SERIES M-92

U. S. Patent # 5,654,885

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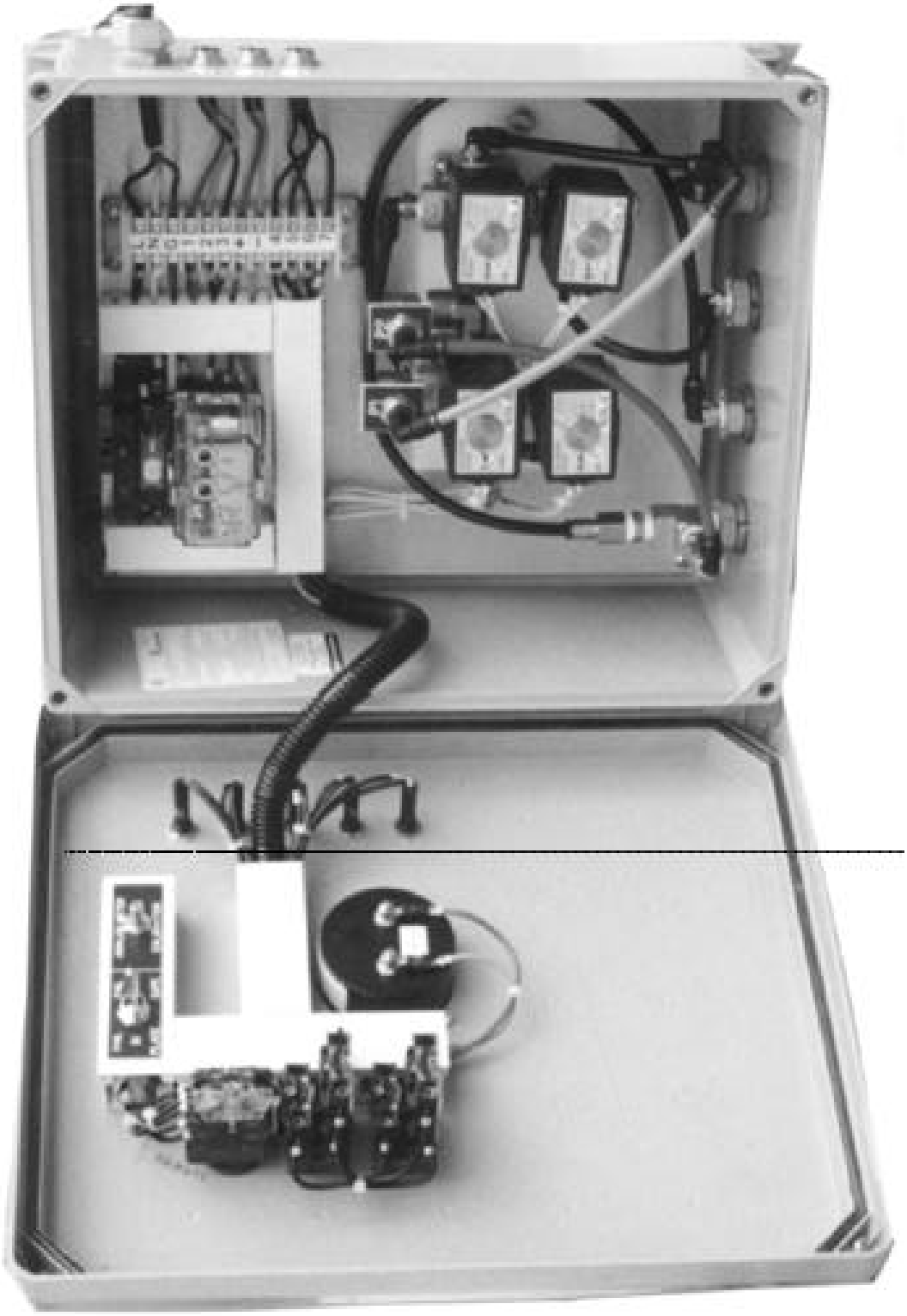
ACTUATOR
POSITIONING SYSTEM

ELECTRO-POSITIONING FOR
DOUBLE ACTING OR SPRING RETURN
HYDRAULIC OR PNEUMATIC
ACTUATORS



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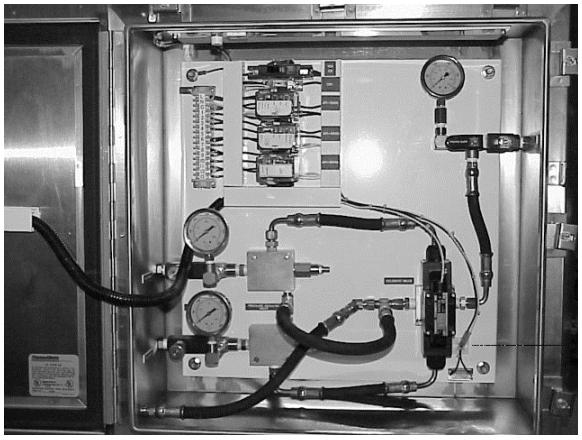
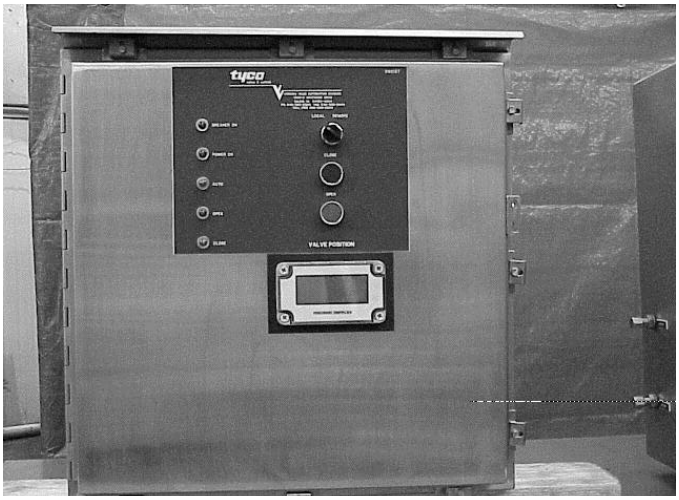
ACTUATOR POSITIONING USING…

