Sun Hydraulics' First Publication

The following document is a scanned copy of Sun's first publication, including a price list and a discount schedule. The first print run of 300 was completed on August 1, 1971.

The document was typed on a typewriter. The symbols and schematics were hand drawn by Bob Koski, one of the co-founders of Sun Hydraulics. The drawings included were also done by Bob starting with the CPEA-XAN which is dated July 29, 1970. Incidentally, the first cartridge valve that Sun shipped was a CPEA-LAN.

While reading this document, please keep in mind that this publication is close to 40 years old. In today's world, pressures are higher, fluids are cleaner and Sun has learned a lot.

All of the products shown in this document are still available or have direct replacements that are current in today's product line. Please refer to the following cross reference when using this publication:

CPEA-*AN—is now **CKEB-*CN**

RPGB—use either the **RPGC** or the **RDFA**

SPEA—use either the **SCEA** or the **RSFC**

PBFA—use **PBFB**

PPFA—use **PPFB** or **PRFB**

CXEB—still available but we recommend using **CXED**

NCEA—still available but we recommend using **NCEB**

TECHNICAL BRIEFING MANUAL

Contents

1.1 Pilot Check Valves

1.11 Function of Pilot Check Valves

A. To prevent cylinders from drifting due to direction control valve leakage.

B. As a safety device (e.g. To lock cylinders when the pump is turned off or in case of line breakage).

1.111 Typical Applications

A. Industrial machinery

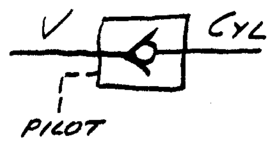
1) To hold press platens, etc. in position.
2) To lock clamping devices.
3) As normally closed two-way valves (pilot operated to open).

B. Mobile machinery

1) To lock work holding devices.
2) To lock machine position holding devices (e.g. Vehicle platforms, outriggers, etc.).

1.12 ANS Symbols

A. Single Pilot Check

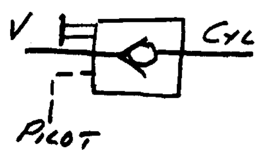


Checked Flow

Free Flow Direction

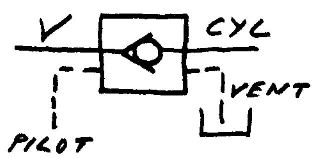
Piloted Open

B. Single Pilot Check with Manual Override



(The manual release allows valve to be opened when pilot pressure is not available.)

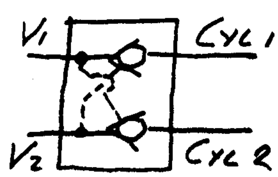
C. Vented Pilot Check



(The pilot piston has one side vented to tank - - a feature which allows some 'feathering" of the directional valve with light overrunning loads.)

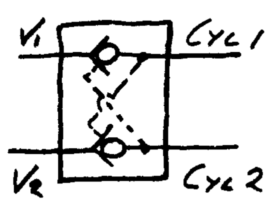
D. Double Pilot Check

Normal Type



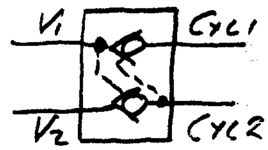
(Pilots on valve port side)

Inverted Type



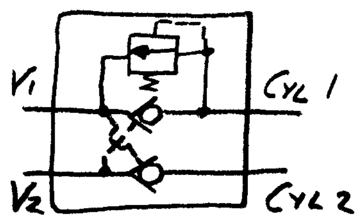
(Pilots on cylinder port side - - eliminates the need for thermal relief protection in most systems.)

Semi-inverted
Type



(Eliminates need for thermal relief in most systems with greatest safety)

With Thermal Relief on One Side



1.13 Description of Operation

A. Flow from direction control valve to cylinder passes through free flow check.

B. With direction control valve centered (or with dead pump) check poppet closes against resilient seat to form a zero leak seal. Cylinder is locked in position.

C. When directional valve is shifted to retract cylinder, pressure is fed to pilot piston which pushes poppet off seat, opening valve. Cylinder can then retract.

D. Some comments on important design features in pilot check valves:

1. Resilient seat for check poppet assures zero leak sealing. Metal seat is less costly and can tolerate higher working pressures but will seal with leakage of one (1) to five (5) drops per minute (Note: 250 drops is approximately equal to one (1) cubic inch of hydraulic oil).

2. Check poppet guide prevents poppet from chattering at high flow rates (Chatter quickly destroys the seat sealing surface.).

3. Damped pilot action provides "soft" decompression at retract.

4. Pilot ratio should always exceed 3:1. With lower pilot ratios, booster action of cylinders having proportionally large rods can cause lock-up (boost ratio exceeds pilot ratio). The pilot ratio of a pilot check is the ratio of the piston area to the seat area. In a 3.5:1 ratio pilot check, the piston area is 3.5 times the seat area. Therefore, a 1000 psi pilot pressure is required to open a pilot check holding a 3500 psi load ($3500 \div 3.5 = 1000$).

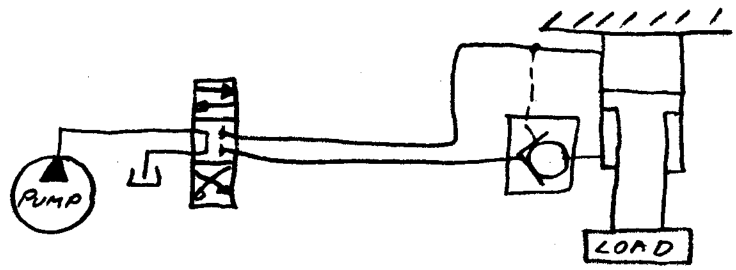
5. A pilot piston seal is sometimes required (e.g. In low flow machine tool feed circuits or with inverted pilot lines). Separate pilot piston return spring assures that seal friction does not cause valve to "stick open" (Note: For smooth pilot action it is usually necessary to bleed the air out of the pilot line. When no seal is used, purging is automatic).

E. Other types of pilot check valves

1. "Vented" pilot check valves are made insensitive to back pressure between the pilot check valve and directional control valve by adding a port and internal seals to keep one side of the pilot piston at low (vent - - or tank) pressure. This allows use of the direction control valve for throttling and controlling overrunning loads.

2. "Decompression" or "two-stage" pilot check valves utilize a small high-pilot-ratio check valve and a large low-pilot-ratio check valve in a telescoping construction. They can be used when locked (checked) hydraulic pressure can be reduced to low pressures by relieving a few cubic inches of oil (e.g. a clamp). "Decompression" pilot check valves should not be used to hold overrunning loads and will usually leak one(1) to fine (5) drops per minute past each metal to metal seal.

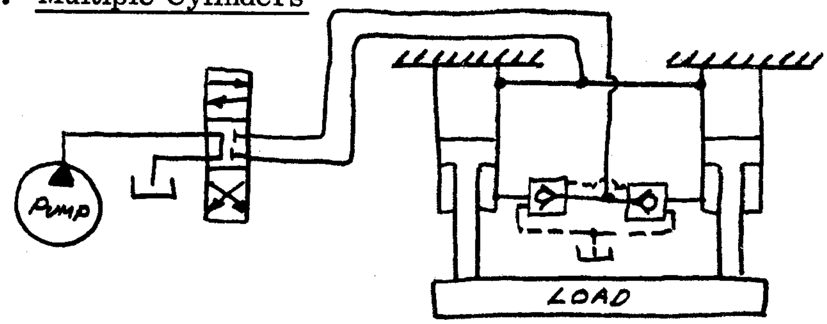
C. <u>Insufficient Pilot Ratio</u>



1. Problem: Large area of piston (relative to cylinder) is such that pilot check fails to "pilot" open. This occurs when head area ratio to head area minus rod area [Ah: (Ah-Ar)] is less than about 2:1 with most pilot check valves.

2. Solution:
Use counterbalance valve (which is insensitive to cylinder proportions). With varying loads, use counterbalance valve with pilot assist.

D. Multiple Cylinders



1) Problem: Least loaded pilot check opens before most heavily loaded pilot check.

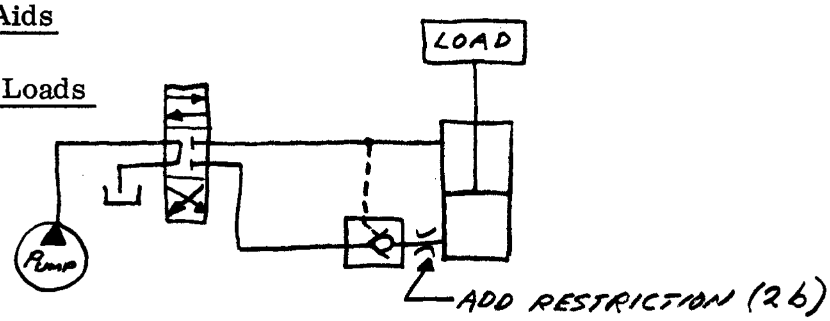
2) Solutions:

a) Use vented pilot checks (which require separate drain lines) and a direction control valve which first applies pressure to lower the load (opening pilot check valves fully) and then, with further control valve movement, opens return flow to tank. Cylinders may be synchronized within ± 15% with pressure compensated proportional flow dividers or with in ± 5% with matched pressure compensated fixed flow regulators. More accurate synchronization can be achieved with servo-controls.

b) In some systems, counterbalance valves with pilot assist can be used at each cylinder.

