An apparatus (100) for dispensing a liquid feed supplement to animals in measured quantities according to an established schedule within which both quantity dispensed and times when dispensed are user definable. Liquid feed is allowed to flow from a bulk storage vessel (101) by lowering a transfer pipe (105) a predetermined distance into the storage vessel (101), thereby allowing the liquid feed to gravity flow from the storage vessel (101) to a feeding vessel (102). The control of dispensing time and the quantity of liquid feed dispensed are accomplished through the use of a microcomputer (125) which can be programmed to enable the dispensing of liquid feed for two time periods in a 24-hour cycle.
FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Code</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austria</td>
<td>GB</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>GE</td>
<td>Georgia</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
<td>GN</td>
<td>Guinea</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>GR</td>
<td>Greece</td>
</tr>
<tr>
<td>BF</td>
<td>Burkina Faso</td>
<td>HU</td>
<td>Hungary</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
<td>IE</td>
<td>Ireland</td>
</tr>
<tr>
<td>BJ</td>
<td>Benin</td>
<td>IT</td>
<td>Italy</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>JP</td>
<td>Japan</td>
</tr>
<tr>
<td>BY</td>
<td>Belarus</td>
<td>KE</td>
<td>Kenya</td>
</tr>
<tr>
<td>CA</td>
<td>Canada</td>
<td>KG</td>
<td>Kyrgyzstan</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>KP</td>
<td>Democratic People’s Republic of Korea</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>CR</td>
<td>Cuba</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>CZ</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>CI</td>
<td>Côte d’Ivoire</td>
<td>DE</td>
<td>Germany</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>DK</td>
<td>Denmark</td>
</tr>
<tr>
<td>CN</td>
<td>China</td>
<td>ES</td>
<td>Spain</td>
</tr>
<tr>
<td>CS</td>
<td>Czechoslovakia</td>
<td>FI</td>
<td>Finland</td>
</tr>
<tr>
<td>CZ</td>
<td>Czech Republic</td>
<td>FR</td>
<td>France</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
<td>GA</td>
<td>Gabon</td>
</tr>
<tr>
<td>MR</td>
<td>Mauritania</td>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>NE</td>
<td>Niger</td>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>NO</td>
<td>Norway</td>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>PL</td>
<td>Poland</td>
<td>PT</td>
<td>Portugal</td>
</tr>
<tr>
<td>RO</td>
<td>Romania</td>
<td>RU</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>SD</td>
<td>Sudan</td>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>SI</td>
<td>Slovenia</td>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>SN</td>
<td>Senegal</td>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>TG</td>
<td>Togo</td>
<td>TJ</td>
<td>Tajikistan</td>
</tr>
<tr>
<td>TT</td>
<td>Trinidad and Tobago</td>
<td>UA</td>
<td>Ukraine</td>
</tr>
<tr>
<td>US</td>
<td>United States of America</td>
<td>UZ</td>
<td>Uzbekistan</td>
</tr>
<tr>
<td>VN</td>
<td>Viet Nam</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TITLE OF INVENTION:
PORTABLE PROGRAMMABLE LIQUID FEED DISPENSING DEVICE

RELATED APPLICATIONS:
This application is a continuation of United States Patent Application Serial No. 08/055,811, which will issue on 9 August, 1994, bearing United States Patent No. 5,335,625.

DESCRIPTION
BACKGROUND OF THE INVENTION

Technical Field. This invention generally relates to an apparatus for controlling the feeding of liquid feed to livestock. More particularly, this invention relates to a portable programmable device for the feeding of liquid feed to livestock in controlled quantities and at controlled times.

Background Art. A common practice within the livestock industry, is to utilize liquid feed products to provide supplemental nutrients and feed additives to animals. These liquid feeds are manufactured by solubilizing or suspending a wide range of individual ingredients that contain specific nutrients and feed additives within a variety of liquid carriers, such as molasses, fermentation solubles, condensed whey, etc. These finished products are then fed to the animals. There is a wide
variation in the application of these liquid feed products
as they are fed to variable numbers within the feeding
groups as well as various classes, weights and ages of
animals. Frequently, it is inconvenient to combine the
liquid feed with other feed ingredients prior to feeding,
and consequently they must be provided to the animals as a
separate ingredient and in a manner in which the animals
have unlimited access to the liquid feed in an undiluted
form. Unfortunately, it is oftentimes difficult to con-
strain the animals voluntary intake within a range which
provides for maximum response to the nutrients and feed
additives. Over feeding of nutrients and additives is
wasteful and will adversely affect the return on the
feeding investment. Also, animal health and mortality can
be affected if the nutrients and feed additives are not
provided at the prescribed rate. For this reason there
are governmental regulations which specifically control
the allowable levels or dose for some nutrients and feed
additives. Furthermore, when these feed additives are
provided on a basis where the animals are given unlimited
access to a feed source in which the additives are includ-
ed, the manufacturer must provide demonstrable evidence
that the average twenty-four hour consumption for the
group of animals being fed will provide the feed additive
at a level which falls within the required dose range for
that particular feed additive.

In addition to the need for regulating the quantity of
liquid feed fed, it has also been demonstrated that the
timing in which the nutrients and feed additives are
provided has an effect on production. For example, it has
been demonstrated that cattle grazing on pasture will
consume more grass when supplemental feeds are not made available until the afternoon of each day. By consuming more grass, the animals have more energy to support production and this results in an increase in performance and average daily gain for each animal. In a like manner, it has been demonstrated that the death loss which can be associated with cattle grazing legume pasture in a rotational grazing system, can be reduced or eliminated if the cattle consume a liquid feed containing a feed additive which affects the surface tension of gas bubbles formed in the animal's rumen. The ability to control bloat in these applications is enhanced if the cattle consume this additive approximately one hour before they are moved to a new pasture containing the legumes.

It can be seen that there are a wide variety of liquid feed needs from one location to another and the needs change throughout the year. Therefore, there are a wide variety of formulations required to meet these needs and any feeding system must easily accommodate change in regards to quantities being fed, timing at which the liquid feed is made available and varying product composition.

The application of liquid feeds of the type previously described are most often accomplished in remote locations. More often than not, it is economically impractical to provide the labor required for daily hand feeding operations. Because of a lack of convenient access to an AC power source it is necessary to have feeding systems which require no power or which can be operated on a DC power source for long periods of time. The feeding system must
also be readily portable as the animals are frequently moved from one confined feeding area to another.

Prior art solutions to the needs described above have generally relied on methods and devices directed towards affecting the quantities of liquid feed being voluntarily consumed as opposed to those directed towards controlling the amount actually dispensed and being made available for voluntary consumption. One common method has been to decrease voluntary intake of the liquid feed by lowering its relative palatability. An example of this approach would be the practice of incorporating increased levels of a specific ingredient such as salt within the liquid feed. This can affect the animals' sense of taste in such a way as to sometimes lower the animals' voluntary intake.