Standard Hydraulic or Pneumatic Actuators



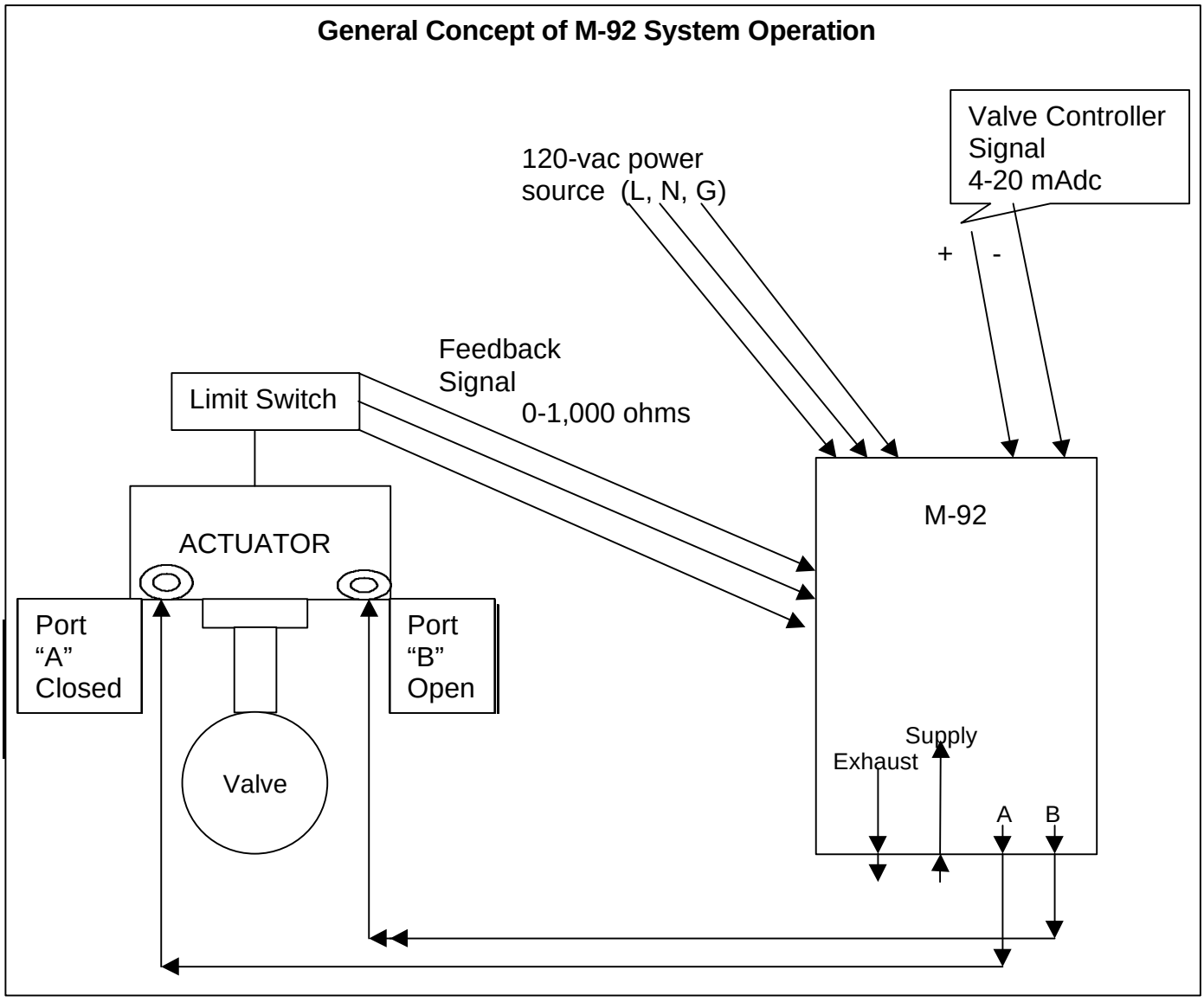


- **Same unit suitable for all types of hydraulic or pneumatic actuators.**
- **Custom designed systems available.**
- **Positioning for both quarter-turn and linear actuators.**
- **Variable speed for both “Open” & “Close” via standard flow control valves.**
- **Suitable for air, oil hydraulic or water hydraulic service.**
- **120-vac input power.**
- **Standard industrial components with interchangeable parts.**
- **Electric “Fail Safe” using spring return actuators or accumulator systems with double acting actuators.**
- **4-20 mAdc command input signal, standard.**
- **Can be remote-mounted away from actuator.**
- **“Auto / Manual” modes for local manual override.**

