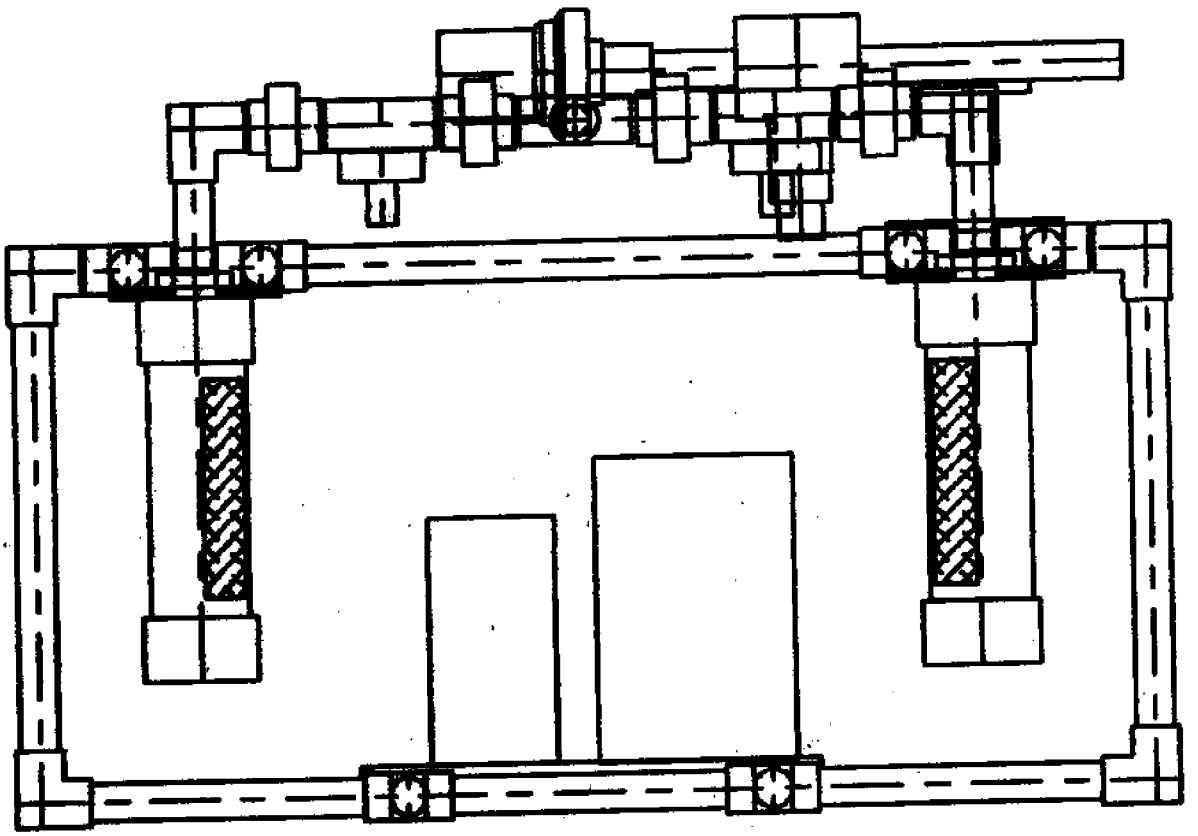
REPPS



Fall 1990/Spring 1991

REMOTE, PROGRAMMABLE PLANKTON SAMPLER (REPPS)

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The members of our group wish to thank the men and women who contributed to this project:

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Omega Instruments
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PORTLAND PLASTIC PIPE

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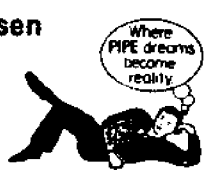

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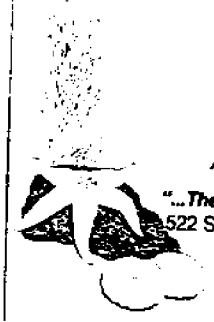

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PREFACE

This report has been prepared in fulfillment of the requirements of the University of New Hampshire Ocean Project Course (TECH 697). This report was prepared by the project team for their assigned area of responsibility as described below.

Jeffrey Chace (Zoology)	Pool/Field Tests Plankton Fixative Analyze Retrieved Data
Kevin Landerman (Mechanical Engineering)	Structure Manifold
Jonathan Miner (Computer Science)	Electronics Programming
Christopher Quinn (Mechanical Engineering)	Housings Structure Chambers

Advisors for this project were as follows:

Kenneth Baldwin	Mechanical Engineering Department
Randy Olson	Zoology Department

ABSTRACT

The REmote, Programmable Plankton Sampler (REPPS) was an extension of the HUSTLE project, which was conducted at the University of New Hampshire, in 1988. The REPPS project was designed to examine the dynamics of plankton communities. The main goals of the REPPS system were to collect both biological and physical data, with minimal effort and maximal research flexibility. This goal was achieved through a specialized design integrating a Tattletale computer with solenoid valves. With the aid of this design, the entire system is completely autonomous and has the ability to collect twelve plankton samples in any programmed sequence. The system was developed over two semesters through computer analysis, working drawings, fabrication and preliminary testing. The REPPS system was taken out of the laboratory and into the field and placed in two different aquatic environments, Barbadoes Pond and Great Bay Estuary.

Basic plankton Ecology

Plankton are "organisms that exist as free floating entities which are unable to maintain their distribution against prevailing currents" (Parsons et.al.,1984). These organisms exist in a wide array of aquatic habitats ranging from fresh to estuarine to ocean water. Plankton can be broken down into three major categories: bacterioplantkton, phytoplankton, and zooplankton (Levinton, 1982). This project will be most concerned with the ecology of the latter category, zooplankton.

Why Study Zooplankton?

Zooplankton comprise a crucial link in the biological food web of aquatic systems. Zooplankton's major roles in the community are two fold. The first important role of zooplankton is to function as regulators of phytoplankton populations through grazing during seasonal blooms (Riley and Bumpus, 1946). A local example of the zooplankton grazing pressure takes place within the waters of George's Bank. During the spring, nutrients are released into the water through runoff and other physical factors inducing population explosions of phytoplankton. The explosion of phytoplankton is followed by the zooplankton population which increases in response to the bloom. The increase in phytoplankton then shifts to a drop in population numbers due to the grazing pressure of the zooplankton (Riley and Bumpus, 1946). The zooplankton help to

effectively regulate and provide a degree of stability to the existing system.

Zooplankton are primaryconsumers in the biological food web. By existing in the base of the numerous trophic levels, zooplankton exist as a primary food source and energy base for countless other aquatic organisms. This is important in considering the dynamics of a community and assessing the possible productivity of a given area. Of special interest is looking at the efficiency with which energy is transferred from one trophic level to the next. This factor is crucial because energy efficiency often sets limits on the number of trophic levels and interactions possible within a community (Levinton, 1982).

The Problem

The main problem faced by plankton ecologists is accurately assessing the density of a plankton community. The ability to examine the population dynamics of zooplankton is hindered by the present means of sampling and the characteristic patchy distribution of plankton (Parsons, et.al., 1984). Plankton communities exist in random aggregations in different spatial arrays at all scales of sampling. The mechanisms leading to these differences are linked to both biological and physical processes. Parsons and Takahashi (1973) produced a list of the major factors producing patchiness.

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1. Physical-chemical boundary conditions, including light, temperature, and salinity gradients.
2. Advective effects as in water transport, including small-scale variations due to turbulence.
3. Grazing.
4. Reproduction rates within the population.
5. Social behavior in populations of the same species.
6. Intraspecific interactions resulting in either attraction or repulsion between species.

These factors usually integrate with one another to produce patches on scales ranging anywhere from one meter to forty kilometers in diameter (Mackas and Boyd, 1979).

All of these factors produce a difficult sampling regime for the ecologist. To produce data that is statistically significant, good experimental design coupled with a working knowledge of the system being analyzed is essential. Several of the basics in experimental design are the necessity for replication of the sampling methods, the obtaining of multiple samples, and accurate assessment of the surrounding physical processes.

Present day samplers

Most of the conventional sampling methods present problems to the biologists and hinder their ability to reach these goals. All of the present day technologies lack the necessary research flexibility to accurately assess plankton communities. Most

plankton sampling is accomplished with plankton nets, pumps, and water bottles (Omori and Ikeda, 1984). This presents real problems to the ecologist because the sampling is "labor intensive and time consuming, making near-real assessment of zooplankton distributions virtually impossible." (Greene, 1990). In addition to being labor intensive many of the present conventional techniques can only assess mid-to large scale distributional features of plankton communities (Greene, 1990). All of these drawbacks lead one to believe that present day technology does not have the ability to obtain reliable data on plankton community dynamics.

Non-conventional samplers

Several attempts have been made to overcome these problems and produce research flexibility. The OHARA sampler (O'Hara, 1984) lacks two essential components that allow for research flexibility: a self-incorporated power supply and on-board probes to assess the surrounding physical environment. The lack of an on-board power supply requires the system to be tethered to either the shore or to a boat. This is not economically feasible for the average ecologist. The EZY-ZOOP plankton sampler lacks the ability to obtain multiple samples over an extended period of time and is not completely submersible (Dixon and Robertson, 1986). The lack of an ability to submerge the plankton sampler greatly limits the sampling scale and is inadequate for an extensive study.

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The Answer - REPPS

This present project attempted to address and answer some of these basic problems in plankton sampling methodology that are inherent in most of the conventional techniques.

Overview

The REPPS plankton sampler was designed to be a portable plankton sampler that is fully automated, programmable, and submersible up to 100 feet. In addition to these qualities REPPS has the added research flexibility of being able to collect and preserve twelve samples in any programmed sequence. The REPPS sampler also has the ability to continually monitor and collect data on the surrounding physical processes.

The backbone of the REPPS sampler is a manifold design that distributes water from an in-take pump to twelve collection chambers lined with 75 micron nytex mesh. The distribution system is controlled by a Tattletale computer board that serves to activate and de-activate the in-take pump as well as the solenoid valves. The solenoid valves are placed before each of the twelve collection chambers and serve to regulate when the water flows into the collection chamber. The thirteenth valve controls a purge valve that functions to flush the system before each sample is taken. The Tattletale is programmed to activate the solenoid valves at a

specific initiation time, in sequential sampling intervals. Once programmed the entire unit is then lowered into the water with the aid of rope attached to each of the four corners of the frame.

While deployed, the system is fully autonomous being powered by a 12 volt battery and following the commands of the computer programmed sequence. As the system goes through the sampling program each sample taken is preserved by a formalin sponge located at the bottom of each collection tube. Preservation was deemed necessary because unpreserved plankton at the concentration convenient for examination will not remain alive long, and upon death will encourage a destructive growth of bacteria (Fraser, 1985).

The REPPS sampler also logs data into the Tattletale's memory system from a flow meter, as well as a temperature and conductivity probe. The flow meter records how many liters of water passed through the system for each sampling period. This is essential in considering the density of the plankton population that is being sampled. The conductivity and temperature probes are mounted adjacent to the intake of the pump. Their values are recorded into the Tattletale's memory bank, every few minutes. This may produce some idea as to the links between physical pyrocesses and the abundance of zooplankton in certain patches.

Once the sampling period has ended the sampler is retrieved by noting its marker buoy and hoisting it out of the water by means of the attached rope. When brought up the sampler is returned to the

lab, where the chambers are easily rinsed down into a collecting chamber. The plankton can then be classified according to species and quantity. The plankton was counted with a Stempel pipet (extracts exactly 1 ml samples) and a Bogarov tray (Colman, 1931). The information collected by the Tattletale over the sampling period can also be downloaded onto either a PC or a Macintosh computer system, where it can be analyzed. The flow meter data which was correlated with the sub-samples taken and counted in the Bogarov tray. Upon completion of data collection the results can be downloaded into a database where statistical tests can be run to determine if there are any significant trends.

Preliminary Testing

Preliminary testing was broken up into three different tests. The first test was designed to investigate the operation capability of the solenoid valves, as well as the basic design of the manifold. A scaled-down manifold was utilized for the test with three solenoid valves, a Rule 2000 pump and a DC power source. The manifold and solenoids were completely submersed into a tub of water and brought down to pressure at one hundred feet in the UNH hyperbaric chamber. The system successfully pumped water through the solenoid valves and vertically, up a twelve inch PVC pipe, into a bucket.

The second test was performed in the UNH pool. The basic operational aspects of the system were analyzed in the dry lab

prior to the pool test. Once the electronics were complete and fully operational, the system was taken down to twelve feet in the pool and allowed to run through a mock sampling sequence. Phosphorescence die was utilized to determine if the water was flowing through the system in the programmed sequence. This procedure involved using a syringe and dispensing die at the intake of the pump and watching the marker die exit out the respective collection chamber. The test was a great success.

The final test was performed in the UNH hyperbaric chamber. The entire system was taken down to one hundred feet to insure that the housings were pressure tight and the system would function normally. This test was also a success and verified the feasibility of deploying the REPPS sampler down to one hundred feet.

Study Areas

Barbadoes Pond (Madbury, NH) and Great Bay Estuary (Durham, NH) have been selected to be two study sites for the field testing of the REPPS sampler. See appendix one for test site locations.

Barbadoes Pond

Barbadoes Pond is used for limnological studies by numerous UNH faculty and students. This body of water was selected because of its physical conditions and in hopes of recording a clear trend of zooplankton vertical migration. Barbadoes Pond itself is a thermally stratified system and contains a hypolimnetic oxygen

deficit. Light penetration into the lake is moderate extending through a large portion of the epilimininon (Baker and Haney, 1976). These physical qualities make Barbadoes Pond a good area to examine zooplankton vertical migration. During this process light intensity stimulates zooplankton to travel through the water column. Most species migrate upward from deeper strata to more surficial areas as darkness approaches, and return to deeper strata at dawn (Wetzel, 1983).

The first field test will incorporate suspending the plankton sampler 3 meters in the water column (to insure the largest amount of species migration will be seen). The sampling time will run for a period of twenty four hours with a sample being taken every two hours. By spacing the twelve samples over a twenty four hour period it is hoped that a clear vertical migration trend will be displayed in the counted data set.

Great Bay Estuary

Great Bay Estuary is bordered by several New Hampshire towns. The area of the bay that will be looked at is Durham Point. The estuary was also chosen for reasons linked to its physical characteristics as well as its plankton. Estuarine systems are bodies of water that are subject to quick changes in salinity, rapid tidal currents, and strong vertical mixing (Day et. al., 1989). Due to the extreme of the physical forces inherent in an estuarine system different patch producing processes develop for

different species of zooplankton (Jeffries, 1967). By studying this system the link may be able to be made between the physical processes present and the abundance of certain species of zooplankton.

This field test will be based around the tidal cycle for the area on the particular day of sampling. Tidal cycles usually last for a period of six hours and can have profound impacts upon plankton communities. By separating the samples at the proper intervals, considering the current rate and what period of the cycle the estuary is at, it is hoped that some connections can be made between the physical processes and plankton abundance.

Approach to Final Design:

Since this project was a continuation started two years ago, modifications were needed to eliminate many of the problems plaguing the old design. After much deliberation, a "No Moving Parts" concept was adopted by the group, which meant discarding the stepper motor/rosette system for pumping water through the chambers. The answer was to employ a manifold with electrically actuated solenoid valves controlled by the Tattletale. Polyvinylchloride (PVC) was the material chosen for the job. An important design constraint was to reduce the weight of the prototype from 120 pounds down to 60-80 pounds.

Manifold

The first idea for a manifold was to drill a one inch hole down the center of 2"x2" block of PVC 20-24 inches long. Eptam Plastics quoted the cost of the drill alone to be $120.00! A request like this was considered unusual, because of the difficulty in drilling such a long piece of material. Even if the block was cut in half and then drilled, the cost and effort still exceeded the worth. More thought was given, and the idea to chop six smaller blocks for a twelve port manifold seemed like the best solution since the machining involved was reduced.

Valves

It was decided that electrically actuated solenoid valves was the "No Moving Parts" solution. The first valve chosen for testing was the Richdel 2400T irrigation valve, using 12 volt DC coils. After repeated attempts using the Rule 1500 bilge pump, the pressure generated was not strong enough to push open the valve for appreciable flow. It was discovered that a minimum of 5-10 psi was needed to open the valve, and the pump was measured at only six psi. This was simply unacceptable.

The next two valves selected were Asco pilot operated solenoid valves. One was made of aluminum and the other brass. Both performed well under testing but showed two serious drawbacks. 1) Both valves failed to suppress backpressure leaks, and, 2) each weighed 5-6 pounds. A twelve port manifold with just the valves weighed 65-78 pounds. Again, this was not the answer.

At the end of February, 1991, Portland Plastic Pipe disclosed information regarding a motorized ball valve, the Electromni, manufactured by Asahi/America. Finally, a valve sensitive to the design constraints had been found. However, two seemingly small limitations disqualified it from final consideration. 1) An additional twenty hours was estimated to modify the electronics

capable of supporting the hardware, and, 2) an encapsulation to protect the motor was necessary to isolate it from water contact.

Frame

Not much designing was needed to create a frame for the manifold, chambers and housings. At worst, the old design with reduced pipe sizes would comprise the frame, but a more refined look was desired. Sheet PVC was investigated as a possible design, however, a combination of sheets and pipes was considered a better answer to satisfy the project's goals.

Fixative Device

Since a preservative such as Formalin or Magnesium Chloride paralyzes plankton , a device was needed to emit or inject such a substance. However, careful thought and innovation failed to yield a product that could easily be produced. Therefore, a sponge to contain the fixative was deemed the most appropriate answer. Had time permitted, perhaps a more creative idea could have been devised.

The Final Design

Shown in Figures 1-3 are three views of the plankton sampler. The components specifications are located in Appendix Three and Appendix 6. The components consist of: the Rule 2000 pump, the manifold including 1" I.D. PVC Schedule 40 crosses, unions, elbows and pipe; the 1" I.D. 12V DC solenoid irrigation valves from Richdel; the flowmeter, temperature and conductivity probes; the battery, Tattletale and their Ikelite housings; the 3/8" sheet PVC plates composing the supports and manifold flanges; and, the 1" I.D. PVC Schedule 40 tees, elbows, street 90 elbows and pipe that make up the frame. Three inch I.D. PVC Schedule 40 pipes and end caps were used for the chambers built two years ago. A fixative sponge was employed to preserve the plankton. A hydrogen catalator placed in the Ikelite housing absorbs any hydrogen gas emitted by the battery, preventing the possibility of explosion.

Pump

The Rule 2000 bilge pump with better pressure head was purchased and found to open the Richdel valves. A test conducted on March 6, 1991 at the Hyperbaric Chamber in Putnam Hall concluded that the pump can pump adequate flow through the valves sufficient for this application.

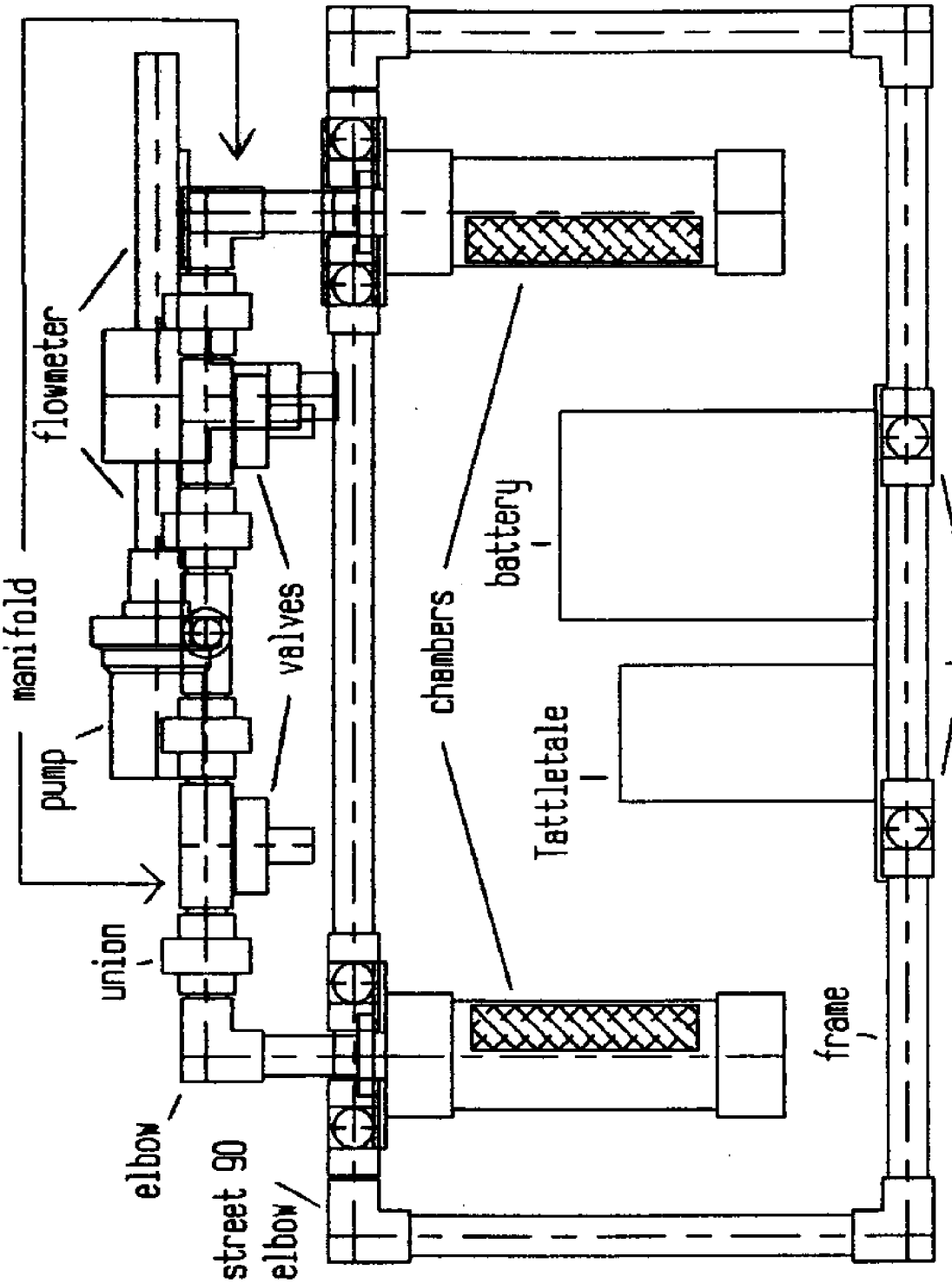
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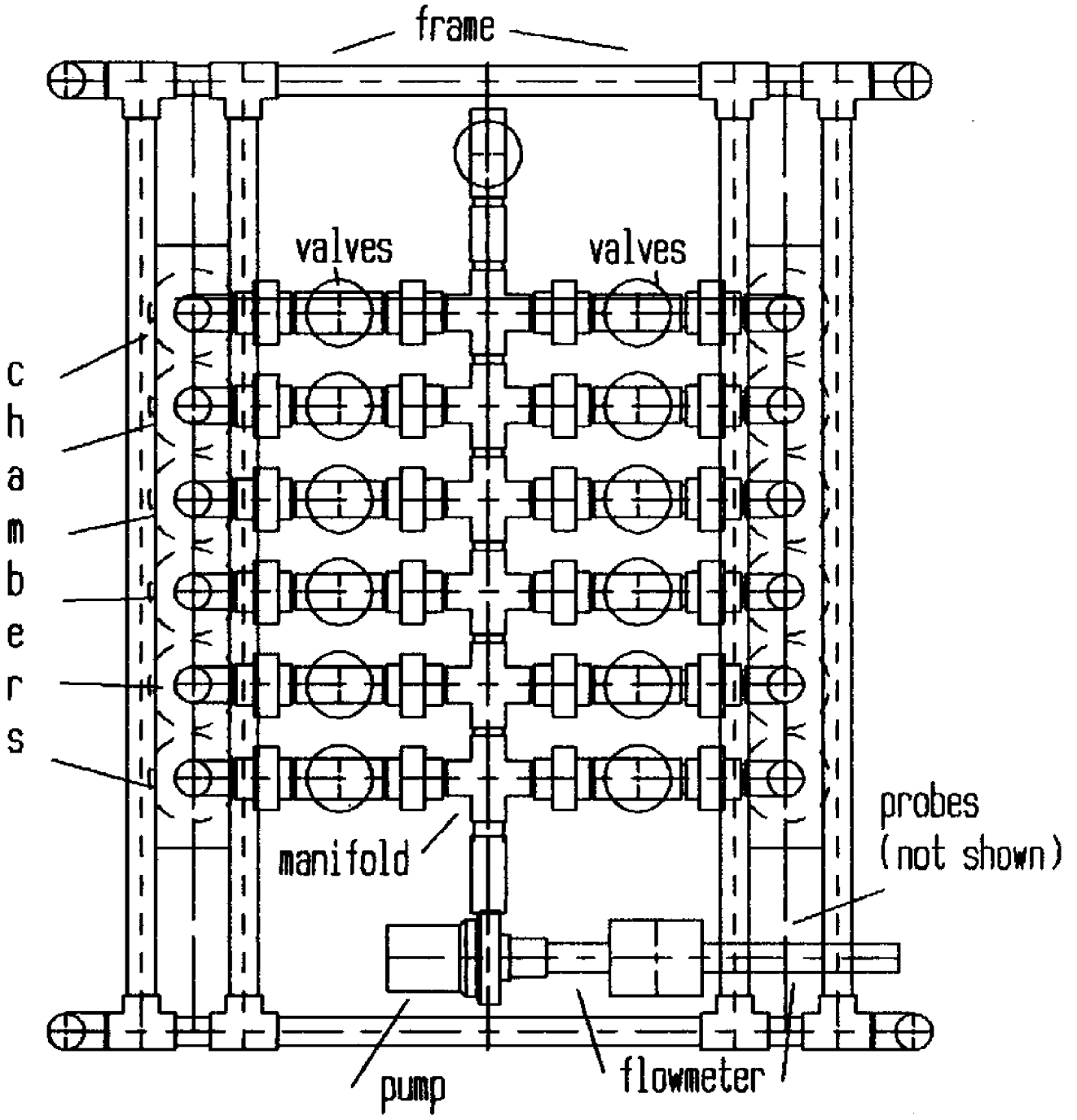
FIGURE 1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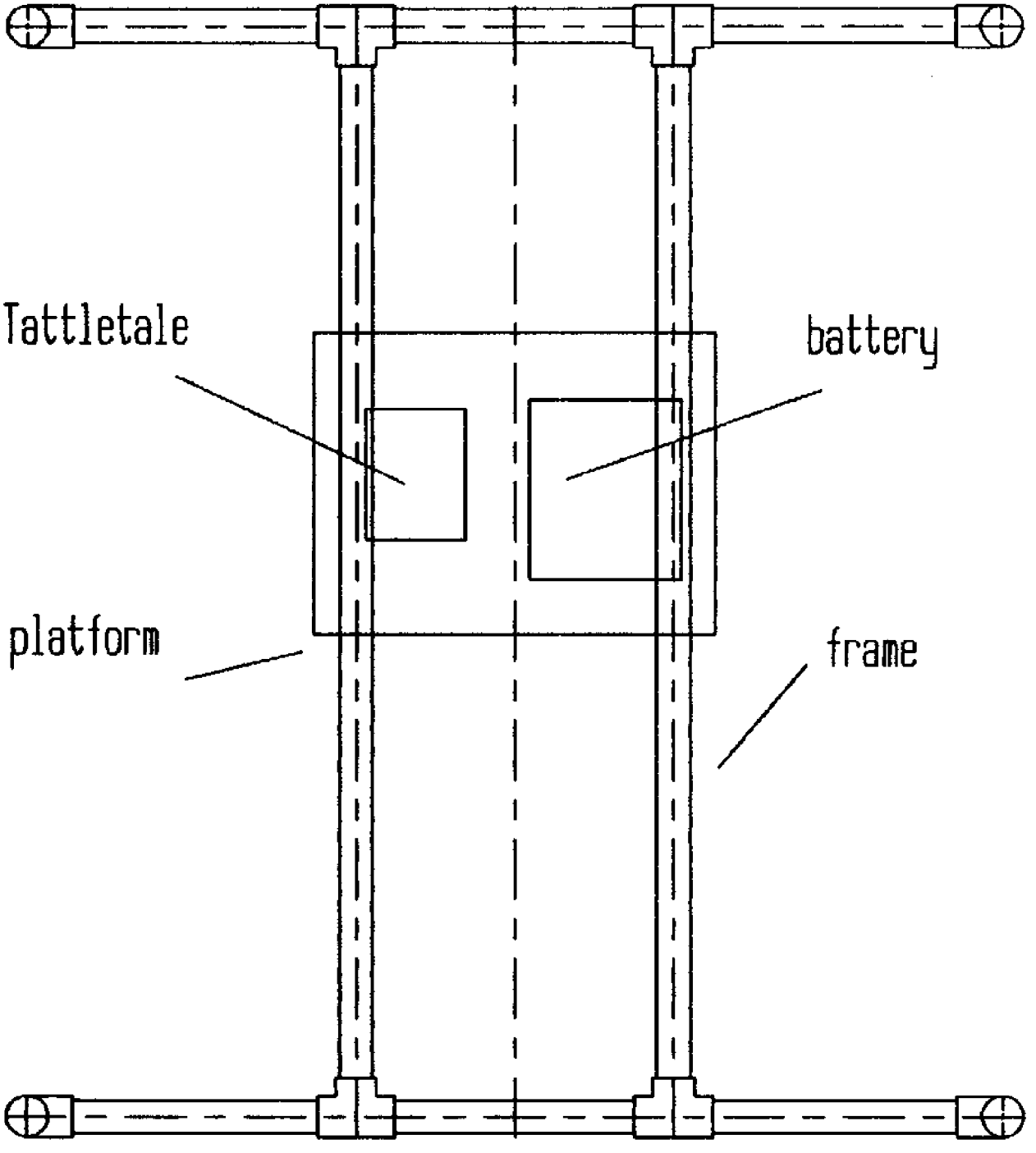

FIGURE 3

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Valves

Several tests were performed using the new pump on the Richdel valves. The Rule 1500 pumped only 60 % of the flow with the plunger spring removed, but the Rule 2000 was able to pump at least 80 % of the flow without the spring removed. The successful test on March 6 showed the valves to function at a depth of 100 feet without any modifications to make them submersible.