1.14 Application Aids

A. Lowering Loads



1. Problem: Load tends to overrun pump causing loss of pilot pressure. Pilot check closes and pilot pressure builds again to open check. The cycle repeats itself. In many circuits, this is negligible. In others chatter ranging from "ratcheting" to violent "cathunk-cuthunk" will be heard and observed.

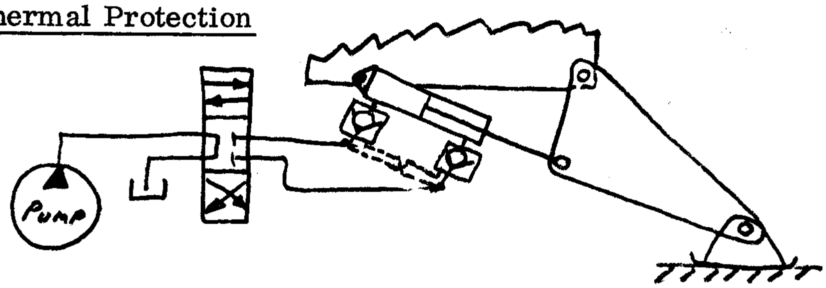
2. Solutions:

   a. Use counterbalance valve (Note: If zero leakage is required, one of the following suggestions may prove useful.)

   b. Restrict the flow between the cylinder and pilot check so that load cannot overrun the pump. With constant or near-constant loads, fixed orifices frequently work well. With varying loads, fixed flow pressure compensated flow regulators sometimes work satisfactorily.

   c. Use vented pilot check (which requires a separate drain line) and a direction control valve which first applies pressure to lower the load (opening pilot check valve fully) and then, with further control valve movement, opens return flow to tank.

B. Thermal Protection



1. Problem: Vehicle stabilizer
Oil expands about 3% per 100 degree fahrenheit rise in temperature and compresses about 1/2% per 1000 psi. High pressures can develop in cylinders with zero leak pilot check valves at both ends and is aggravated further by the "booster" effect natural to cylinders (head end area times pressure equals rod end area times a higher pressure). This problem is not as common as one might expect but does occur occasionally (e.g. Bringing a vehicle with stabilizers into a heated garage after being out in sub-zero weather).

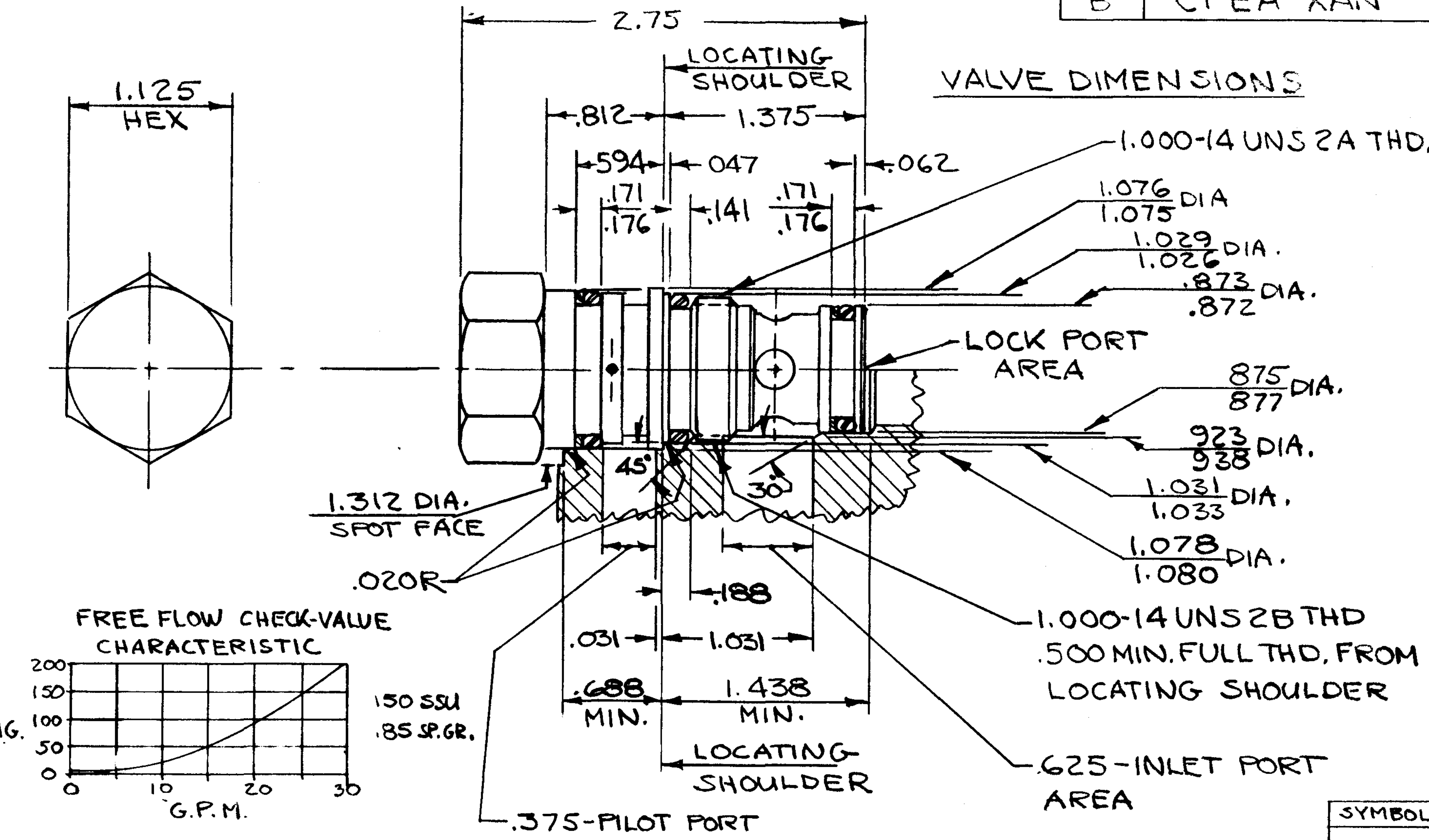
2. Solutions:

   a) Use inverted pilot on one or both pilot checks. Pressure build-up in one end of cylinder will open pilot check at other end of cylinder. Leakage through directional valve will prevent damage.

   b) Use counterbalance valve at one end of cylinder. Counterbalance valves have built-in thermal relief protection.

   c) Use thermal relief in one end of cylinder.
   Note: Most thermal relief valves leak slightly sooner or later and this should be considered in the circuit.

3. Thermal protection is not usually required for in-plant machinery. The theoretical pressure rise of about 1000 psi per 17 degree fahrenheit rise in a trapped hydraulic system rarely occurs because expansion of metal containing the fluid, expansion and flexing of tube and hose lines and entrained gas bubbles usually absorb most of the energy (Note: Gasses dissolved in fluids make the the fluids less compressable and therefore aggravate the problem slightly.).



2. PILOT RATIO: 3.5:1 MIN

1. SEALS: BUNA-N

LET.	REVISION	DATE	CHECK	REL.
B	EXTENDED FLOW CURVE	4-30-71	J.D.A.	
A	REVISED FLOW CURVE	1-8-70	J.D.A.	

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE	PILOT CHECK VALVE CARTRIDGE		REVISION B	PART NO. CPEA XAN
SCALE FULL	REF.	MATERIAL ~		
DRAWN J.D.A	CHECK	RELEASE	HEAT TREAT & FINISH ~	
DATE 7-29-70	DATE	DATE		