Another method of reducing voluntary intake has been to provide a means for applying increased tension on a revolving lick wheel that is acting as a liquid feed pickup device. This increased tension will result in the animals requiring more time and effort to consume a specified quantity of liquid feed and this may also lower voluntary intake.

The prior art specifically describing liquid feed dispensing devices which can provide a means of controlling the quantity of liquid feed that is dispensed within a specified period of time to one or more animals is lacking. Typically, the devices available can be best described as constant flow or constant level devices which allow the animals access to unlimited quantities of liquid feed or they may be designed to provide access to unlimited quantities of liquid feed during specified periods of time. Unlike the invention which we will describe these
devices typically utilize a pressurized source of liquids, an AC powered electric control circuit and some type of automated control valve. Additional mechanical elements common to prior art but which also fall outside our invention are pumps, hydraulic cylinders, vacuum valves, air pressure valves, weighing systems, float valves, stopper plugs, metering valves, metering orifices and batch dumping cylinders.

More specifically, U.S. Patent 3,347,212 to ANDERSON ET AL. discloses an apparatus for the feeding of liquid feed to livestock on a continuing output basis. This is accomplished by lowering a flexible hinged transfer tube through a vertical plane in a storage vessel containing liquid feed thereby allowing the liquid feed to gravity flow through the tube and into a liquid feed pickup device. It can then be accessed by the livestock through a lick ball. The device described by this patent utilizes a predicted rate of descent as a means of dispensing liquid feed on a constant flow basis. The rate of descent is controlled through the use of a battery assisted spring wound clockwork motor and integrated unwinding cable working in conjunction with a spool assembly fitted with multiple diameters the use of which allows for selecting differing rates of descent by the drop tube assembly. The element of time in the device described by this patent only has meaning in respect to affecting the rate of descent. As soon as automated feeding is initiated the control means will continue on a basis that is only manually interruptable and therefore the transfer tube will normally continue to drop through the fluid until it rests on the bottom of the supply vessel. Thus it can be seen
that the quantity of liquid feed automatically dispensed is totally independent of the liquid feed actually consumed by the livestock during the total dispensing period. This period being the time required to allow the transfer tube to travel from the top of the liquid level to the bottom of the storage vessel. This system has a number of disadvantages as applied under practical feeding situations. The primary deficiency of this invention is that if the voluntary consumption is less than the projected rate the potential consumption is accumulated. This can continue to a point where the total remaining feed in the storage vessel is essentially all available. Therefore, there is no means of protecting the livestock against excessive consumption when there has been a period of time when consumption is less than projected in establishing the rate of decent. This is particularly a problem when the number of cattle placed in a particular feeding area are being changed from one day to the next. This is a common livestock management practice. Another disadvantage of the device described by this patent is that the use of controlled rate of descent as applied in a battery operated system results in a significant opportunity for error. A small difference in the total distance traveled by the transfer tube can make a significant difference in the total quantity of liquid feed dispensed. The effective voltage potential in a battery powered operation can vary significantly depending on the batteries remaining charge or the batteries effective ambient temperature. This drop in voltage output will produce a corresponding drop in revolutions and or a sporadic disfunctioning of the clockwork motor and thereby changes the effective
distance of downward travel by the transfer tube. Furthermore, the opportunity for inaccuracy and the lack of an ability to time the feeding periods in a more specific manner give rise to the significant need for our invention.

DISCLOSURE OF INVENTION

Each of the devices described in the prior art have disadvantages in terms of their effectiveness in achieving our desired results.

Therefore, the primary object of the invention is to provide a portable programmable device for the feeding of liquid feed on an accurate and repeatable basis and which allows control of the quantity of liquid feed dispensed and the timing at which the liquid feed is dispensed. This is accomplished by providing a means which allows for feeding liquid feed within definable blocks of time in a 24 hour period. Furthermore, the means allow for definable increments of time between liquid feed dispensing cycles within the definable blocks of time.

Another object of this invention is to provide a control device that when appropriately integrated with a storage vessel of uniform and proportional dimensions and which when fitted with an appropriately designed transfer tube assembly will transfer a known quantity of liquid feed in proportion to each measurable drop made by the transfer tube within the liquid feed in the storage vessel. Furthermore, to control the drop in elevation of the transfer tube assembly in such a manner that the amount of programmed descent is consistent and independent of the rate of descent as affected by the DC batteries voltage potential.
Another object of the invention is to provide a device that will operate on stand alone batteries, a solar assisted battery system, or a supplementary DC power supply that is assisted by a converted AC power source.

Another object of the invention is to provide a high level sensing means within the liquid feeding vessel which will abort the programmed liquid feed dispensing cycle in the event that the animals are unable to consume the programmed quantity of liquid feed dispensed due to less than predicted feed intakes or because some or all of the animals have been removed from the feeding area. Furthermore, the detected level can be adjusted in such a manner that no more than a desired amount of liquid feed can be accumulated within the liquid feeding vessel.

Another object of this invention is to enhance the high level sensing means through the addition of an inverted cup being axially attached in such a manner as to prevent a false conductivity path between the sensor probes and which could result from advancing or receding liquid feed levels.

Another object of the invention is to provide a timing means in the form of a highly accurate 24 hour clock in which time is set by a simple incremental program input method. This clock is continuously being referred to by the control program throughout the devices normal operation.

Another object of the invention is to provide a simple incremental numerical program input method that can allow for accurate feeding of liquid feed on a repeatable basis regardless of the variability of the quantity of liquid feed desired, the time blocks in which the feed could be
dispensed, and the definable time increments between liquid feed dispensing cycles within each block of time.

Another object of the invention is to provide a simple incremental numerical program input method that will allow for accurate units of dispensed liquid feed regardless of the size of the storage vessel or liquid feeding vessel being utilized.

Another object of the invention is to provide a simple incremental numerical program input method that will allow for accurate measurable units of dispensed liquid feed on a repeatable basis regardless of the liquid feeds formulation and resulting weight per gallon.

Another object of the invention is to provide a means to display program numerical values in the alpha numeric display while depressing any one of the touch pad input means.

Another object of the invention is to provide a device with a means of testing the actual mechanical response to the current numerical input values of the dispensing units as well as a means of revealing a mechanical or electrical failure.

Another object of the invention is to provide a means for calculating the quantity of liquid feed which has been dispensed on an ongoing basis between times of refilling of the storage vessel by referencing a position marked on the tube elevation cable against a volume index attached to the top of the device support frame.

Another object of the invention is to provide a stop rotation switch means which aborts all dispensing cycles in response to that point when the transfer tube contacts the bottom of the storage vessel.
Another object of the invention is to provide a means which allows for manually controlled dispensing of the liquid feed as required to initially transfer some liquid feed into the liquid feeding vessel or in the event of a mechanical or electrical failure within the control system.

Another object of the invention is to provide a device which allows easy access to the liquid feeding vessel by a variety of classes and size of livestock and which therefore can accommodate a lick wheel, lick ball or open tray as an animal liquid feed pickup device.