PRINCIPAL OF POSITIONER OPERATION:

The M-92 Positioner/Controller gives a variable pressure (water, oil or air) output signal in response to receiving a variable input command signal (4-20 mAdc). The M-92 positions an actuator (linear or quarter-turn) in response to a valve stem position feedback signal (0-1,000 ohms or 4-20 mAdc). A 4-20 mAdc command input signal is received from a process controller. This command input signal is then compared to the valve stem position feedback signal. The M-92 has a single-pole-double-throw (SPDT) center-off relay contact output switch. This switch is used with two (2) single-coil three-way solenoid valves. After comparing the values of both the command input signal and the valve stem position feedback signal, the switch will energize the proper coil transferring fluid power (water, oil or air) to the "Open" or "Close" port of the actuator. This transfer will cause the actuator to begin moving in the desired direction. The movement of the actuator causes the valve stem position feedback value to change. As the value of the feedback signal approaches the value of the command input signal the relay output shifts to the center-off position. At this point, the value of the two signals is equal and will remain so until the command signal changes again. When the two signals are equal, the M-92 is in a "steady state" and there is no fluid power (water, oil or air) being consumed.

General Concept of M-92 System Operation



Virginia Valve Co.

Automation Division

Series M-92

Actuator Positioning System

U.S. Patent # 5,654,885

Feature	Benefit
NEMA 4X FRP (fiberglass reinforced polyester enclosure, standard. Others available optionally.	♦ **Remote mounting capabilities** away from actuator. ♦ Indoor, outdoor and corrosive applications. ♦ Padlockable for security.
Can tolerate water, oil or air as its pressure media (up to 150 psig), standard.	♦ **Filtered and regulated instrument air is not required.** ♦ Suitable for pneumatic, water hydraulic or oil hydraulic applications.
"Manual / Auto" selector switch, standard.	◆ Permits **manual override and jogging** of actuator from M-92. ◆ Easier and safer maintenance and calibration procedures.
Analog or digital valve position meter on front panel, optional.	♦ **Visual confirmation** of valve/actuator position while in front of the M-92. ♦ Easier and safer maintenance and calibration procedures.
Circuit breaker, w/trip indicator, standard.	♦ **Electrical isolation** of M-92 for installation, maintenance and calibration.
Speed control valve, standard.	♦ **"Fine tuning"** of relationship between actuator and positioner to prevent or eliminate oscillation and overshooting.
Zero and Span adjustment.	♦ Quick and easy calibration adjustments.
Control module w/**adjustable deadband (differential).**	♦ Adjustable resolution of M-92.
Field selectable failure modes not only for spring return actuators but also for double acting actuators.	♦ "Fail Safe" (upon loss of 120-vac power) operation of any actuator
Zero "Bleed", standard.	♦ **Zero air consumption** while in steady state.
Insensitive to vibrations.	♦ Can be installed in difficult environments.
100% Bench testing and calibration prior to shipment.	Quality assurance. ◆ Documentation of operating performance at the time of shipment.

Feature	Benefit
Wide variety of optional, special and custom configurations.	◆ Broad application suitability. Relatively quick lead times on specials.
Standard industry-common components.	Easy replacement of components. ◆ Not "locked in" to manufacturer for costly proprietary components. Enhanced system "up time".
Legend plates and labeling of all critical system components.	Enhanced operator safety. ◆ Easy maintenance identification and troubleshooting.
Diagnostic "LED" light array.	System status available at a glance. ◆ Enhanced safety and troubleshooting during maintenance operations.
"Open and "Closed" pushbuttons, standard.	♦ Permits **manual override** from front panel of M-92 while in "Manual" mode only.
Auxiliary **"Dry contacts"** for remote "Open", "Closed" and "Auto" indication in control room. (Driven by customer-supplied limit switches).	◆ Provides a new set of dry limit switch contacts for remote applications. ◆ Provides easy and electrically safe connections to PLC for automated and remote operations.

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M-92 Actuator Positioning System

U. S. patent # 5,654,885

Performance*

Characteristic		Results
Hysteresis:	Maximum position error of the same input value, **when approached from opposite ends of the input scale.**	0.5% Full Scale
Repeatability:	Maximum variation in position for the same input value, **when approached from the same direction.**	0.36% Full Scale
Response Level:	Maximum change in input signal necessary to cause a change in the actuator position **in one direction.**	0.6% Full Scale
Deadband:	The change in input signal required to cause the actuator to move, when the direction of movement is reversed.	1.2% Full Scale
Resolution:	The smallest possible change in the actuator's position.	0.6% Full Scale
Steady-State Air Consumption:	Air consumption when the M-92 is in a steady-state (e.g. when the actuator has reached the position of the Command input signal).	0.0 SCFM @ any psig
Maximum Flow Capacity:	Maximum output of the pressurized media through the M-92 at a given supply pressure.	6.0 SCFM @ 100 psig
Stroking Speed:	Speed for a 100% step change in the input signal (e.g. from 4 to 20 mAdc) "Close" to "Open".	Opening =1.4"/Sec. Closing =1/4"/Sec.

NOTE: *Data is based upon tests of the M-92 Positioner installed on a linear application with 9" of stroke on a double acting cylinder with ¼" connections, an 8 sq. inch piston area, 80-psig of supply air pressure and a 4-20 mAdc command input signal.