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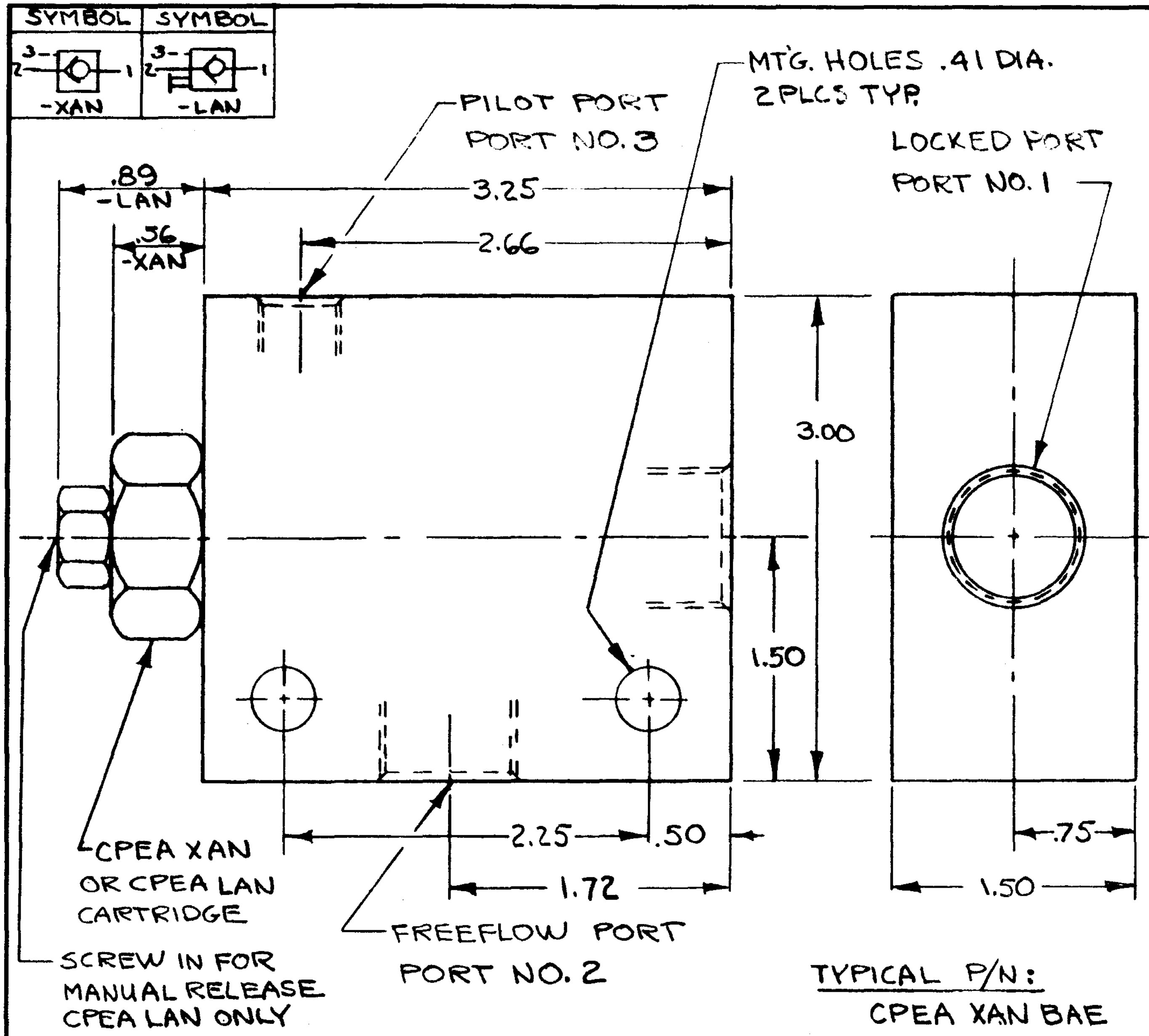
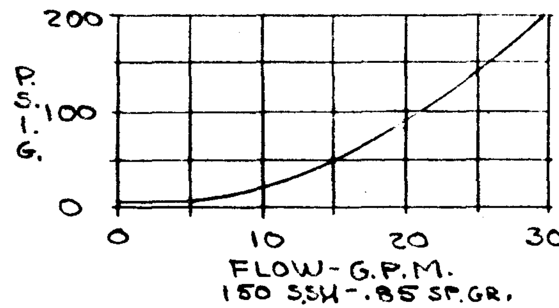
SARASOTA, FLORIDA 33578

REVISION	PART NO. CPEA XAN BA- / CPEA LAN BA- CHART



TYPICAL P/N:
CPEA XAN BAE

FREE FLOW CHECK VALVE CHARACTERISTIC



1. PILOT RATIO: 3.5-1 MIN.
2. SEALS: BUNA "N"
3. CHECK SEAT: DELRIN

BODY NO.	PORT 1 LOCKED	PORT 2 FREEFLOW	PORT 3 PILOT
BAH	.750 N.P.T.F.	.750 N.P.T.F.	.250 N.P.T.F.
BAG	.500 N.P.T.F.	.500 N.P.T.F.	.250 N.P.T.F.
BAF	.375 N.P.T.F.	.375 N.P.T.F.	.250 N.P.T.F.
BAE	.250 N.P.T.F.	.250 N.P.T.F.	.250 N.P.T.F.

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE PILOT CHECK VALVE CARTRIDGE IN BODY

SCALE	REF.	MATERIAL
FULL		ALUM & STEEL (SEE NOTES)

DRAWN J.D.A.	CHECK	RELEASE	HEAT TREAT & FINISH
DATE 4-3c	DATE	DATE	

REVISION PART NO. CPEA XAN BA- / CPEA LAN BA- CHART

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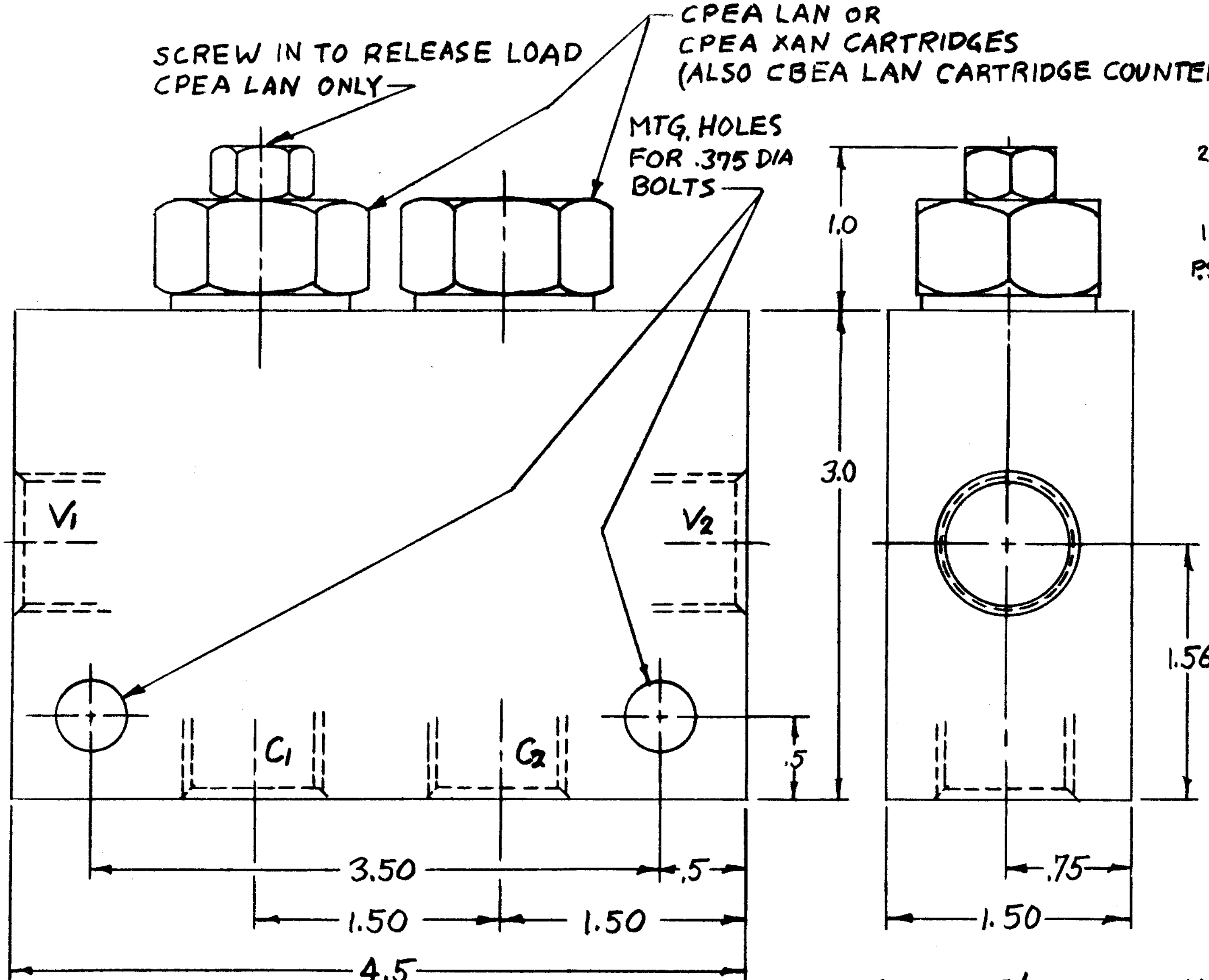
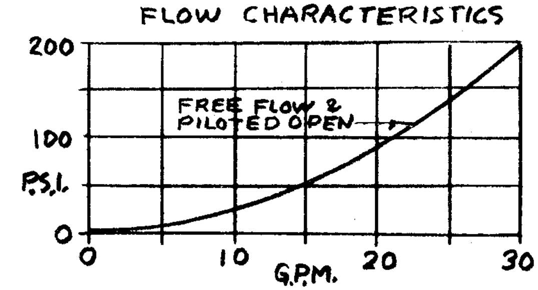
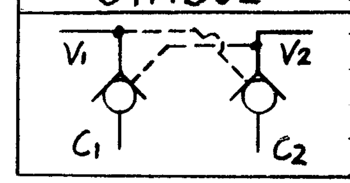
SH 5 5-70



TYPICAL P/N CPEA LAN YAA



SYMBOL



NOTES:
1. PILOT RATIO: APPROX. 3:1
2. SEALS: BUNA N
3. SEAT MAT'L: DELRIN

BODY NO.	PORTS V_1, C_1, V_2, C_2
YAD	.750 N.P.T.F
YAC	.500 N.P.T.F
YAB	.375 N.P.T.F
YAA	.250 N.P.T.F.