These objects and others are accomplished by a battery powered programmable controlled quantity dispensing device for liquid feed which enables measured quantities of liquid feed to be dispensed within programmed time blocks and with programmed increments of time between liquid feed dispensing cycles. Both quantity dispensed and times when dispensing occurs are user definable through a simple input entry device. This device when fitted to an appropriate storage vessel with appropriate transfer tube assembly and appropriate liquid feeding vessel allows the liquid feed to flow from the storage vessel by lowering the mouth of a transfer tube a programmed distance below the liquid level of the storage vessel, thereby allowing the liquid feed to gravity flow from the storage vessel, through the transfer tube and into the feeding vessel. The preferred embodiment of this invention allows for control of measured quantities of liquid feed dispensed as described above, by counting measurable and definable portions of a revolution of any certain drive associated with an output spool. A means is then provided for con-
verting this count into a digital signal that is inputted into the control unit. The control unit utilizes unique program logic which provides for numerical input of all parameters which defines the operational output.

A gear motor assembly drives a spool to which one end of a cable has been attached. The other end of this cable is attached to the transfer tube. As the spool rotates, this cable moves the mouth of the transfer tube up or down depending upon which direction the spool turns.

Furthermore, this digital signal produced by the counting process is compared with stored values entered into the microprocessor control circuit through a touch pad entry and accompanying liquid crystal, dot matrix alpha numeric display.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of the liquid feed dispensing device;

Fig. 2 is a side view of the liquid feed dispensing device;

Fig. 3 is a partial representational view of the gear, spool and transfer tube assembly;

Fig. 4 is a top view of the dispensing controller;

Fig. 5 is a partial representational view of the gear assembly, motor, control circuit, power supply and the liquid level sensor;

Fig. 6 is a detailed sectional view of the liquid level sensor;

Fig. 7 is a block circuit schematic of the control circuit;
Figs. 8A and 8B are partial detailed circuit schematics of the control circuit; Fig. 9 is a partial detailed circuit schematic of the control circuit; Fig. 10 is a flow diagram of the main control program; Fig. 11 is a flow diagram of the time regulation subprogram; Fig. 12 is a flow diagram of the keyboard control subprogram; Fig. 13 is a flow diagram of the motor control subprogram; Figs. 14 - 23 list the controller Source Code; Fig. 24 is a diagram of a sample program; and Fig. 25 is a detail view of the control panel.

BEST MODE FOR CARRYING OUT INVENTION

Referring now to Figures 1 - 25 an portable programmable liquid feed dispensing device 100 is illustrated. The liquid feed dispensing device 100 generally consists of a large supply vessel 101, a separate feeding vessel 102 attached to the supply vessel and a self-contained dispensing controller 104. Supply vessel 101 is first filled with a liquid feed of a known specific gravity. A chart is provided and attached to the inside of the vessel, proximate lid 136, which is used to determine the setting of the "dispensing units" value of the dispensing controller 104, which will be explained later. The liquid feed is added to supply vessel 101 through vessel access opening 106, provided at the top, which can be closed when not in use.
A length of rigid tube, transfer tube 105, is located inside supply vessel 101 and has one of its ends attached to a flexible coupling 139. Flexible coupling 139 connects transfer tube 105 to feeding vessel 102 via connecting nipple 141. The other end of transfer tube 105, here designated as transfer tube inlet end 109, is left open and free to move up and down. A length of stainless steel cable, designated as tube elevation cable 108, is attached, by means of a welded eyelet for instance, to transfer tube 105.

The purpose of tube elevation cable 108 is to measurably control the elevation of inlet end 109. As tube elevation cable 108 is let out, inlet end 109 will dip below the surface level 138 of the liquid in supply vessel 101, thus causing the liquid feed to flow into inlet end 109 through transfer tube, flexible coupling 139, connecting nipple 141 and into feeding vessel 102. Supply vessel 101 and feeding vessel 102 are rigidly attached together by a suitable coupling device to prevent damage to the components from livestock.

Dispensing controller 104 consists of four major components. They are, a geared spool assembly 112, a direct current gear motor 115, a battery power supply 135 and a microprocessor based control circuit 125. All of the major components and the not-yet-described supporting components are mounted to the device support frame 107 which is attached to the top of supply vessel 101. Here a "U" shaped frame is used.

Tube elevation cable 108 passes up through a hole in the top of supply vessel 101 and through a hole in the base of device support frame 107. The tube elevation
cable 108 then passes over a cable spindle 137 and on to geared spool assembly 112, to which its end is attached. Geared spool assembly 112 is centered on, and affixed to, rotatable spool shaft 111 which is supported by device support frame 107. Tube elevation cable 108 can be manually wound on or off of geared spool assembly 112 by means of a handle 142, provided on the left side of dispensing controller 104. Handle 142 is attached to a shaft, designated as adjustment shaft 117, on which manual adjustment gear 116 is also attached. Manual adjustment gear 116 is continuously engaged with geared spool assembly 112, and when manually turned, will rotate resulting in the inlet end 109 of transfer tube 105 being raised or lowered. By this means, an operator may adjust the level of inlet end 109 to the liquid level 138 in the supply vessel 101 to the proper position to start the dispensing cycles or to reel in tube elevation cable 108 so as to prepare to refill supply vessel 101.

Gear motor 115 is attached to one end of drive shaft 114, which is rotatably attached to the side of frame 107 opposite gear motor 115. Drive gear 113 and drive shaft 114 are coupled together by a clutch assembly. Drive gear 113 and geared spool assembly 112 are continuously engaged. This clutch assembly allows for manual adjustment of geared spool assembly 112 while still providing a sufficient friction coupling between the drive shaft 114 and gear motor 115. Power to operate gear motor 115 is supplied from a battery power supply 135 which is controlled by control circuit 125.

A rotation limiting switch 130 is located near geared spool assembly 112 adjacent on the inside surface of
device support frame 107 and is activated by a pin 140 located on the side of geared spool assembly 112 at a point which corresponds to a depleted liquid level in supply vessel 101. Additionally, the rotation of geared spool assembly 112 can be limited to maximum and minimum points by screws fastened to the geared spool assembly 112 and to the device support frame 107 in such a way that they interact to prevent the geared spool assembly 112 from being rotated beyond a point which would result in damage to the various components.

A liquid feed level sensor 120 is provided in the top of feeding vessel 102 to sense a specific high liquid level. This will suspend further dispensing cycles, at least while a high level condition exists. Liquid feed level sensor 120 has a short conductive probe 121 and a long conductive probe 122 held in parallel spaced relation, one to the other. The liquid feed provides a path of conductivity between short probe 121 and long probe 122 once both probes come in contact with the liquid feed. An inverted cup 123 is axially attached around long probe 122 and sealed to the inside top surface of feeding vessel 102. In the event that the level of liquid feed rises up into inverted cup 123, an air bubble is formed which prevents the highly conductive liquid feed from coating the uppermost part of long probe 122 or the inside of inverted cup 123, thereby preventing a continuously conductive path of residual material after liquid level recedes. A wire running between liquid feed level sensor 120 and dispensing controller 104 is provided to communicate with the dispensing controller 104 when a high level of liquid feed is sensed.
Liquid level feed sensor 120 serves a dual purpose. Not only does it prevent feed from overflowing the feeding vessel 102, but it also provides a means by which the operator can prevent the liquid feed level from exceeding the maximum desired amount of liquid feed in the feeding vessel, regardless of the programmed dispensing cycle. The operator can select appropriate lengths for probes 121 and 122 which cause the programmed dispensing cycle to be aborted as soon as sensor 120 detects that particular level of liquid. In this way the operator can be assured that the group of livestock being fed never gets more than their prescribed quantity of liquid feed.

