normal first state at the time that monostable multivibrator 134 returns to its stable state. In other words, the returns of both of the multivibrators occur simultaneously. When the monostable multivibrator 134 is in its astable state it will provide a negative potential to the left hand end of resistor 138. When the bistable multivibrator 136 is in its second state it will provide a positive potential to the right hand end of resistor 140. The two resistors are connected together and at 142 to an integrator and amplifier 144 which provides current to the winding 46 of motor 42.

The operation of what has just been described is as follows, considering that the negative and positive potentials applied to 138 and 140 are equal in magnitude. If a pulse arriving at 106 precedes that arriving at 108, the monostable multivibrator 134 will produce a negative pulse having duration equal to that of the astable state of this multivibrator. Following the initiation of this pulse, when a pulse arrives at 108 the bistable multivibrator 136 will produce a positive pulse which will last for the remainder of the duration of the astable state of multivibrator 134. The result is that there is delivered to the integrator and amplifier 144 a negative pulse during the period between pulses 106 and 108. Following the pulse received at 108 the two potentials cancel to provide a zero input to the integrator at 142. On the other hand, if the pulse at 108 arrives before that at 106, the bistable multivibrator will be thrown to its second state to provide a positive potential to resistor 140. When the pulse arrives at 106, the monostable multivibrator 104 is then thrown to its astable state to provide a negative pulse lasting for the duration of that state, which also measures the remaining duration of the positive pulse from multivibrator 136. The result, then, is to provide a positive pulse during the interval between the pulses at 108 and 106. The action is thus to contribute a current to winding 46 which determines the direction of drive of motor 42. As will be more fully indicated hereafter, the action through the valves 36 and 38 is a corrective one which seeks to establish coincidence of the pulses appearing at 106 and 108.

Since it may be desirable to provide base only or additive only, in which cases, respectively, no pulses would appear at 108 and at 106, current is desirably provided to winding 46 to override that provided from 144. For this purpose supply terminals 146 (which may be the same ones supplying winding 44) are arranged to provide reversible currents through a double-pole double-throw switch 148 which is controlled through a connection 150 from wheel 86. When that is in one extreme position, for example, determining the delivery of base only, the switch 148 is closed in a position to drive motor 42 to close additive valve 38 and open base valve 36. In the alternative extreme position calling for delivery of additive only, the switch 148 is thrown to its opposite position to effect closure of base valve 46 and fully open condition of additive valve 38. In intermediate positions of adjustment the switch 148 is open so that control of motor 42 is solely from the integrator and amplifier 144.

In order to provide price indication when the additive only is being delivered, a switch 152 is closed to connect the output of amplifier 112 to the connection 114 through

the line 154 when this delivery of additive is effected. The switch 152 may be operated through the connection 150 already described. The overall operation is as follows:

Assuming that a particular ratio of additive to base is to be delivered, adjustment of nut 90, indicated by the dial on wheel 86, is made to correspond to this ratio. Then a price adjustment is made at dial 100. This adjustment has the following characteristics:

Let it be assumed that a pulse is to be delivered from the pickup 68 whenever the delivery is to have a money value of, for example, 0.01 cent. In operation, a pulse emitted from pickup 68 passing through amplifier 110 and pulse former 116 will produce a pulse on the drum 54 through recording head 60 which pulse will then be carried around to provide a new pulse from pickup 68. Thus the rotation of drum 54 through the arc A must correspond to the delivery of 0.01 cent's worth of fuel. Only pulses from amplifier 110 are delivered to the pulse counter 130 and then to price counter 132 at some reduced rate of recurrence (for example, the price counter may receive one pulse for every ten entering the pulse counter so that the successive advances of the price counter are in increments of 0.1 cent). The adjustment of price at dial 100 is, therefore, such that the price assigned to delivery of base takes care, in view of the chosen ratio of additive to base, of the price of the mixture which is being delivered. For example, assume that there is to be delivered a grade of fuel containing 50% additive and 50% base and that a gallon of this fuel is priced at 30 cents. This would mean that when the price is to be determined by the delivery of the base, the price per gallon of base would be evaluated at 60 cents for this mixture. One-six-thousandth of a gallon would then correspond to 0.01 cent and adjustment would be made so that the arc A of movement of drum 54 would correspond to the drum displacement for one-six-thousandth of a gallon. This is, of course, taken care of by suitable calibration of the disc 100.

At the beginning of a delivery operation, closure of the usual switch to start the pump motors will simultaneously involve closure of the switch at 124 to provide an initial pulse record on the drum 54 and on the drum 58 at the locations of the recording heads 60 and 62. The valves 36 and 38 at this time will probably be in positions resulting from the last delivery operation. As the drums rotate, the initial pulses will reach the pickup heads 68 and 70, and the pulse reaching head 68 will produce a new pulse on each of the drums at 60 and 62. Initially it will not be expected that pulses will reach the pickup heads 68 and 70 simultaneously, but depending on that which first arrives at its pickup head operations will take place as described above involving the multivibrators to provide drive of motor 42 to correct the relative valve positions and this correction will occur rapidly so as to bring the valves to relative positions such that the pulses will arrive, on the average, simultaneously at the pickup heads. Whenever one falls behind the other a corrective action of the valves is effected involving throttling of flow providing a feedback action whereby the desired ratio of the two constituents is, on the average, maintained. This maintenance of the proper ratio makes it legitimate to take the price from only one of the drums.

It will be noted that when mixtures of two constituents are supposed to be delivered the exhaustion of one of the supply tanks will necessarily result in closing down of the delivery since the corrective action will close off the valve corresponding to the constituent which still flows.