Manifold

Refer to Figure 4 for a schematic of the manifold. Using six crosses, 24 unions, 13 valves, 12 elbows, pieces of 1" I.D. Schedule 40 pipe, PVC cleaner, primer and cement, the final design was approved and built with few problems. Not all of the pieces were cut to the same length, so an error in center hole alignment resulted. To remedy this dilemma, a larger hole for each port was bored in the support plates. The unions allow each valve to be removed should any one of them fail in service.

Hoist Support System

Four 1/4"x3" eye screws were bolted on top of the four corners of the frame to allow a harness to hoist the sampler. For each eye screw a marine clip was attached to remove the harness. Another

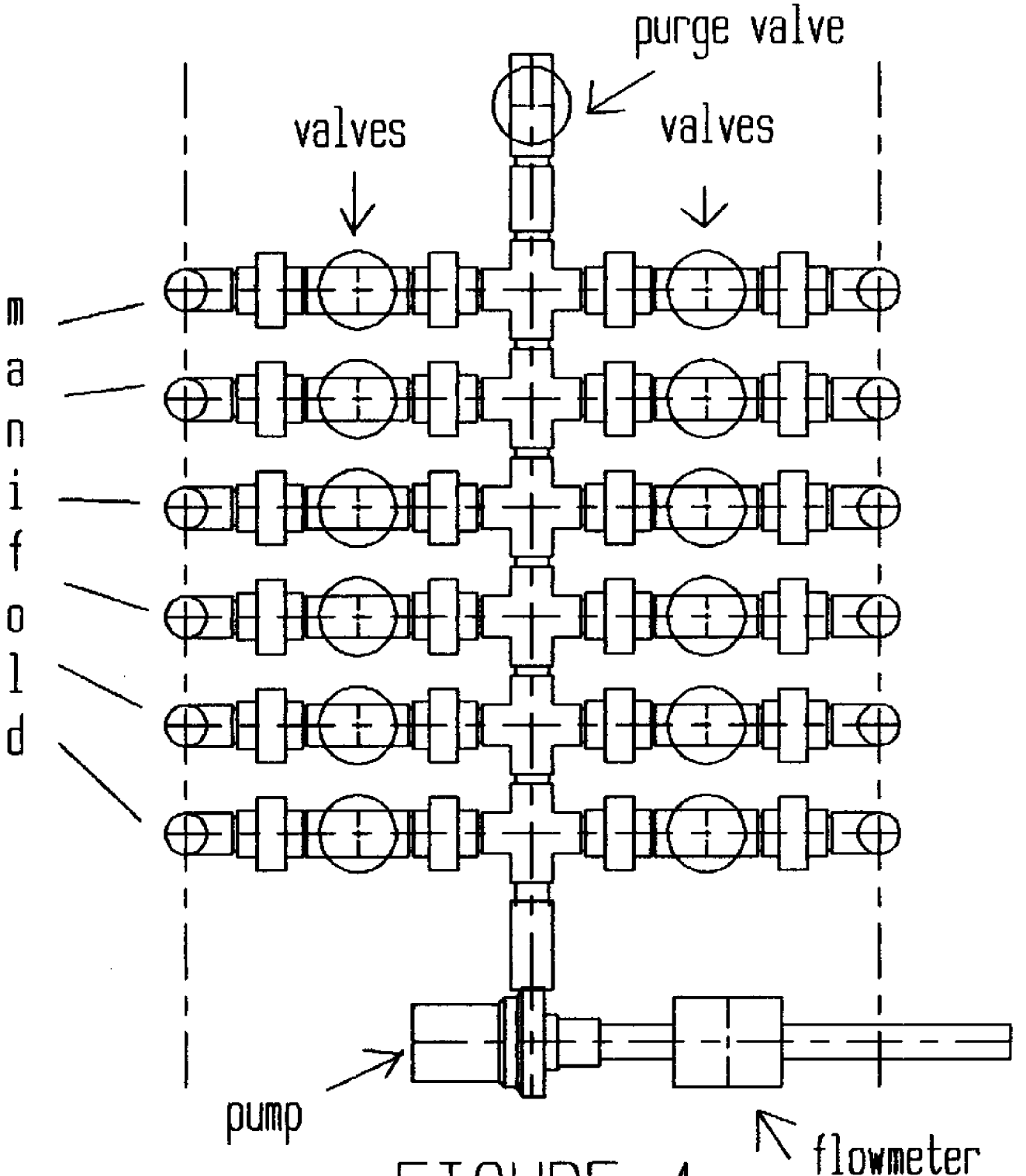


FIGURE 4

marine clip was employed to connect the buoy with the harness. All five clips are made up of 300 series Stainless Steel to prevent corrosion or electrolysis. This design arose completely by availability of marine supplies found at Jackson's Hardware and Marine of Kittery, ME. A long piece of 3/8" lobster rope was used to tie this all together.

Support Plates and Flanges

Smaller pieces of 3/8" sheet PVC were cut for supporting the probes, with 1" I.D. PVC Schedule 40 pipe to hold the plates together. A 12"x16" piece of 3/8" sheet PVC was used to support the Tattletale and battery housings. Ten Stainless Steel screws were used to mount all plates to the frame. Twelve 3/8"x2- 5/8"x2-5/8" PVC plates were cut with a 1.315" hole bored at the centers to serve as the manifold support flanges. Their purpose was to clamp the manifold and chamber end caps to the support plates.

Frame

Refer to Figures 2 and 3 for a diagram of the frame. Much in the same way the manifold was assembled, the frame followed suit. Pieces of 1" I.D. PVC Schedule 40 pipe were cut to length and carefully glued to the tees, elbows and street 90 elbows. It was quickly discovered that the safest way to cement the frame was to

assemble it first. The PVC cement sets in less than 2 seconds, allowing very little margin for error.

Fixative Sponge

Since a working prototype of preserving the plankton could not be achieved, a Formalin sponge had to be used instead. The difficulty stemmed from the limited space inside the chambers, which did not allow much room for anything. If the chambers were a bit larger perhaps some small device could fit inside. A next generation prototype may prove this to be the case.

Chambers

As stated before, twelve 3" I.D. PVC Schedule 40 pipes with end caps were introduced in the old design to serve as sample chambers. Each chamber contains a portion of 75 micron nytex mesh along its length to filter the plankton from the water. The surface area was found to be large enough to prevent backpressure.

Electronics

The electrical design had two objectives. First, to record environmental data over the entire sampling time. And secondly, to sequence the solenoid valves and the pump during the sampling

session. In order to avoid repeating work done by the previous research group, as much as the original electronic design as possible was preserved. The same temperature probe and conductivity probe were used, thus eliminating the need for re-calibration, and the need for circuit redesign. In addition, the two Ikelite housings from the previous project were reused. One housing contained the battery, and the other contained the Tattletale computer. Stuff tubes were used to penetrate the housings. The HUSTLE specifications called for temperature measurement within 0.01°C, and a conductivity measurement within 0.1 mS/cm. The flow meter was reused as well. A new pump, rated at 2000 gal/hr was used, along with thirteen electrically controlled solenoid valves for chamber selection and sea water distribution. A twelve volt, twenty-four amp hour battery provides the power for the system. Figure E1 provides an overview of the

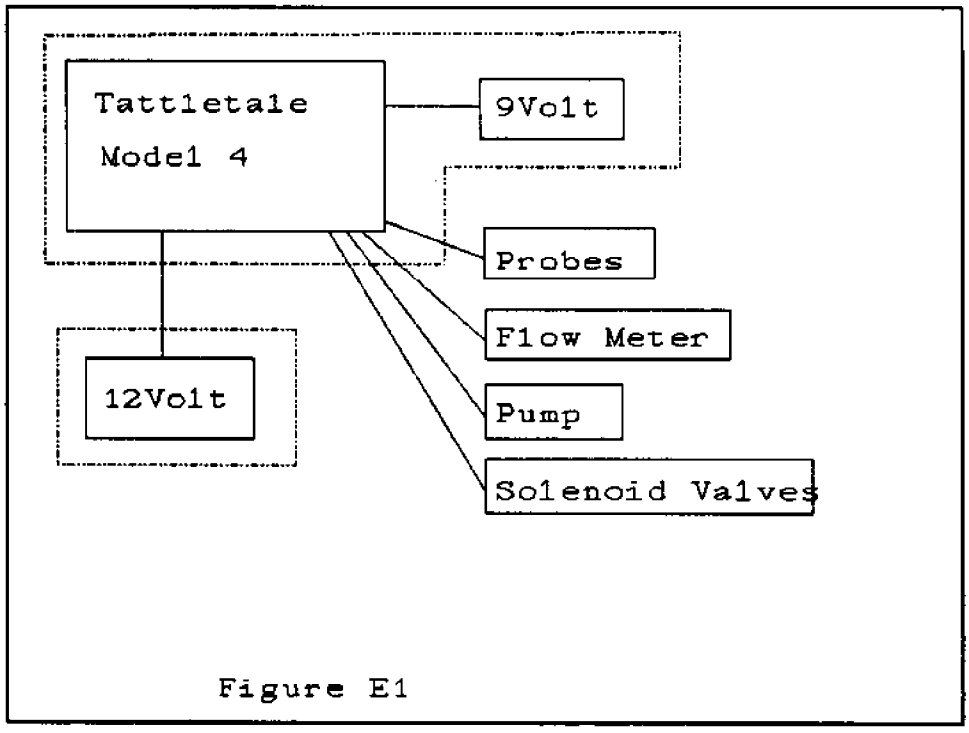


Figure E1

system. The dotted lines indicate the two housings.

The heart of the electronics is a Tattletale Model 4 from Onset Computer Corp. The system has the following features:

a. 32K RAM for program and data storage

b. Built-in BASIC operating system

c. 11 A/D converter inputs with 10-bit resolution

d. 16 digital I/O lines

e. Real time clock

f. Low power drain

Temperature probe, conductivity probe, and flow meter are attached to three of the analog input lines. (See figure E2) Both the probes, from Marteck Instruments, are connected in voltage divider configuration with 10K and 100K potentiometer, respectively. The actual values

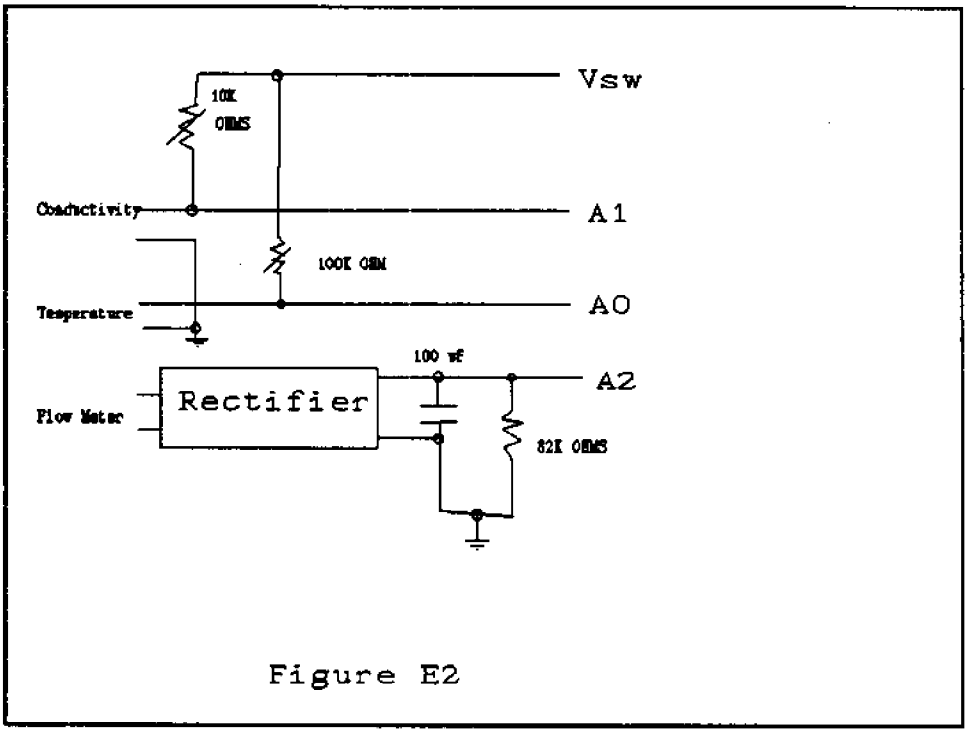


Figure E2

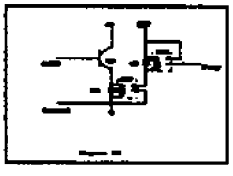
can be computed using the following:

$$\text{Temperature} = -26.437 + 0.28473*X - 3.3255E\text{-}4*X^2$$

$$\text{Conductivity} = -31.036 + 0.1674*Y - 7.2498*Y^2$$

where X and Y are the integer values stored by the Tattletale. These conversions are made by the host computer.

The flow meter from Omega Instruments produces a sine wave with the amplitude of 1 V/ft. The output is rectified and smoothed out with a RC circuit with a resistance of 83K ohms and a capacitance of 100 uF.



Controlling the pump and valves involved interfacing the CMOS logic levels from the

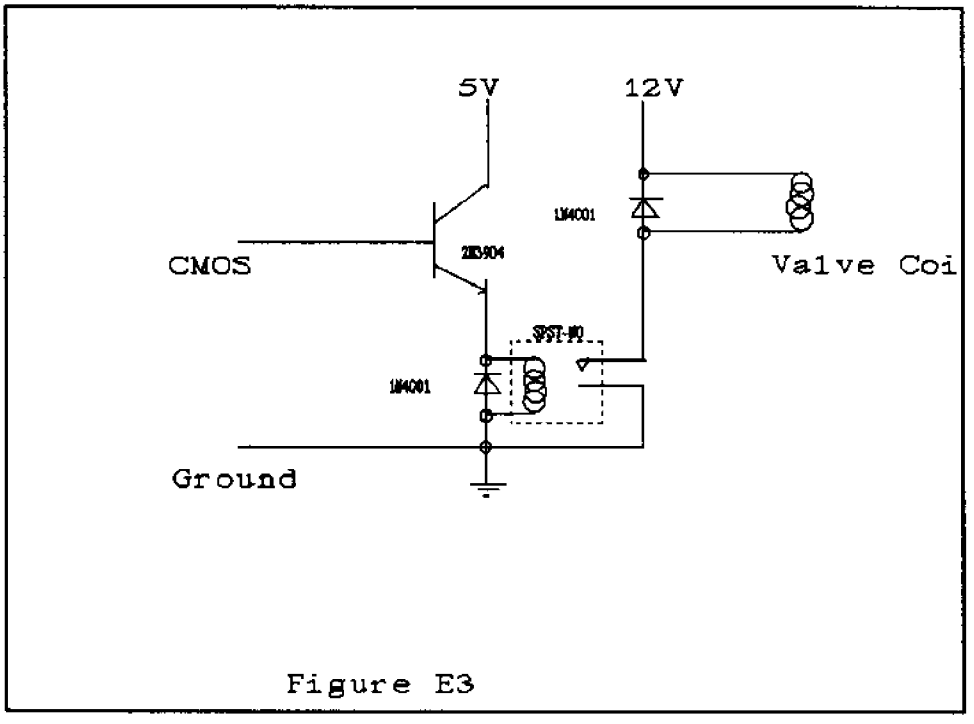


Figure E3

Tattletale with the twelve volt battery power source. The Tattletale was powered by its own nine volt battery. The thirteen valves were wired in a common source configuration. The Tattletale digital output pins 0 through 13 were used for valve selection, with the exception of pin 4, which must be high on power up. The output from the Tattletale switched a 2N3904 transistor, energizing low voltage reed relays (EAC-SD1A05A), and grounding the solenoid valves. Both the relay coils and the solenoid coils required a blocking diode 1N4007 to suppress the voltage spike caused by de-energizing. (See Figure E3). The pump was switched using a slave relay (OMRON G7G-1C4-CB), powered by the same reed relays as the valves. (See Figure E4).

Software

The host computer must have a RS-232 serial port and be running a communication program capable of XMODEM protocol. Two computers were used in our case, a SCI 80286 AT and a DELL 316LT (80386SX). Software was written in C that translated the binary files from the Tattletale into ASCII text files that can be imported into programs such as LOTUS 1-2-3.

A sample Tattletale program is shown on the following pages. The program is for a twenty-four hour sample cycle,

```
10 IF Z = 1 GOTO 40
20 IF Z = 2 GOTO 50
30 Z=1 : GOSUB 1000 : DONE
40 Z=2 : GOSUB 2000 : DONE
50 GOSUB 3000
100 STOP
```

with one sample every two hours. Probe readings are set for every ten minutes. The first section provides the wake up control. When the program is first run, Z must be set to zero. The program executes the initialization code starting at line 1000. When the routine returns, the Tattletale switches into its low power 'done' state and waits until the reset button on the RS-232 cable is pressed.

```
1000 X=0:Y=5000
1010 PCLR 0,1,2,3,4,5,6,7
1020 PCLR 8,9,10,11,12,13,14
1030 INPUT 'YEAR ' ?(5)
1040 INPUT 'MONTH ' ?(4)
1050 INPUT 'DAY ' ?(3)
1060 INPUT 'HOUR ' ?(2)
1070 INPUT 'MINUTE ' ?(1)
1080 INPUT 'SECOND ' ?(0)
1090 STIME
1100 INPUT 'START HOUR ' A
1110 FOR I=0 TO 11
1120 @(I) = A : A = A + 2
1130 IF (A>23) A = A - 24
1140 NEXT I
1150 PRINT 'DETACH HOST'
1160 PRINT 'COMPUTER, AND'
1170 PRINT 'PRESS THE RESET'
1180 PRINT 'BUTTON BEFORE'
1190 PRINT 'DEPLOYING...'
1200 RETURN
```

The next section of code is the initialization code. It first sets the data file pointers and prompts the user for the current date and time. This program then asks for the hour of the first sample. It then proceeds to calculate the times of the eleven other samples.

The third section is the main body of the program. It loops once for each of the twelve sample chambers. First it reads the controller's real time clock and decides whether it is time to start a sample. If it is time for a sample, the controller first purges the system to clear out the water left over from the pervious sample. Then the sample chamber is selected and

pumping begins. The flow is monitored and recorded.

```
2000 FOR I = 0 TO 11
2010 RTIME
2020 IF?(2)=@(I) GOTO2120
2030 STORE X,#1,CHAN(0)
2040 STORE X,#2,CHAN(1)
2050 STORE X,#1,?(3)
2060 STORE X,#1,?(2)
2070 STORE X,#1,?(1)
2080 SLEEP 0
2090 SLEEP 30000
2100 SLEEP 30000
2110 GOTO 2010
2120 PSET 13,14
2130 SLEEP 0 : SLEEP 3000
2140 PCLR 13,14
2150 SLEEP 0 : SLEEP 3000
2160 A=I:IF I<4 A = A - 1
2170 PSET A,14
2180 FOR B = 0 TO 2
2190 STORE Y,#2,CHAN(2)
2200 SLEEP0 : SLEEP 10000
2210 NEXT B
2220 STORE Y,#2,CHAN(2)
2230 PCLR A,14
2240 NEXT I
2250 RETURN
```

If it is not time for a sample, the controller takes probe readings every ten minutes. It reads both the temperature probe and conductivity probe. The time of the sample is also recorded.

The final section of the program handles the transfer of data from the Tattletale to the host computer. The data is transmitted in XMODEM format in two passes. The first file contains the temperature and conductivity data. The second file contains the flowmeter data. Once this data is transferred to the host computer, it must be decoded from its binary form. The decoded files can be loaded into a spread sheet for analysis.

```
3000 PRINT 'TEMPERATURE &' 3010 PRINT
'CONDUCTIVITY'
3020 PRINT 'PRESS <ENTER>'
3030 PRINT 'TO BEGIN'
3040 INPUT '' R
3050 OFFLD 0,X
3060 PRINT 'FLOWMETER'
3070 PRINT 'PRESS <ENTER>'
3080 PRINT 'TO BEGIN'
3090 INPUT '' R
3100 OFFLD 5000,Y
3110 RETURN
```

Future Designs

There are other methods of accomplishing the same goals, which could prove to be better than the existing design. Some methods are simple, but require more machining, and others are more advanced and more expensive. Or, a combination of the two can satisfy the needs. Listed below are just a few of the ideas worth mentioning. All are quite feasible, but at varying costs.

1) Using a PVC conduit pipe with reinforcing brackets, twelve Electromni motorized ball valves can penetrate the pipe in two rosettes along the girth. All Schedule 40 parts can be replaced by Schedule 80 components. The weight increases, but so does the space to install a fixative device. Since this sampler can go deeper than 150 feet, a high pressure seal for greater depths requires specialized coatings and/or encapsulations. Appendix Five displays various types of coatings for a wide range of applications. Underwater bulkhead connectors are highly recommended for leak prevention and convenience. See Appendix Four

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for details. See Figure 5.

2) Another means to achieve the same effect for the current manifold is to employ an air/pneumatic system involving an air (or oxygen) supply tank. A central reservoir controlled by the Tattletale can manipulate the flow through the chambers exactly like the electrically actuated valves. Appendix 6 contains information regarding a pneumatic system. The interested reader can refer to current valve industry standards for different option packages. The only known submersible valve company in the nation receives $2000 for a one inch valve, but a discount of $500 each is available with a purchase of a dozen or more.

By modifying the current sampler, the unions can be removed to reduce the size of the manifold and frame. However, it still requires two people for deployment. An important drawback is not being able to remove the valves should any one of them fail. Removal involves cutting the pipe and boring out the valve, a rather painstaking and time consuming task. Alignment would have to be near perfect in order to avoid problems. See Figure 6.

4a) Future thoughts for a fixative device lead to one simple and one complex device. A vile containing a fixative suspended upside-down and sealed by a latex sheath can be struck by a lever, activated by the flow of water into the chamber. See Figure 7. Assuming vibration occurs during sampling, ideally the fixative should not be released until the flow stops. The buoyancy of the float acts to pivot the lever, which then releases the fixative.