Control circuit 125 is a microprocessor based circuit, here employing an appropriate microprocessor such as a 80C39. The Microprocessor 125 gathers information from rotation limiting switch 130, liquid feed level sensor 120, Hall effect transducer 118 and touch pad 124.

The components of an operational control circuitry are shown in Figures 7, 8 & 9. The control logic that enables the hardware to operate is shown in Figures 10 - 13. An example of an actual program for the 27C16 memory device implementing this program logic is listed in source code in Figures 14 - 23. CMOS circuit technology is utilized for its ability to provide very low power consumption. This hardware is used in conjunction with a slow clock speed to reduce the total power consumption, thereby allowing long periods of operation on a battery powered supply, before replacement batteries are required.

The gear motor 115 and clutched gear assembly 113 and 114, drive geared spool assembly 112 to pull out cable 108 in measured amounts determined by user programmed units.
This is accomplished by the rotations of an idler gear located inside of the geared motor 115. A toroidal magnet 119 is fixed about this idler gear within gear motor 115, which drives drive shaft 114. A Hall effect transducer 118 is fixed to the casing of motor 115 in close proximity to toroidal magnet 118 to sense alternating magnetic fields when the magnet rotates. The output of Hall effect transducer 118 is electrically connected to control circuit 125. Each revolution of the idler gear corresponds to a fractional angular advance of the spool attached to geared spool assembly 112. Exactly how many degrees the spool rotates through for each half revolution of the idler gear depends upon the gear ratio established by gear motor 115, drive gear 113 and geared spool assembly 112.

Control circuit 125 processes the information received from Hall effect transducer 118 to control the power supplied to gear motor 115 and thereby dispense a measured amount of liquid feed as described above. The actual quantity of liquid dispensed for a given number of rotations of the idler gear and particularly sized storage vessel is calibrated by direct measurement of liquid dispensed during a test cycle. From this information, tables can be generated to define the value of a unit of liquid feed. The operator then uses this information to program the desired quantity of liquid feed.

Other methods for sensing, monitoring and controlling the length of cable 108 are possible and include using optical or mechanical devise in place of Hall effect transducer 118. It should also be apparent that there are many possible variations in the system programming, gear ratios, motor selection and transfer tube inlet elevation
control. Design considerations include the cross-sectional area of the supply tank, the minimum measurable length of cable played out and the necessary resolution. Obviously, if it is desired to measure feed dispensed to the nearest ounce, much higher resolution is required and the system design would have to be altered accordingly, for example by decreasing the cross-sectional area of the tank to the point where each resolvable unit corresponded to one ounce.

Once the liquid feed is delivered into the feeding vessel 102 there are several means for an animal to consume liquid feed. For example, lick wheel 103 mounted through the top of feeding vessel 102 serve this purpose nicely. Lick wheels 103 extend down into the vessel to just above its bottom. The operator turns each wheel 103 through the liquid feed once to coat it with the liquid. The livestock will then continue rotate these wheels by licking, which collects any liquid feed pooled in the feeding vessel by again coating the wheels as they turn through the liquid feed. Thus the liquid feed is delivered to the livestock. Lick balls or an open tray are alternative feed delivery devices which can be used dependent upon the size and class of livestock being fed. Each of these means can be implemented to actually deliver the liquid to the livestock as are well known in the industry.

In use, the operator raises the transfer tube to its uppermost elevation within the storage vessel by turning the transfer tube elevation control handle in a clockwise direction. The operator then fills the liquid feed storage vessel through the fill hole located on top of the
storage vessel. Next, utilizing the elevation control handle, the operator lowers the transfer tube below the storage vessel's liquid level, allowing adequate time for enough liquid feed to flow through the transfer tube to wet the lick wheels, lick balls or feeding tray in the feeding vessel. As soon as this is accomplished, the operator raises the transfer tube to the point where the transfer tube inlet is resting just above the liquid level in the liquid feed storage vessel. Next, the operator must calculate the required quantity of liquid feed to be dispensed per feeder unit utilizing the method illustrated on the following worksheet and in the programming examples. After calculating the required quantity of liquid feed being dispensed, the program parameters are input utilizing the following programming definitions and input guideline.

PROGRAMMING DEFINITIONS AND INPUT GUIDELINE

LIQUID FEED DISPENSING CYCLE - The dispensing cycle is initiated when the controller activates the motor on the cable release assembly thereby lowering the transfer tube in the storage vessel and allowing feed to flow into the liquid feeding vessel. The start time of each feeding time block will always be the time when the first dispensing cycle is initiated.

TIME CLOCK - The current Time will normally be displayed in the LCD display screen, e.g. 12:10, with the time increasing by one minute every 60 seconds.

SET TIME - This is the way you enter the current time of day. This is accomplished by depressing the time clock
touch pad square at the same time as either the + or - touch pad entry square.

TIME SYSTEM - Military time (1 - 24 hours)

TIME DISPLAY - Time will be continuously displayed in the LCD display screen (i.e.) 12:10 until any function touch pad square is depressed, e.g. "START TIME." At the moment that a touch pad function square is depressed the LCD display screen will show the specific function being viewed and the current set numeric value of this function.

The display is automatically programmed to return to the current time, e.g. 12:11 at the time when the display would normally advance to the next minute.

FEEDING TIME BLOCK - This represents the user defined time block which is established by the start and stop program input. The controller allows up to two such defined time blocks and can be defined as the time which begins with Start #1 or Start #2 and ends with Stop #1 or Stop #2. The assigned start and stop times must fall within one 24 hour period.

START TIME - Start time is used to set the time for the beginning of each feeding time block. Start #1 is always the first time block to run therefore, if two run periods are selected Start #2 must follow Stop #1. The current start time entered into the controller can be viewed on the LCD display screen while depressing the start touch pad square. Either Start #1 or Start #2 may appear upon depressing the start touch pad square. If the opposite start time is desired for either viewing or input then this can be accomplished by alternately releasing and depressing the touch pad square. To change the programmed start display the touch pad entry square for either Start
#1 or Start #2 must be depressed at the same time as either the + or - touch pad entry square.