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: DUAL PILOT CHECK VALVE (WITH INTERNAL CROSS PILOTING) CARTRIDGES IN BODY

SCALE	REF.	MATERIAL
FULL	CPEA LAN CPEA XAN YA-	ALUM. & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 2-3-72	DATE	DATE	

REVISION	PART NO.
	CPEA LAN YA- (CHART) CPEA XAN YA-

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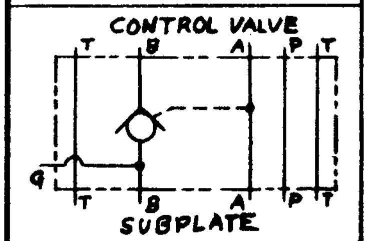
SARASOTA, FLORIDA 33578

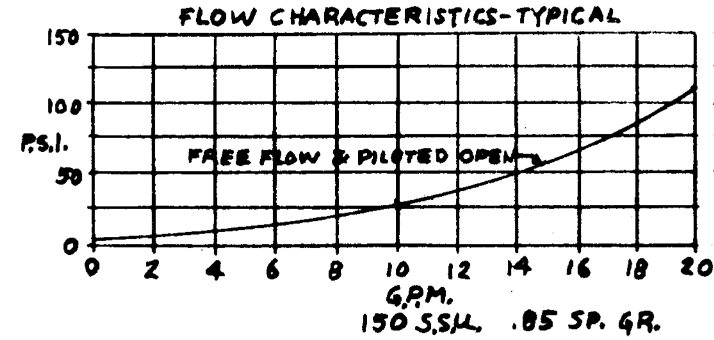
SH 5 5-70

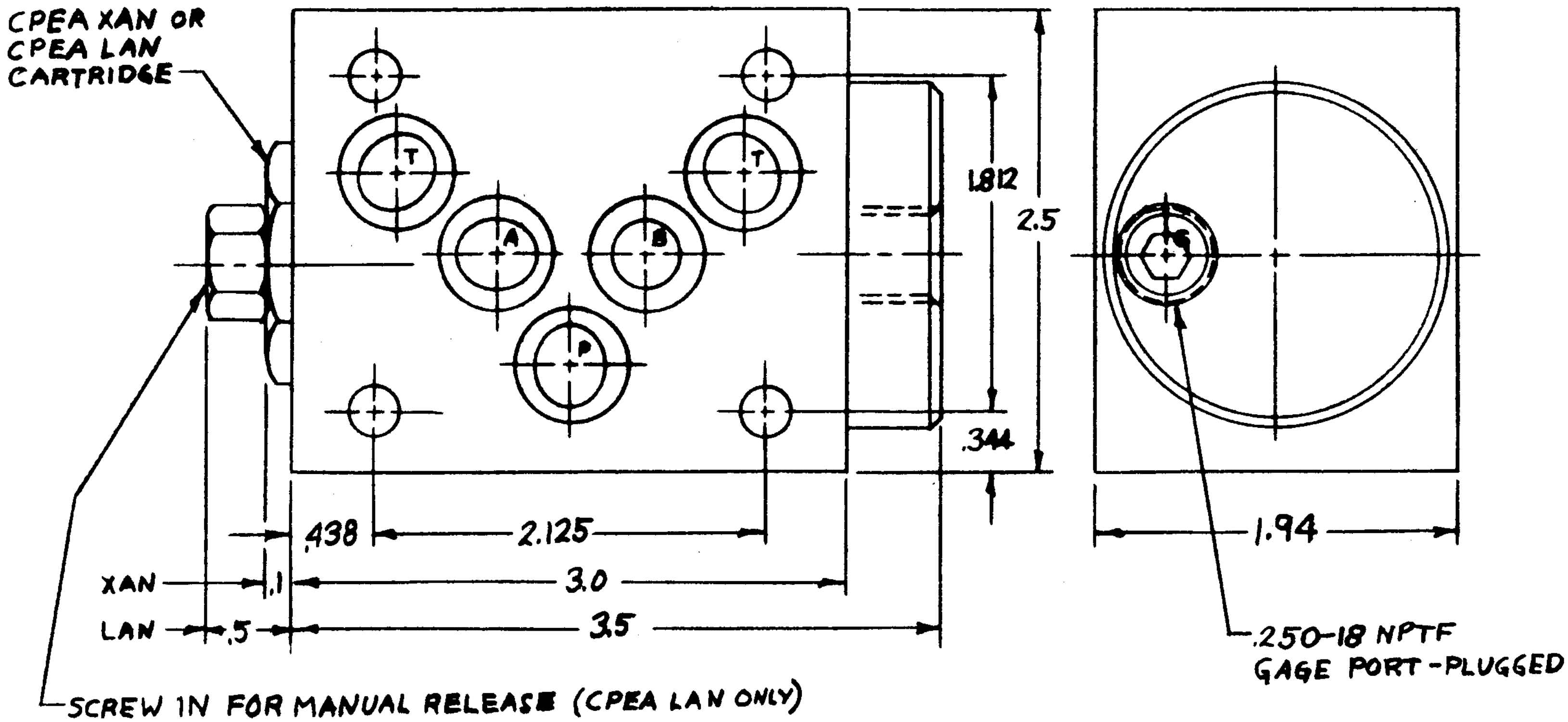
SYMBOL



NOTES:
1. PILOT RATIO: APPROX. 3:1
2. SEALS: BUNA N
3. STD. - 014 SUBPLATE SEALS PROVIDED

REVISION	PART NO.
A	CPEA XAN BBB CPEA LAN BBB





LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED A&B PORT IDENT.	4-24-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE PILOT CHECK VALVE
("B" PORT CONTROL - STD. NFPA SUBPLATE)

SCALE	REF.	MATERIAL
FULL	CPEA XAN CPEA LAN BBB	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 2-2-	DATE	DATE	

REVISION	PART NO.
A	CPEA XAN BBB CPEA LAN BBB

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SARASOTA, FLORIDA 33578

SH 5 5-70

1.4 Counterbalance Valves

1.41 Functions of Counterbalance Valves

A. To prevent loads from running ahead of pump (Note: When loads vary, use counterbalance valve with pilot assist).

B. As a safety device in case of line breakage (when mounted directly on or in cylinders).

C. Occasionally used as a decelleration valve.

1.411 Typical Applications

A. Industrial machinery

1) To hold fixed loads such as press platens, etc. in position. (Counterbalance)

2) To hold platforms, swinging arms, booms, etc. in position. (Counterbalance with pilot assist)

3) To decellerate moving loads. (Counterbalance with pilot assist)

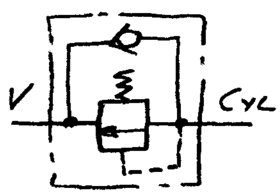
B. Mobile machinery

1) To hold platforms, swinging arms, booms, etc. in position. (Counterbalance with pilot assist)

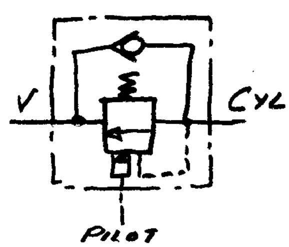
2) To decellerate moving loads. (Counterbalance with pilot assist)

1.42 ANS Symbols

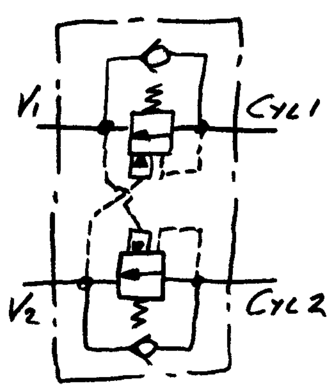
A. Counterbalance Valve



B. Counterbalance with Pilot Assist



C. Double Counterbalance with Pilot Assist



1.43 Description of Operation

A. Counterbalance valves are actually two valves in parallel:

1. A check valve provides free flow into cylinders or motors.

2. A relief valve restrains flow out of the cylinders or motors. The relief valve must be set high enough to assure a good reseat at load pressures (usually at least 1.3 times the maximum anticipated load).

B. Counterbalance valves with pilot assist provide for lowering the setting of the relief valve with pilot pressure. The setting is reduced according to the ratio of the differential pilot area on the piston compared to the differential area exposed to the relief (load) (e.g. In a valve with a 3:1 pilot area, set for 3000 psi with a load of 2000 psi, the pilot pressure required to open the relief valve is $(3000-2000) \div 3 = 333$ psi pilot pressure).