NOTE: Accurately predicting valve/actuator/positioner "installed dynamic" performance is impossible. There are simply too many variables to consider in predicting actuator cycle times with positioners. "Full stroke" times for a particular positioner and actuator under a "zero" load can be calculated but would **not** be accurate for the same system or package under a live or "installed dynamic" valve load. The following equation can be used to predict actuator stroking times:

$$\text{Time} = \frac{\text{Required Free Air Volume}}{\text{System Flow Capacity}}$$

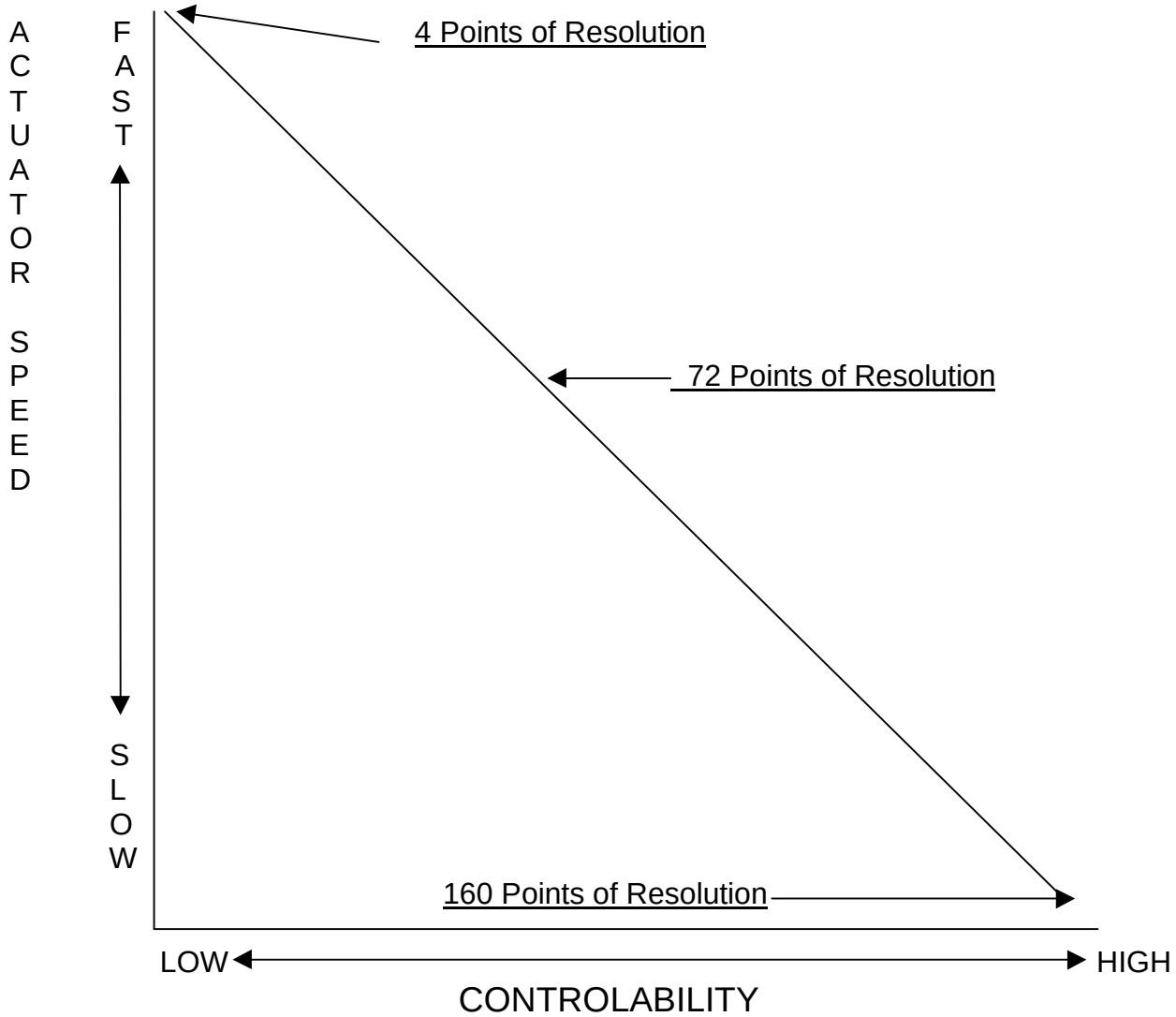
Example: A double acting actuator with 1 cubic foot of volume and no valve load is connected to an air supply which can deliver 5.0 SCFM @ 60-psig.

$$\text{Time} = \frac{1 \text{ SCFM}}{5 \text{ SFCM}} = 0.2 \text{ minutes} = 12 \text{ seconds.}$$

NOTE: All adjustments to performance involve tradeoffs. You cannot increase the sensitivity of the package or system without raising the likelihood of overshooting or oscillation. Likewise, you cannot reduce overshoot without also reducing the sensitivity of the package or system.

NOTE: Many parameters have to be considered to assure proper valve or damper functioning. Proper valve sizing ensures sufficient process flow with acceptable pressure drop. Correct actuator selection and sizing guarantees that valves will open, close and modulate properly. These two requisites are typically regarded as the most critical. However, other factors affect performance as well, although not as profoundly. In most cases, valve stroking speed is a concern. A fast stroking speed may be necessary for safety or process reasons. Excessively fast stroking speeds can cause controllability problems such as overshoot, reduced resolution, reduced repeatability, or damaging "water hammer".