STOP TIME - Stop time is used to set the time for the ending of each feeding time block. Stop #1 is always the first time block to run therefore, if two run periods are selected Stop #2 must follow Stop #1. The current stop time entered into the controller can be viewed on the LCD display screen while depressing the stop touch pad square. Either Stop #1 or Stop #2 may appear upon depressing the stop touch pad square. If the opposite stop time is desired for either viewing or input then this can be accomplished by alternately releasing and depressing the touch pad square. To change the programmed stop display the touch pad entry square for either Stop #1 or Stop #2 must be depressed at the same time as either the + or - touch pad entry square.

CYCLE DELAY TIME - The period of time which elapses between each dispensing cycle within each feeding time block. The cycle delay time must be the same for both feeding time blocks if both time blocks are used. The minimum cycle delay time is 1 minute and the maximum cycle delay period is 90 minutes or (01:30) as it is displayed. The current cycle delay time entered into the controller can be viewed on the LCD display screen while depressing the cycle delay touch pad square. To change the programmed cycle delay time the touch pad entry square for cycle delay time must be depressed at the same time as either the + or - touch pad entry squares.

DISPENSING UNITS - This is a number the operator must enter which is determined by first calculating the desired liquid feed output per feeder per day then dividing this
amount by the total desired cycles per day and then referencing this number against the programmed guide located on the inside cover of the control unit. This number represents the number of dispensing units to enter into the controller. The current units entered into the controller can be viewed on the LCD display screen while depressing the dispensing units square. To change the programmed units display the touch pad entry square for units must be depressed at the same time as either the "+" or "-" touch pad entry square.

PROGRAM TEST - By momentarily depressing the touch pad square TEST, the gear motor will begin running, provided previous program entries have been entered. The gear motor will run until the number of units counted matches the number that is currently in the UNITS variable. If no number has been entered, i.e. UNITS equals zero, the motor can not run. Provided there is a value greater than zero, running of the gear motor will occur whenever the TEST touch pad square is pressed, regardless of the current time or at what place the controller is in the running of the entered program values.

To Figure Units: Refer to programming examples using the following formulas:

\[
\text{Head} \times \text{lbs/hd/day} = \text{lbs/day}
\]

\[
\text{lbs/day} \div .33 \text{ lbs/unit} = \text{Total units/day}
\]
Stop #1 _____ - Start #1 _____ + ___ hrs. and ___ min. = total minutes.

Total min. ___ ÷ Cycle delay in minutes ___ + 1 = ___ # of cycles.

Stop #2 _____ - Start #2 _____ = ___ hrs. and ___ min. = ___ total minutes.

Total min. ___ ÷ Cycle delay in minutes ___ + 1 = ___ # of cycles.

# of Cycles Time # 1 _____ + # Cycles Time #2 _____ = total # cycles/day. Drop any numbers less than a full cycle e.g., 1.5 = 1 cycle.

___ Total units/day ÷ ___ Total cycles/day = ___ units/cycle.

**PROGRAMMING EXAMPLE #1**

Assume 50 head (hd) of livestock which are to consume 2 lbs. per head per day, start time at 7:00 A.M., stop at 9:00 P.M. and the controller to run once per hour.

1. Make sure time is correct
2. Set Start #1 at 07:00
3. Set Stop #1 at 21:01
4. Set cycle delay at 01:00
5. Figure Units:
   50 hd x 2 lbs/hd/day = 100 lbs/day.
   100 lbs/day ÷ .33 lbs/unit = 303 units/day.
21:01 hrs - 7:00 hrs = 14.01 hrs + 1 hr for 1st cycle.
15:01 hrs/day ÷ 1 hr/cycle = 15 cycles/day.
303 units/day ÷ 15 cycles/day = 20.2 units/cycle.

6. Set units at 00:20.

PROGRAMMING EXAMPLE #2
Assume 75 head (hd) of livestock which are to consume 1.75 lbs/day. The feed is to be dispensed between 6:00 a.m. and 11:15 a.m. and between 4:30 p.m. and 9:45 p.m. The controller is to cycle and dispense supplement every 45 minutes.

1. Make sure time is correct.
2. Set Start #1 at 06:00.
4. Set Stop #1 at 11:16.
5. Set Stop #2 at 21:46.
6. Set cycle delay at 00:45.
7. Figure Units:
   75 hd x 1.75 lbs/hd/day = 131.25 lbs/day.
   131.25 lbs/day ÷ .33 lbs/unit = 398 units/day.
   Time Period #1: 11:16 - 6:00 = 5 hrs 16 min. or 316 min.
   316 min. ÷ 45 min./cycle = 7 cycles + 1 for 1st cycle = 8 cycles Time Period #1
   Time Period #2: 21:46 - 16:30 = 5 hrs 16 min. or 316 min.
   316 min. ÷ 45 min./cycle = 7 cycles + 1 for 1st cycle = 8 cycles (16 total)
   Therefore, 398 units/day ÷ 16 cycles/day = 24.87 or 25.
While the foregoing material describes the present preferred embodiment of the invention, it is to be distinctly understood that this invention is not limited thereto but may be variously embodied to practice within the scope of the following claims.

We claim:
Claims:

1. A liquid feed dispensing device for livestock which is characterized by:
   a supply vessel;
   a feeding vessel being attached to the supply vessel and configured to receive a flow of liquid from the supply vessel;
   a transfer tube, being located within the supply vessel, having an inlet end which is freely movable to any elevation within the supply vessel and a second end in fluid communication with the feeding vessel;
   programmable inlet elevation control means for discretely and incrementally controlling the elevation of the inlet end of the transfer tube to permit a predetermined volume of fluid, which is the volume located at an elevation above the inlet end, in the supply vessel, to flow through the transfer tube into the feeding vessel;
   means for delivering any liquid in the feeding vessel to the livestock;
   timer means for accruing elapsed time and dispensing liquid into the feeding vessel at predetermined times during the day; and
   liquid level sensor means for sensing a high liquid level in the feeding vessel.
2. The livestock feeder of claim 1 wherein the liquid level sensor is characterized by a pair of conductive probes located on an upper inside surface of the feeding vessel and positioned in spaced apart relation one to the other.

3. The livestock feeder of claim 2 wherein the liquid level sensor is further characterized by an inverted cup being axially attached about the longer probe.
4. The livestock feeder of claim 1 wherein the inlet elevation control means is characterized by:
   a microprocessor based electronic control circuit;
   a power supply electrically connected to the control circuit;
   an electric motor being electrically connected to the power supply through a switching means, which is electrically connected to the control circuit to selectively supply power to the electric motor in response to the control circuit;
   a spool being driven by the motor;
   a cable having one end attached to the spool, the cable being wound around the spool, and a second end attached to the inlet end of the transfer tube to selectively raise and lower the inlet end in response to the control circuit;
   means for counting the number of degrees of rotation of the spool to monitor and determine the elevation of the inlet end of the transfer tube; and
   manual adjustment means for manually rotating the spool to adjust the elevation of the inlet end of the transfer tube.
5. The livestock feeder of claim 4 wherein the means for counting the number of degrees of rotation is characterized by a Hall effect transducer magnetically coupled with a magnet, the magnet being affixed to a rotating member, wherein the rotating member rotates proportionately with the spool.
6. A liquid feed dispensing device for livestock which is characterized by:
   a supply vessel;
   a feeding vessel being attached to the supply vessel and configured to receive a flow of liquid from the supply vessel;
   a transfer tube, being located within the supply vessel, having an inlet end which is freely movable to any elevation within the supply vessel and a second end in fluid communication with the feeding vessel;
   timer means for accruing elapsed time and dispensing liquid into the feeding vessel at predetermined times during the day;
   liquid level sensor means for sensing a high liquid level in the feeding vessel; and
   means for delivering any liquid in the feeding vessel to the livestock.
7. The livestock feeder of claim 6 wherein the liquid level sensor is characterized by a pair of conductive probes located on an upper inside surface of the feeding vessel and positioned in spaced apart relation one to the other.