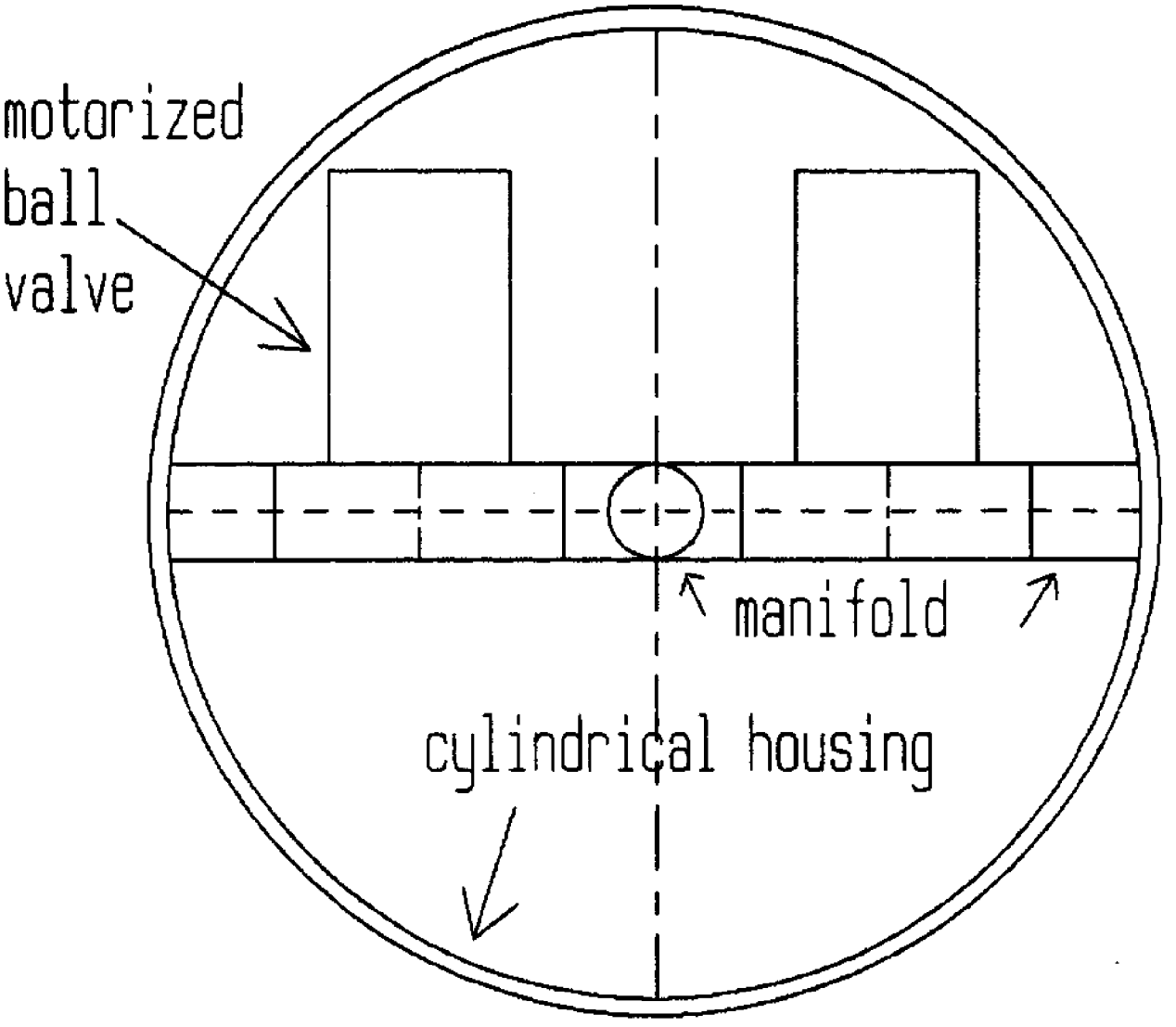
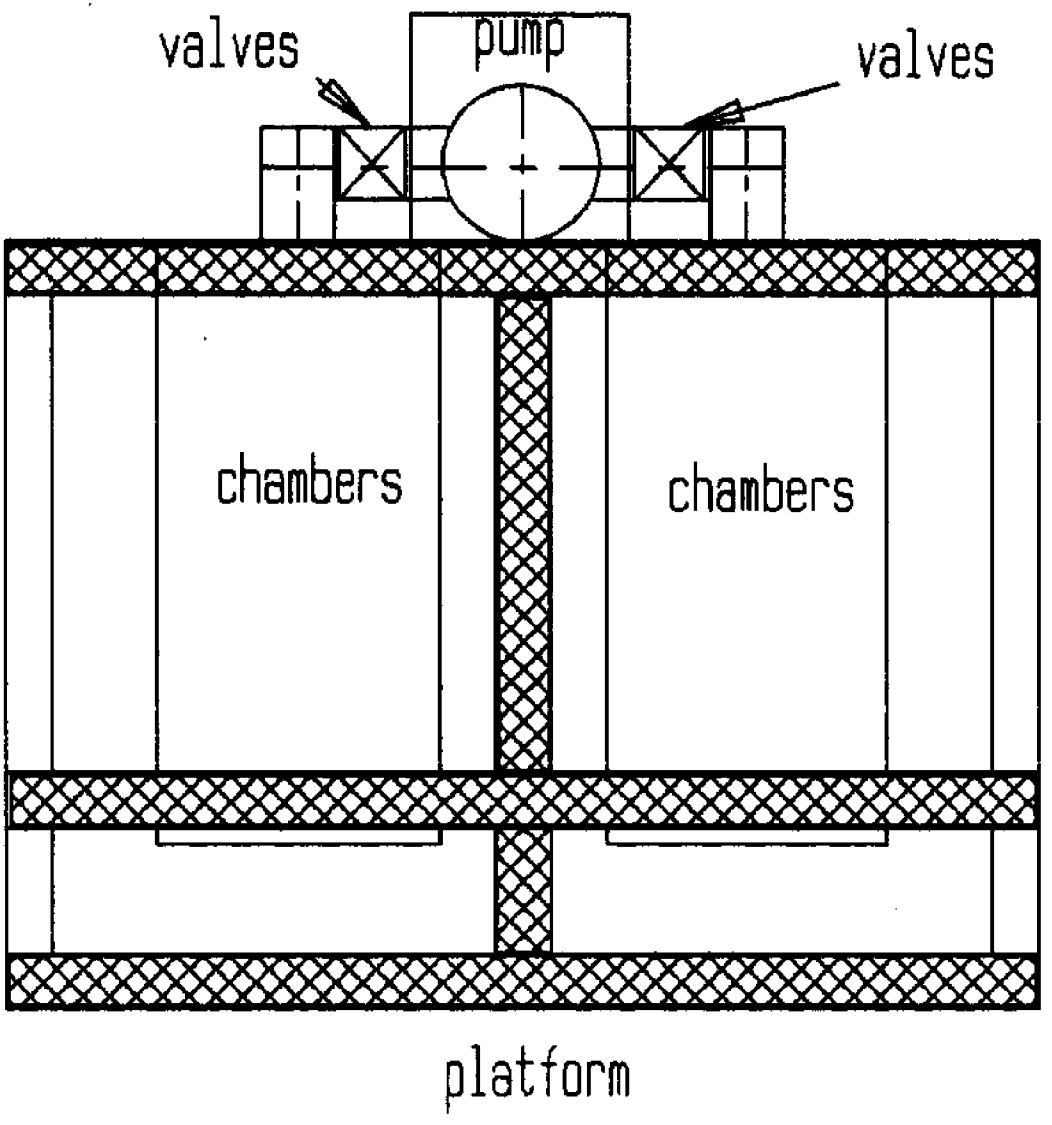


FIGURE 5



28b

FIGURE 6

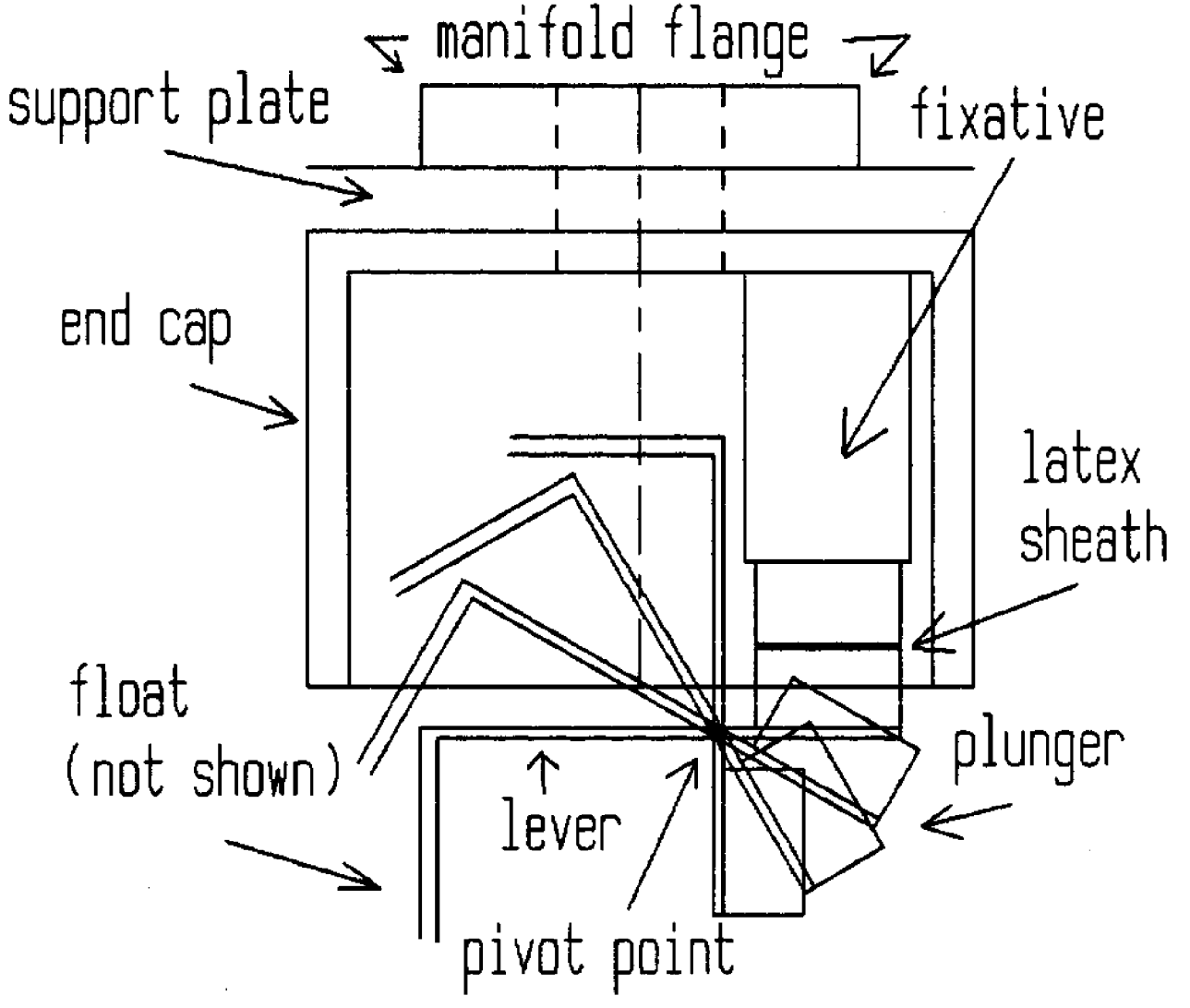

manifold flange
support plate
fixative
end cap
latex
sheath
float
(not shown)
plunger
lever
pivot point

FIGURE 7

Styrofoam is one prospective material that floats. Another suitable buoyant material is balsa wood. Compression due to depths of 200 feet or more could shrink the styrofoam, but tests can be performed to observe this. The balsa wood requires coats of shellac to prevent water absorption.

4b) The more advanced and favored solution is to utilize a fixative reservoir regulated by solenoid valves. See Appendix Five. Chemical analyses are required for valve selection, and a chemical corrosion chart for Asco valves is located in Appendix Five. The largest advantage to this system is the amount of control. Simply program the Tattletale to inject the fixative moments before the water flow terminates. As with all the systems researched, altering the electronics is necessary.

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Components Specifications List

Pump: Rule 2000 bilge

Manifold:
length: 35.25"
width: 30.5"
height: 6.25"

Composition:
13 1" Richdel 12V DC solenoid valves
24 1" PVC Schedule 40 unions
6 1" PVC Schedule 40 crosses
12 1" PVC Schedule 40 elbows
12 .375"x2.625"x2.625" flanges with 1.315" hole at center

Frame:
length: 45"
width: 40.5"
height: 19.75"

Composition:
12 1" PVC Schedule 40 tees
4 1" PVC Schedule 40 elbows
4 1" PVC Schedule 40 street 90 elbows
Assorted 1" PVC Schedule 40 pipes

Support plates:
length: 27"
width: 6"
thickness: .375"

Chambers:
3" PVC Schedule 40 pipe 13" long with 2 end caps

Preservative: Formalin

Probes:
flowmeter: OMEGA Series FP-5300
temperature: Marteck Instruments
conductivity: Marteck Instruments

Battery: Panasonic 12V DC 24 amp-hr.

Screws, nuts and washers: 300 series Stainless Steel

Housings: 2 Ikelite underwater pressure vessels

Hoist Support System: 4 .25"x3" eye screws
5 300 series Stainless Steel marine clips
400' .375" lobster rope

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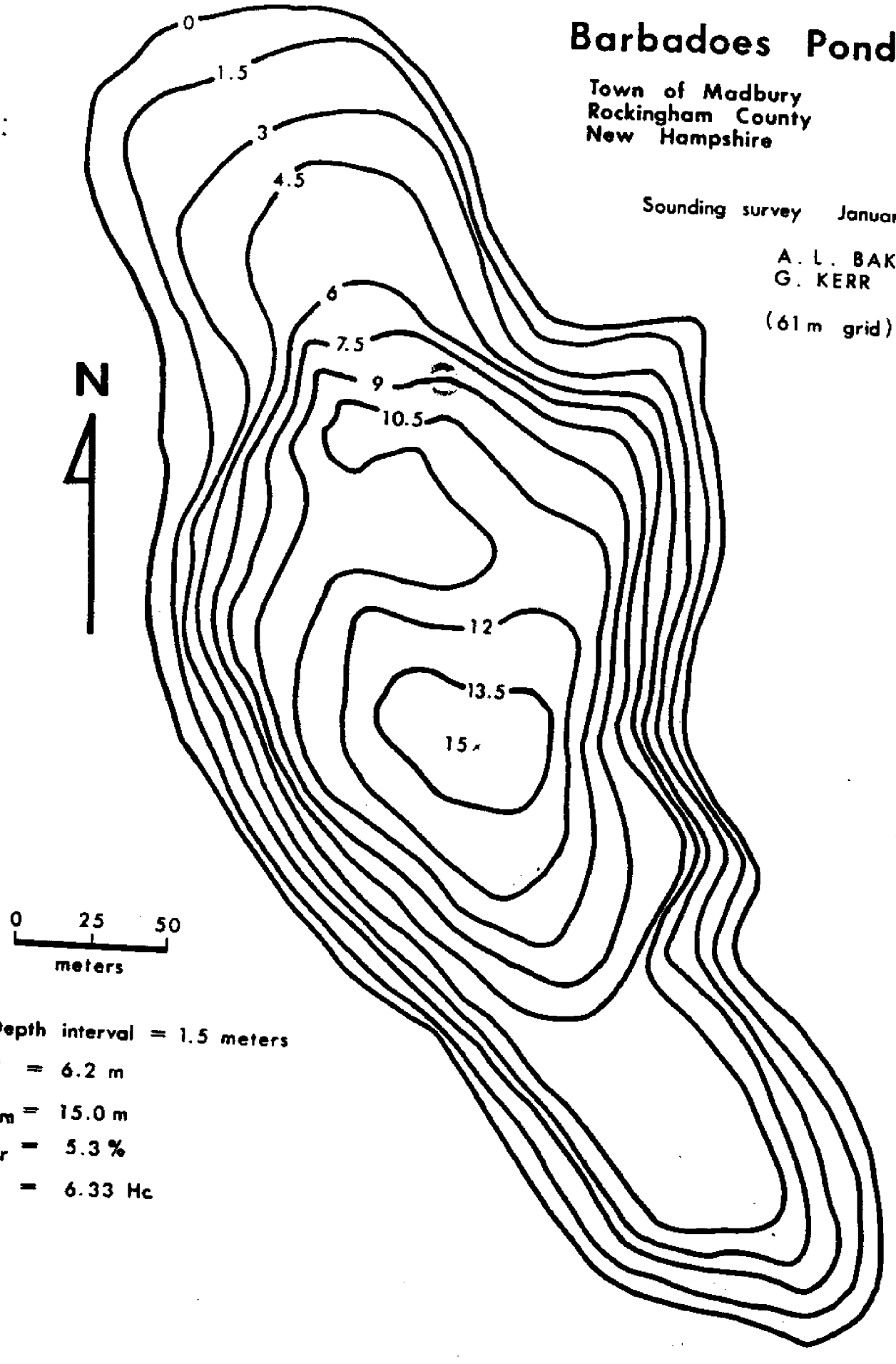
APPENDIX ONE

1. Test site one - Barbadoes Pond; Madbury NH

2. Test site two - Great Bay Estuary; Jackson Lab; Durham Point NH

Appendix



Barbadoes Pond

Town of Madbury
Rockingham County
New Hampshire

Sounding survey January, 1974

A. L. BAKER
G. KERR

(61 m grid)

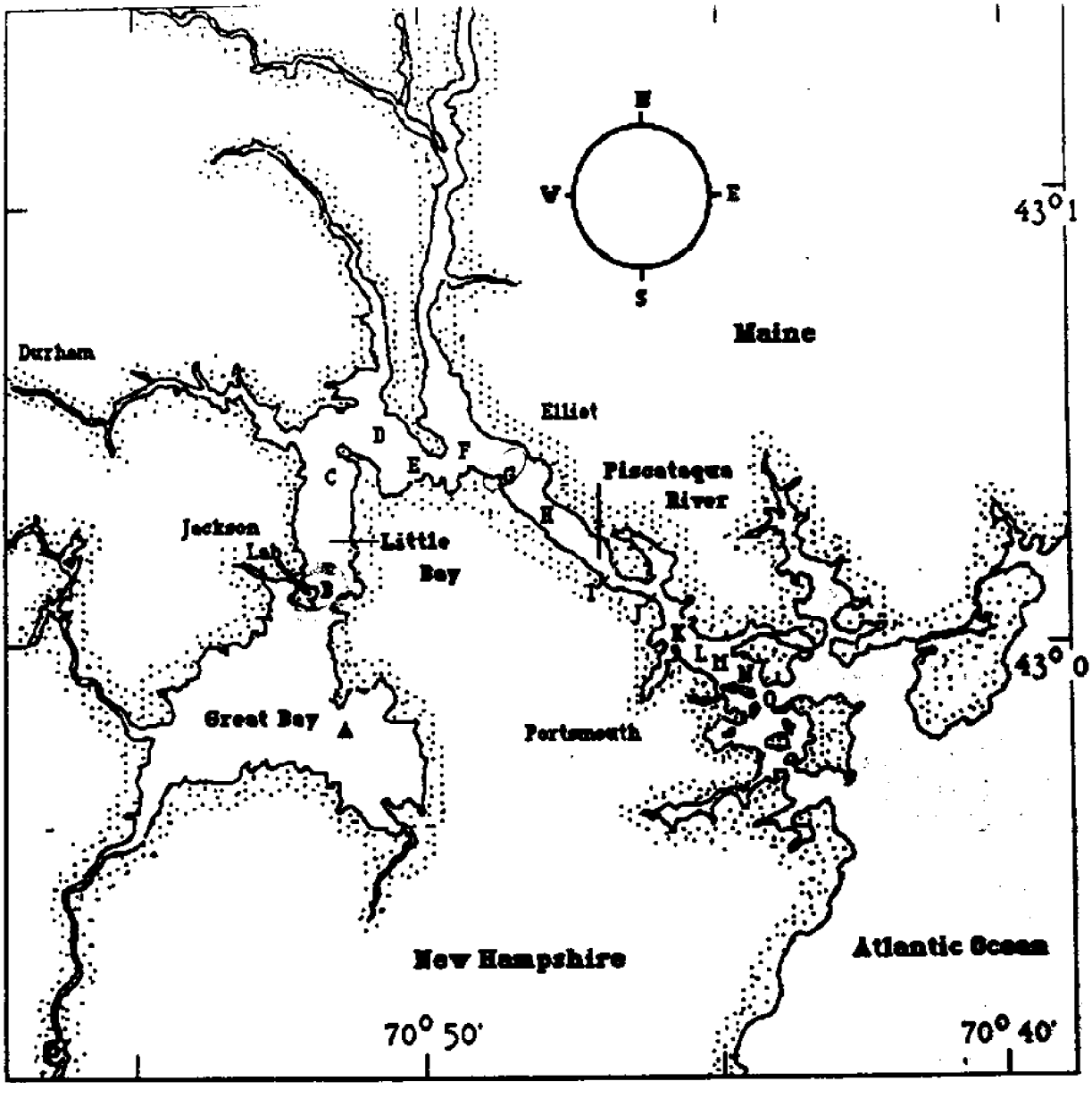
Depth interval = 1.5 meters

$\bar{z}$ = 6.2 m

z_m = 15.0 m

z_r = 5.3 %

A = 6.33 Hc


N
W
E
S
Maine
Durham
Elliot
Piscataqua River
Jackson Lab
Little Bay
Great Bay
Portsmouth
New Hampshire
Atlantic Ocean
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
43° 1
43° 0
70° 50'
70° 40'

APPENDIX TWO

1. PVC Pipe

2. PVC Accessories

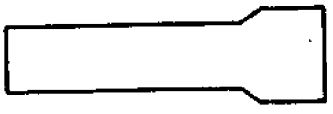
3. PVC Plates

National Pipe Company
PRESSURE RATED (SDR)
SCHEDULE 40 — SCHEDULE 80 DIMENSIONS

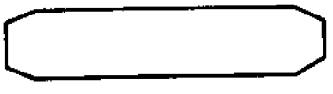
Manufacturing Specifications:
National Pipe Company manufactures PVC Pressure Pipe to meet the following standards:
ASTM-D-1784 PVC Compounds
ASTM-D-1785 PVC Plastic Pipe, Schedules 40 & 80
ASTM-D-2241 PVC Plastic Pipe, (SDR)
ASTM-D-2672 Bell-End PVC Pipe
NSF Standard No. 14
SCS 432-D High Pressure Underground Plastic Irrigation Pipelines

Key Definitions:
O.D. — Average Outside Diameter
I.D. — Average Inside Diameter (The I.D. dimensions shown are the result of using the minimum wall thickness plus half of the wall tolerance.)
WA. — Minimum Wall Thickness
WT. — Weight Per Foot
PSI — Rated Working Pressure for Water at 73.4°F.

National Pipe Company manufactures Schedule 40 and 80 Pressure Pipe with Three End Finishes



Plain End **Belled End**



Tapered End

TAPERED END
This pipe is normally available only in 1½" through 8" sizes, and is assembled with gasket joint couplings and fittings.

PLAIN END
Both ends of the pipe are cut square. A solvent-weld coupling or fitting is required for assembly.

BELLED END
One end is Plain End, the other is Belled. The pipe is coupled by solvent welding the Plain End of the pipe into the Belled End. A separate coupling is not needed.

Dimensional Specifications

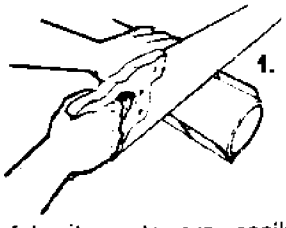
SIZE IN INCHES	O.D. IN INCHES	KEY	100 PSI SDR 41*	125 PSI SDR 32.5*	160 PSI SDR 26	200 PSI SDR 21	250 PSI SDR 17	315 PSI SDR 13.5	SCHED 40	SCHED 80
½	.840	I.D.		.730				.696	.602	.526
		WA.		.045				.062	.109	.147
		WT.		.082				.106	.164	.205
		PSI							600	850
¾	1.050	I.D.		.934		.910	.906	.874	.804	.722
		WA.		.048		.060	.062	.078	.113	.154
		WT.		.102		.131	.135	.162	.218	.278
		PSI							480	690
1	1.315	I.D.		1.191	1.175	1.169	1.141	1.101	1.029	.936
		WA.		.052	.060	.063	.077	.097	.133	.179
		WT.		.149	.167	.174	.205	.248	.321	.409
		PSI							450	630
1¼	1.660	I.D.		1.528	1.512	1.482	1.444	1.394	1.360	1.255
		WA.		.056	.064	.079	.098	.123	140	.191
		WT.		.202	.225	.268	.321	.389	.434	.567
		PSI							370	520
1½	1.900	I.D.		1.764	1.734	1.700	1.656	1.598	1.590	1.476
		WA.		.058	.073	.090	.112	.141	.145	.200
		WT.		.239	.289	.345	.416	.506	.518	.686
		PSI							330	470
2	2.375	I.D.		2.209	2.173	2.129	2.075	2.002	2.047	1.913
		WA.		.073	.091	.113	.140	.176	.154	.218
		WT.		.364	.440	.530	.639	.783	.695	.949
		PSI							280	400
2½	2.875	I.D.		2.679	2.635	2.581	2.517	2.423	2.445	2.290
		WA.		.088	.110	.137	169	.213	.203	.276
		WT.		.521	.633	.768	.924	1.147	1.096	1.449
		PSI							300	420
3	3.500	I.D.	3.310	3.264	3.210	3.146	3.063	2.951	3.042	2.864
		WA.	.085	.108	.135	.167	.206	.259	.216	.300
		WT.	.620	.764	.932	1.127	1.376	1.699	1.435	1.938
		PSI							260	370
3½	4.000	I.D.	3.784	3.734	3.672	3.597	3.502	3.372	3.521	3.326
		WA.	.098	.123	.154	.190	.235	.296	.226	.318
		WT.	.805	.985	1.205	1.470	1.789	2.217	1.729	2.365
		PSI							240	350
4	4.500	I.D.	4.260	4.204	4.133	4.046	3.938	3.794	3.998	3.786
		WA.	.110	.138	.173	.214	.265	.333	.237	.337
		WT.	1.007	1.234	1.521	1.858	2.271	2.804	2.043	2.833
		PSI							220	320
5	5.563	I.D.	5.271	5.200	5.109	5.001	4.870	4.690	5.016	4.768
		WA.	.136	.171	.214	.265	.327	.412	.258	.375
		WT.	1.515	1.876	2.330	2.843	3.467	4.291	2.776	3.938
		PSI							190	290
6	6.625	I.D.	6.282	6.193	6.084	5.955	5.798	5.584	6.031	5.709
		WA.	.162	.204	.255	.316	.390	.491	.280	.432
		WT.	2.126	2.652	3.299	4.036	4.926	6.092	3.600	5.411
		PSI							180	280
8	8.625	I.D.	8.180	8.063	7.921	7.754	7.548		7.942	7.565
		WA.	.210	.265	.332	.411	.508		.322	.500
		WT.	3.589	4.491	5.578	6.825	8.349		5.427	8.219
		PSI							160	250
10	10.750	I.D.	10.195	10.048	9.874	9.665	9.410		9.976	9.493
		WA.	.262	.331	.413	.512	.632		.365	.593
		WT.	5.577	6.992	8.652	10.599	12.937		7.693	12.195
		PSI							140	230
12	12.750	I.D.	12.091	11.919	11.711	11.463	11.160		11.889	11.294
		WA.	.311	.392	.490	.607	.750		.406	.687
		WT.	7.851	9.829	12.183	14.913	18.206		10.171	16.765
		PSI							130	230

*There is no NSF Standard for sizes ½" through 2½" SDR 32.5, or 3" SDR 41.

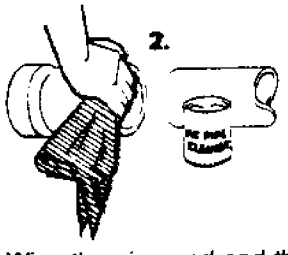
NATIONAL

National Pipe
Company
3421 Vestal Road
Vestal NY 13850
(607) 729-9381

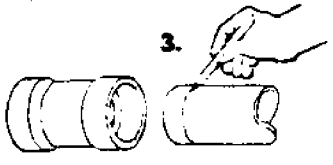
Installation Information for Drain, Waste, Vent and Schedule 40 and 80 PVC Pipe



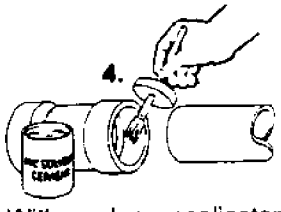
1. Job-site cuts are easily made with a fine-toothed handsaw. Make the cut square, then remove all burrs from the cut edges with a rasp. Chamfer the end of the pipe to a 15 degree bevel.



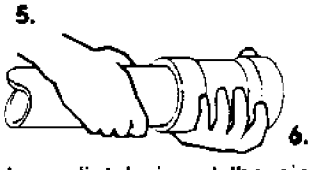
2. Wipe the pipe end and the fitting socket dry, and then clean using National Pipe Company PVC Pipe Cleaner.



3. Measure the socket depth of the fitting and mark the outside of the pipe.



4. With a clean applicator, apply a thin coat of National Pipe Company PVC Solvent Cement to the inside of the fitting socket, and a heavier coat to the outside of the pipe end for the total length of the measured socket depth.



5. Immediately insert the pipe end as far as possible into the fitting socket and twist (one-quarter turn) to evenly distribute the cement. Wipe off excess cement.
6. Hold together firmly for 15 seconds to prevent the pipe from backing out of the fitting. Allow at least 15 minutes for the joint to develop good handling strength.

NOTE: When installing under the IAPMO Uniform Plumbing Code, National Pipe Company PVC Pipe Primer must be used following Step 2.

Distributed by:

National Pipe Company
3421 Vestal Road
Vestal, NY 13850
(607) 729-9381

NATIONAL

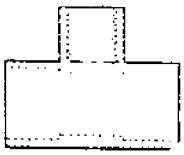
One phone call gets you the PVC product and assistance you need to meet or exceed your specifications at an affordable price!