Relationship of Actuator Speed vs Controlability



NOTE: For faster speeds with infinite resolution (positions), select Option # 11.

Actuator Positioning System:

Suggested Engineering Specification:

The system shall be equipped with the following provisions which will permit the positioning of an actuator both in an “Auto” mode and in a “Manual” mode given only a 120-vac power source, a command input signal, a valve stem position feedback signal and pressure media for the actuator:

A.) The unit shall be housed in a padlockable NEMA 4X FRP (fiberglass reinforced polyester) enclosure, which is suitable for both wall-mounting away from the actuator and bracket-mounting onto the valve/actuator assembly.
B.) The unit will have a 2-position “Auto / Manual” selector switch, which permits operation of the actuator either manually via front panel mounted pushbuttons or remotely via a command input signal (typically 4-20 mAdc).
C.) The unit will have two (2) pushbuttons, one for “Open” and one for “Close” actuator movements while in the “Manual” mode **only**.
D.) The unit will have a diagnostic “LED” light array. The five (5) lights are as follows: “Power On”, “Breaker On”, “Auto”, valve “Open” and valve “Close”.
E.) The unit will be suitable for 120-vac / 1 Ph / 60 Hz input power. It will include a terminal strip and legend plate for field wiring connections. Further, it will include a 3-amp circuit breaker.
F.) The unit will include a flow control valve on the exhaust port, which will permit “fine tuning” opening and closing actuator stroking speeds.
G.) The unit will include four (4) bulkhead connections at the bottom of the M-92 enclosure. They are as follows: valve “Open”, valve “Close”, “Exhaust” and “Supply Pressure”.
H.) The unit will contain locking solenoid valves to prevent “drift” of the actuator.
I.) The unit will be capable of operating both linear and quarter-turn actuators.
J.) The unit will be suitable for use on either pneumatic, water hydraulic or oil hydraulic actuators.
K.) The standard unit will be designed to operate at pressures up to 150-psig.
L.) The unit will have a toggle switch for “Fail-In-Place” or “Fail Safe” configurations upon loss of 120-vac power.
M.) The unit will be field configurable for double acting or spring return actuators.
N.) The unit will provide a “dry contact” electrical output for remote “Auto” mode indication.
O.) The unit will be suitable for operating pressure medias of water, oil or air.

The Actuator Positioning System shall be Model # M-92-
(see Model # Detail) as manufactured by Virginia Valve Co. Corp., 1390-C Southside Dr., Salem, VA 24153-4604.

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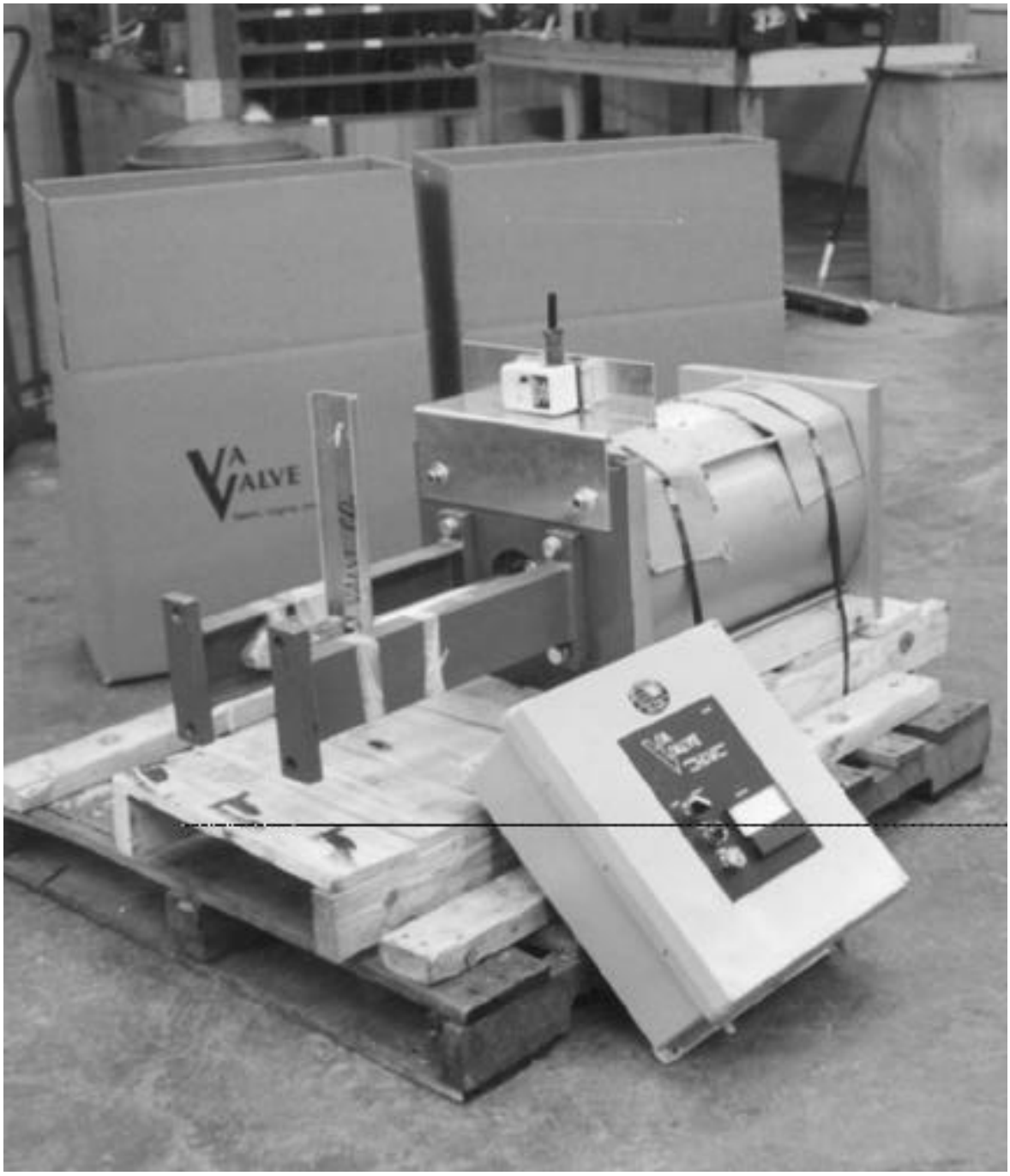