8. The livestock feeder of claim 7 wherein the liquid level sensor further is characterized by an inverted cup being axially attached about the longer probe.
FIG. 1
11/26
REGULATE PROGRAM & CONTROL

INITIALIZE CONTROLLER AND DISPLAY

MAIN CONTROL LOOP

CHECK 1 MINUTE TIMER REGISTER

DOES REGISTER = 0

YES

CHECK AND ADJUST TIME AND CONTROL VALUES

NO

 WHICH CONTROL BUTTON IS BEING PUSHED

IS REGISTER DIFFERENT THAN 0

YES

INPUT SET VALUES FROM INPUT KEYS

NO

CHECK FOR UNITS IN MOTOR CONTROL REGISTER

IS VALUE GREATER THAN #

YES

RUN REGULATE MOTOR FOR THE # OF UNITS SET

NO

FIG. 10
REGULATE TIME CONTROL

ADVANCE CLOCK TIME BY 1 MINUTE AND DISPLAY TIME

CHECK START 1/2 TIME AND SET MOTOR FLAG IF CLOCK TIME = START TIME

CHECK STOP 1/2 TIMES AND CLEAR MOTOR FLAG IF CLOCK TIME START TIME

CHECK LIMIT SWITCH

LIMIT SWITCHES OFF

NO

YES

MOTOR FLAG SET

NO

YES

SUBTRACT 1 MINUTE FROM HOLD TIMER

NO

YES

HOLD TIMER = 0

PUT MOTOR UNITS VALUE INTO MOTOR CONTROL REGISTER

RETURN TO MAIN PROGRAM

FIG 11
KEY BOARD SWITCH PUSHED

WAS START KEY PRESSED? YES DISPLAY START TIME OR TOGGLE START DISPLAY

NO

WAS STOP KEY PRESSED? YES DISPLAY STOP TIME OR TOGGLE STOP DISPLAY

NO

WAS WAIT KEY PRESSED? YES DISPLAY WAIT TIME

NO

WAS TIME KEY PRESSED? YES DISPLAY TIME OF DAY

NO

WAS UNITS KEY PRESSED? YES DISPLAY UNITS DISPLAY

NO

WAS TEST KEY PRESSED? YES RUN TEST AND DISPLAY RESULTS

NO

WAS "+" KEY PRESSED? YES INCREMENT CURRENT DISPLAY

NO

WAS "-" KEY PRESSED? YES DECREMENT CURRENT DISPLAY

NO

RETURN TO MAIN PROGRAM

FIG. 12
MOTOR CONTROL PROGRAM

TURN ON MOTOR POWER

CHECK FOR MOTOR TIMING PULSES

IS MOTOR RUNNING

NO

COUNT MOTOR TIMING PULSES

CLEAR MOTOR COUNTER REGISTER

YES

SUBTRACT 1 FROM MOTOR CONTROL REGISTER

MOTOR REGISTER = 0

NO

YES

TURN OFF MOTOR POWER

RETURN TO MAIN PROGRAM

FIG. 13
Regulate Source Code

setpoint storage addresses
20-21 = time of day
22-23 = start time 1
24-25 = stop time 1
26-27 = start time 2
28-29 = stop time 2
2A-2B = hold minutes
2C-2D = motor distance units 1/10 inch

register assignments
R7 = seconds counter
R6 = hold minutes counter
R5 = minutes register
R4 = hours register
R0 = index pointer
F0 = time 1 or time 2 flag
F1 = timer on - off flag

store ascii value for message

ASCII 0300H "-TIME-"
ASCII 0308H "SET TIME"
ASCII 0310H "STOP #1"
ASCII 0318H "STOP #2"
ASCII 0320H "START #1"
ASCII 0328H "START #2"
ASCII 0330H "WAIT min"
ASCII 0338H "-UNITS-"
ASCII 0340H "-TEST-"
ASCII 0350H "0123456789ABCDEF"
ASCII 0360H "C1993-REG0293-GS"

START OF REGULATE PROGRAM

ADDR 000H
NOP
CPL F0 set start to select #1 time option
CALL INIT power up initialization

MAIN   JTF CNTR   jmp if counter overflow flag set
       MOV A,R7   check to see if seconds counter is 0
       JNZ MNA   If it is not then skip next part
       MOV R0,#20 time of day pointer
       MOV R7,#3C restore seconds counter to 59
       CALL INCT Increment time by 1 min.
       MOV A,#00 address for "-TIME-" message
       CALL DSPM display message
       CALL DSPT display time from R4 and R5
       CALL REGC regulate time control prog

MNA CALL MOTOR check and run motor if motor count >0
       OR P1,#FF set up port 1 as inputs
       IN A,P1 get switch data

FIG. 14
CPL A
JZ MAIN    loop if no switches
CALL SWTCH go to selected sub
JMP MAIN   main program loop
NOP
NOP

Update counter for next minute

<table>
<thead>
<tr>
<th>CNTR</th>
<th>DEC R7</th>
<th>seconds counter -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV</td>
<td>A,T</td>
<td>get counter data</td>
</tr>
<tr>
<td>ADD</td>
<td>A,#38</td>
<td>offset for /200</td>
</tr>
<tr>
<td>MOV</td>
<td>T,A</td>
<td>put counter data back</td>
</tr>
<tr>
<td>JMP</td>
<td>MAIN</td>
<td></td>
</tr>
</tbody>
</table>

Initialize system values

<table>
<thead>
<tr>
<th>ADDR 0030H</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
</tr>
<tr>
<td>MOV A,#CF</td>
</tr>
<tr>
<td>OUT P2,A</td>
</tr>
<tr>
<td>OR P1,#FF</td>
</tr>
<tr>
<td>CLR A</td>
</tr>
<tr>
<td>MOV R6,#00 clear hold counter</td>
</tr>
<tr>
<td>MOV R0,#20 clear all time values</td>
</tr>
<tr>
<td>MOV R1,#10</td>
</tr>
<tr>
<td>MOV R7,A  clear seconds counter</td>
</tr>
<tr>
<td>ITA MOV @R0,A</td>
</tr>
<tr>
<td>INC R0</td>
</tr>
<tr>
<td>DJNZ R1,ITA repeat until done</td>
</tr>
<tr>
<td>START CNT start counter mode</td>
</tr>
<tr>
<td>MOV A,#38 8 bit mode 5X7 format 2 line</td>
</tr>
<tr>
<td>CALL COUT send out command to LCD display</td>
</tr>
<tr>
<td>MOV A,#0D display on command</td>
</tr>
<tr>
<td>CALL COUT</td>
</tr>
<tr>
<td>MOV A,#06 right shift cursor mode</td>
</tr>
<tr>
<td>CALL COUT</td>
</tr>
<tr>
<td>RET</td>
</tr>
</tbody>
</table>