SCHEDULE 40

CARTON QUANTITY: SP = Standard Pack MC = Master Carton

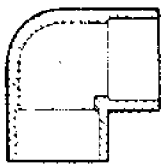
REDUCING TEE (Slip x Slip x Fipt)

(Continued)



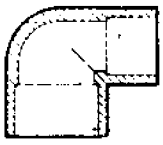
Part No.	Size	SP/MC	Price Each
402-249	2x2x1	10	5.38
402-250	2x2x1¼		
402-251	2x2x1½		
402-287	2½x2½x½		11.68
402-288	2½x2½x¾		
402-289	2½x2½x1		
402-290	2½x2½x1¼		
402-291	2½x2½x1½		
402-333	3x3x½	10	16.66
402-334	3x3x¾		
402-335	3x3x1		
402-336	3x3x1¼		
402-337	3x3x1½		
402-338	3x3x2	6	
402-417	4x4x1	6	27.78
402-419	4x4x1½	10	
402-420	4x4x2		
402-422	4x4x3	6	
402-490	5x5x4	3	72.66
402-528	6x6x2	3	94.16
402-530	6x6x3		
402-532	6x6x4	2	
402-580	8x8x3	4	249.40
402-582	8x8x4	2	

90° ELL (Slip x Slip)



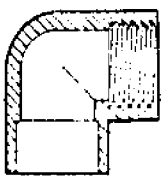
Part No.	Size	SP/MC	Price Each
406-003	3/8	50/400	1.56
406-005	1/2		• .44
406-007	3/4	50	• .50
406-010	1		• .89
406-012	1¼	25	• 1.55
406-015	1½		• 1.66
406-020	2	10	• 2.61
406-025	2½		7.94
406-030	3		• 9.50
406-040	4	8	• 17.00
406-050	5	4	43.94
406-060	6	5	• 54.05
406-080	8	2	137.80

90° ELL REDUCING (Slip x Slip)



Part No.	Size	SP/MC	Price Each
406-053	3/8x1/2	50	1.28
406-101	¾x½		.89
** D406-101	3/41/2		1.08
406-130	1x½	50	1.56
** D406-130	1x½		1.87
406-131	1x¾		1.56
406-166	1¼x½	25	2.45
** D406-166	1¼x1¼x½		2.86
406-167	1¼x¾		2.45
406-168	1¼x1		2.45
406-209	1½x½	25	3.89
406-211	1½x1		
406-251	2x1½	10	6.72

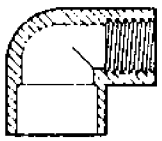
90° ELL (Slip x Fipt)



Part No.	Size	SP/MC	Price Each
407-005	1/2	50/400	• .55
407-007	3/4		• .61
407-010	1	50	• 1.16
407-012	1¼		• 1.94
407-015	1½	25	• 2.16
407-020	2		5.60
407-025	2½	10	13.80
407-030	3		20.70
407-040	4	8	31.40
		4	

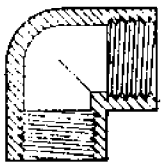
**DEEP SOCKET

90° ELL REDUCING (Slip x Fipt)



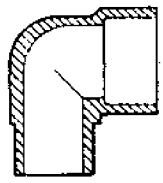
Part No.	Size	SP/MC	Price Each
407-053	3/8x1/2	50/400	1.50
407-074	½x¾	50	1.16
407-101	¾x½	50	• .66
407-130	1x½	50	1.78
407-131	1x¾		
407-168	1¼x1	25	2.61
407-211	1½x1	25	4.34
407-251	2x1½	10	7.50

90° ELL (Fipt x Fipt)



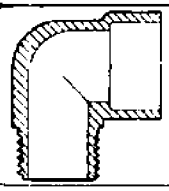
Part No.	Size	SP/MC	Price Each
408-005	1/2	50/400	1.06
408-007	3/4	50	1.56
408-010	1		3.34
408-012	1¼	25	3.56
408-015	1½		4.50
408-020	2	10	6.84

90° STREET ELL (Spig x Slip)



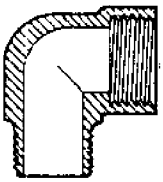
Part No.	Size	SP/MC	Price Each
409-005	1/2	50/400	1.22
409-007	3/4	50	1.50
409-010	1		2.61
409-012	1¼	25	3.11
409-015	1½		3.44
409-020	2	10	6.78

90° STREET ELL (Mipt x Slip)



Part No.	Size	SP/MC	Price Each
410-005	1/2	50/400	• .94
410-007	3/4	50	• 1.11
410-010	1		• 1.88
410-012	1¼	25	• 2.61
410-015	1½		• 2.72
410-020	2	10	6.72

90° STREET ELL (Mipt x Fipt)



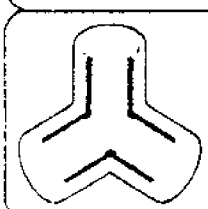
Part No.	Size	SP/MC	Price Each
412-005	1/2	50/400	1.28
412-007	3/4	50	1.56
412-010	1		2.68
412-012	1¼	25	3.34
412-015	1½		3.61
412-020	2	10	6.89

* MARLEX ELLS
(For Sprinkler System Swing Joints)

Part No.	Size	SP/MC	Price Each
M412-005	1/2	50/400	1.20
M412-007	3/4	50	1.43
M412-010	1		2.49
M412-012	1¼	50	3.30
M412-015	1½		3.75
M412-020	2	10	7.10

*Not NSF Approved

SIDE OUTLET ELL (Slip x Slip x Fipt)

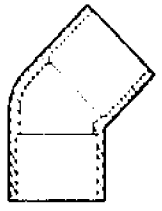


Part No.	Size	SP/MC	Price Each
414-005	1/2	50	2.28
414-101	¾x¾x½		2.95
414-130	1x1x½		3.89

SCHEDULE 40

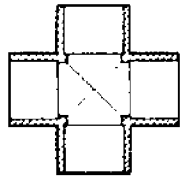
CARTON QUANTITY: SP = Standard Pack MC = Master Carton

45° ELL (Slip x Slip)



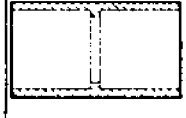
Part No.	Size	SP/MC	Price Each
417-005	1/2	50/400	• .72
417-007	3/4	50	• 1.11
417-010	1		• 1.33
417-012	1¼	25	• 1.89
417-015	1½		• 2.34
417-020	2	10	• 3.06
417-025	2½		7.96
417-030	3		12.36
417-040	4	5	22.16
417-050	5		43.94
417-060	6	8	54.70
417-080	8	3	131 .60

CROSSES (Slip)



Part No.	Size	SP/MC	Price Each
420-005	1/2	50	1.66
420-007	3/4		2.78
420-010	1		3.44
420-012	1¼	25	4.55
420-015	1½		5.17
420-020	2	10	7.61
420-025	2½		16.94
420-030	3	5	20.00
420-040	4	4	30.28

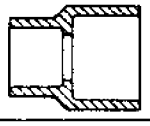
COUPLING (Slip x Slip)



Part No.	Size	SP/MC	Price Each
429-003	3/8	50/200	.78
429-005	1/2	50/600	• .28
429-007	3/4	50/400	• .39
***429-007N	3/4	50	.55
429-010	1		• .67
***429-010N	1		.92
429-012	1¼	25	• .94
429-015	1½		• 1.00
429-020	2	10	• 1.56
429-025	2½		3.44
429-030	3		5.39
429-040	4	6	7.70
429-050	5	5	14.30
429-060	6	4	24.66
429-080	8	6	• 46.05

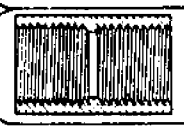
For Deep Socket Couplings refer to 479 series on page 6

REDUCER COUPLING (Slip x Slip)



Part No.	Size	SP/MC	Price Each
429-101	¾x½	50/200	72.
429-131	1x¾	50	1.22

COUPLING (Fipt x Fipt)



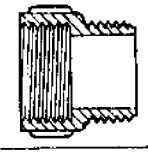
Part No.	Size	SP/MC	Price Each
430-005	1/2	50/600	.56
430-007	3/4	50/400	1.00
430-010	1	50	1.34

IPS to PIP ADAPTER* (Spig x Slip)

Part No.	Size	SP/MC	Price Each
431-060	6	5	21.50
431-080	8		26.50

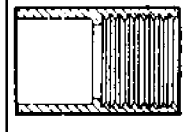
*Not NSF Approved

RISER EXTENSION (Fipt x Mipt)



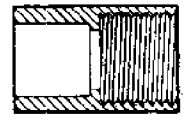
Part No.	Size	SP/MC	Price Each
434-005	1/2	50/200	.84
434-007	3/4	50/200	1.33
434-010	1	50	1.66

FEMALE ADAPTER (Slip x Fipt)



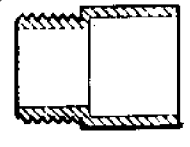
Part No.	Size	SP/MC	Price Each
435-003	3/8	50/300	1.61
435-005	1/2	50/600	• .50
**D435-005		50	.70
435-007	3/4	50/400	• .61
**D435-007		50	.94
435-010	1		• .72
435-012	1¼	25	• 1.11
435-015	1½		• 1.28
435-020	2	10	• 1.72
435-025	2½		4.55
435-030	3		5.83
435-040	4	6	9.66
435-050	5	5	25.00
435-060	6		35.55
435-080	8	2	67.00

FEMALE ADAPTER REDUCING (Slip x Fipt)



Part No.	Size	SP/MC	Price Each
435-072	½x¼	50/600	.89
435-073	½x⅜		
435-074	½x¾	50/400	
435-101	¾x½		
435-102	¾x1	50	1.16
435-131	1x¾		

MALE ADAPTER (Mipt x Slip)



Part No.	Size	SP/MC	Price Each
436-003	3/8	50/2400	1.50
436-005	1/2	50/300	• .39
436-007	3/4	50/400	• .44
436-010	1	50	• .78
436-012	1¼	25/200	• .95
436-015	1½	25	• 1.28
436-020	2	10/80	• 1.67
436-025	2½	10	4.94
436-030	3		7.22
436-040	4	6	9.22
436-050	5	5	16.94
436-060	6		24.05
436-080	8	2	109.40

**DEEP SOCKET ***NESTING

Trovidur®

Properties of

150/152 PVC

Conforms to ASTM D 1784-78, Type I, Grade 1
(Class 12454-B)

Dynamit Nobel of America Inc.

PROPERTY	ASTM#*	UNIT	VALUE	ISO#**	UNIT	VALUE
Physical						
Density	D 792	g/cm³	1.45	R 1183	g/cm³	1.45
Water Absorption	D 570	%	0.04	-	-	-
Mechanical						
Tensile Strength at Yield	D 638	psi	7,820	DIS 527	N/mm²	55
Modulus of Elasticity	D 638	psi	469,000	-	-	-
Ultimate Elongation	D 638	%	150	DIS 527	%	15
Notch Impact Strength (@ 73°F)	D 256	ft.-lbs./ in. of notch	1.3	179	kJ/m²	3
Rockwell Hardness	D 785	"R"	113	-	-	-
Thermal						
Heat Distortion Temperature						
at 66 psi	D 648	°F	172	R 75	°C	78
at 264 psi	D 648	°F	162	R 75	°C	72
Vicat Softening Point	D 1525	°F	169	306	°C	76
Linear Coefficient of Expansion	D 696	in./in./°C	2.76×10^{-5}	-	-	-
Flammability	D 635	-	self-extinguishing	-	-	-
Electrical						
Volume Resistivity	D 257	ohm-cm	$> 10^{15}$	-	-	-

Property values reflect typical average values obtained by testing specimens taken at random and are correct to the best of our knowledge, but are given without obligation on our part.

*ASTM - American Society for Testing and Materials
**ISO - International Organization for Standardization

APPENDIX THREE

1. Bilge Pump

2. Richdel Valve

3. Asco Valve

4. Asahi Valve

500/2000 PUMPS

• SUBMERSIBLE
• IGNITION PROTECTED

rule®

INSTALLATION INSTRUCTIONS

A WRITTEN EXPLANATION OF RULE'S ONE YEAR LIMITED WARRANTY POLICY IS AVAILABLE UPON REQUEST BY WRITING TO:

CUSTOMER SERVICE DEPARTMENT
RULE INDUSTRIES, INC.
70 BLANCHARD ROAD
BURLINGTON, MA 01803

rule

MO2 55 / 12-89

TROUBLE-SHOOTING SECTION

Symptom	Possible Cause	Cure
Reduced Flow	Plugged strainer	Clean outside of strainer and clean debris from around impeller
	Discharge line plugged with trash	Clean out hose by back-flushing.
	Low battery voltage	Check battery condition and charge if necessary.
	Kinked discharge hose	If hose is kinked because of sharp bend, convert to Rule #80 hose which will not kink at bends.
No water pumped	Wire connections	Make sure wire connections are not corroded. Visual check is not enough—a slight pull on each wire will tell if the wires are still joined. Check to be sure no wire joints are hanging down into the water.
	Blown fuse	Check fuse to see that it is the correct size according to the chart in step 9. If fuse size is correct and fuse still blows, check impeller through inlet opening to be sure it is not jammed or stuck with debris.
	Float switch failure	Lift end of float switch up—if pump runs, switch is OK. If pump does not run, turn Manual Switch to ON position—if pump runs, automatic switch has failed.
Pump won't shut off	Something under float	Clean under the float to make sure debris is not holding the float up.
	Stuck float	Check to see that the float is loose and free of gummy bilge oil. If float action appears sluggish and/or the float does not move freely, intermittent or sporadic operation of the pump may occur. This condition is usually the result of oil and/or dirt accumulating in and around the movable parts of the switch. To correct, try soaking the entire switch in Sudbury® Automatic Bilge Cleaner or Rule® All Purpose Marine Cleaner for ten minutes, agitating several times and checking for smooth and free operation of the float. Repeat if necessary.
	Switch mounted too low	If the pump is sucking air and the automatic switch has not reached the OFF position, then the switch may be mounted too low for the pump and should be reinstalled ¼" to ½" higher than the pump base.
Wires over-heated. Melted insulation	Combination of jammed impeller and wrong size fuse.	Be sure impeller is clean of debris and is free to rotate. Reduce fuse to proper size shown in chart in step 9. Replace damaged wiring and/or switch.
Repeated blown fuse	Fuse size or Jammed impeller	Be sure fuse has amp rating shown in chart in step 9. Check impeller to see that it is not bound up by fish line, etc.

IMPORTANT

CONGRATULATIONS!

You have just purchased one of the finest quality bilge pumps available in the industry. It was developed after years of experience, research and testing by our research staff and hundreds of thousands of users. It is built to give years of reliable trouble free performance. Most early pump failures are due to improper installation and wiring. Please read and follow the instructions carefully and your pump will provide you with the maximum output and the life for which it was designed.

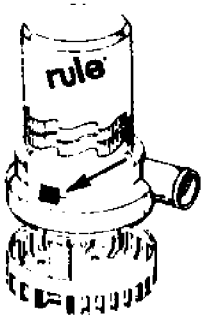
These pumps are rated "Ignition Protected."

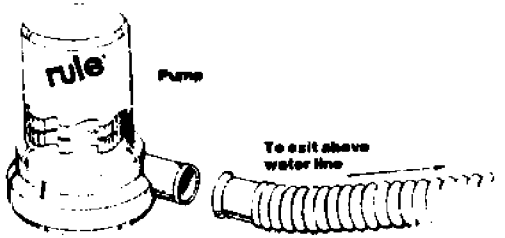
PROUDLY MADE IN THE U.S.A.

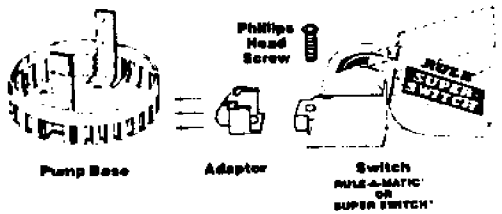
INSTRUCTIONS

STEP 1 Remove the strainer from the bottom of the pump by depressing the lock tabs on both sides of the pump.

CAUTION: Strainer must always be properly installed before attaching and running pump.







STEP 2 Determine the desired location for the pump. If only one pump is used it is usually located where the water is deepest in the bilge while the boat is at rest. The installation must allow for complete drainage of the hose. All water pockets must be eliminated by having the hose running level or continuously upward.

STEP 3 Position the strainer so that the pump nozzle is in the proper position to connect to the discharge hose.

STEP 4 Mounting the Strainer

A. If attaching the strainer to wood, fasten with the stainless steel screws provided.

B. If attaching the strainer to metal or fiberglass, first mount a wooden block and then fasten the strainer to the wooden block.

STEP 5 Mount the pump on the strainer so that both 1½" lock-tabs "snap" into place. (The pump may be reversed on these tabs if so desired.)

STEP 6 Attach 1 1/8" I.D. hose to the discharge nozzle and fasten with a stainless steel clamp. Rule flexible hose (Model #60) is recommended because it will not kink when making sharp bends.

If your pump is replacing a competitive model with small diameter hose which is hard to replace, you may use rule* Adaptor Model #69 to adapt to the smaller hose.

Note: Restricting the flow from a Rule pump by using a smaller hose does not damage the pump. However, it will reduce the flow.

STEP 7 Thru-hull Fittings

A. For most installations, install a full size 1⅛" I.D. thru-hull fitting (Rule Model #60) to achieve the rated flow of the Rule pump. Locate the thru-hull fitting at least 12" above the water line to prevent water from flowing back into the hull when the pump is off.

B. For stern installations, place the 1⅛" thru-hull fitting high enough in the stern so that submergence of the fitting will not occur under any conditions.

* Rule Registered Trademark *Property of Rule Industries Inc

STEP 8 Wiring

In order to prevent electrolysis and corroded wire connections, it is essential that all wire ends and terminals be sealed with Rule* Heavy Duty Marine Sealant and located above the highest possible water level by fastening with insulated staples or plastic straps.

When installing your pump, 16 gauge wire should be used. However, if your installation is over 20' from the battery source, the wire size should be increased to 14 gauge. Using a wire which is too small causes undesirable heat in the wires and results in a voltage drop and lower performance of the pump.

STEP 9 Fusing

To protect your electrical wiring and automatic switch from possible overload install a fuse in the positive (+) lead from the battery. The fuse should be sized according to the following chart.

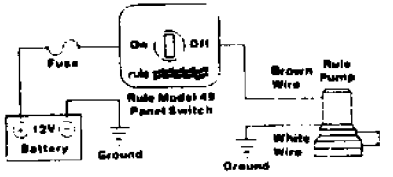
PUMP	1500-12 volt	2000-12 volt	2000-24 volt	2000-32 volt
AMP DRAW	7.0 amp	12 amp	6 amp	5 amp
FUSE	9.0 amp	15 amp	7.5 amp	6 amp

If using a panel switch with a fuse holder, check to see that the proper fuse is being used. You may wish to install a Rule* Panel Switch with a built-in fuse holder (Model #41 for 12 VDC or # 42 for 24/32 VDC).

STEP 10 Follow one of the two wiring diagrams:

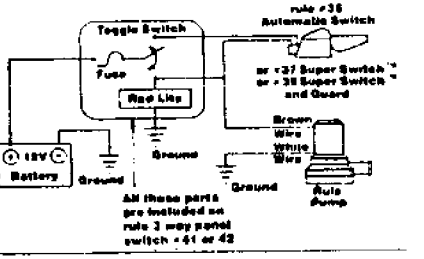
Wiring for Manual Operation

The **manual system** is the simplest system but it only provides ON-OFF control of the pump. Consequently, pumps are often left ON longer than necessary.



Wiring for Automatic Operation

The **automatic system** assures that the vessel is always pumped out, even when unattended. In addition, it extends the life of the pump and your battery by automatically shutting the pump off when the water has been pumped out. The automatic system can also provide for manual control of the pump by installing a Rule* Panel Switch (Models #41, 42 or 45). These switches have a "fail-safe" feature which automatically returns the switch to the "off" position, preventing the pump from being inadvertently left on.

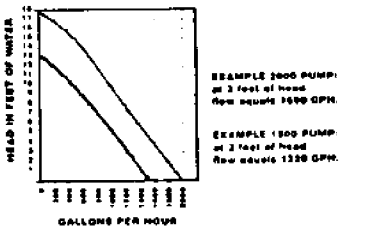


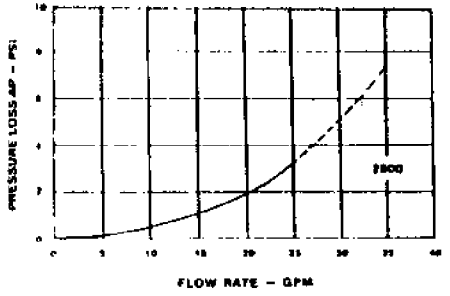
STEP 11 Polarity is important. If it is not correct, the pump will rotate backwards. Water will still come out of the discharge nozzle but the flow will be very much reduced. On the Rule* 1500/2000 pump the correct polarity will be obtained when the **BROWN** wire of the pump is connected to the POS or + side of the battery. The way to verify that the direction of rotation (and thus the polarity) is correct is to look into the inlet hole on the bottom of the pump while the pump is running and see if the impeller rotates in the direction of the arrow molded into the bottom. Never insert fingers or other objects into the inlet hole.

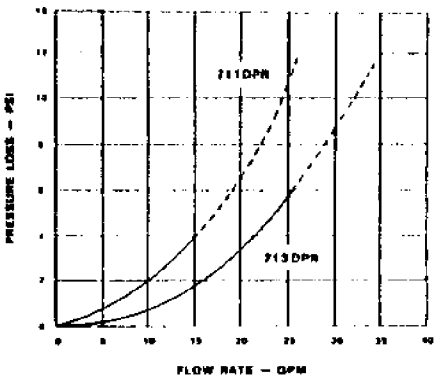
Storage

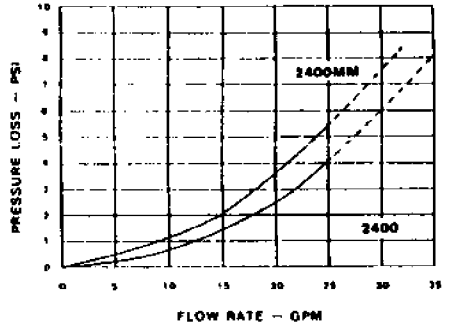
The pump itself is not affected by freezing temperatures. However, if the pump is embedded in ice or surrounded by ice, it cannot be used. Never turn the pump on if it is embedded in or surrounded by ice.

Performance Data









Recommended _____

Not Recommended _ _ _

Richdel 1-800-634-8873

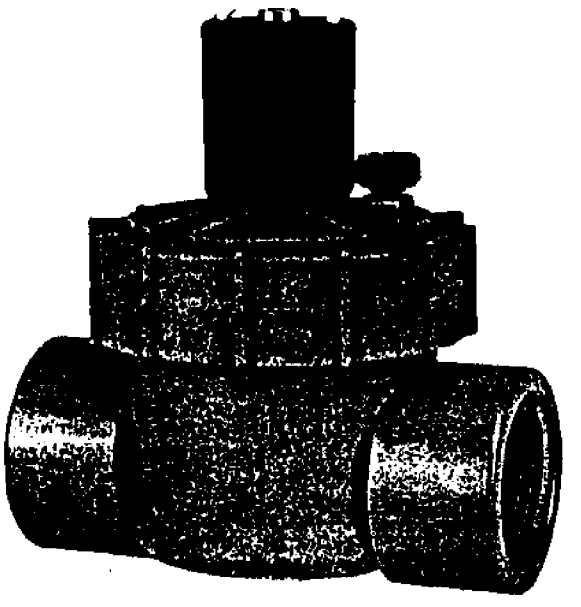
65 psi ⇒ 21 gpm

≈ 75 psi → 25 gpm

GARDENAMERICA
A BLACK & DECKER COMPANY
Manufacturing:
788 Fairview Drive
P.O. Box A
Carson City, Nevada 89701-5370
(702) 882-6786

RICHDEL®

AUTOMATIC VALVE WITH THREADED BONNET



INSTALLATION AND OPERATING GUIDE FOR MODELS 2400 Series, 2600, and 700D Series

INSTALLATION INSTRUCTIONS

The 2400, 2600 and 700D Series valves incorporate a threaded bonnet design. The 700D, and the "F" version of the above valves, also have a flow adjustment screw. All the valves can be operated electrically or, for ease of installation, manually.

In areas where freezing conditions occur, make provisions for draining the system and use a stop and waste shut-off valve installed on the main line feeding the sprinkler system. To assure complete drainage of the valves after the water suppy is shut off, electrically energize each valve for at least a few minutes (dry run). This vents the upper cavity of the valve, allowing maximum drainage.

Although the valves are rated to 150 psi, where local water pressure exceeds 80 psi, a pressure regulator should be used. [See Uniform Plumbing Code, Sec. 1007 (b)]. It is advisable to use a regulator with any automatic valve to assure long life as well as uniform and controllable operation.

The anti-siphon valves (700D Series) should be installed at least 6" above the surrounding ground and above a sufficient number of heads so at no time will the anti-siphon valve be subject to back pressure or drainage. There must not be any valve downstream of the anti-siphon valve. [See Uniform Plumbing Code, Sec. 1003 (2) (7)].

The 700D Series Anti-Siphon valves must not be operated continuously for more than twelve (12) hours. (see American Society of Sanitary Engineering Standard 1001, Sec. 1.5.2.4.)

Step 1. Flush the line thoroughly before installing the valve. Use teflon pipe tape for thread sealant on male threads; or PVC pipe cement on slip.

CAUTION: DO NOT PLUG DOWNSTREAM BLEED PORT WITH CEMENT.

Step 2. Screw the valve onto the supply pipe threads hand tight. Use a wrench only to straighten the valve into position; on slip models install valve, and twist to straighten.

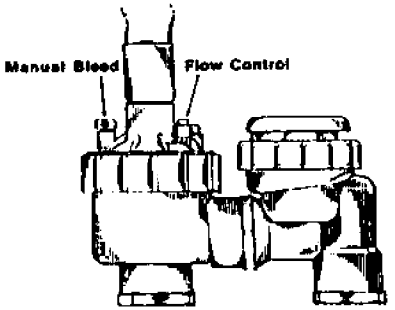
CAUTION: Check flow arrows on the valve before installation.

Step 3. Screw the outlet pipe into the valve with a wrench. Hold the valve by hand as the outlet pipe is tightened. For valves with the barbed outlet, use a clamp to secure the piping to the valve.

Step 4. Wiring to the valves can be placed underground alongside the pipes. Use approved underground type wire and be sure all splices are soldered or joined with wire nuts and sealed with vinyl cement or other suitable water-proofing cement. Run one common wire to serve all the valves at that location. Use 18 gauge solid wire plastic jacketed thermostat control wire for runs not over 800 feet and 14 gauge over 800 feet. Connect the solenoid to a controller that uses an approved class 2, -24V. transformer as a power source.

Step 5. With **Flow Control** turn the flow control clockwise until it seats, closing the valve. Turn the water supply on. The valve will remain closed.

Step 6. Turn the manual bleed screw counterclockwise. This will allow water to flow through the valves as the flow control is backed out. Adjust the flow control for desired flow. Tighten the manual bleed screw and the valve will close.



Electrical requirements are 18 volts AC minimum at the solenoid.

Inrush volt-amps	@ 24 VAC =	11.50 VA
Inrush current	@ 24 VAC =	.48 AMPS
Holding volt-amps	@ 24 VAC =	5.75 VA
Holding current	@ 24 VAC =	.24 AMPS

NOTICE: The 2400 and 2600 are not backflow prevention valves. They may have to be

MAINTENANCE INSTRUCTIONS

Valves with threaded bonnets are easily disassembled and maintained, including the flow tube if necessary, without removing the valve body from the circuit.

TO DISASSEMBLE THE VALVE:

Step 1. Shut off the water supply and bleed pressure from the valve.

Step 2. Unscrew (counter clockwise) the cap nut (2), then remove the cap assembly (3) by gripping the solenoid and gently rocking it back and forth until, the cap is loose and lifts off.

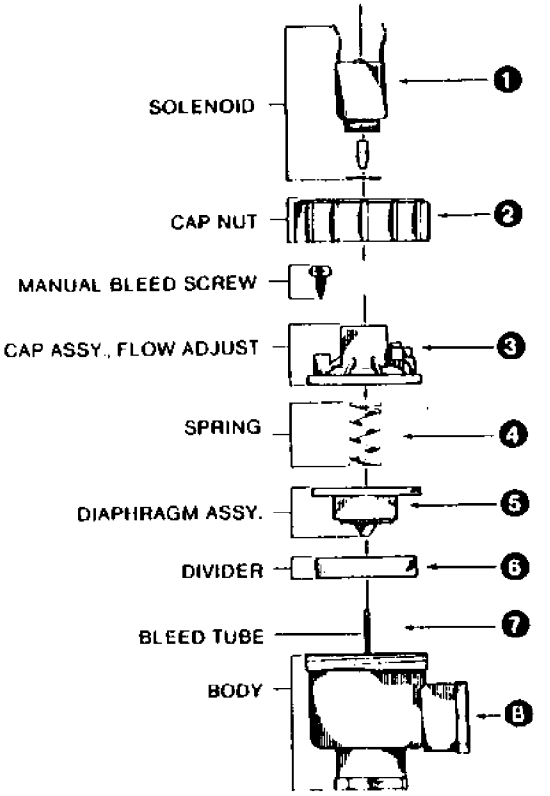
Step 3. You may then remove the spring (4), diaphragm (5), divider (6).