C. Some comments on design features that are important in counterbalance valves:

1. Hardened, ground and lapped seating surfaces assure long, troublefree life with little, if any, deterioration in sealing ability even in dirty systems. However, counterbalance valves rarely seal with zero leakage and can never be depended upon for absolutely zero leakage. Typical leakage at any pressure drop (provided the relief setting is at least 1.3 times the maximum load pressure) will initially be 20-30 drops per minute and will diminish with time (250 drops is approximately equal to one cubic inch of hydraulic oil).

2. Dynamic seals work best on hardened and ground O.D. surfaces and exhibit less friction and wear than seals working on soft I.D. surfaces whose finish is hard to control and where hard particles will embed.

3. Check poppet guide prevents poppet from chattering at high flow rates. Chatter quickly destroys the seat sealing surfaces causing leakage.

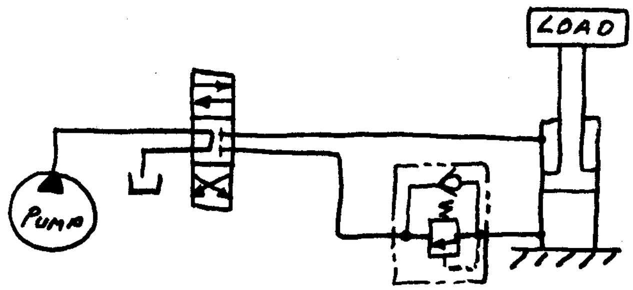
4. Damped relief and check provide "soft" action with smooth control and very fast seating.

5. Pilot assist ratios between 2:1 and 3:1 have proved less "spongy" and more "stable" than higher pilot ratios. This is particularly important in "high inertia" circuits to prevent low frequency oscillation.

6. Emergency manual release is accomplished by lowering the relief valve setting, by pushing the check poppet off its seat or both.

1.44 <u>Application Aids</u>

A. Constant load



1. Problem: Load tends to overrun the pump when it is lowered.

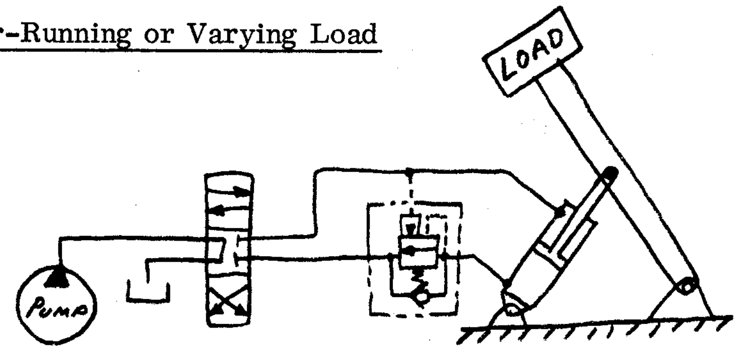
2. Solution: Counterbalance valve

   a) Prevents load from running ahead of pump on lowering.

   b) Holds load with near zero drift.

   c) Holds load safely in place in case of line breakage (when counterbalance valve is mounted on cylinder).

B. Over-Running or Varying Load



1. Problem: As load approaches vertical the pressure produced in the cylinder base by the load approaches zero.

2. Solution: Use counterbalance valve with pilot assist.

   a) Unlike a straight counterbalance valve (which might lock up in this circuit because of the area difference between the rod and head ends of the cylinder) there will always be adequate pump pressure available to lower the load.

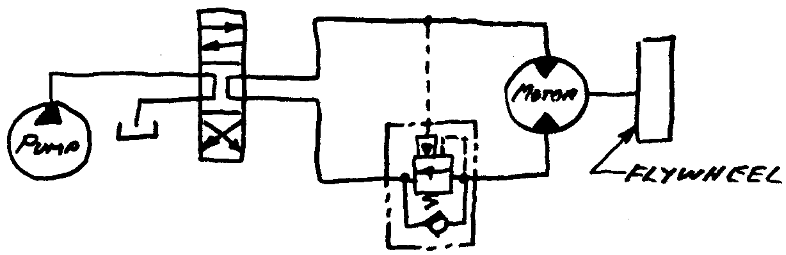
   b) The cylinder will be held safely in position with little drift when there is no signal to lower, with a dead pump or with line breakage (if the valve is mounted on or in the cylinder).

3. With overcenter loads: Use double counterbalance valve with pilot assist or two counterbalance valves, cross piloted.

   a) Cylinders will be locked against drift in either direction.

   b) Thermal relief protection is automatically provided (relief flow will normally leak past spools of closed center directional valves).

C. Decelleration Control



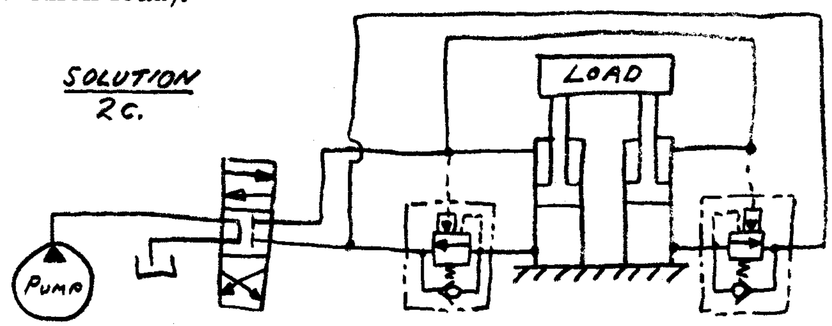
1. Problem: Smooth over-running speed control and cushioned hydraulic braking as the directional valve is centered (Note open center direction control valve).

2. Solutions:

   a) Use counterbalance valve with pilot assist. When pilot pressure drops to zero (e.g. With an over-running load or when supply flow to the motor is cut off), the relief valve will provide cushioned braking. Motors can be locked in position with low drift (due only to slippage past motors). Note: With reversing loads, use double counterbalance with pilot assist.

   b) Use crossover relief with closed center direction control valve. This will provide cushioned braking but no control of over-running loads except when braking.

D. Multiple Cylinders (physically close to each other supporting a common load).



1) Problem: Over-running but reasonably balanced load must be locked in case of line breakage. If. normal (unvented) checks are used, least loaded cylinder will move first and most heavily loaded cylinder will remain locked, supporting the entire load plus the load induced by the down pressure exerted on the unlocked cylinder.

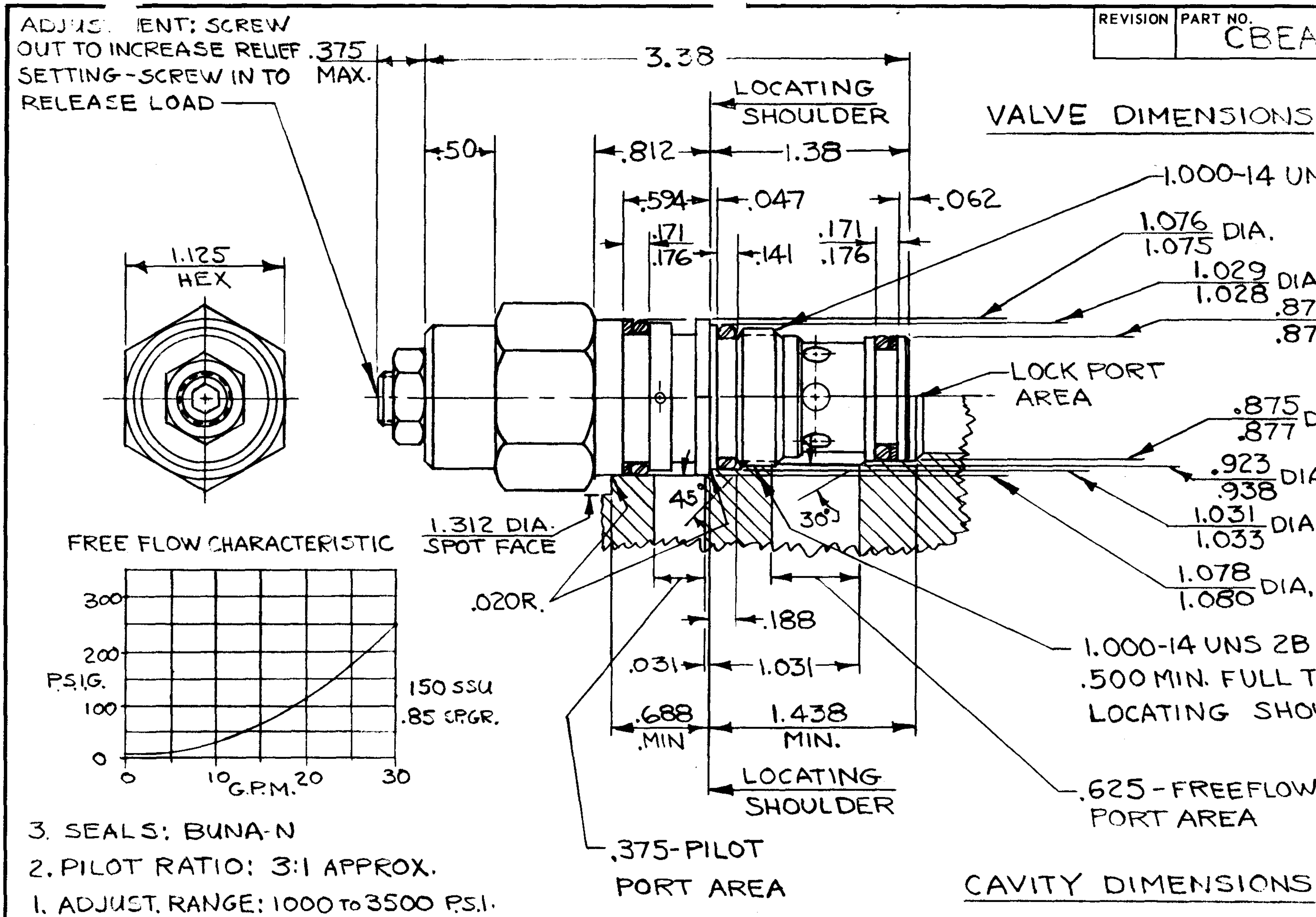
2) Solution:

   a) Use one counterbalance valve teed into both cylinders. The short hose connections to the cylinder bases will reduce the risk of line breakage.

   b) Use a vented pilot check valve teed into both cylinders. Again, there will be short hose connections to the cylinders.

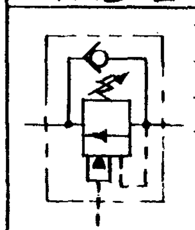
   c) Use two counterbalance valves with pilot assist (one connected to the base of each cylinder and pilots connected to opposite ends of cylinders). The most heavily loaded cylinder will open first. The load taken off one cylinder will transfer to the other cylinder. When the cylinders are equally loaded, they will move together.

   d) Use two vented pilot check valves (one connected to the base of each cylinder and pilots connected to opposite ends of cylinders) and one counterbalance valve (with cylinder port teed into valve ports of both vented pilot check valves). When pressure is applied to lower load, both pilot check valves will open and the load will be equally destributed on both cylinders. The counterbalance valve will prevent the load from running ahead of the pump.



3. SEALS: BUNA-N
2. PILOT RATIO: 3:1 APPROX.
1. ADJUST. RANGE: 1000 to 3500 P.S.I.

SYMBOL



LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE COUNTERBALANCE VALVE CART. W/PILOT ASSIST

SCALE	REF.	MATERIAL
FULL		

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A.			
DATE 6-15-71	DATE	DATE	

REVISION | PART NO. CBEA LAN

sun hydraulics CORPORATION
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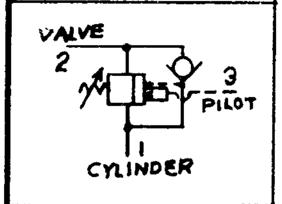
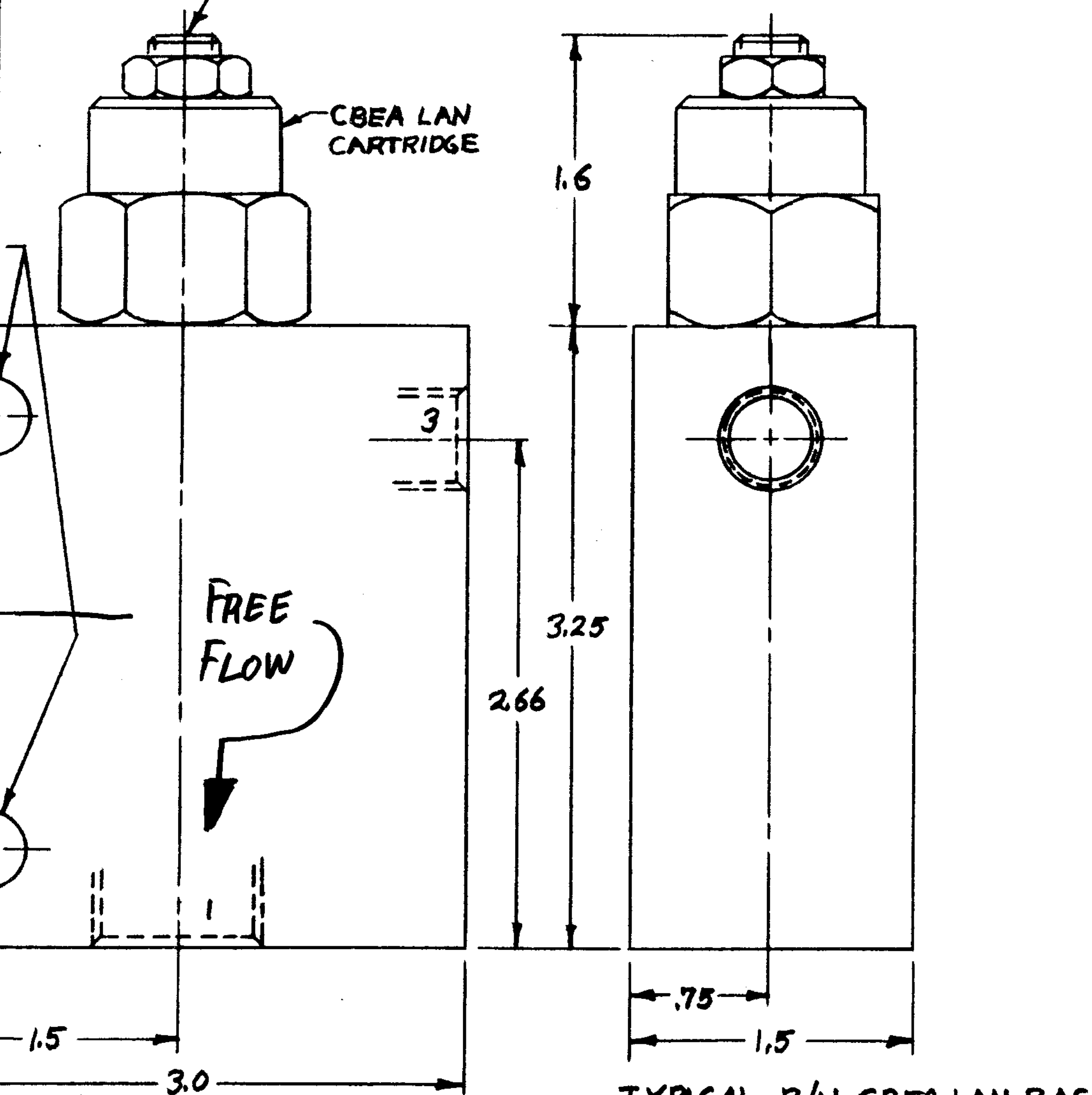
SARASOTA, FLORIDA 33578

REVISION | PART NO. CBEA LAN BA-(CHART)

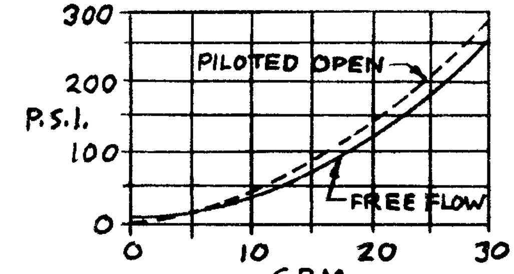
SYMBOL





TYPICAL P/N CBEA LAN BAG

FLOW CHARACTERISTICS



150 S.S.U. .85 SP.GR.

NOTES:
1. ADJUST RANGE: 1000-4000 PSI
3000 PSI STD.
2. PILOT RATIO: APPROX. 3:1
3. SEALS: BUNA N

BODY NO.	PORT 1 CYLINDER	PORT 2 VALVE	PORT 3 TANK PILOT
BAH	.750 NPTF	.750 NPTF	.250 NPTF
BAG	.500 NPTF	.500 NPTF	.250 NPTF
BAF	.375 NPTF	.375 NPTF	.250 NPTF
BAE	.250 NPTF	.250 NPTF	.250 NPTF

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE COUNTERBALANCE W/PILOTASSIST CARTRIDGE IN BODY

SCALE FULL	REF. CBEA LAN BA-	MATERIAL ALUM & STEEL
DRAWN RK	CHECK	RELEASE
DATE 2-2	DATE	DATE

HEAT TREAT & FINISH

REVISION | PART NO. CBEA LAN BA- (CHART)