Get time data from @R0 into R4 and R5

<table>
<thead>
<tr>
<th>GTD MOV A,@R0</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV R4,A</td>
</tr>
<tr>
<td>INC R0</td>
</tr>
<tr>
<td>MOV A,@R0</td>
</tr>
<tr>
<td>MOV R5,A</td>
</tr>
<tr>
<td>DEC R0</td>
</tr>
<tr>
<td>RET</td>
</tr>
</tbody>
</table>

Save time data from R4 and R5 into @R0

<table>
<thead>
<tr>
<th>STD MOV A,R4</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV @R0,A</td>
</tr>
<tr>
<td>INC R0</td>
</tr>
<tr>
<td>MOV A,R5</td>
</tr>
</tbody>
</table>
MOV @R0, A
DEC R0
RET

Decrement time value R0, by 1 minute steps

DECT  CALL GTD  get time data into r4,r5
  MOV A,R5
  JZ DCB  jump if minutes =0
  AND A,#0F  check 1's digit =0
  JZ DCA
  DEC R5
  JMP DS
DCA  MOV A,R5
  CPL A  invert a
  ADD A,#07  subtract 7
  CPL A
  MOV R5,A
  JMP DS
DCB  MOV R5,#59  reset to 59 minutes
  MOV A,R4  get hours
  JZ DCC
  AND A,#0F
  JZ DCD
  DEC R4
  JMP DS
DCD  MOV A,R4
  CPL A
  ADD A,#07
  CPL A
  MOV R4,A
  JMP DS
DCC  MOV R4,#23  reset hours to 23
DS   CALL STD  store data back into @R0
  RET

Increment time values by 1 minute steps

INCT  CALL GTD  get time data into R4 and R5
  MOV A,R5
  ADD A,#01
  DA A
  MOV R5,A
  XOR A,#80  check for 80 minutes
  JNZ INA  if not then skip to hours
  XCH A,R5  set minutes to zero
  MOV A,R4  get hours
  ADD A,#01
  DA A  decimal adjust
  MOV R4,A
  XOR A,#24  check for 24 hours
  JNZ INA
  XCH A,R4  reset hours to zero
INA  CALL STD  store time data to @R0

FIG. 16
RET

Output commands from A to LCD display

COUT AND P2,#C0 select command mode
OUT P1,A send data
OR P2,#10 strobe E line
AND P2,#E0
RET

send out data from A to display

DOUT OR P2,#20 select data mode
OUT P1,A send out data
OR P2,#10 strobe E line
AND P2,#E0
RET

Display message @A from page 3

DSPM MOV R2,A save message address
MOV A,#80 display address 0 command
CALL COUT send out command
MOV R3,#08: set up for 8 characters
DSA MOV A,R2 get message address
MOV P3 A,:A replace with character from page3
CALL DOUT output data character
INC R2
DJNZ R3,DSA
RET

Display time data to LCD

DSPT CALL GTD get time values from @R0 into R4 and R5
MOV A,#C0 address of second half of display
CALL COUT send out command
MOV A,#20 send out space
CALL DOUT
MOV A,#2D output a - character
CALL DOUT send out data character
MOV A,R4 get hours data into A
CALL DSPD convert binary data to ascii and send out
MOV A,#3A output a : character
CALL DOUT
MOV A,R5 get minutes
CALL DSPD send out
MOV A,#2D output a - character
CALL DOUT display should look like -04:35.-
RET
NOP
NOP
NOP

convert binary number to ascii and send to display

FIG. 17
DSPD   MOV R2,A     save data value in r2
SWAP A    get upper time digit in place
AND A,#0F         clear unwanted digit
OR A,#50        add base address for ascii table
MOV P3 A,A      get ascii value for number
CALL DOUT     send ascii number to LCD display
MOV A,R2     get time data back
AND A,#0F         select lower digit
OR A,#50        add base address
MOV P3 A,A      get ascii data from table
CALL DOUT     send out to LCD display
RET
NOP
NOP

Switch jump table

ADDR 0100H
SWITCH    JB7 STOP  set stop times 1 and 2
        JB6 START  set start times 1 and 2
        JB5 TIME   set time of day
        JB4 HOLD   set wait time between cycles
        JB3 TEST   test cycle
        JB2 MTU    motor time units
RET
NOP
NOP

Enter stop time data

ADDR 0110H
STOP    MOV R0,#24   stop time 1
        MOV A,#10   stop 1 message
        JF0 SPA
        MOV R0,#28   stop time 2
        MOV A,#18   stop 2 message
        SPA        CALL DSPM display message
                   CALL DSPT display time data
        SPB        CALL ICDC add or subtract time
        JB7 SPB   wait for release of stop button
RET
NOP
NOP

enter start times

START    MOV R0,#22  start time 1
         MOV A,#20  start 1 message
         JF0 STA
         MOV R0,#26  start time 2
         MOV A,#28  start 2 message
         STA        CALL DSPM display message
                   CALL DSPT display time data

FIG. 18
STB CALL ICDC add or subtract time
JB6 STB wait for release of start switch
RET
NOP
NOP

set hold time

HOLD MOV R0,#2A wait time
MOV A,#30 wait message
CALL DSPM display message
CALL DSPT display time data
HOA CALL ICDC add or subtract time
JB4 HOA wait for release of hold switch
RET
NOP
NOP

set time of day

TIME MOV A,#08 set time message
MOV R0,#20 address of time data
CALL DSPM display sub
CALL DSPT
TIA CALL ICDC add + or - time
JB5 TIA wait for release of hold switch
RET
NOP
NOP

enter motor counter units

MTU MOV R0,#2C motor time units
MOV A,#38 motor units message
CALL DSPM display message
CALL DSPT display data
MTA CALL ICDC add or subtract
JB2 MTA repeat until units switch released
MOV R4,#00 erase any motor units > 59
CALL STD store data for motor
RET
NOP
NOP

Increment or decrement time values

ICDC MOV R1,#20 value for a 3 second timeout
ICLC OR P1,#FF set up switch input
IN A,P1
CPL A
JB1 ICA test - switch for dec
JB0 ICB test + switch for inc
JMP ICC if no switch then return
ICA CALL DECT decrement time

FIG. 19
CALL DSPT  display time
JMP ICD

ICB CALL INCT  increment time
CALL DSPT  display time

ICD CALL WAIT1  wait .1 seconds
OR P1,#FF
IN A,P1  get switch data
CPL A
JB1 ICE  test switches
JB0 ICE