Step 4. If it is necessary to replace the flow tube (7), this may be done at this time. A flow tube insertion tool (521001) is required to set a new tube in place FOLLOW INSERTION TOOL INSTRUCTIONS.

TO REASSEMBLE THE VALVE

Step 1. Into the valve body (8) install the divider (6), the diaphragm (5) (be sure the bead is seated), the spring (4), the cap (3), and cap nut (2).

Step 2. Screw down the cap nut until hand tight. DO NOT OVER TIGHTEN.

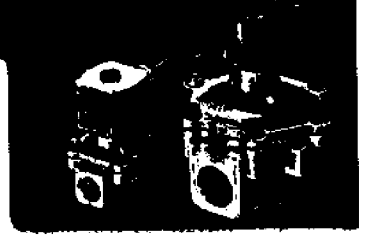


2 WAY

Aluminum Body Solenoid Valves

ASCO

8040/8215



Specifications

Solenoid Enclosures: Valves listed in this series have either Red Hat metal solenoid enclosures or Red Hat II molded epoxy solenoids. Red-Hat II valves are identified by the change letter "G" in their catalog numbers, e.g., 8040**G**3, and are shown in red.

Standard Enclosures:
Red Hat — Type 1 General Purpose

Red Hat II — Types 1, 2, 3, 3S, 4 and 4X Combination General Purpose and Watertight

Optional Enclosures:
Red Hat — Types 3, 7 and 9 Combination Explosionproof and Raintight. To order, add prefix "EF" to catalog number. (Except Catalog Numbers EF8215A40, EF8215A90 and EF8215D93.)*

Red Hat II — Types 3, 3S, 4, 4X, 6, 6P, 7 and 9 Combination Explosionproof and Watertight. To order, add prefix "EF" to catalog number.

Additional constructions are available. The Optional Electrical Features Section, page 11, contains descriptions and ordering information for: Open Frame Solenoids • Junction Box Enclosures • Panel Mount Constructions.

Electrical: Standard Voltages: 24, 120, 240, 480 volts, AC, 60 Hz (or 110, 220 volts, AC, 50 Hz.)

6, 12, 24, 120, 240 volts, DC

Other voltages are available when required.

Coil: Continuous duty molded Class B or F, as listed

Nominal Ambient Temperature Ranges: Red Hat and Red-Hat II Valves/AC Construction: 32°F to 125°F.

Red-Hat Valves/DC Construction: 32°F to 77°F (104°F occasionally.)

Red Hat II Valves/DC Construction: 32°F to 104°F.
Refer to Engineering Section for details.

Valve Parts In Contact with Fluids:
Body — Aluminum
Seals, Diaphragms and Discs — Buna "N"
Disc Holder — Nylon (8040 and 11.6 watt Normally Open only.)
Core Guide — Acetal
Rider Rings — Filled Teflon*
Core and Plugnut — 430F s.s., Silicone Steel (8215A40 and 8215A90)
Springs — 302 s.s.
Shading Coil — Copper

Approvals: USA certified. UL listed as indicated. FM approved (Normally Closed valves only, except Catalog Numbers 8215A90 and 8215A40). Refer to Engineering Section for details.

Ordering Information:
Important: We must have catalog number, voltage and Hertz, operating pressure and fluid handled. Use strainers with solenoid valves.
*Teflon is a trademark

SPECIFICATIONS

Pipe Size (Inch.)	Orifice Size (Inch.)	Cv Flow Factor	Operating Pressure Differential (psi) Min.	Max. AC Air-Fluid Gas	Max. DC Air-Fluid Gas	Max. Fluid Temp. °F. AC	Max. Fluid Temp. °F. DC	Standard Solenoid Enclosure Red-Hat—Type 1 Red-Hat II—Types 1, 2, 3, 3S, 4 and 4X Aluminum Body Catalog Number	Constr. Ref. No.	UL Listing	Watt Rating/ Class of Coil Insulation ① AC	Watt Rating/ Class of Coil Insulation ① DC
NORMALLY CLOSED (Closed when de-energized)												
1/8, 1/4 SAE	1/8	1.2	0	15	—	125	—	8040G8	11	⊙	8.1/F	—
1/4, 3/8	1/4	3.4	0	50	25	125	104	8215G10	2	⊙	10.1/F	11.6/F
3/8	3/8	3.5	5	125	125	125	104	8215G1②	1	⊙	8.1/F	11.6/F
1/4, 3/8	1/4	5.4	0	2	—	125	—	8040G22	13A	⊙	10.1/F	—
1/4, 3/8	1/4	4.4	0	50	25	125	104	8215G20	2	⊙	10.1/F	11.6/F
1/4, 3/8	1/4	4.8	5	125	125	125	104	8215G2③	1	⊙	8.1/F	11.6/F
1/4	1/4	9.5	0	2	—	125	—	8040G23	13B	⊙	10.1/F	—
1/4	1/4	5.1	0	50	25	125	104	8215G30	4	⊙	10.1/F	11.6/F
1/4	1/4	5.1	5	125	125	125	104	8215G3	3	⊙	8.1/F	11.6/F
1	1 1/16	21	0	25	25	125	77	8215B50	6	⊙	15.4/F	14.9/B
1 1/4	1 1/16	32	0	25	25	125	77	8215B60	6	⊙	15.4/F	14.9/B
1 1/2	1 1/16	35	0	25	25	125	77	8215B70	6	⊙	15.4/F	14.9/B
2	2 1/16	60	0	25	15	125	77	8215B80	7	⊙	15.4/F	14.9/B
2 1/2	3	117	0	5	—	125	—	8215A90	8	⊙	28.2/F	—
3	3	136	0	5	—	126	—	8215A40	8	⊙	28.2/F	—

SPECIFICATIONS

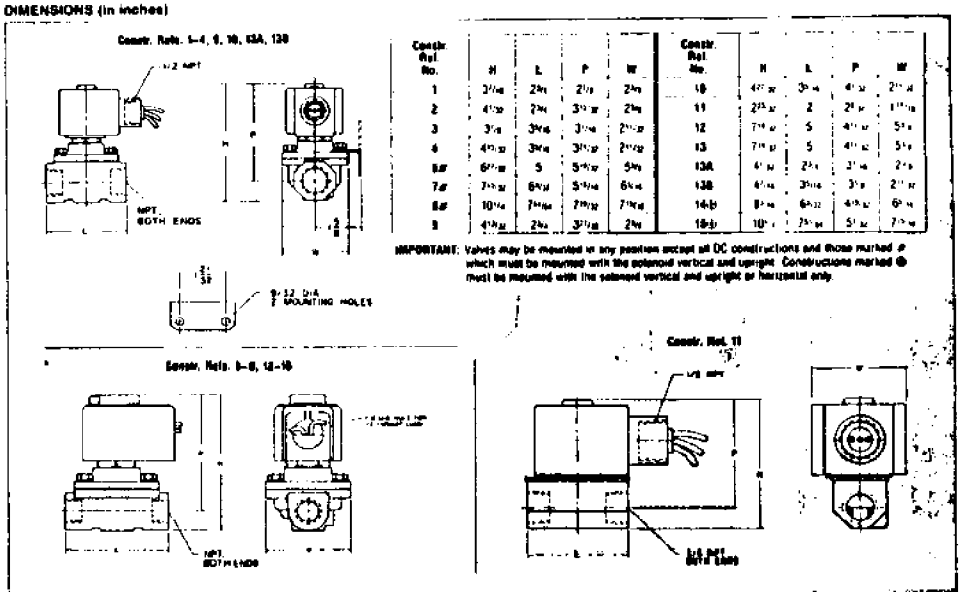
Pipe Size (Inch.)	Orifice Size (Inch.)	Cv Flow Factor	Operating Pressure Differential (psi) Min.	Max. AC Air-Fluid Gas	Max. DC Air-Fluid Gas	Max. Fluid Temp. °F. AC	Max. Fluid Temp. °F. DC	Standard Solenoid Enclosure Red-Hat—Type 1 Red-Hat II—Types 1, 2, 3, 3S, 4 and 4X Aluminum Body Catalog Number	Constr. Ref. No.	UL Listing	Watt Rating/ Class of Coil Insulation ① AC	Watt Rating/ Class of Coil Insulation ① DC
NORMALLY OPEN (Open when de-energized)												
1/8	1/4	3.2	0	125	125	125	104	8215G13	9	⊙	10.1/F	11.6/F
1/8	1/4	4	0	125	125	125	104	8215G23	9	⊙	10.1/F	11.6/F
1/4	1/4	4.6	0	125	125	125	104	8215G33	10	⊙	10.1/F	11.6/F
1	1 1/16	22	0	25	15	125	77	8215C53	12	⊙	15.4/F	14.9/B
1 1/4	1 1/16	33	0	25	15	125	77	8215C63	12	⊙	15.4/F	14.9/B
1 1/2	1 1/16	37	0	25	15	125	77	8215C73	12	⊙	15.4/F	14.9/B
2	2 1/16	58	0	25	15	125	77	8215C83	14	⊙	15.4/F	14.9/B
2 1/2	3	117	0	5	—	125	—	8215B93	15	⊙	28.2/F	—

Notes: ① Do not use for Fuel Gas.
② Suitable for Types 4 and 7 (C and D) only, and have a T4B temperature range code. See Engineering Section, beginning on page 97, for details.
③ On 50 Hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.

ELECTRICAL INFORMATION

Standard Coil and Class of Insulation	Watt Rating and Power Consumption DC Watts	AC Watts	AC VA Holding	AC VA Inrush	Spare Coil Part No. General Purpose AC	General Purpose DC	Explosionproof AC	Explosionproof DC
F	—	6.1	15	40	238210	—	238214	—
F	11.6	10.1	25	70	238610	238710	238614	238714
B	14.9	—	—	—	—	62691	—	—
F	—	15.4	27	160	99257	—	99257	—
F	—	28.2	50	385	206409	—	206409	—

DIMENSIONS (in inches)



Constr. Ref. No.	H	L	P	W
1	3 1/16	2 3/16	2 1/16	2 3/16
2	4 1/32	2 3/16	3 1/32	2 3/16
3	3 1/16	3 3/16	3 1/16	2 1/32
4	4 1/32	3 3/16	3 1/32	2 1/32
8#	6 7/32	5	5 1/32	5 3/16
7#	7 1/32	6 3/16	5 1/16	6 3/16
8#	10 1/16	7 3/16	7 1/32	7 1/16
9	4 1/32	2 3/16	3 1/32	2 3/16

Constr. Ref. No.	H	L	P	W
10	4 1/32	3 3/16	4 1/32	2 1/32
11	2 3/32	2	2 1/32	1 11/16
12	7 1/16	5	4 1/32	5 3/16
13	7 1/16	5	4 1/32	5 3/16
13A	6 1/16	3 3/16	3 1/32	2 3/16
13B	6 1/16	3 3/16	3 1/32	2 1/32
14-B	8 3/16	6 3/32	4 9/32	6 3/16
16	10	7 3/16	5 1/32	7 3/16

IMPORTANT: Valves may be mounted in any position except all DC constructions and those marked # which must be mounted with the solenoid vertical and upright. Constructions marked ⊙ must be mounted with the solenoid vertical and upright or horizontal only.

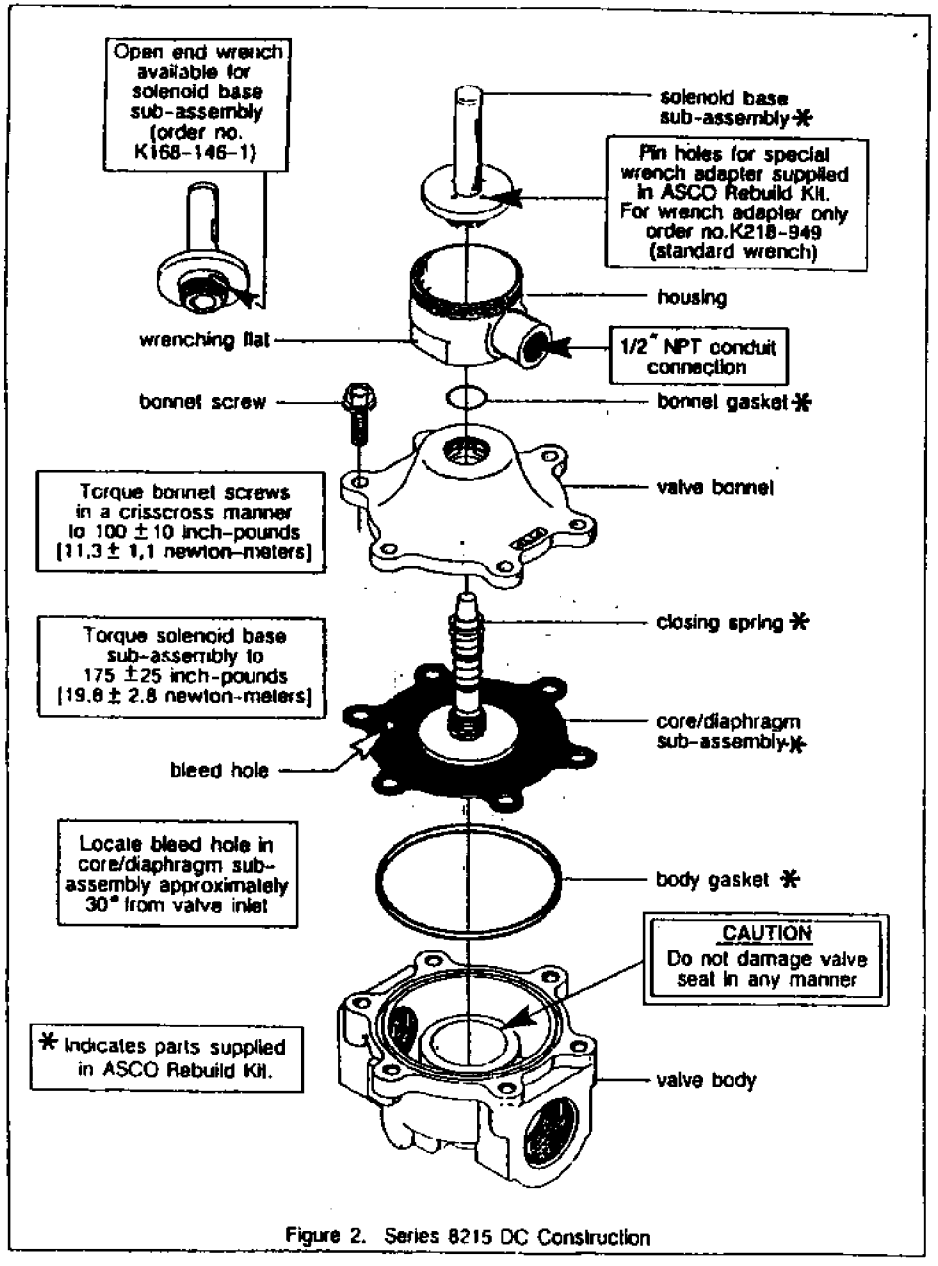


Figure 2. Series 8215 DC Construction

Installation & Maintenance Instructions

2-WAY INTERNAL PILOT-OPERATED SOLENOID VALVES
NORMALLY CLOSED OPERATION - 3/4", 1", 1-1/4", 1-1/2" OR 2" NPT
HIGH FLOW AIR OR FUEL GAS SERVICE

SERIES 8215

Form No. V598ER2

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Causes of Improper Operation, and Coil Replacement.

DESCRIPTION

Series 8215 valves are 2-way normally closed diaphragm type, solenoid valves design for high flow air or fuel gas service. Valve bodies are made of rugged aluminum with trim and internal parts made of steel and stainless steel. Series 8215 valves may be provided with a general purpose or explosionproof solenoid enclosure.

OPERATION

Normally Closed: Valve is closed when solenoid is de-energized; open when energized.

IMPORTANT: No minimum operating pressure differential required.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to chart below. Check catalog number prefix on nameplate to determine maximum temperatures.

Construction	Coil Class	Catalog Number Prefix	Max. Ambient Temp°F	Max. Fluid Temp°F
AC Construction	A	None	104	104
	F	FT	125	125
	H	HT	140	140
DC Construction	B or H	None or HT	77	77

*Dupont's Registered Trademark

Positioning

Valve must be mounted with solenoid vertical and upright.

Piping

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

CAUTION: To avoid damage to the valve body, DO NOT OVERTIGHTEN PIPE CONNECTIONS. If Teflon* tape, paste, spray or similar lubricant is used, use extra care when tightening due to reduced friction.

IMPORTANT: To protect the solenoid valve, install a strainer or filter, suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601 and 8602 for strainers.

MAINTENANCE

⚠ WARNING: To prevent the possibility of severe personal injury or property damage, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area before servicing the valve.

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean valve strainer or filter when cleaning the valve.

Preventive Maintenance

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, the valve should be operated at least once a month to insure proper opening and closing.
3. Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Causes of Improper Operation

1. Incorrect Pressure: Check valve pressure. Pressure to valve must be within range specified on nameplate.
2. Excessive Leakage: Disassemble valve (see Maintenance) and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly

⚠ WARNING: To prevent the possibility of severe personal injury or property damage, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area before servicing the valve.

NOTE: Determine valve construction AC (Figure 1) or DC (Figure 2) then proceed as follows:

1. Remove solenoid enclosure, see separate installation and maintenance instructions.
2. For AC Construction, unscrew solenoid base sub-assembly. For DC Construction, unscrew solenoid base sub-assembly with special wrench adapter provided in ASCO Rebuild Kit. For wrench adapter only, order kit No.K218-949. NOTE: For alternate type open end wrench, order kit No.K168-146-1 which is available for solenoid base sub-assembly removal or replacement.
3. Remove bonnet screws, valve bonnet, bonnet gasket, core/diaphragm sub-assembly and body gasket.
4. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild kit.

Valve Reassembly

1. Lubricate bonnet gasket and body gasket with a light coat of DOW CORNING® 111 Compound lubricant or an equivalent high-grade silicone grease.
2. Apply a light coat of RemGrit TFL 50® Dry Lubricant to:
   - Valve seat
   - Valve body flange where diaphragm assembly seats against valve body and body gasket.
   - Internal surface of valve bonnet where diaphragm assembly seats when valve is in the energized (open position).

IMPORTANT: If valve has been disassembled for inspection and cleaning only and a Rebuild Kit is not being installed, lubricate the following with RemGrit TFL 50® Dry Lubricant:

- **Diaphragm assembly on both sides.**
- **Main disc at base of core/diaphragm sub-assembly.**
- **Pilot disc at base of core assembly.**

CAUTION: Do not distort hanger spring between core assembly and diaphragm assembly when lubricating pilot disc.

3. Replace body gasket and core/diaphragm sub-assembly with closing spring attached. Locate bleed hole in core/diaphragm sub-assembly approximately 30° from the valve inlet.
4. Replace valve bonnet and bonnet screws (6). Torque screws in a crisscross manner to 100 ± 10 in-lbs (11,3 ± 1,1 Nm).
5. For AC construction, replace bonnet gasket and solenoid base sub-assembly. For DC construction refer to separate "Solenoid Installation and Maintenance Instructions" for lubrication instructions; then install bonnet gasket, housing and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 in-lbs (19,8 ± 2,8 Nm).
6. Replace solenoid (see separate instructions) and make electrical hookup.

⚠ WARNING: To prevent the possibility of severe personal injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

7. Restore line pressure and electrical power supply to valve.
8. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic "click" signifies the solenoid is operating.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded views are supplied in Rebuild Kits.

• When Ordering Rebuild Kits for ASCO Valves, order the Rebuild Kit number stamped on the valve nameplate. +

+ If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

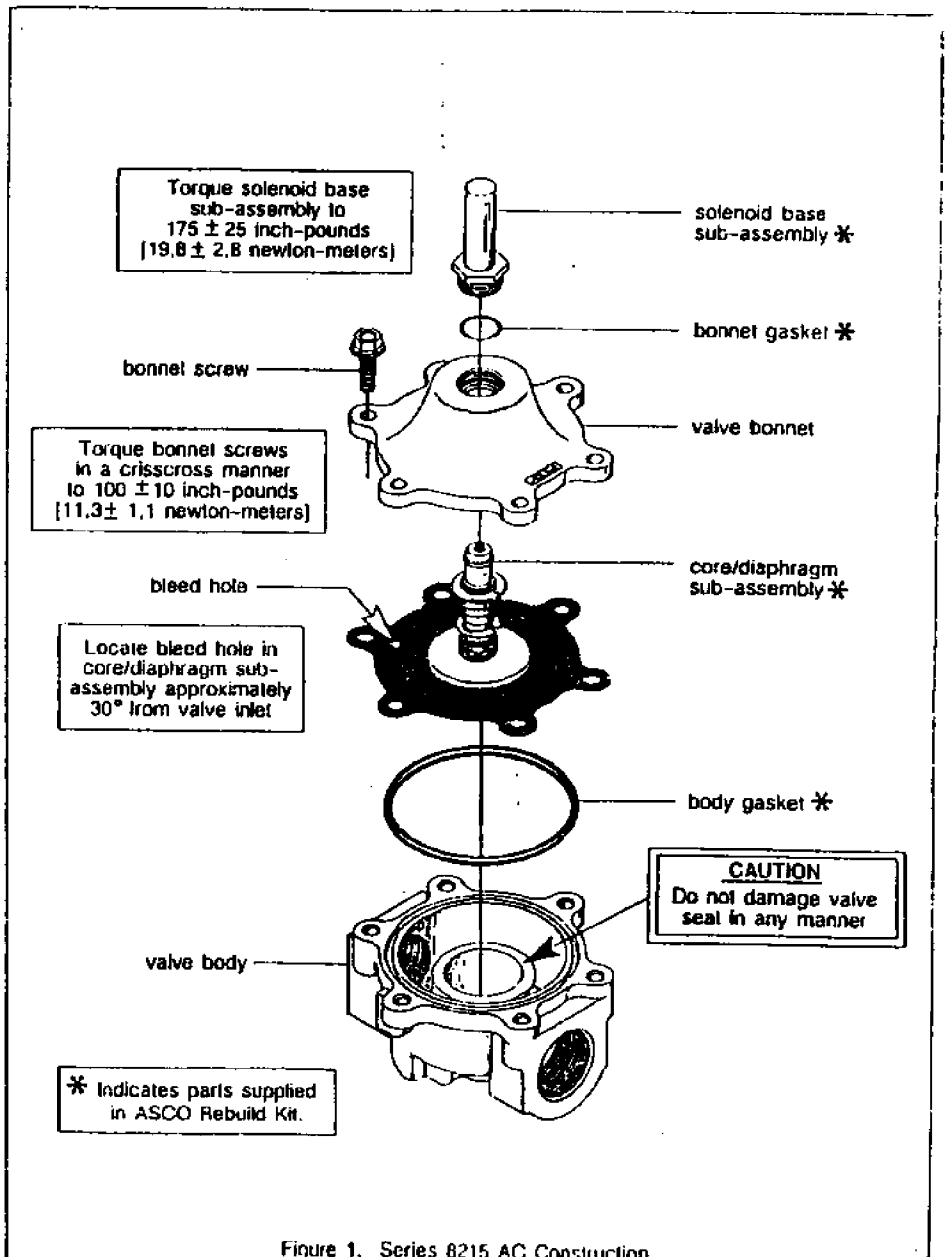


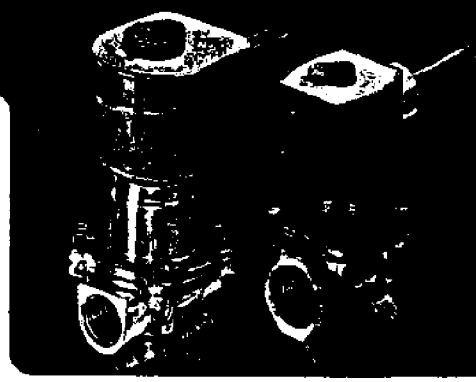
Figure 1. Series 8215 AC Construction

2 WAY PILOT OPERATED
General Service Solenoid Valves

Brass or Stainless Steel Bodies • 3/8" to 2 1/2" N.P.T.

ASCO Red-Hat • Red-Hat II

8210 SERIES



Specifications

Solenoid Enclosures: Valves listed in this series have either Red-Hat metal solenoid enclosures or Red-Hat II molded epoxy solenoids. Red-Hat II valves are identified by the change letter "G" in their catalog numbers, e.g., 8210G4, and are shown in red.

Standard Enclosures:
Red-Hat — Type 1 General Purpose

Red-Hat II — Types 1, 2, 3, 3S, 4 and 4X Combination General Purpose and Watertight.

Optional Enclosures:
Red-Hat — Types 3, 7 and 9 Combination Explosionproof and Raintight. To order, add prefix "EF" to catalog number. (Except Catalog Numbers 8210B57, 8210B58 and 8210B59)⑨

Red-Hat II — Types 3, 3S, 4, 4X, 6, 6P, 7 and 9 Combination Explosionproof and Watertight. To order, add prefix "EF" to catalog number.

Additional constructions are available. The Optional Electrical Features Section, page 11, contains descriptions and ordering information for: Open Frame Solenoids • Junction Box Enclosures • Panel Mount Constructions.

Electrical: Standard Voltages: 24, 120, 240, 480 volts, AC, 60 Hz (or 110, 220 volts, AC, 50 Hz)

6, 12, 24, 120, 240 volts, DC

Other voltages are available when required.

Coil: Continuous-duty molded Class F or H, as listed.

Nominal Ambient Temperature Ranges: Red-Hat and Red-Hat II Valves AC Construction: 32°F to 125°F.

Red-Hat Valves/DC Construction: 32°F to 77°F (104°F occasionally).

Red-Hat II Valves/DC Construction: 32°F to 104°F.

Refer to Engineering Section for details.

Valve Parts in Contact with Fluids:
Body — Brass or Stainless Steel, as listed
Seals and Discs — Buna "N" or Teflon*, as listed

Disc Holder — Nylon, as listed
Core Tube — 305 s.s.
Core and Plugnut — 430F s.s.
Springs — 302 s.s.
Shading Coil — Copper (Brass body) & Silver (stainless steel body)

Approvals: CSA certified. UL listed as indicated. Refer to Engineering Section for details.

Ordering Information: *Important:* We must have catalog number, voltage and Hertz, operating pressure and fluid handled. Use strainers with solenoid valves.