Modulating Control Unit

This M-92 positioner is modulating a 16” knife gate valve with a 4 – 20 madc input control signal. It is using the customer’s air supply, which happens to have a lot of water, oil and trash in the air lines. This application requires a manual override local station as well as at least 80 positions of resolution throughout the stroke of the valve. This positioning was at a speed of 3 – 5 seconds per inch of travel. The valve was to be located in an area that was not very accessible. Therefore, the M92 was mounted conveniently on a wall away from the valve and actuator to facilitate easy operator manual override for maintenance and calibration.

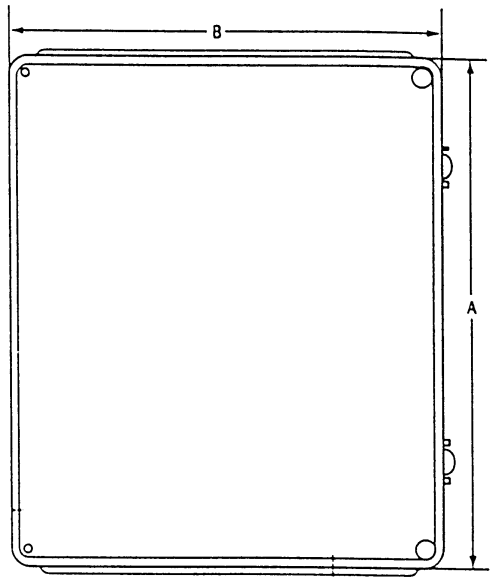
Series M-92

Actuator Positioning System

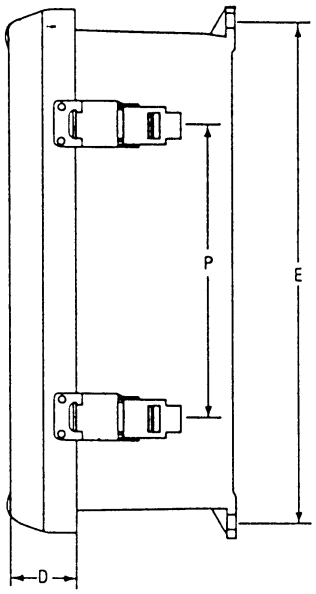
Technical Specifications

Enclosure:	NEMA 4X FRP (fiberglass reinforced polyester).14” H x 12” W x 5.84” D (Inside Dimensions). NEMA 4X stainless steel and NEMA 4 carbon steel are optionally available. Size will vary depending upon overall system requirements and customer specification.	
Power Required:	120-vac / 1 Ph / 60 Hz, (Standard).	
Circuit Breaker:	3-amps.	
Input Signal Range:	4-20 mAdc.	
Feedback Signal Range:	0-1,000 (1K) ohms, (Standard).	
Actuator Supply Pressure Media:	Water, oil or air, (Standard).	
Supply Pressure:	5-150-psig, (Standard).	
Operating Modes:	“Auto” / “Manual”.	
Manual Controls:	“Open” pushbutton “Close” pushbutton	
Diagnostic Lights:	“Power On” “Breaker On” “Auto” valve “Open” valve “Close”	
Connections:	Signal:	4-20 mAdc (Rec. ½” NPT for customer-supplied conduit). 0-1,000 ohm (Same as above). 120-vac power (Same as above).
	Pressure:	Media Supply = ¼” NPT female, (Standard). “Close” port = ¼” NPT female, (Standard). “Open” port = ¼” NPT female, (Standard).
Output:	“dry contact” for “Auto” indication. valve “Open” from limit switch (supplied by others). valve “Close” from limit switch (supplied by others).	
Weight:	25 lbs., (Standard).	