ICC RET  quit if switch released

ICE MOV A,R1  check timeout counter for 0
JZ ICLC
DEC R1  dec timeout loop counter
JMP ICD
NOP
NOP

push motor units into cycle register to test it

TEST MOV A,#40  test message address
CALL DSPM
MOV R0,#2D  address of user set units
MOV A,R0.  get user set units
SEL RB1  select alternate register
MOV R4,A  put units into motor control reg
SEL RB0  return to normal registers
CALL RHV  restore hold register value
RET

compare on and off times and set timer flag

TIMER MOV R0,#20  get time value from memory
CALL GTD  move it into R4 and R5
MOV A,R4
MOV R2,A
MOV A,R5
MOV R3,A
MOV R0,#22  start1 time address
CALL GTD  get start1 time
CALL COMP  compare time values for =
JNZ TMA  if start1 = time of day then
CLR F1
CPL F1  turn on timer flag

TMA MOV R0,#24  stop1 time address
CALL GTD  get stop1 time data
CALL COMP  compare time values
JNZ TMB  if stop1 = time of day then
CLR F1  turn off timer flag

TMB MOV R0,#26  start2 time address
CALL GTD  get data
CALL COMP  compare times
JNZ TMC
CLR F1

FIG. 20
CPL F1    turn on timer flag
TMC MOV R0,#28    get stop2 time
CALL GTD
CALL COMP
JNZ TMD
CLR F1    turn off timer flag
TMD RET

compare time values    return A=0 if match

COMP MOV A,R2    compare time r2,r3 with
XOR A,R4    time data in r4,r5
JNZ CMA
MOV A,R3
XOR A,R5
CMA RET    return a=0 if values match

regulate control program

REGC CALL TIMER    compare time and set timer flag
MOV A,R6    get wait timer value
JZ RGA    if r6 wait timer >0 then
DEC R6    count r6 timer down by 1 mln
RET    and return
RGA JF1 RGB    if timer flag is on then continue
RET    else return
RGB NOP
IN A,P2    get switch data
JBE RGC    check float switch for 1
RET    if not then return
RGC MOV R0,#2D    address of motor units
MOV A,@@R0    get data
MOV R2,A    save data for conversion to binary
AND A,#F0    mask off 10s digit
SWAP A
MOV R1,A    save 10s digit
MOV A,R2    get original number
AND A,#0F    mask for ones digit
RGD ADD A,#0A    add 10 to A
DJNZ R1,RGD    repeat until done
SEL RB1    select alternate reg
MOV R4,A    store number for motor sub
SEL RB0    set original register back
CALL RHV    restore hold value to R6
RET

wait for 1024 machine cycles

ADDR 0200H

WAIT1 MOV A,#55    wait for 1024 machine cycles
WTA DEC A
NOP
JNZ WTA
RET
NOP

FIG. 21
NOP

check for units in motor register and count to 0

MOTOR SEL RB1          select reg for motor data
? MOV A,R5
? JNZ MRE            check motor units for 0
    MOV A,R4
    JZ EDM            if r4 = 0 then quit
    DEC R4
    MOV R5,#0A        motor counts/.01 inch * 2
MRE    INC R0         inc delay counter
    MOV A,R0
    JNZ GMD           test it for 00 if it is
    INC R1            inc timeout R1
    MOV A,R1
    AND A,#F0         check if it is > 8 (about 4 seconds)
    JZ GMD            if not then go on to next part
    MOV R5,#00        if it is then clear all motor
    MOV R4,#00        units to stop motor from running
    JNZ EDM
GMD    OR P2,#C0       set up to get switch data
    OUT P4,A          send out motor on pulse
    MOV A,R5         get motor count data
    JB0 MRA          jump if odd number
    IN A,P2          get switch data
    JB6 MRB          check for motor pulse low
    DEC R5           if low then dec r5
    MOV R1,#00       clear timeout counter
MRB    JMP EDM
MRA    IN A,P2       get data
    CPL A            invert it
    JB6 EDM          check for motor pulse hi
    DEC R5           if hi then dec r5
    MOV R1,#00       clear timeout counter
EDM    SEL RB0        return to main registers
    RET

restore register values

ADDR 0240H

RHV    MOV R6,#00      clear R6
    MOV R0,#2A       hold data address
    MOV A, @R0      get hold time hours
    JZ RHA           skip if hours = 0
    MOV R6,#3C       load R6 with 60 minutes
RHA    INC R0         next address
    MOV A, @R0      get hold minutes
    AND A,#F0       mask for 10s digit
    JZ RHB          if 10s digit = 0 then skip to minutes
    SWAP A          exchange
    MOV R1,A        setup loop counter
    MOV A,R6       get hold data from R6
RHC    ADD A,#0A      add 10s to counter value
    DJNZ RHC        repeat until done

FIG. 22
MOV R6,A  save hold counter
RHB  MOV A,@R0  get hold minutes again
AND A,#0F  mask for ones digit
ADD A,R6  add ones digit to counter value
MOV R8,A  put total hold value back into R8
JZ RHD  check for 0 if not then
DEC R6  adjust wait value for extra minute
RHD  RET

FIG 23
SAMPLE PROGRAM

24 HOUR TIME PERIOD

TEST (ANY TIME)

TIME BLOCK 1

ON

OFF

START 1

STOP 1

TIME BLOCK 2

ON

OFF

START 2

STOP 2

CYCLE DELAY

ON

OFF

ONE SHOT TRIGGER TO START GEAR MOTOR TO RUN UNTIL X # OF ROTATIONAL UNITS HAVE BEEN COUNTED

FIG 24
# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : A01K 7/02

US CL. : Please see Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 119/74, 51.03, 51.11, 51.5, 71, 77

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US, A, 3,208,431 (KLOSS) 28 September 1965, col. 5, lines 63-69.</td>
<td>1-3</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 3,265,036 (KLOSS) 09 August 1966, col. 6, lines 51-56.</td>
<td>1-8</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 3,347,212 (ANDERSON et al.) 17 October 1967, see the entire document.</td>
<td>1-8</td>
</tr>
<tr>
<td>A</td>
<td>SU, A, 1,556,606 (BELGOROD AGRIC. INST.) 07 April 1990, see the entire document.</td>
<td>1-8</td>
</tr>
</tbody>
</table>

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
  *A* document defining the general state of the art which is not considered to be part of particular relevance
  *E* earlier document published on or after the international filing date
  *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another invention or other special reason (as specified)
  *O* document referring to an oral disclosure, use, exhibition or other means
  *P* document published prior to the international filing date but later than the priority date claimed

**Date of the actual completion of the international search**

10 JANUARY 1995

**Date of mailing of the international search report**

27 FEB 1995

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Authorized officer
ROBERT P. SWIATEK

Telephone No. 703/305-0850
A. CLASSIFICATION OF SUBJECT MATTER:

US CL:

119/74