*DuPont Co. trademark

SPECIFICATIONS

Pipe Size (Inches)	Orifice Size (Inches)	Cv Factor	Operating Pressure Differential (psi) Max. AC: Min.	Max. AC: Air-Inert Gas	Max. AC: Water	Max. AC: Light Oil @ 300 SSU	Max. DC: Air-Inert Gas	Max. DC: Water	Max. DC: Light Oil @ 300 SSU	Max. Fluid Temp. °F. AC	Max. Fluid Temp. °F. DC	Standard Solenoid Enclosures Red-Hat–Type 1 Red-Hat II–Types 1,2,3,3S,4 and 4X: Brass Body Catalog Number	Brass Body Constr. Ref. No. ⑧	Brass Body UL Listing	S.S. Body Catalog Number	S.S. Body Constr. Ref. No. ⑧	S.S. Body UL Listing	Watt Rating/ Class of Coil Insulation ⑦ AC	Watt Rating/ Class of Coil Insulation ⑦ DC
NORMALLY CLOSED (Closed when de-energized), Buna "N" or Teflon® Seating																			
3/8	3/8	1.5	①	150	125	—	40	40	—	180	150	8210G73⑤	1P	•	8210G36⑤	1P	•	6.1/F	11.6/F
3/8	5/8	3	0	150	150	—	40	40	—	180	150	8210G93	5D	o	—	—	—	18.1/F	11.6/F
3/8	5/8	3	5	200	150	135	125	100	100	180	150	8210G1	6D	o	—	—	—	6.1/F	11.6/F
3/8	5/8	3	5	300	300	300	—	—	—	175	—	8210G6	5D	o	—	—	—	17.1/F	—
1/2	7/16	2.2	①	150	125	—	40	40	—	180	150	8210G15⑤	2P	•	8210G37⑤	2P	•	6.1/F	11.6/F
1/2	5/8	4	0	150	150	—	40	40	—	180	150	8210G94	5D	o	—	—	—	18.1/F	11.6/F
1/2	5/8	4	0	150	150	125	40	40	—	175	150	—	—	—	8210G87	7D	•	17.1/F	11.6/F
1/2	5/8	4	5	200	150	135	125	100	100	180	150	8210G2	6D	o	—	—	—	6.1/F	11.6/F
1/2	5/8	4	5	300	300	300	—	—	—	175	—	8210G7	5D	o	—	—	—	17.1/F	—
3/4	5/8	5	0	150	150	125	40	40	—	175	150	—	—	—	8210G88	7D	•	17.1/F	11.6/F
3/4	3/4	5	5	125	125	125	100	90	75	180	150	8210G9	9D	o	—	—	—	6.1/F	11.6/F
3/4	3/4	5	0	150	150	—	40	40	—	180	150	8210G95	8D	o	—	—	—	18.1/F	11.6/F
3/4	3/4	6.5	5	250	150	100	125	125	125	180	150	8210G3	11D	o	—	—	—	6.1/F	11.6/F
3/4	3/4	6	0	350	300	200	200	180	180	200	77	8210B26⑦	10P	⑨	—	—	—	15.4/F	30.6/H
1	1	13	0	150	125	125	100	100	80	180	77	8210B54	31D	⑨	8210D89	15D	⑨	15.4/F	30.6/H
1	1	13	5	150	150	100	125	125	125	180	150	8210G4	12D	o	—	—	—	6.1/F	11.6/F
1	1	13.5	0	300	225	115	—	—	—	200	—	8210B27	14P	•	—	—	—	20/F	—
1 1/4	1 1/8	15	0	150	125	125	100	100	80	180	77	8210B55	32D	⑨	—	—	—	15.4/F	30.6 H
1 1/4	1 1/8	15	5	150	150	100	125	125	125	180	150	8210G8	16D	o	—	—	—	6.1/F	11.6 F
1 1/2	1 1/4	22.5	0	150	125	125	100	100	80	180	77	8210B56	33D	⑨	—	—	—	15.4/F	30.6/H
1 1/2	1 1/4	22.5	5	150	150	100	125	125	125	180	150	8210G22	18D	•	—	—	—	6.1/F	11.6/F
2	1 3/4	43	5	150	125	90	50	50	50	180	150	8210G100	20P	—	—	—	—	6.1/F	11.6/F
2 1/2	1 3/4	45	5	150	125	90	50	50	50	180	150	8210G101	21P	—	—	—	—	6.1/F	11.6 F

SPECIFICATIONS (continued)

Pipe Size (Ins.)	Orifice Size (mm.)	Cv Flow Factor	Min.	Operating Pressure Differential (psi) Max. AC: Air-Inert Gas	Max. AC: Water	Max. AC: Light Oil @ 300 SSU	Max. DC: Air-Inert Gas	Max. DC: Water	Max. DC: Light Oil @ 300 SSU	Max. Fluid Temp. °F. AC	Max. Fluid Temp. °F. DC	Standard Solenoid Enclosures Red-Hat I—Types 1, 2, 3, 3S, 4 and 4X: Brass Body: Catalog Number	Brass Body: Constr. Ref. No. ⑤	Brass Body: UL Listing	S.S. Body: Catalog Number	S.S. Body: Constr. Ref. No. ⑤	S.S. Body: UL Listing	Watt Rating/ Class of Coil Insulation: AC	Watt Rating/ Class of Coil Insulation: DC
NORMALLY OPEN (Open when de-energized), Buna "N" Seating (Nylon Disc Holder, except as noted)																			
3/8	9/16	3	0	150	150	125	125	125	80	180	150	8210G33	23D	•	—	—	—	10 1/F	11.6/F
3/8	9/16	3	5	250	200	200	250	200	200	180	180	8210G11-B/⑨	39D	•	—	—	—	10 1/F	11.6/F
1/2	9/16	4	0	150	150	125	125	125	80	180	150	8210G34	23D	•	—	—	—	10 1/F	11.6 F
1/2	9/16	3	0	150	150	100	125	125	80	180	150	—	—	—	8210G30	37D	•	10.1/F	11.6 F
1/2	9/16	4	5	250	200	200	250	200	200	180	180	8210G12-B/⑨	39D	•	—	—	—	10.1/F	11.6/F
3/4	9/16	5.5	0	150	150	125	125	125	80	180	150	8210G35	25D	•	—	—	—	10 1/F	11.6 F
3/4	9/16	3	0	150	150	100	125	125	80	180	150	—	—	—	8210G36	38D	•	10.1/F	11.6 F
3/4	9/16	6.5	5	250	200	200	250	200	200	180	180	8210C13	24D	•	—	—	—	15 4/F	16.8 F
1	1	13	0	125	125	125	—	—	—	180	—	8210B57 & ⑨	34D	•	—	—	—	20 F	—
1	1	13	5	150	150	125	125	125	125	180	180	8210D14	26D	•	—	—	—	15 4/F	16.8 F
1 1/4	1 1/4	15	0	125	125	125	—	—	—	180	—	8210B58 & ⑨	35D	•	—	—	—	20 F	—
1 1/4	1 1/4	15	5	150	150	125	125	125	125	180	180	8210D18	28D	—	—	—	—	15 4/F	16.8 F
1 1/2	1 1/4	22.5	0	125	125	125	—	—	—	180	—	8210B59 & ⑨	36D	•	—	—	—	20 F	—
1 1/2	1 1/4	22.5	5	150	150	125	125	125	125	180	180	8210D32	29D	—	—	—	—	15 4/F	16.8 F
2	1 1/4	43	5	125	125	125	125	125	125	180	150	8210103	30P	—	—	—	—	15 4/F	16.8 F
2 1/2	1 1/4	45	5	125	125	125	125	125	125	180	150	8210104	27P	—	—	—	—	15 4/F	16.8 F

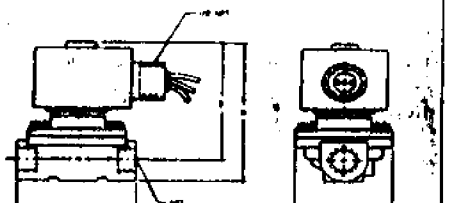
Notes:
- ① 5 psi on Air, 1 psi on Water
- ② Valves provided with teflon main seat
- ③ Valve includes Lilian #6 ℄ trademarks piston
- ④ Letter "B" denotes diaphragm construction. "P" denotes piston construction
- ⑤ UL listed as General Purpose valve on AC voltage only
- ⑥ Valves not available with Explosionproof enclosures
- ⑦ On 50 Hertz service, the watt rating for the 6.1 F solenoid is 8.1 watts
- ⑧ AC Construction also has nylon sealing
- ⑨ No disc holder
- ⑩ Stainless Steel disc holder

ELECTRICAL INFORMATION

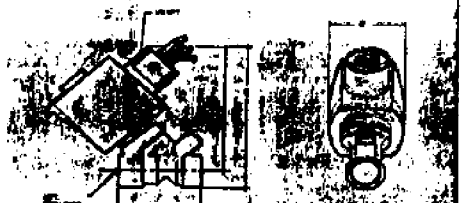
Standard Coil and Class of Insulation	Watt Rating and Power Consumption: DC Watts	AC: Watts	AC: VA Holding	AC: VA Inrush	Spare Coil Part No.: General Purpose: AC	General Purpose: DC	Explosionproof: AC	Explosionproof: DC
F	—	6.1	16	40	238210	—	238214	—
F	11.6	10.1	25	70	238610	238710	238614	238714
F	16.8	15.4	27	160	99257	97617	99257	97617
F	—	17.1	40	93	238610	—	238614	—
F	—	20	43	240	99257	—	99257	—
H	30.6	—	—	—	—	74073	—	74073

DIMENSIONS (in inches)

Constr. Nos. 3, 5, 7, 8, 9, 11, 12, 15, 18, 20, 21, 23, 25, 37, 38

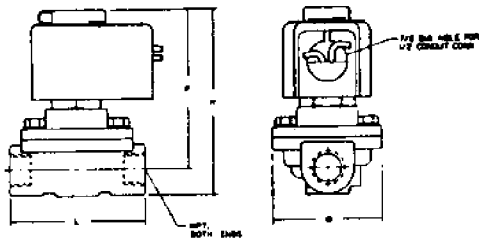


Constr. Nos. 1, 2



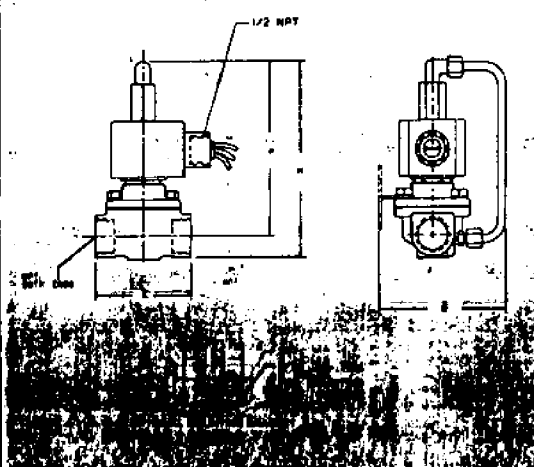
DIMENSIONS (in inches)

Constr. Nos. 10, 14, 15, 24, 26–36

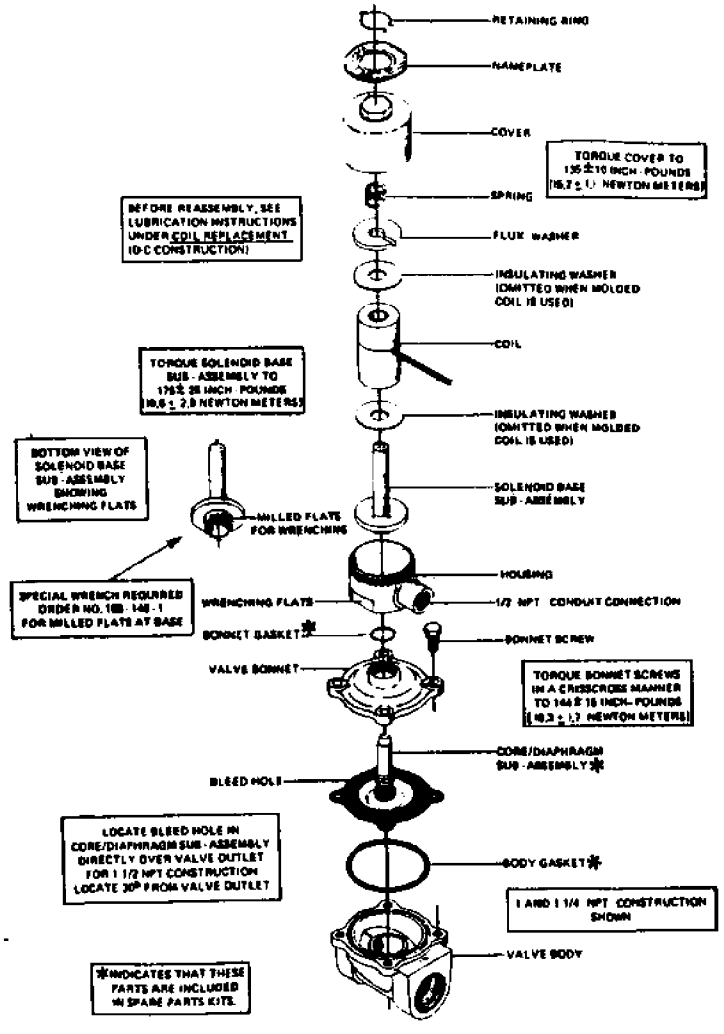


Constr. Ref. No.	H	L	P	W
1*	3 11/32	1 29/32	3 1/16	1 11/16
2*	4 5/32	2 5/32	3 7/32	1 11/16
5	3 29/32	2 5/16	3 7/32	2 1/16
6*	3 15/32	2 5/16	2 27/32	2 1/16
7	4 5/32	2 11/16	3 7/32	2 5/16
8	3 7/16	2 5/16	4 1/16	2 5/16
9*	3 5/8	2 11/16	3	2 5/16
10* ②	5 1/16	2 11/16	4 13/32	2 5/16
11*	4 5/32	3 5/8 ②	3 7/32	2 5/16
12*	5 1/16	3 1/16	4	2 1/16
14 ②	6 11/32	3 11/16	5 1/32	3 1/16
15*	5 11/32	3 1/16	4 13/32	3 1/16
16*	5 1/16	3 1/16	4	3 1/16
18*	6 1/16	4 1/16	4 1/16	3 1/16
20*	7 1/16	5 1/16	4 1/16	4 1/16
21*	7 1/16	5 1/16	5 1/16	5 1/16
23	6 11/32	2 1/16	5 1/32	2 1/16
24	5 1/16	3 1/16	4 1/16	2 5/16
25	4 5/32	2 11/16	3 7/32	2 5/16
26	6 11/32	3 1/16	4 9/32	2 5/16
27	8 1/32	5 1/32	5 1/32	5 1/16
28	6 11/32	3 1/16	4 9/32	3 1/16
29	7 1/16	4 1/16	5 1/16	3 1/16
30	8 1/32	5 1/16	5 1/32	6 1/16
31*	6 1/16	3 1/16	5 1/16	3 1/16
32*	5 1/16	3 1/16	5 1/16	3 1/16
33*	6 1/16	4 1/16	5 1/16	3 1/16
34 ②	6 11/32	3 1/16	6 1/32	3 1/16
35 ②	7 1/16	3 11/16	6 1/32	3 1/16
36 ②	7 1/16	4 1/16	6 1/16	3 1/16
37	4 1/16	2 1/16	3 1/16	2 1/16
38	4 1/16	2 1/16	3 1/16	2 1/16
39	5 1/16	2 1/16	4 1/16	3 1/16

Constr. Nos. 20



IMPORTANT: Valves may be mounted in any position except as noted.
*Valve must be mounted with solenoid vertical and upright.
**DC dimensions slightly larger.



Bulletin 8210 and 8211 — D-C Construction (Direct Current)
Solenoid enclosure shown is used for general purpose and watertight & explosion-proof.
For watertight & explosion-proof requirements, see note under "Coil Replacement".

Figure 3.

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V5465R3 PRINTED IN U.S.A. 1982

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY INTERNAL PILOT OPERATED SOLENOID VALVES
DIAPHRAGM TYPE — 1, 1 1/4 AND 1 1/2 NPT
NORMALLY CLOSED OPERATION

BULLETINS
8210
8211
ASCO
Form No. V5465R3

DESCRIPTION

Bulletin 8210 valves are 2-way, normally closed internal pilot operated solenoid valves, and are provided with a TYPE 1, General Purpose Solenoid Enclosure. Bulletin 8211 valves are the same as Bulletin 8210s with the exception of the pilot valve being provided with a combination Watertight & Explosion-proof Solenoid Enclosure designed to meet Enclosure TYPE 4-Watertight, TYPE 7 (C & D) — Explosion-proof Class I, Groups C & D and TYPE 9 (E, F & G) — Dust Ignition-proof Class II, Groups E, F & G. For Installation and Maintenance Instructions for the Watertight & Explosion-proof Solenoid Enclosure (A-C Construction) see Form No. V5381.

OPERATION

Normally Closed: Valve is closed when solenoid is de-energized. Valve opens when solenoid is energized.

IMPORTANT: No minimum operating pressure differential required.

MANUAL OPERATOR (Optional)

Valves with Suffix "MO" in the catalog number are provided with a screw type manual operator which allows manual operation when desired or during an interruption of electrical power. To operate manual operator, remove operator cap and gasket. To open valve, turn stem in base of body clockwise as far as possible. Do not force operator stem. Valve will then be in the same position as when the solenoid is energized. Disengage manual operator by turning stem counterclockwise as far as possible before operating electrically. CAUTION: Stem must be fully retracted before operating valve electrically. Replace manual operator cap gasket and cap.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. For higher ambient and fluid temperature limitations, consult factory. Check catalog number prefix on nameplate to determine maximum temperatures.

A-C CONSTRUCTION ONLY			
COIL CLASS	CATALOG NUMBER PREFIX	MAXIMUM AMBIENT TEMP. °F	MAXIMUM FLUID TEMP. °F
A	NONE	77	180
F	FT	104	200
H	HT	140	200

POSITIONING

A-C Construction (Alternating Current): Valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area.

D-C Construction (Direct Current): Valve must be mounted with solenoid vertical and upright.

PIPING

Connect piping to valve according to flow markings on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening the pipe, do not use valve or solenoid as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. For valves equipped with a watertight & explosion-proof solenoid enclosure, the electrical fittings must be approved for use in approved hazardous locations. Housings for all solenoids are provided with connections or accommodations for 1/2 inch conduit. Both the general purpose and watertight & explosion-proof solenoid enclosure may be rotated to facilitate wiring by loosening the cover or removing the retaining cap or clip. CAUTION: When metal retaining clip disengages, it will spring upward. Rotate enclosure to desired position. Tighten cover on watertight & explosion-proof solenoid enclosure to 135 ± 10 inch-pounds [15.3 ± 1.1 newton meters].

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched by the hand for only an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

Warning: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove the valve from the pipeline for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary depending upon medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Be sure to clean valve strainer when cleaning solenoid valve.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on medium and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires, terminals or splice connections.
2. **Burned-Out Coil:** Check for open-circuited coil. Replace coil if necessary.
3. **Low Voltage:** Check for voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

COIL REPLACEMENT

Turn off electrical power supply and disconnect coil lead wires.

A-C Construction (Refer to Figure 2.)

1. Remove retaining cap or clip, nameplate and cover. CAUTION: When metal retaining clip disengages, it will spring upward.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
3. Slip coil, sleeves and insulating washers from yoke.
4. Reassemble in reverse order of disassembly, paying careful attention to exploded view provided for identification and placement of parts.

ASCO Valves
Form No. V5465R3 PRINTED IN U.S.A. 1982 Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932

D-C Construction (Refer to Figure 3.)

1. Unscrew cover with nameplate and retaining ring attached. Two wrenching flats are provided on the housing to hold it securely in place while cover is being removed or replaced.
2. Slip spring, flux washer, insulating washer and coil off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
4. For greasing requirements of watertight & explosion-proof solenoid enclosure, refer to the paragraph below before reassembly.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Be sure to replace insulating washer at each end of non-molded coil.

NOTE: Installation and Maintenance of Watertight & Explosion-proof equipment requires more than ordinary care to insure safe performance. All finished surfaces of the solenoid are constructed to provide a flameproof seal. Be sure that the surfaces are wiped clean before replacing. If watertight, as well as explosion-proof is a requirement, grease the joints of the watertight & explosion-proof solenoid enclosure with DOW CORNING® 111 Compound lubricant or an equivalent high-grade silicone grease. Grease joints thoroughly covering all surfaces. Follow this procedure each time the solenoid enclosure is disassembled.

VALVE DISASSEMBLY (Refer to Figure 1, 2 and 3)

Depressurize valve and turn off electrical power supply. Disconnect conduit and lead wires when necessary. Proceed in the following manner.

1. For the general purpose solenoid enclosure, remove the retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upward. For watertight & explosion-proof construction or general purpose D-C Construction, follow Disassembly Instructions under "Coil Replacement" D-C Construction.
2. Unscrew solenoid base sub-assembly. For D-C Construction, a special wrench adapter (Order No. 164-144) is required. Remove bonnet gasket.
3. Remove bonnet screws, valve bonnet, spring retainer (A-C Construction only) core spring, core/diaphragm sub-assembly and body gasket.
4. For valves equipped with a manual operator, remove cap, cap gasket, and bonnet. Remove stem assembly from bonnet.
5. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

VALVE REASSEMBLY

1. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
2. Replace body gasket and core/diaphragm sub-assembly. Locate bleed hole in core/diaphragm sub-assembly directly over valve outlet. For 1 1/2 NPT construction, locate bleed hole in core/diaphragm sub-assembly approximately 30° from valve outlet.
3. Replace core spring and spring retainer (A-C Construction only). Install small end of core spring in core first, wide end protruding from top of core. For D-C Construction, install core spring, small end down toward valve body.
4. Replace valve bonnet and bonnet screws. Hand tighten bonnet screws. **IMPORTANT: PRESS FIRMLY DOWN ON CORE/DIAPHRAGM SUB-ASSEMBLY TO SEAT DIAPHRAGM ASSEMBLY AGAINST VALVE SEAT WHILE HOLDING THIS POSITION. TIGHTEN BONNET SCREWS IN A CRISSCROSS MANNER TO 144 ± 15 INCH-POUNDS [16,3 ± 1,7 newton meters].**
5. Replace bonnet gasket and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 inch-pounds [19,8 ± 2,8 newton meters]. For D-C Construction, the solenoid base sub-assembly must be placed inside the housing before assembling into the valve body. Before doing this, refer to greasing instructions under "Coil Replacement".
6. Reassemble remaining solenoid parts according to instructions under "Coil Replacement" and exploded views provided. For D-C Construction, (watertight & explosion-proof solenoid enclosure) be sure to torque cover to 135 ± 10 inch-pounds [15,2 ± 1,1 newton meters].
7. For valves provided with a manual operator, replace stem assembly and bonnet (with gaskets). Torque bonnet to 75 ± 10 inch-pounds [8,5 ± 1,1 newton meters]. Replace cap gasket and cap.
8. After maintenance, operate the valve a few times to be sure of proper opening and closing.

SPARE PARTS KITS

Spare Parts and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts or Coils, Specify Valve Catalog Number, Serial Number, Voltage and Hertz A-C, or Voltage D-C

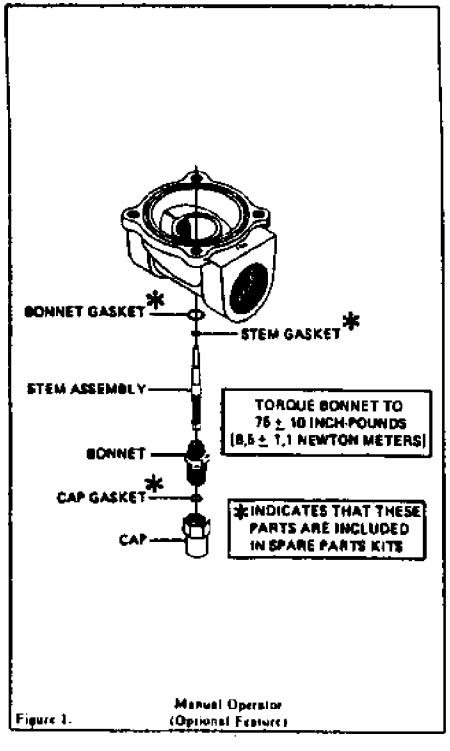


Figure 1. Manual Operator (Optional Feature)

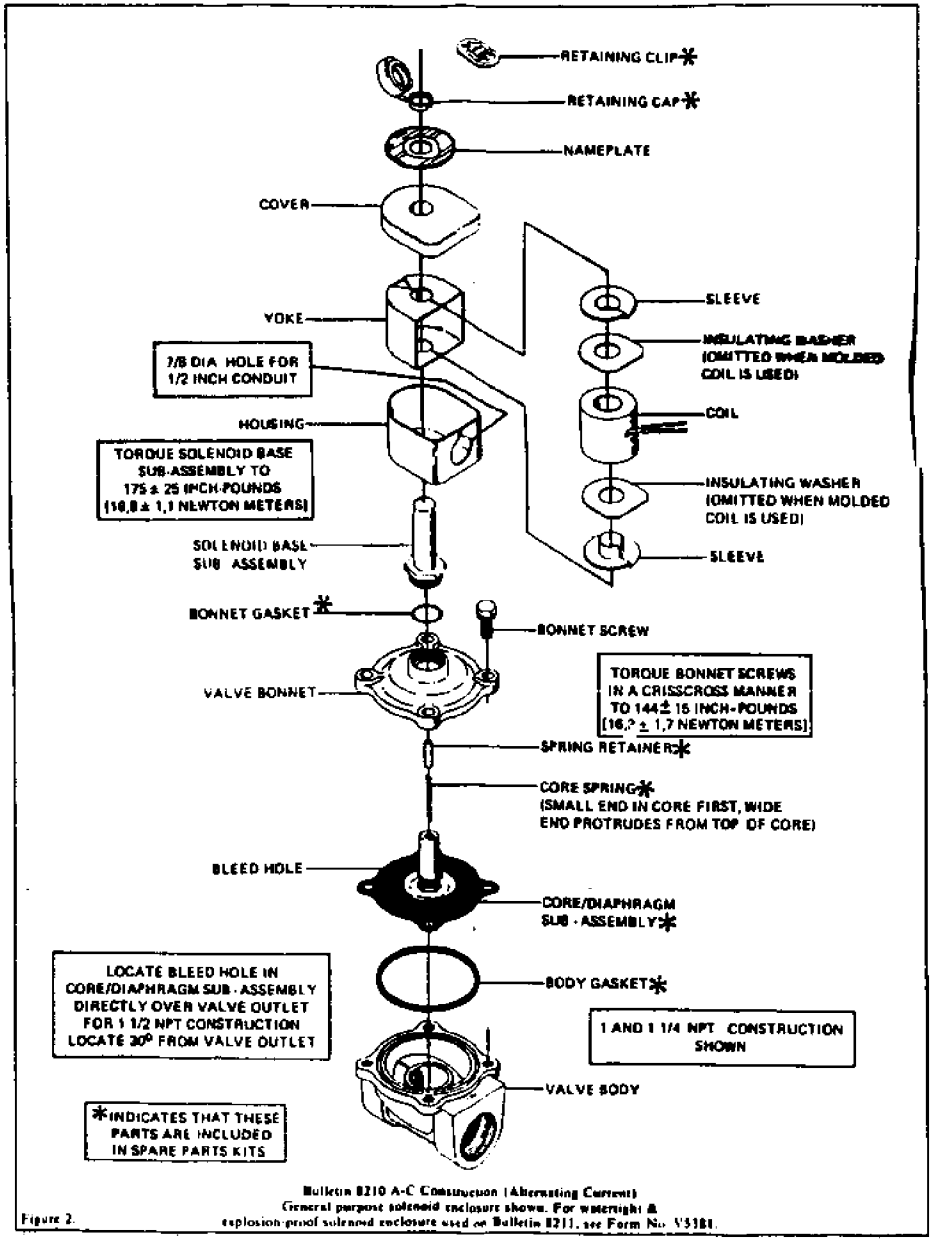


Figure 2. Bulletin 8210 A-C Construction (Alternating Current) General purpose solenoid enclosure shown. For watertight & explosion-proof solenoid enclosure used on Bulletin 8211, see Form No. V5181.

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V8468R3 PRINTED IN U.S.A. 1982

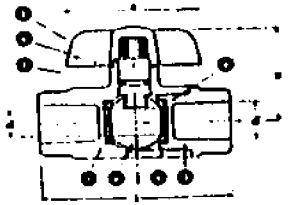
OMNI® BALL VALVE

5/11/11

Features
Sample Specifications
Pressure vs. Temperature
Dimensions Parts
ELECTROMNI

OMNI® BALL VALVE

SIZES 3/8"–3"
MODELS Socket, Threaded, Flanged (ANSI)
BODIES PVC, CPVC
SEATS Teflon® backed with EPDM
SEALS EPDM



FEATURES

- Teflon® seats with EPDM cushion.
- Dry construction.
- Corrosion-resistant Type 1 PVC or CPVC body and ball.
- Compact uni-body construction.
- EPDM stem "O" ring.
- All sizes rated for vacuum service.

SAMPLE SPECIFICATIONS

All thermoplastic ball valves size ⅜"–3" shall be of a molded construction where parts are assembled through one end during manufacturing. All valves must have Teflon seats with EPDM backing cushions. Valves shall be rated 150 PSI at 120 degrees F as manufactured by AsahiAmerica.