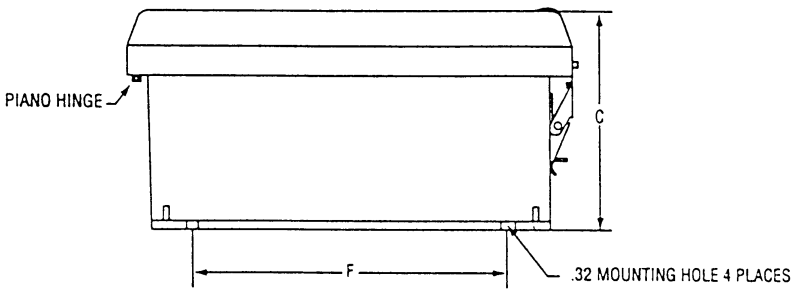
FRONT VIEW



RIGHT SIDE VIEW



END VIEW



Dimensions:

A.) = 15.32"
B.) = 13.30"
C.) = 6.70"
D.) = 1.75"
E.) = 14.75"
F.) = 10.00"
P.) = 9.45"

NEMA-4X -Gray hot molded FRP (fiberglas reinforced polyester) complete with stainless steel hinges, padlockable latches and UL / CSA label. Enclosure can withstand 300° F (180° F for electronics inside enclosure). Maintenance free and corrosion resistant. Wall mounted or suitable for bracket mounting. Estimated weight = 25 lbs.

Issue #:	Action:	Date:	By:	Issue #:	Action:	Date:	By:
1	Original	05-13-96	R. Furr				

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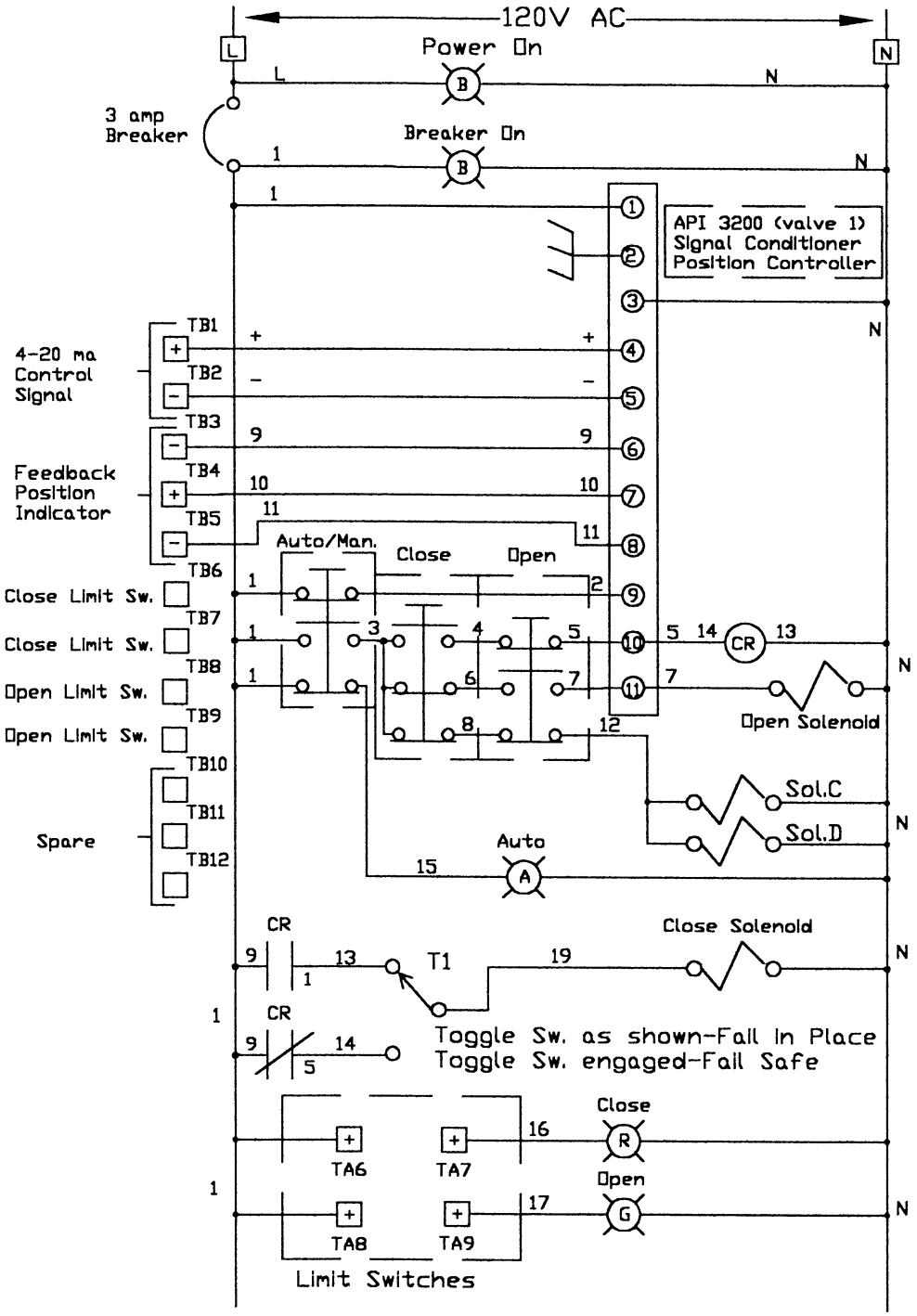
DRWG. TITLE: M-92 Actuator Positioning System Enclosure		
PROJECT NAME: M-92		
DATE: 05-13-96	SCALE: None	DRWG. #: M-92-ENCLOSURE
DRAWN BY: R. Furr	APPROVED BY: J. Mayhew	SHEET # 1 of 1



VA VALVE Virginia Valve Automation Division 1350-C Southside Dr. Tel. 540-389-0364 Salem, Va. 24153 Fax 540-389-0494	TITLE M-92			
	PROJECT			
	DATE 12/08/98	SCALE	DWG. NO. Electrical	
	DRAWN BY BGS	APPROVED	SHEET NO.	