If base alone is to be delivered the operation of switch 148 will close the additive valve and fully open the base valve and the price assigned to the base will be properly recorded by way of pulses from the drum 54. However, when additive alone is to be delivered and switch 148 effects closure of the base valve and full open position of the additive valve the price determining pulses will originate from drum 58 and will be delivered through

closed switch 152. At this time since drum 54 will not operate there will be no pulses emitted through amplifier 110.

It will be evident from what has been described that various parts of the apparatus may well be isolated from other parts as may be desired. For example, local to the point of delivery there may be provided the pumps, meters, the base and additive valves and their controlling motor 42. The remaining apparatus may be located at an associated building, with exhibition of the price on a counter located on a panel in the building. The connections 52 and 56 may be provided by selsyn drives to effect rotations of drums 54 and 58 in accordance with the rotations of the meter shafts. The total gallons delivered may be exhibited, for example, by adding the rotations of the drum shafts through differential gearing operating a volume counter. It will be evident that automatic controls may be used to stop operation upon the attainment of a predetermined price on counter 132 or upon the delivery of a predetermined number of gallons as determined by a volume counter. (This end may be simply effected by association with such counters of other presettable counters counting backwardly to zero with opening of a controlling switch when zero is attained). Drums 54 and 58 may, of course, carry in additional pulse channels permanent magnetic pulses which may be electronically added, after suitable scaling down, to provide indications of total delivery.

It may be noted that pulse and price counters such as 130 and 132 may also be associated with amplifier 112 for drive thereby as a check on proper operation.

A limit cut-off relay may be made responsive to the integrator-amplifier 144 to stop operation if the output current to winding 46 exceeds some predetermined value during a blending operation, thus indicating malfunction of the apparatus.

It will be evident that if only a single fuel is to be delivered the apparatus may be greatly simplified, i.e., by omission of all elements which would be inactive during the delivery of base alone as described above, namely the additive pump and meter, drum 58 and its associated parts, amplifier 112, the proportioning mechanism, and the valve controlling means. An advantageous pricing means would nevertheless remain in accordance with the invention.

It will also be evident that if proportioning of flow rates alone is of significance (pricing not being involved by the method of counting pulses) the pulses at 60 and 62 may be independently repetitively provided rather than by feedback from the reproducer 68.

What is claimed is:

1. In fluid dispensing apparatus, a displaceable element providing an endless circulating recording channel, a fluid meter driving said element at a rate proportional to the fluid flow through said meter, first means responsive to pulses to produce records of said pulses on said element, second means located beyond the first means in the direction of displacement of said element for sensing said records and emitting pulses corresponding to the sensed records, means for varying the spacing between the first and second means, unit price indicating means connected to said last-mentioned means, means for delivering to the first means pulses emitted from the second means to produce records by the former, and means for erasing said records from the element prior to rearrival of said records at the position of the first means.

2. Apparatus for the concurrent delivery of at least two fluids in predetermined proportion comprising a pair of flowmeters one for each respective fluid, means providing a first series of electrical pulses spaced by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second concurrent series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, valve

means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two concurrent series for controlling said valve means to adjust the ratio of flow rates of said two fluids to produce approximate coincidence of pulses of said two concurrent series.

3. Apparatus according to claim 2 in which said valve means concurrently controls flow of both of said fluids, reducing the flow of one and concurrently increasing the flow of the other.

4. Apparatus for the delivery of at least two fluids in predetermined proportion comprising a pair of flowmeters for said fluids, means providing a first series of electrical pulses spaced by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, means for changing the factor of proportionality between one of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

5. Apparatus for the delivery of at least two fluids in predetermined proportion comprising a pair of flowmeters for said fluids, means providing a first series of electrical pulses spaced by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, means for changing the factors of proportionality between each of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

6. Apparatus for the concurrent delivery of at least two fluids in predetermined proportion comprising a pair of flowmeters one for each respective fluid, means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second concurrent series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two concurrent series for controlling said valve means to adjust the ratio of flow rates of said two fluids to produce approximate coincidence of pulses of said two concurrent series.

7. Apparatus for the delivery of at least two fluids in predetermined proportion comprising a pair of flowmeters for said fluids, means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, means for changing the factor of proportionality between one of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

8. Apparatus for the delivery of at least two fluids

in predetermined proportion comprising a pair of flowmeters for said fluids, means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow through the first of said flowmeters, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow through the second of said flowmeters, means for changing the factors of proportionality between each of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

9. Apparatus for the concurrent delivery of at least two fluids in predetermined proportion comprising means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow of the first of said fluids, means providing a second concurrent series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow of the second of said fluids, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two concurrent series for controlling said valve means to adjust the ratio of flow rates of said two fluids to produce approximate coincidence of pulses of said two concurrent series.

10. Apparatus according to claim 9 in which said valve means concurrently controls flow of both of said fluids, reducing the flow of one and concurrently increasing the flow of the other.

11. Apparatus for the delivery of at least two fluids in predetermined proportion comprising means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow of the first of said fluids, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow of the second of said fluids, means for changing the factor of proportionality between one of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

12. Apparatus for the delivery of at least two fluids in predetermined proportion comprising means providing a first series of electrical pulses spaced with respect to repetitive instants of time by a period inversely proportional to the rate of flow of the first of said fluids, means providing a second series of electrical pulses spaced with respect to pulses of the first series by a period inversely proportional to the rate of flow of the second of said fluids, means for changing the factors of proportionality between each of said periods and the corresponding rate of flow, valve means controlling the flow of at least one of said fluids, and means responsive to the time relationship of pulses of said two series for controlling said valve means to adjust the ratio of flow rates of said fluids to produce approximate coincidence of pulses of said two series.

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