PARTS

No.	Parts*	Pcs.	Materials
1	Body	1	PVC, CPVC
2	Ball	1	PVC, CPVC
3	End Connector	1	PVC, CPVC
4	Stem	1	PVC, CPVC
5	Handle	1	ABS
6	Seat	2	Teflon®
7	"O" Ring	1	EPDM
8	Cushion	2	EPDM

*Parts for throttle valve only and should be removed

PRESSURE VS. TEMPERATURE (PSI, WATER, NON SHOCK)

Size (inches)	PVC 35°F 120°F	CPVC 35°F 120°F	140°F	175°F	195°F
⅜–3	150	150	120	85	65

DIMENSIONS (IN INCHES UNLESS OTHERWISE NOTED)

Size	Weight (lbs.)	D_1	D_2 Socket	D_3 Threaded	L	A	H	C, VALUES Cv Min. @ 1 PSI Pressure Drop
⅜"	0.12	0.88	0.88	NPT ⅜	3.38	3.38	1.88	10.0
½"	0.22	0.81	0.88	NPT ½	3.38	3.38	1.88	12.0
¾"	0.44	0.78	1.06	NPT ¾	4.02	3.16	2.17	30.0
1"	0.69	1.00	1.33	NPT 1	4.48	3.16	2.36	47.0
1¼"	.90	1.22	1.67	NPT 1¼	5.00	3.74	2.76	80.0
1½"	1.18	1.40	1.91	NPT 1½	5.88	4.33	3.00	140.0
2"	1.88	1.90	2.38	NPT 2	6.93	4.33	3.31	185.0
3"	6.30	2.76	3.88	NPT 3	8.29	7.87	4.88	430.0

ELECTROMNI®

SIZES 3/8"–3"
MODELS Socket, Threaded, Flanged (ANSI)
BODIES PVC, CPVC
SEATS Teflon® backed with EPDM
SEALS EPDM
ACTUATOR 115 VAC single phase

FEATURES

- PVC or CPVC valve
- 2-part Teflon® seats with EPDM backing
- Available in threaded or socket models
- 115 VAC single phase
- .4 amp unidirectional ¼ turn motor
- 5 second cycle time
- Actuator housing of high impact ABS (NEMA IV, weatherproof)

OPTIONS

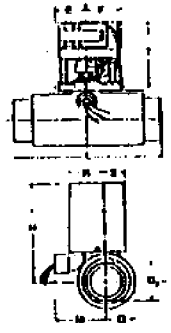
- Other voltages (see table on reverse side)
- Extra limit switch (SPDT) for sequencing with other equipment and for remote light indication
- Position indication lights, built into base of unit, signal whether valve is open or closed
- 2-wire control for retrofitting solenoids or for direct wiring timers, level switches, etc.

P.O.#: 88813-1

OMNI® BALL VALVE continued

ELECTROMNI cont.
OMNIMATIC—Dimensions
Features, Options
Sample Specifications
Line Pressure

ELECTROMNI® continued



WIRING DIAGRAM

VOLTAGE

Voltage	Current Draw	Cycle Time	Duty Cycle
12 VAC	4.4 AMPS	5 SEC.	75%
24 VAC	2.8 AMPS	5 SEC.	75%
115 VAC	.40 AMPS	5 SEC.	75%
220 VAC	.25 AMPS	5 SEC.	75%
12 VDC	1.0 AMPS	5 SEC.	75%
24 VDC	.60 AMPS	5 SEC.	75%

DIMENSIONS (in inches)

Valve Size	Weight (lbs.)	D_3 Threaded	D_2 Socket	H	T	L	R	S	Q	E	F	M	C, Values
⅜	1.75	NPT ⅜	0.88	5.00	4.50	5.35	2.0	1.0	0.75	1.75	1.50	2.75	10.0
½	1.75	NPT ½	0.88	5.00	4.50	5.35	2.0	1.0	0.75	1.75	1.50	2.75	12.0
¾	2.0	NPT ¾	1.06	5.48	4.50	5.62	2.0	1.0	1.00	1.75	1.50	2.75	30.0
1	2.5	NPT 1	1.33	5.75	4.50	5.48	2.0	1.0	1.19	1.75	1.50	2.75	47.0
1¼	3.0	NPT 1¼	1.67	6.00	4.50	6.00	2.0	1.0	1.56	1.75	1.50	2.75	80.0
1½	3.0	NPT 1½	1.91	6.00	4.50	5.88	2.0	1.0	1.44	1.75	1.50	2.75	140.0
2	4.0	NPT 2	2.38	6.50	4.50	6.83	2.0	1.0	1.75	1.75	1.50	2.75	185.0

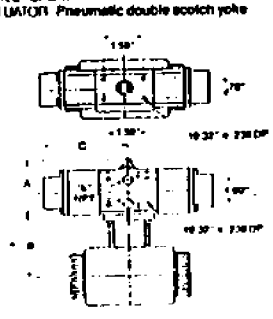
LINE PRESSURE – All sizes 100 PSI

SAMPLE SPECIFICATION

All electrically actuated ball valves in sizes ⅜" through 2" shall have direct-mounted actuators with unidirectional ¼-turn motors. Actuator housings shall be weather proof (NEMA IV). Valves shall be of a one-piece construction in PVC or CPVC with Teflon® seats backed by EPDM cushion rings, as manufactured by AsahiAmerica, Inc., 425 Riverside Ave., Medford, MA 02155.

OMNIMATIC®

SIZES 3/8"–3"
MODELS Socket, Threaded, Flanged (ANSI)
BODIES PVC, CPVC
SEATS Teflon® backed with EPDM
SEALS EPDM
ACTUATOR Pneumatic double scotch yoke



FEATURES

- PVC or CPVC valve
- 2 part Teflon® seats with EPDM backing
- Available in threaded or socket models
- Ultra-compact double scotch yoke pneumatic actuator
- Corrosion resistant, anodized actuator and mounting bracket
- All stainless steel shaft and hardware
- Choice of "air-to-air" or "air-to-spring" actuator (specify "Fail Open" or "Fail Close")
- Actuator air supply 80 PSI

OPTIONS

- Solenoids (all voltages)
- Positioner
- Limit switches (SPDT) for sequencing with other equipment and for remote light indication

SAMPLE SPECIFICATION

All pneumatically actuated ball valves in sizes ⅜" through 2" shall have corrosion resistant, anodized, double scotch yoke actuators with stainless steel shafts and hardware. Actuators must work with 80 PSI supply air. Valves shall be of a one piece construction in PVC or CPVC with Teflon® seats backed by EPDM cushion rings, as manufactured by AsahiAmerica, Inc., 425 Riverside Ave., Medford, MA 02155.

DIMENSIONS

Valve Size (inches)	Weight (lbs.) Air-to-Air	Weight (lbs.) Air-to-Spring	A	B	C A-A	C A-S	C_v Values
⅜	1.00	1.30	2.12	1.85	1.50	3.38	10.0
½	1.00	1.30	2.12	1.85	1.50	3.38	12.0
¾	1.25	1.50	2.12	2.17	1.50	3.38	30.0
1	1.50	1.80	2.12	2.37	1.50	3.38	47.0
1¼	2.00	2.30	2.12	2.95	1.50	3.38	80.0
1½	2.00	2.30	3.13	3.35	1.50	3.38	140.0
2	2.70	3.00	3.12	3.75	1.50	3.38	185.0

LINE PRESSURE – Sizes ⅜"–1" 100 PSI; sizes 1¼"–2" 80 PSI

APPENDIX FOUR

1. Joy Bulkhead Connectors

2. SJ Electro Systems Inc. (cable connectors)

JOY® TP Mini-Line™ Connectors...

- **Economical To Use**
- **Reduce Installation Costs**
- **Provide Long Reliable Service**
- **Protect Against Harsh Environments**

Electrical Parameters
2 to 5 Contacts,
#16 AWG Conductors,
Up to 600 Volts, 13 Amps.

Tough JOY TP Mini-Line connectors are designed to provide dependable and economical service. The use of compact limit and proximity switches, solenoid valves, and other small components creates space problems the JOY TP Mini-Line connector can solve.

TP Mini-Line connectors eliminate time consuming rewiring of equipment on the job. Components can be quickly replaced by simply unplugging the defective unit and plugging in a prewired spare. Wire portable equipment just once, then connect it and disconnect it at will. Rugged, sealed construction allows use in toughest industrial environments.

JOY TP Mini-Line connectors are factory molded, from high-quality thermoplastic rubber compounds, to various standard lengths of cable and are available in two through five contacts.

Designed for safe operations
Molded of thermoplastic rubber, TP Mini-Line connectors offer excellent electrical insulation. Male contacts are shielded by a skirt during connect and disconnect operations. Polarized keyway facilitates correct pin engagement. A molded-in alignment arrow on the shrouded male plug indicates alignment with the keyway so that even in the dark, keyway alignment is made easier. All socket contacts are recessed from the connector face to prevent accidently touching live contacts. The ground pin makes contact first and breaks contact last.

Save space and withstand rugged operating conditions

UL PENDING

Sealed against environment
Molded-to-cable design and double-face seal are unaffected by water, coolants or condensation. Female half fits like a cork into the flexible shroud portions of the male. In addition, individual shoulders around the pins fit into recesses in the female sections. The thermoplastic rubber used has excellent weathering properties and is specifically selected for outdoor application. The cable used is also selected for outdoor use and passes UL 1581 for sunlight resistance.

Withstand physical abuse
The one-piece molded thermoplastic rubber construction shrugs off heavy physical abuse. They will withstand many times the twisting and flexing of conventional connectors.

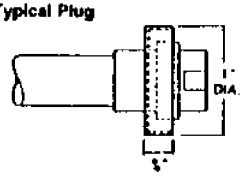
Highly visible
Plugs and receptacles are molded with yellow thermoplastic rubber compound. Plugs are supplied with yellow jacketed cable.

Positive lockings
Threaded couplings insure tight connections — release quickly.

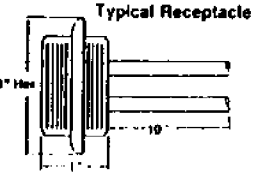
Corrosion resistant
Thermoplastic rubber components are impervious to most industrial environments. Mounting shells and couplers are metal or nylon.

Easily installed
Receptacles are threaded at rear to fit standard pipe threads.

Typical Plug



Typical Receptacle



ORDERING INFORMATION

WITH **METAL** COUPLER AND RECEPTACLE SHELL

ELECTRICAL DATA					PLUGS			RECEPTACLES (10" Pigtails)		
No. of Contacts	Maximum Rating (Cable) Volts	Amps	AWG	Cable Type	Length Feet	Male	Female	Male	Female	Pipe Thread Size
2	600	13	16	SEOW-A	3 6 12	5000108-6 5000108-7 5000108-8	5000108-3 5000108-4 5000108-5	5000108-10	5000108-9	1/2
2	300	13	16	SJEOW-A	3 6 12	5000108-22 5000108-23 5000108-24	5000108-19 5000108-20 5000108-21	5000108-10	5000108-9	1/2
3	600	13	16	SEOW-A	3 6 12	5000109-6 5000109-7 5000109-8	5000109-3 5000109-4 5000109-5	5000109-10	5000109-9	1/2
3	300	13	16	SJEOW-A	3 6 12	5000109-22 5000109-23 5000109-24	5000109-19 5000109-20 5000109-21	5000109-10	5000109-9	1/2
4	600	10	16	SEOW-A	3 6 12	5000110-6 5000110-7 5000110-8	5000110-3 5000110-4 5000110-5	5000110-10	5000110-9	1/2
4	300	10	16	SJEOW-A	3 6 12	5000110-22 5000110-23 5000110-24	5000110-19 5000110-20 5000110-21	5000110-10	5000110-9	1/2
5	250*	8	16	SEOW-A	3 6 12	5000111-6 5000111-7 5000111-8	5000111-3 5000111-4 5000111-5	5000111-10	5000111-9	1/2

WITH **NYLON** COUPLER AND RECEPTACLE SHELL

2	600	13	16	SEOW-A	3 6 12	5000108-26 5000108-29 5000108-30	5000108-25 5000108-28 5000108-27	5000108-18	5000108-17	1/2
2	300	13	16	SJEOW-A	3 6 12	5000108-14 5000108-15 5000108-16	5000108-11 5000108-12 5000108-13	5000108-18	5000108-17	1/2
3	600	13	16	SEOW-A	3 6 12	5000109-26 5000109-29 5000109-30	5000109-25 5000109-28 5000109-27	5000109-18	5000109-17	1/2
3	300	13	16	SJEOW-A	3 6 12	5000109-14 5000109-15 5000109-16	5000109-11 5000109-12 5000109-13	5000109-18	5000109-17	1/2
4	600	10	16	SEOW-A	3 6 12	5000110-26 5000110-29 5000110-30	5000110-25 5000110-28 5000110-27	5000110-18	5000110-17	1/2
4	300	10	16	SJEOW-A	3 6 12	5000110-14 5000110-15 5000110-16	5000110-11 5000110-12 5000110-13	5000110-18	5000110-17	1/2
5	250*	8	16	SEOW-A	3 6 12	5000111-14 5000111-15 5000111-16	5000111-11 5000111-12 5000111-13	5000111-18	5000111-17	1/2

Face View of Male

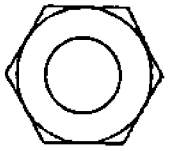
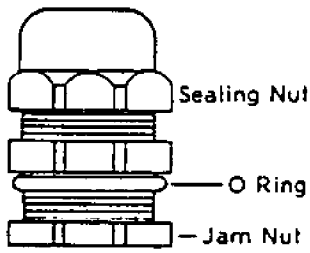
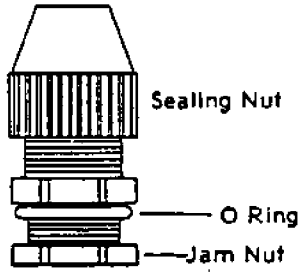
2 POLE	3 POLE	4 POLE	5 POLE
1. White	1. Green	1. Black	1. White
2. Black	2. Black	2. White	2. Red
	3. White	3. Red	3. Green
		4. Green	4. Orange
			5. Black

Accessories
Adaptor -1316511
Threaded Aluminum Adaptor to couple Male and Female Plugs
Dust Cap with Chain for Receptacle - 3316582-1
Dust Cap with Chain for Plug - 3316582-2

Note: Refer to price list for identification of stock items
Temperature Rating 90°C
Pressure Rating 30 PSIG on Receptacle
*Wire and Cable rated at 600 V

CABLE CONNECTORS

Cable connectors provide strain relief and a liquid-tight seal — all in one connector. By merely inserting the cord or cable through the center hole and screwing down the sealing nut, the cable is held in position, centered, sealed, strain relieved, and automatically adjusted to the size of the cable.

WIRE/CABLE ACCOMMODATED	ROUND CABLE, LIQUID TIGHT CONNECTORS		SPECIFICATIONS
18/2 SJ - SJO - SJTO 18/3 S - SO - STO 18/4 16/2 ST - STO - SJTO 16/3 S - SO - STO 16/4 14/2 SJO 14/3	**P/N RCC-8** ½" NPT HUB Max. dia. .480 Min. dia. .270		MATERIAL: Polymid-flame resisting, self-extinguishing plastic THERMAL RESISTANCE: -22° F (-30° C) to 212° F (100° C) O RING: Neoprene plastic (Included) HOLE REQUIREMENT: NPT threaded OR Clearance holes (Jam Nut is included)
14/2 14/3 S - SO - STO 14/4 12/2 12/3 S - SO - STO 12/4 10/2 10/3	**P/N RCC-12** ¾" NPT HUB Max. dia. .709 Min. dia. .545		
	FLAT UF CABLE, LIQUID TIGHT CONNECTORS		
14/2 UF 12/2 UF 10/2 UF	**P/N UFCC-8** ½" NPT HUB Min. .190 x .400 Max. .280 x .550		MATERIAL: Weather stabilized Thermo plastic THERMAL RESISTANCE: -29° F (-34° C) 221° F (105° C) O RING: Neoprene plastic (Included) HOLE REQUIREMENT: NPT threaded OR Clearance holes (Jam Nut is included)
14/3 UF 12/3 UF 10/3 UF	**P/N UFCC-12** ¾" NPT HUB Min. .190 x .625 Max. .280 x .775		

APPENDIX FIVE

1. Emerson and Cummings

2. Corrosion Data For Valves

EMERSON & CUMING™
a GRACE company

Product Listing

Product	Description
UNICAST™	One-component, epoxy casting resins including general purpose, thermally conductive and fire retardant.
STYCAST®	Two-component, epoxy casting resins including general purpose, thermally conductive, lightweight, fire retardant and clear varieties.
ECCOSIL®	Silicone casting resins for mold making, encapsulation, clear systems, low density and thermally conductive versions are standard.
ECCOSEAL®	Epoxy impregnant and casting resins.
UNISET®	One-component adhesives and casting materials with a wide range of properties for general and specialized applications.
ECCOBOND®	Two-component, high strength, high performance adhesives for industrial and electronic use. Thermally conductive, fire retardant and clear formulations. ECCOBOND, electrically conductive adhesives – Silver, low cost silver and non-silver grades available for cold solder, wire bonding and shielding applications.
UNISET UV	Fast curing U.V. systems for adhesive and coating applications which cure when exposed to ultraviolet light.
UNISET Pellets	Preformed epoxy shapes for sealing and bonding wire leads.
UNICOAT™	One-component conformal coatings for electronics, dip coats for resistors and capacitors and spray or brush coatings for general purpose applications.
ECCOCOAT®	Two-component coatings for electronics, dip coats for resistors and capacitors, conformal coatings for circuit boards, spray or brush coating for general purpose applications.
ECCOSHIELD®	Adhesives, coatings, caulks, sealants, tapes and gaskets for EMI/RFI shielding applications, static dissipation and electrical ground planing.
AMICON® Conductive Products	Adhesives, polymer thick film inks, and component coatings for circuitry fabrication and assembly.
AMICON® Electronic Materials*	Silver-filled epoxy, polyimide or glass for die attach. High strength adhesive tapes to comply with MIL-STD 883C, Method 5011.
[illegible]	Mold release agents, stripping agents, primers and epoxy color pastes.

Emerson & Cuming, Inc.
77 Dragon Court, Woburn, MA 01888 • (617) 938-8630
For technical assistance, call TOLL FREE: 1-800-TECHWAY (1-800-832-4929)

** For questions concerning product availability, order placement, confirmation and delivery of electronic and hybrid materials, contact:*
869 Washington Street, Canton, MA 02021 • (800) 225-9936, *in MA call* (617) 828-3300

2M490E-J078-490 R

Worcester Controls
33 LOCKE DRIVE, PO BOX 538
MARLBOROUGH, MA 01752-9906
(508) 481-4800 TELEX 92-0415
TELECOPY (508) 481-4454
A BTR Company

CORROSION DATA

The following chart is intended as a guide to the engineer in the selection of materials for corrosive service.

No one material can be expected to resist the corrosive action of the wide variety of media found in the complex industries of today. However, experience and research have indicated to us that certain materials will perform satisfactorily under certain conditions and within certain limits.

The physical properties of a material are affected differently by each corrosive medium and is sometimes necessary to sacrifice values in one property to gain a maximum value in another property. It is necessary, therefore, that the user decide, based on his experience, which property is of prime importance for his application.

Internal moving parts, in contact with the media ideally should carry an **"A" rating. Body materials** in direct contact with the media can in many cases, **carry a "B"** rating because the rate of corrosion is not fast enough to become a serious problem.

Although most of the suggested ratings in the following chart are based on experience, it is strongly recommended that, if any question exists regarding the expected performance of a material in a given application, that actual tests be performed to determine the suitability of the materials in question.

EXPLANATION OF RATINGS

A = Excellent
B = Good
C = Poor
D = Do not use
Blank = No Information

NOTE: Ratings are based on media at room temperatures unless otherwise specified.

When using this table, please remember that in any given case many factors such as solution, concentration, temperature, degree of agitation and presence of impurities influence the rate of corrosion. Particularly note the effect of increased temperature on Grafoil and Metal "G" in the presence of oxidizing agents. Corrosion rates generally increase dramatically under these conditions. Worcester Controls Corporation cannot accept responsibility for problems arising from the use of these data. We suggest that in critical applications, test be conducted to verify the ratings.

Corrosion Data

Chemicals	Brass	Carbon Steel	Ductile Iron/Cast Iron	316 Stainless Steel	17-4PH	Alloy 20	Monel	Hastelloy C	Buna N (Nitrile)	Delrin/Lubetal	EPDM/EPR	Viton	Hypalon	Neoprene	Nylon	Metal "A"	Grafoil	Metal "G"	Teflon - Reinforced/ or Polyfill	High-per Fill	UHMWPE
Fatty Acids	C	D	D	A		A	B	A	B	A	D	A	D	B	A	A	A	A	A	A	A
Ferric Hydroxide				A		A	A		B	A						A	A	A	A	A	
Ferric Nitrate	D	D	D	C	B	A	D	B	A	A	A	A	B	A		C	B	C	A	A	A
Ferric Sulfate	D	D	D	B	B	A	D		A	A	A	A	A	A	C	B	A	B	A	A	A
Ferrous Ammonium Citrate				B		B				A						B	A	B	A	A	A
Ferrous Chloride	B	D	D	D		D	D	D	A	A	A	A	B	A	C	D	A	D	A	A	A
Ferrous Sulfate	B	D	D	B		B	B	B	A	A	A	A	B	A		B	A	B	A	A	A
Ferrous Sulfate, Saturated	C	C	C	A		A	B	B	C	A	B	B	B	C		A	A	A	A	A	
Fertilizer Solutions	C	B	B	B		B	B		B					B		B	A	B	A	A	
Fish Oils	B	B	B	A		A	A		A	A	D	A	D	B		A	A	A	A	A	
Flue Gases	B		B	A		A	B		C	C	D	C	B	C		A	A	A	A	A	
Fluoboric Acid				B		A			A	D			B	B		B			A	D	A
Fluorosilicic Acid	B	D	D	B		B	A	B	C	C	C	C	C	C		B			A	D	A
Formaldehyde, cold	A	A	B	A	A	A	A	B	B	A	B	D	C	C	A	A	A	A	A	A	A
Formaldehyde, hot	B	D	D	C		B	B	B	B	A			B	B		C	A	C	A	A	A
Formic Acid, cold	B	D	D	B	B	A	B	A	D	D		B	C	B	A	B	A	B	A	A	A
Formic Acid, hot	B	D	D	B	D	B	B	B	D	D		A		A	D	B	A	B	A	A	A
Freon Gas, dry	B	B	B	A	A	A	A	B	C	A	C	C	B	C	A	A	A	A	A	A	
Freon 11, MF, 112, BF	B		C	A		A	B	B	C	A	C	D	B	C	A	A	A	A	A*	A	
Freon 12, 13, 32, 114, 115	A		B	A		A	B	B	B	A	A	D	B	A	A	A	A	A	A*	A	
Freon 21, 31	B		C	A		A	B	B	D	A	D	D		D	A	A	A	A	A*	A	
Freon 22	A		B	A		A		B	D	A	D	D		B	A	A	A	A	A*	A	
Freon 113, TF	B		C	A		A	B	B	B	A	C	C		C	A	A	A	A	A*	A	
Freon, wet	D		D	C	B	B	B	B	B	A	B	D	B	B	D	C	A	C	A	A	
Fruit Juices	B	D	D	A		A	B		A	A	A	A	C	A		A			A	A	A
Fuel Oil	B	B	B	A		A	B		A	A	D	A	C	C		A	A	A	A	A	D
Fumaric Acid						A			B	A				B					A	A	
Furfural	A	A	B	A	B	A	B	B	D	A	C	D	D	C		A	A	A	A	A	D
Gallic Acid 5%	C	D	D	B		B	B	B	B	A	C	A	C	B	A	B			A	A	A
Gas, Manufactured	B	B	B	B		B	A		A	A		A		A	A	B	A	B	A	A	
Gas, Natural	B	B	B	A		B	A		A	A	D	A	B	A	A	A	A	A	A	A	
Gas, Odorizers	A	B	B	B		A	B		B	A		A		B	A	B	A	B	A	A	
Gasoline, Aviation	A	A	B	A		A	A	A	C	A		A		D	A	A	A	A	A	A	D
Gasoline, Leaded	A	A	A	A		A	B	A	C	A		A	B	D	A	A	A	A	A	A	D
Gasoline, Motor	A	A	B	A	A	A	A	A	C	A	D	A	D	D	A	A	A	A	A	A	D
Gasoline, Refined	B	B	B	A		A	B	A	C	A	D	A	D	C	A	A	A	A	A	A	D
Gasoline, Sour	B	B	B	A		A	C	A	C	A	D	A	C	D	B	A	A	A	A	A	D
Gasoline, Unleaded	A	A	B	A		A	A	A	C	A		A	B	D	A	A	A	A	A	A	D
Gelatin	A	D	D	A		A	B		A	A	A	A	B	A	A	A	A	A	A	A	A
Glucose	A	B	B	A		A	A	A	A	A	A	A	B	A	A	A	A	A	A	A	A
Glue	B	A	B	B		A	B	A	A	A	B	A	B	A	A	B	A	B	A	A	A
Glycerine (Glycerol)	B	C	B	A	A	A	A	A	C	A	A	B	A	D	A	A	A	A	A	A	A
Glycol Amine	D		B	B	A			D	A	C	D	D	C			A	A	B		A	
Glycol	B	C	B	B		A	B		B	C	A	A	B	A		B	A	B	A	A	A
Graphite	B		C	B		A	B		B	A	B	B	B	B		B	A	B	A	A	
Grease	C	A	A	A		A	B		A	A	D	A	D	B		A	A	A	A	A	
Helium Gas	B		B	A		A	B	A	B	A	B	B	B	B		A	A	A	A	A	A
Heptane	A	B	B	A		A	B	A	A	A	D	A	B	B		A	A	A	A	A	C
Hexane	B	B	B	A		A	B	A	A	A	D	A	B	C	A	A	A	A	A	A	D
Hexanol, Tertiary	A	A	A	A		A	A	A	A	A	D	B	C	C	A	A	A	A	A	A	A

Ratings: **A**—Excellent **B**—Good C—Poor D—Do not use **Blank**—No information

APPENDIX SIX

1. Air Pneumatic System

2. Omega Systems (flowmeter)

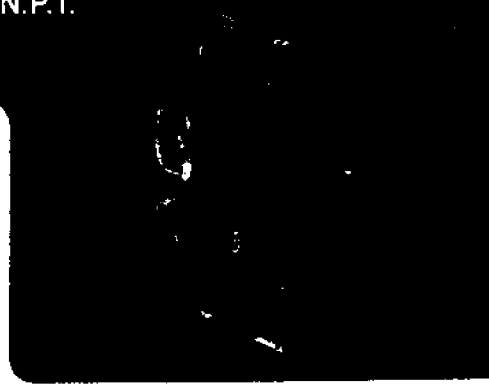
3. Tattletale

4 WAY PILOT OPERATED 2 POSITION
Miniature Directional Control Valves

Aluminum Body • Sub-Base and Manifold Mounted • ⅛" and ¼" N.P.T.

ASCO Red-Hat

8401 8402
SERIES



General Description

These compact designs have a durable ceramic flow plate and dimensionally-stable, self-lubricating Delrin* slide with a "break before make" design to assure positive shifting.

Pressure and/or exhaust ports can be restricted, or an optional built-in linear flow device can be used to control cylinder speed.

Specifications

Solenoid: Molded epoxy open frame solenoid. Can be converted from AC to DC, or vice versa, by simply changing the coil.

Additional constructions are available. The Optional Electrical Features Section, page 11, contains descriptions and ordering information for:
- DIN Coil per ISO 4400/DIN 43650
- ½" Threaded Conduit Hub.

Constructions:
Solenoid Operated Valves: Single and dual solenoid constructions are available. Dual solenoid construction may be energized continuously or momentarily. (Cycle time depends on cylinder size and speed control setting.)

Important: Do not energize both solenoids simultaneously.

Important: Loss of main line pressure will not cause these constructions to shift in either position.

Single Air Piloted Valves: Refer to graph for relationship of auxiliary pilot air pressure to main line pressure.

Important: Valves will not change position if main line pressure is lost as long as pilot pressure is present. If pilot pressure is lost, valve will change position even if main line pressure is present.