Information Required To Correctly Size And Order A Series M-92 Actuator Positioning System:

1.) What is the actuator pressure media? Air?____ Oil?____ Water?___ Electric?

2.) What is the desired **maximum** system operating pressure range? _____ psig.

3.) What type of electrical enclosure is needed? NEMA

4.) What electrical input power available? _____ vac / _____ Ph / _____ Hz _____ amps

5.) Is a "Fail Safe" system required? Yes_____ / No

If "Yes", A.) Accumulator: Yes_____ / No_____ Required recovery time?
B.) Spring Return Actuator: Yes_____ / No

6.) Who is to furnish this system?

7.) What is the desired action upon a loss of 120-vac power?
What is the desired action upon a loss of command input signal?
What is the desired action upon a loss of feedback signal?

8.) Is a freestanding floor stand required for the M-92 enclosure? Yes_____ / No

9.) Is the actuator **linear** or **quarter-turn**?

10.) Is the actuator **double acting** or **spring return**?

11.) What is actuator Mfgr. and Model #?

13.) Who is furnishing this actuator?

14.) What is the designed **maximum** pressure rating of the actuator? _____ psig

15.) What is **minimum** pressure the actuator was sized for? _____ psig

16.) What is the command input signal? 4-20 mAdc_____ Other

17.) What is the valve stem position feedback signal? 0-1,000 ohms_____ 4-20 mAdc
Who is to furnish this feedback signal?

17.) What is the desired actuator stroking speed? Maximum_____ Minimum

18.) What is the **minimum** required thrust or torque to operate the valve?

19.) What are the ambient temperatures of the environment where this system will be operating? **Maximum** _____ ^{0}F / ^{0}C **Minimum** _____ ^{0}F / ^{0}C

20.) List any particular desires or options the customer might want to include

Series M-92 ACTUATOR POSITIONING SYSTEM
MODEL # DETAIL

Base Mdl. #	**Actuator Press. Media**	**Media Input Press. Range** (psig)	**Encl. Type**	**Input Pwr. Req.** Vac/Ph/Hz	**Failure Mode** (upon loss of pwr.)	**Fail Safe Sys./ Furn. By:**	**Valve Act. Type/ Furn. By:**	**Control Input Signal**	**Valve Stem Feedback Signal**	**Options**
M-92	**1**= Air	**A**= 1-150	**1**= NEMA 4X (FRP)	**A**= 120/1/60	**1**= Fail-In-Place	**1**= None	**A**= ¼-turn dbl. acting	**1**= 4-20 mAdc	**1**= 0-1k ohms	**0**= None
	2= Oil	**B**= 150-3,000	**2**= NEMA 4 carbon steel	**B**= 220/440/3/60	**2**= Fail-Closed	**2**= Accum. System	**B**= ¼-turn spring return	**2**= 3-15 psig	**2**= 0-10k ohms	**1**= Enclosure Heater & T-stat (for moisture mgt.).
	3= Water	**C**= Spec.	**3**= NEMA 4X S.S.	**C**= Spec.	**3**= Fail-Open	**3**= Spring Return Act.	**C**= Linear dbl. acting	**3**= 0-1 vdc	**3**= 0-100k ohms	**2**= "Lockable" Auto/Man. selector switch.
	4=Electric		**4**= Spec.	**D**= 24-vdc		**4**= Spec.	**D**= Linear spring return	**4**= 0-5 vdc	**4**= 4-20 mAdc (includes loop pwr. supp.)	**3**= "Lockable" isolation valve for incoming pressure media.
	5= Spec.		**5**= None			**/Furn. By:**	**/Furn. By:**	**5**= 0-10 vdc		**4**= Ground loop isolator for (4-20 mAdc signals) (1 for input signal and 1 for feedback signal).
						1= VA Valve	**1**= VA Valve	**6**= 1-5 vdc		**5**= Pressure gauge (for incoming pressure media connect).
						2= Others	**2**= Others	**7**= 10-50 mAdc		**6**= Rapid "Open" & "Close" upon failure.

(OVER)

Base Mdl. #	**Actuator Press. Media**	**Media Input Press. Range** (psig)	**Encl. Type**	**Input Pwr. Req.** Vac/Ph/Hz	**Failure Mode** (upon loss of pwr.)	**Fail Safe Sys./ Furn. By:**	**Valve Act. Type/ Furn. By:**	**Control Input Signal**	**Valve Stem Feedback Signal**	**Options**
						3= Not App.	**3**= Not App.			**7**= PLC control w / 4-20 mAdc **input** and **feedback** signals.
										8= Fail-In-Place upon loss of **input** signal.
										9= Fail-In-Place upon loss of 4-20 mAdc **feedback** signal.
										10= 4-20 mAdc closed loop "re-transmit" signal (includes loop isolator).
										11= High-speed infinite resolution.
										12= Analog valve stem position meter on front panel.
										13= Digital valve stem position meter on front panel.