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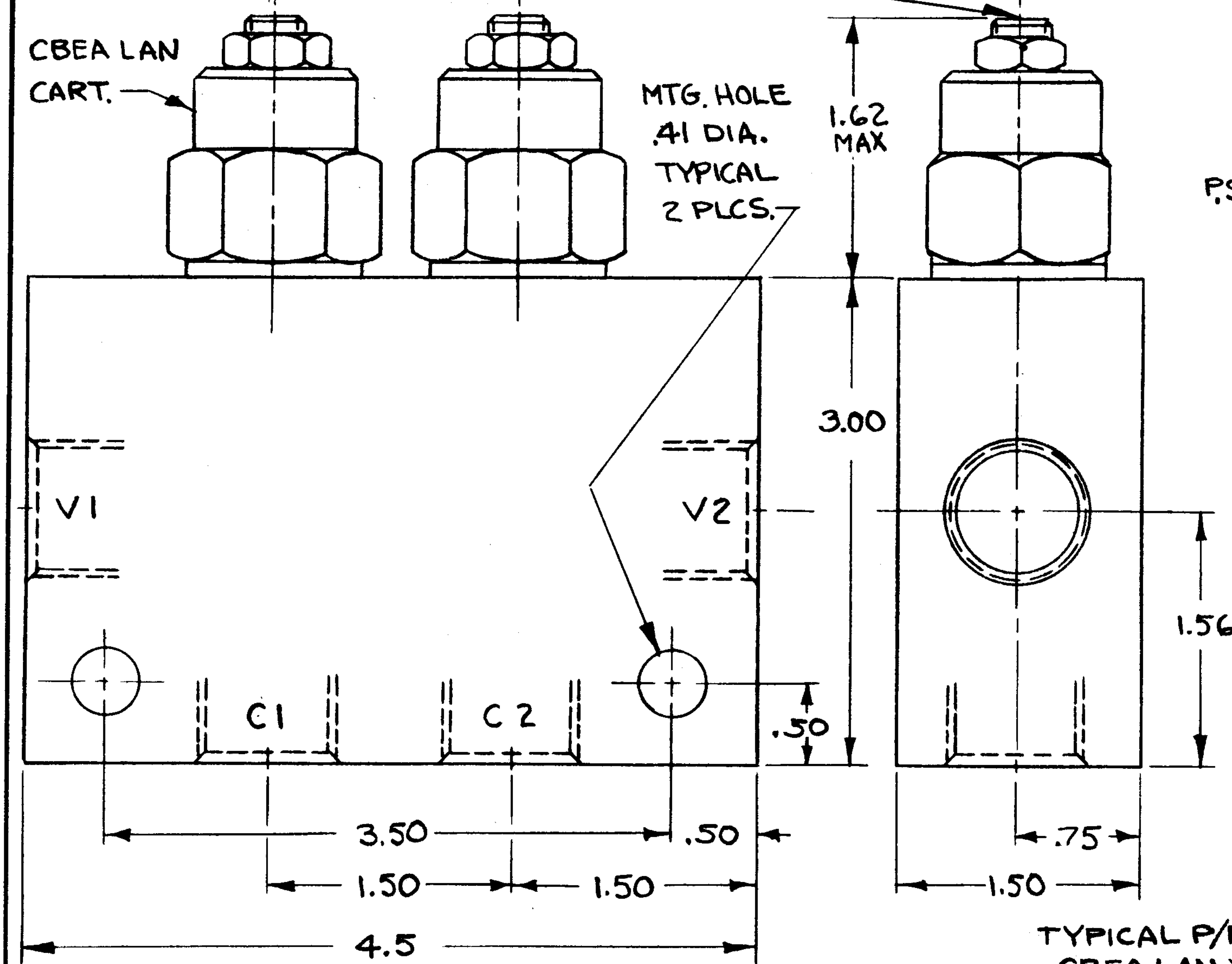
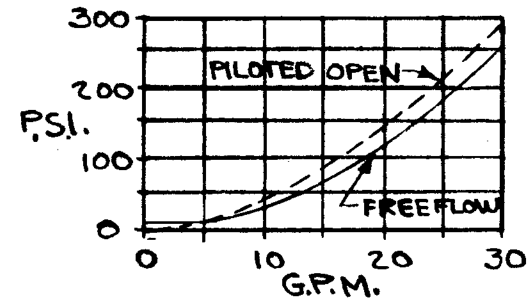
SARASOTA, FLORIDA 33578

ADJU[illegible]MENT: SCREW OUT TO INCREASE RELIEF [illegible]TTING
SCREW IN TO RELEASE LOAD



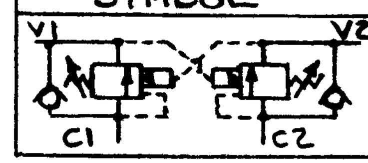
REVISION | PART NO. CBEA LAN YA-CHART

FLOW CHARACTERISTICS PER PATH



150 S.S.U. .85 SP. GR.

SYMBOL



1. ADJ. RANGE: 1000-4000 P.S.I. 3000 P.S.I. STD.
2. PILOT RATIO: 3:1 APPROX.
3. SEALS: BUNA-N

BODY NO.	PORTS V1, V2, C1, C2
YAD	.750 N.P.T.F.
YAC	.500 N.P.T.F.
YAB	.375 N.P.T.F.
YAA	.250 N.P.T.F.

TYPICAL P/N
CBEA LAN YAA

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE DUAL COUNTERBALANCE VALVE - W/INTERNAL CROSS PILOT ASSIST

SCALE	REF.	MATERIAL
FULL	CBEA LAN CART. YA- BODY	ALUM + STEEL

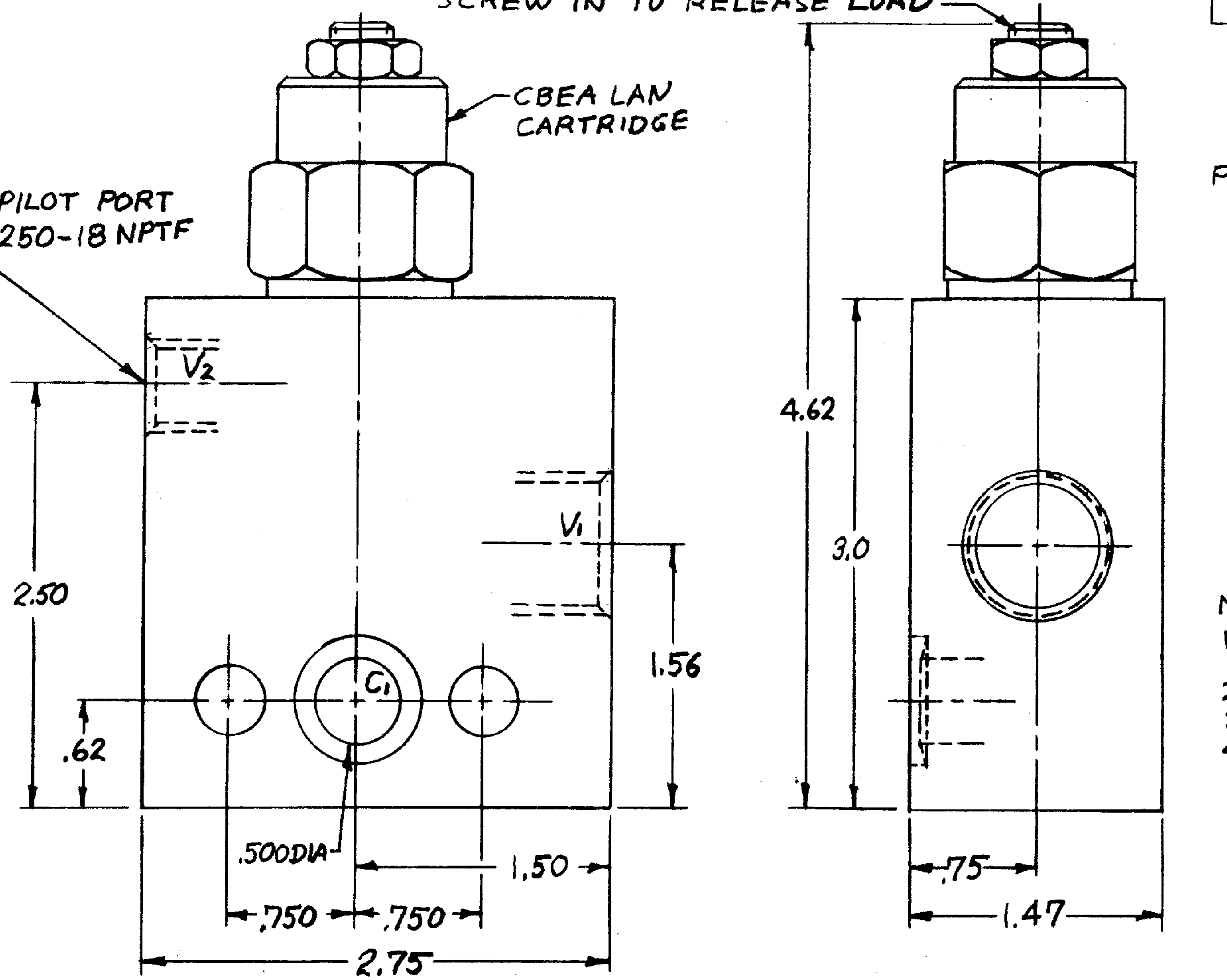
DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A.			~
DATE 1-6-72	DATE	DATE	