Electrical: Standard Voltages:
24, 120, 240 volts, AC, 60 Hz
(or 110, 220 volts, AC, 50 Hz)

6, 12, 24, 120, 240 volts, DC

Other voltages are available when required.

Coil: Continuous duty molded Class F

Nominal Ambient Temperature Ranges: AC Construction: 0°F. to 135°F.
DC Construction: 0°F. to 77°F.

Refer to Engineering Section for details.

Note: For temperatures below 32°F., moisture-free air must be used. Consult your local ASCO sales office for lower temperature requirements.

Valve Parts in Contact with Fluid:
Main Valve Body, Sub-Base, Manifold Base and End Caps — Aluminum
Pilot Valve Body — Molded Zytel Nylon
End Caps — Stainless Steel
(non-metering construction);
Molded Zytel Nylon (metering construction)
Seals — Low friction, low wear Buna "N" (carboxylated nitrile)
Spool and Slide — Molded Delrin
Flow Plate — Ceramic (alumina)
Core Tube — 305 s.s.
Core and Plugnut — 430F s.s.
Springs — 302 s.s.

Other Features: Combination momentary (push) and maintained (push/turn) manual operator is standard.

Optional built-in linear flow device capable of controlling Cv from 0.10 to 0.80 is available.

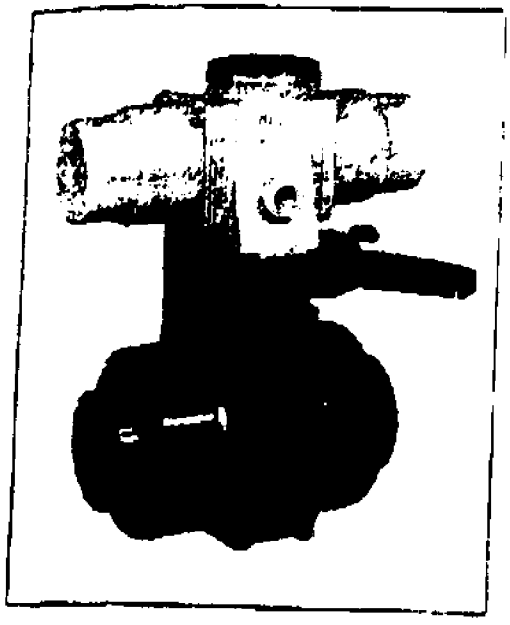
Ordering Information:
Important: We must have catalog number, voltage and Hertz, operating pressure and fluid handled.
Use strainers with solenoid and air operated valves.

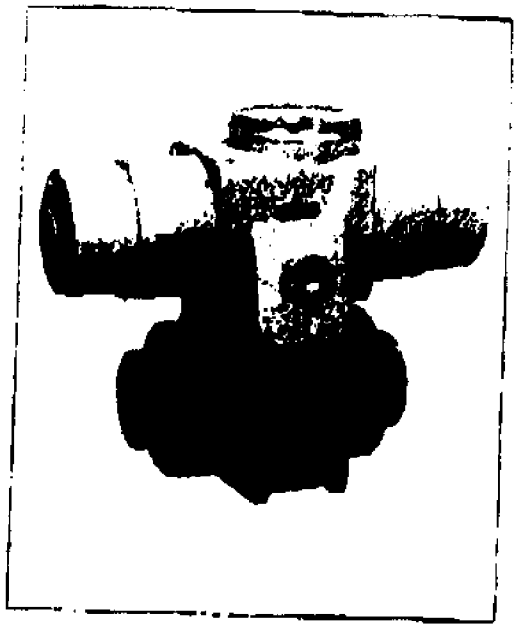
*DuPont Co. trademark

SPECIFICATIONS

Pipe Size (Ins.)	Orifice Size (Ins.)	Cv Flow Factor	Main Line Supply Press. (psi) Min.	Max. AC Air-Inert Gas	Max. DC Air-Inert Gas	Max. Fluid Temp. °F. AC	Max. Fluid Temp. °F. DC	Open Frame Solenoid Sub-Base Mounted Catalog Number	Sub-Base Mounted Constr. Ref. No.	Manifold Mounted Catalog Number	Manifold Mounted Constr. Ref. No.	Watt Rating/ Class of Coil Insulation AC	Watt Rating/ Class of Coil Insulation DC
SINGLE SOLENOID													
⅛	¼	.80	20	150	150	135	135	U8401100	1	U8401102	3	6.2/F	7/F
¼	¼	.80	20	150	150	135	135	U8401101	2	U8401103	3	6.2/F	7/F
DUAL SOLENOID													
⅛	¼	.80	20	150	150	135	135	U8401104	4	U8401106	6	6.2/F	7/F
¼	¼	.80	20	150	150	135	135	U8401105	5	U8401107	6	6.2/F	7/F
SINGLE AIR PILOTED													
⅛	¼	.80	20	150	150	135	135	8402100	7	8402102	9	—	—
¼	¼	.80	20	150	150	135	135	8402101	8	8402103	9	—	—

With Pneumatic Actuator Unit, Type 220





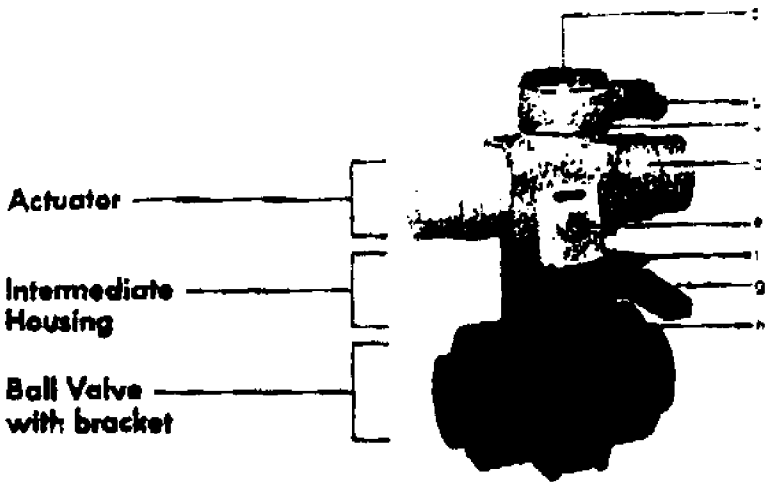
General

George Fischer offers a comprehensive range of pneumatically actuated valves which meet the demand for high standards in industrial pipeline installations. Type 220 is a 2-way ball valve available in PVC in sizes DN 10–DN 50/ d 16–d 63 with pneumatic actuator units PA 10 and PA 20. The valve, with choice of seal materials and an extensive selection of accessories, is eminently suitable for a wide range of applications. High standards of quality and long working life are hallmarks of all George Fischer ball valves.

General Features

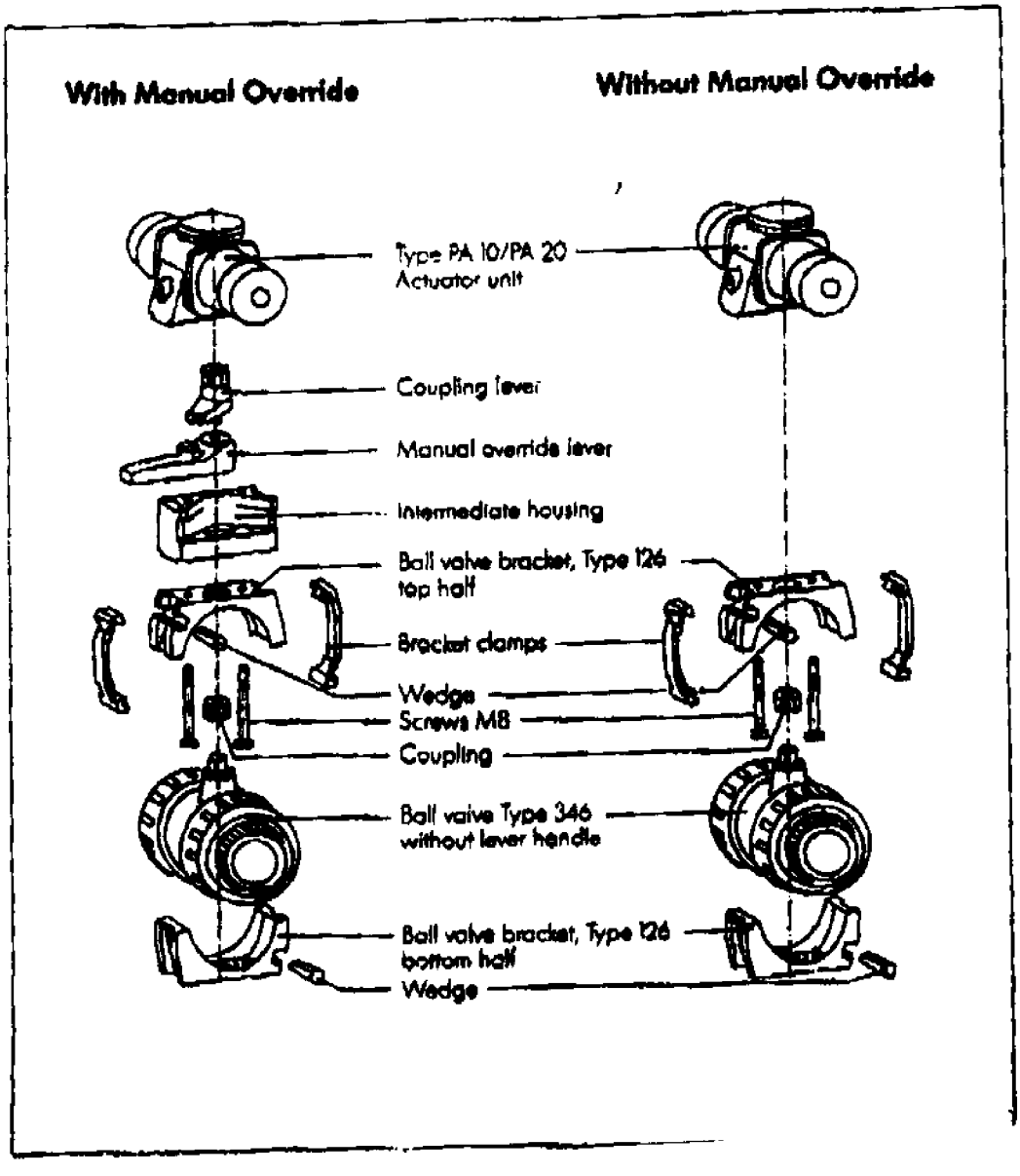
- Modular construction provides flexibility in planning and operation.
- Supplementary components can be added after installation to cater for additional control and signalling functions.
- Compact and sturdy, all plastic corrosion resistant actuator. Ideal for use in aggressive environment.
- Long working life with maintenance-free operation.
- Optimum flow characteristics.
- Two actuator sizes (PA 10/PA 20) for optimum adjustment to the required torque.

Technical Features



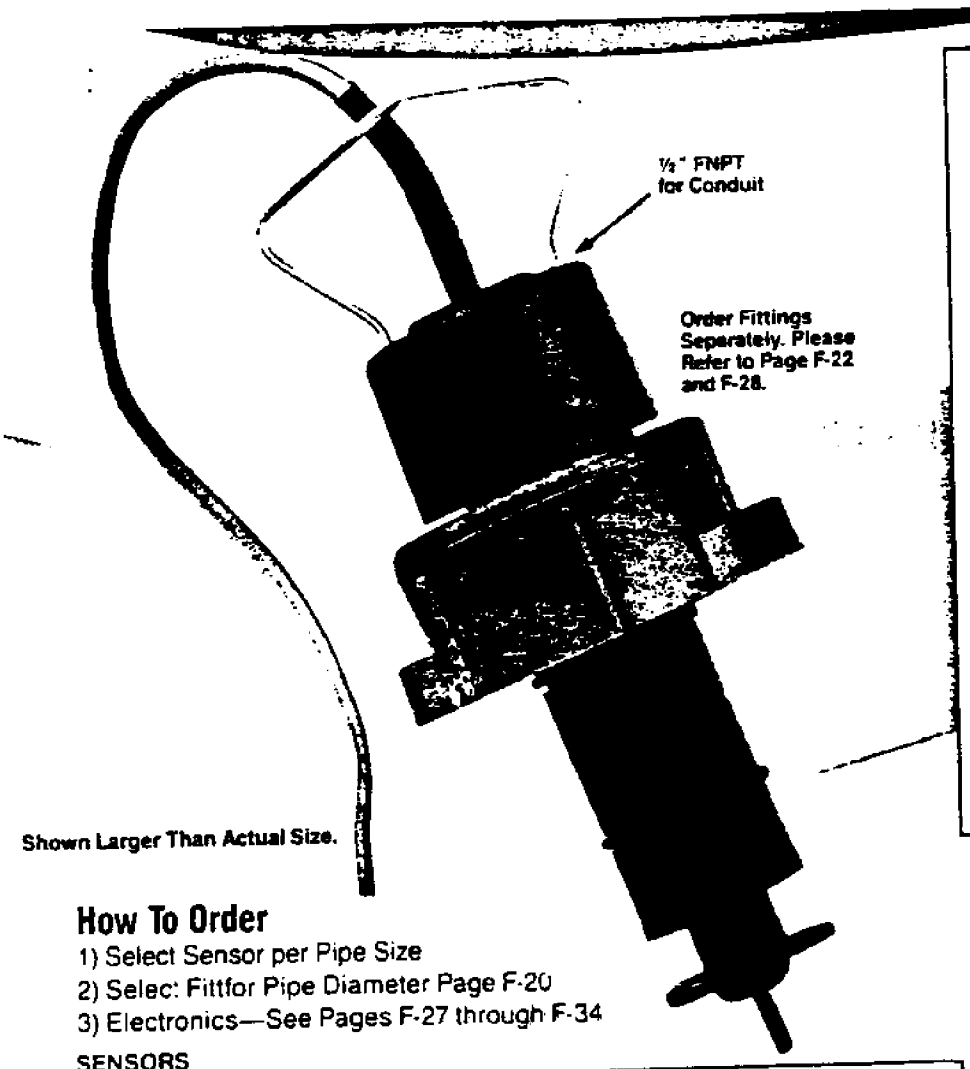
a) Visual position indicator
b) Cable plug for supplementary components
c) Supplementary components for output signal
d) Small and compact actuator unit in PP-GF orange
e) Brass bush G ¼" female for control pressure connection
f) Catch
g) Manual override lever
h) Intermediate housing

Assembly of Valve



ACCURATE INDUSTRIAL FLOWMETER SY

Paddle Wheel Flow Sensors + Installation Fittings + Elec



Shown Larger Than Actual Size.

- For Liquids
- Low Pressure Drop
- Range: 1 to 50 FPS
- Inert to Most Acids and Bases
- ±1% Sensor Accuracy*
- Easy to Install and Maintain
- All Plastic Design Available

2 YEAR

WARRANTY

$160

How To Order

1) Select Sensor per Pipe Size
2) Selec: Fittfor Pipe Diameter Page F-20
3) Electronics—See Pages F-27 through F-34

SENSORS

Model No.	Price	Accuracy*	Pipe Size
FP-5300	$160	± 1% full scale	0.5" to 4.0" Diameter
FP-5301	190		6.0" to 8.0" Diameter

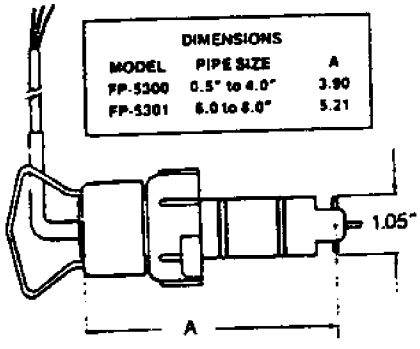
*All installation fittings are supplied with a plug for use when sensor is removed for repair or cleaning.

NOTE: For all plastic unit with PVDF rotor shaft, add suffix "AP" to sensor part number and add $31 to base price.

SPECIFICATIONS:

Output Signal: Sine wave, 1 V p-p per ft./sec.
Output Frequency: 5-6 Hz per ft./sec.
Source Impedance: 8 K ohm
Range: 1-50 FPS
Linearity: ±1% full scale
Accuracy: ±1% full scale
Repeatability: ±0.5% full scale
Maximum Pressure: 200 PSIG max. at 68°F (20°C)
Maximum Temperature: PVC: 140°F max. @ 25 PSIG. CPVC: 180°F
Maximum Percentage of Solids: 1% of fluid volume
Pressure Drop: Equal to 8 ft. straight pipe.
Material: Transducer Housing: glass-filled polypropylene: O-Rings: Viton; Shaft: Titanium; PVDF opt. Rotor: PVDF
Cable Length: 25 ft., can be extended with copper wire to 200 ft.

The OMEGA® Series FP-5300 Flow Sensor is an electromechanical volumetric flow transducer which generates a sine-wave output with a frequency and amplitude linearly proportional to the rotor rotation velocity. Liquid flow rotates four permanent magnets past a coil, inducing an AC voltage proportional to this rotation rate. The frequency output is two cycles per rotation.

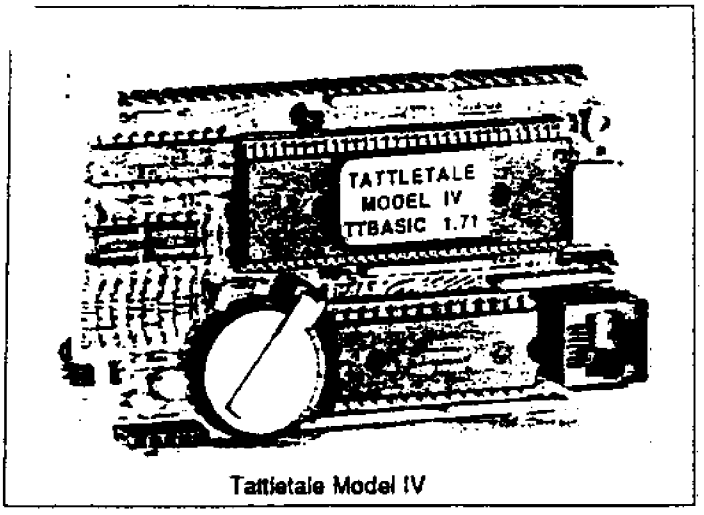


OMEGA's patented open-cell rotor design eliminates cavitation at flow rates up to 50 FPS for providing and maintaining superior linearity. Closed or solid rotor designs will cavitate at these velocities, creating a non-linear and non-repeatable signal.

The FP-5300 Flow Sensor is designed for operation in ½ inch through 4 inches, where flow is fully developed. In 6 to 8 inch pipes, the FP-5301 should be used. These sensors can be used with fluids containing particulate matter up to 1% of volume.

Tattletale® Model IV

0-28K Storage
2 mA dormant



Tattletale Model IV

Features

- 32K for program, variables and storage
- Data storage expandable to 2 Megabytes
- 11-channel, 10-bit A-D ratiometric converter
- 16 programmable digital I/O lines
- 2.25" x 3.725" x 0.8" size
- 2-15 mA operating
- 2 mA dormant, 30 µA 'DONE'
- TTBASIC operating system
- Battery-backed RAM
- Onboard voltage regulator
- Onboard temperature sensor

Applications

Tattletale Model IV addresses applications where small size and low cost are the primary design considerations. Even so, the Model IV boasts extensive versatility with its 11-channel,10-bit A-D converter and 16 digital I/O lines. Instead of utilizing an EPROM, the Model IV maintains the user's program in RAM with an onboard lithium button cell. The lithium backup battery provides at least six months of data retention after the main battery has been removed or has opped below 3 volts.

Applications requiring more data storage can take advantage of the 4MAT and 4PLUS boards to increase the Model IV's capacity to as much as two Megabytes, while allowing operation with average currents as low as 120 µA.

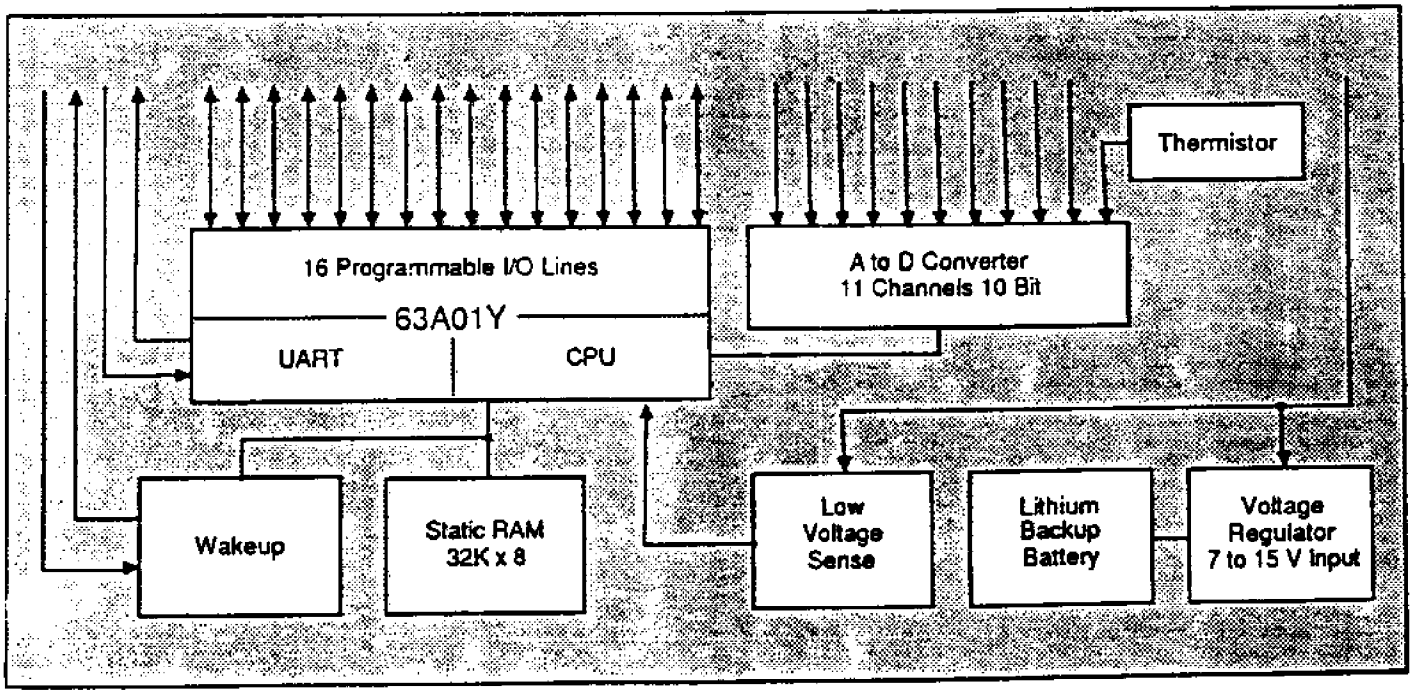
TTBASIC

The Model IV's version of TTBASIC takes advantage of the board's unique hardware.

1) The low power DONE mode places the Model IV in a dormant mode, reducing the current drain to 30 µA. The program will restart when the pushbutton on the interface cable or the board's 'wakeup' pins are momentarily connected.

2) The Model IV has a software real-time clock that will keep time as long as DONE is not executed.

3) The user can divide 28K among program, array variable storage and data storage.



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6301 CPU

The Model IV is based on the 6301 CPU chip. This part is a descendant of Motorola's 6800, but is all CMOS, and has a thoroughly enhanced instruction set that includes 8 bit x 8 bit multiply, and new bit setting and clearing functions. The instructions are fast and very complete. The 6301 has a built-in UART, two timers, 256 bytes of RAM and a host of I/O lines. Most of these features are invisible to the user. They are, however, responsible for TTBASIC's remarkably fast execution speed. The 6301's 4.9152 MHz crystal is adjusted within 5 ppm of its nominal frequency at room temperature, ensuring accurate timekeeping.

The Model IV's TTBASIC is resident in the 6301's 16K ROM.

Hardware UART

The UART is actually located on the 6301. Unlike Models II and III, the Model IV's drivers are mounted in the interface cable. The connections to the interface cable are made at a 6-pin modular socket on the corner of the board.

The UART is interrupt-driven and has a 256-byte input buffer. On power-up the UART runs at 9600 baud. As with Models II and III, the rate can be changed to 1200 or 300 baud using simple commands.

Two other lines are also available at the plug. When momentarily shorted, these lines can wake the Model IV from its low-power 'DONE' mode. These two lines as well as the serial in and out lines are located at a set of 0.025" square pins spaced 0.1" apart next to the modular connector.

16 Digital I/O Lines

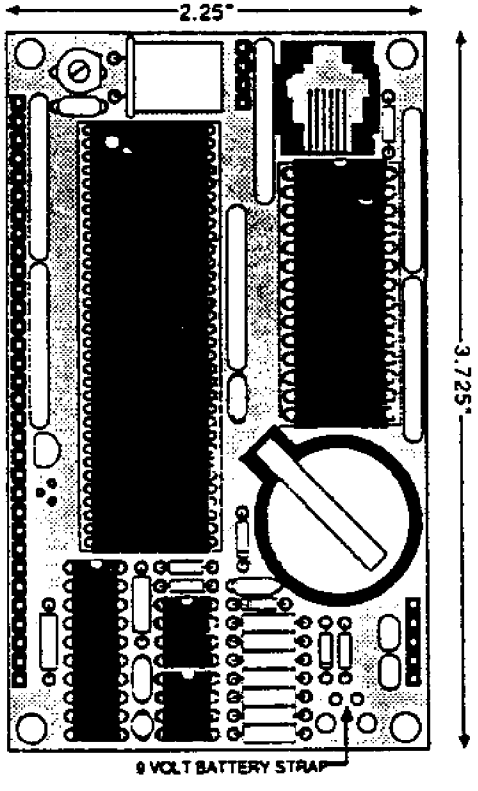
The Model IV has 16 digital I/O lines which can be programmed individually as inputs or outputs. Most of these lines have specialized uses, as software UART, counter input, square wave output, shift register input and output, and interrupts.

Pins D14 and D15 have no alternate use. All other digital I/O pins have the same alternate uses as the Model II (see page 3).

These lines are available at 0.1" spaced 0.025" square pins, along with ground and +5V. Each pin is capable of driving one TTL load, and all are configured as inputs at power-up.

Battery Strap

The Models II, III and IV have a 6" (15 cm) long battery connector attached to the board. This two-conductor wire is designed to connect to a 9-volt transistor radio battery or battery stack with the same snap-type connection.



Tattletale® Model IV

32K byte RAM

Virtually all of the Model IV's RAM is in a socketed 32K x 8 RAM chip. 4K is used for stack and system variables. The remaining 28K can be divided up in any way among program, array variables and data storage. The part is socketed to allow access to the 6301's address and data buses from an add-on card by connecting to the socket. This approach is used by the 4MAT datafile expansion board and its expansion board, the 4PLUS.

Lithium Battery

The Model IV has a lithium battery to retain program and data if the main battery is removed or drops below three volts. This battery has ample capacity to maintain the memory for six months at normal temperatures. The CR2032 battery is standard and available from a number of manufacturers.

10-bit, 11-channel A-D Converter

The Model IV's converter is designed to make conversions ratiometric to the Tattletale's nominal 5-volt supply. The reference input to the converter is brought to one of the pins. A one-ohm resistor mounted on the board shorts the reference input to the converter's switched supply, and should be removed if an external reference is to be used. If used as an absolute converter, its accuracy is degraded to slightly better than 8 bits due to the supply rejection characteristics of the converter.

Channel 10 measures a thermistor divider, and can be converted to tenths of a degree C using TTBASIC's TEMP function.

Voltage Regulator

The Tattletale has a voltage regulator built onto the board. The regulator will accept a 7- to 15- volt input and provides an average current of 20 mA, a little more than needed by the Model IV itself. The regulator is current limited so that accidentally shorting the supply out will not damage the board. The supply voltage is fixed at 5.00 ± 3%.

Should the supply voltage drop below 6.5 volts, the Model IV will drop into a 'DONE'-like dormant mode. No program or data will be lost and the program will automatically restart (from the lowest TTBASIC line number) as soon as the battery is replaced or recharged.

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