REVISION | PART NO. CBEA LAN YA-CHART

SUN hydraulics CORPORATION
1817 57TH STREET • P.O. BOX 3377
SARASOTA, FLORIDA 33578

SH 5 5-70

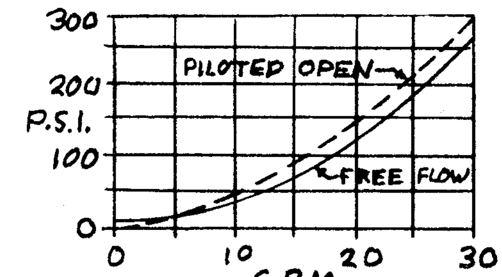
ADJUSTMENT: SCREW OUT TO INCREASE RELIEF SETTING
SCREW IN TO RELEASE LOAD



TYPICAL P/N
CBEA LAN BAM

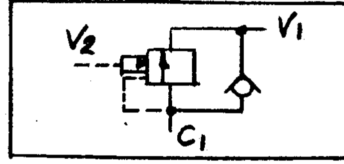
REVISION | PART NO. CBEA LAN BA-CHART

FLOW CHARACTERISTICS



150 S.S.U. .85 SP.GR.

SYMBOL



NOTES:
1. ADJ. RANGE: 1000-4000 P.S.I. 3000 P.S.I. STD.
2. PILOT RATIO: 3:1 APPROX.
3. SEALS: BUNA-N
4. MTG. HOLES FOR .375 DIA. BOLTS FACE O-RING -111 PROVIDED

BAO	.750 N.P.T.F.
BAN	.500 N.P.T.F.
BAM	.375 N.P.T.F.
BODY NO.	PORT V1

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE COUNTERBALANCE VALVE WITH PILOT ASSIST-FOR MANIFOLD MT.

SCALE	REF.	MATERIAL
FULL		ALUM. & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
RFK			
DATE 2-1-…	DATE	DATE	

REVISION | PART NO. CBEA LAN BA-CHART

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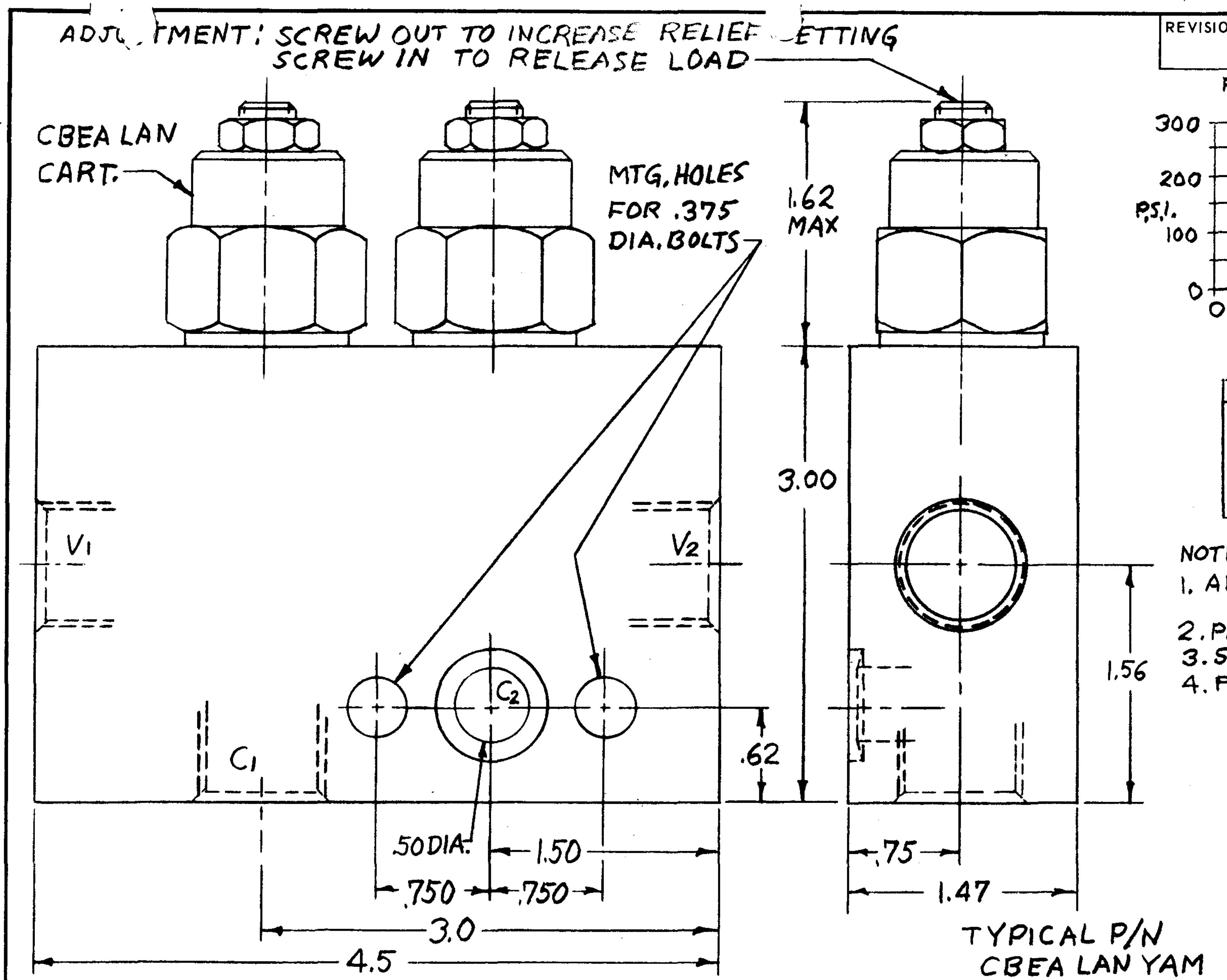
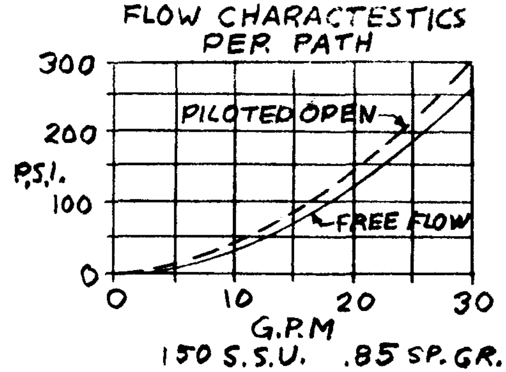
SARASOTA, FLORIDA 33578

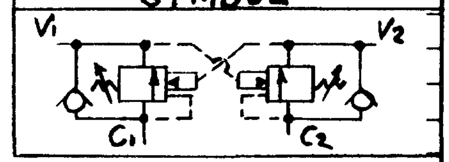
SH 5 5-70



TYPICAL P/N CBEA LAN YAM



SYMBOL



NOTES:
1. ADJ. RANGE: 1000-4000 P.S.I. 3000 P.S.I. STD.
2. PILOT RATIO: 3:1 APPROX.
3. SEALS: BUNA-N
4. FACE O-RING -111 PROVIDED

BODY NO.	PORTS V1, V2, C1
YAO	.750 N.P.T.F.
YAN	.500 N.P.T.F
YAM	.375 N.P.T.F

REVISION	PART NO.
	CBEA LAN YA- CHART

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE DUAL COUNTERBALANCE VALVE - MANIFOLD MOUNT - INTERNAL CROSS PILOT ASSIST

SCALE	REF.	MATERIAL
FULL	CBEA LAN CART. YA- BODY	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 1-31-72	DATE	DATE	

REVISION | PART NO. CBEA LAN YA- CHART

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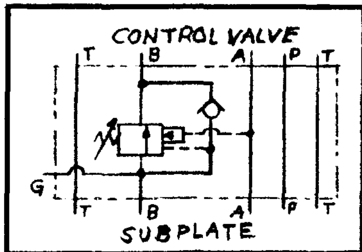
SARASOTA, FLORIDA 33578

SH 5 5-70

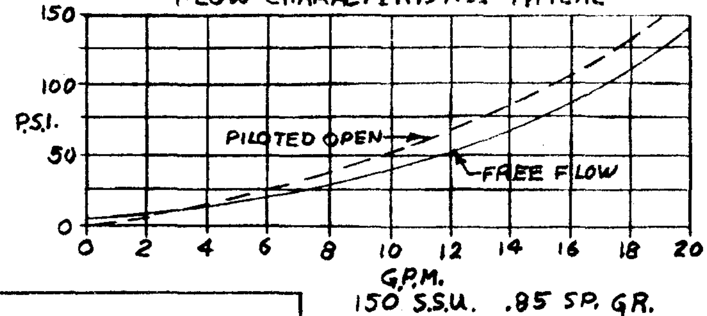
REVISION A | PART NO. CBEA LAN BBB

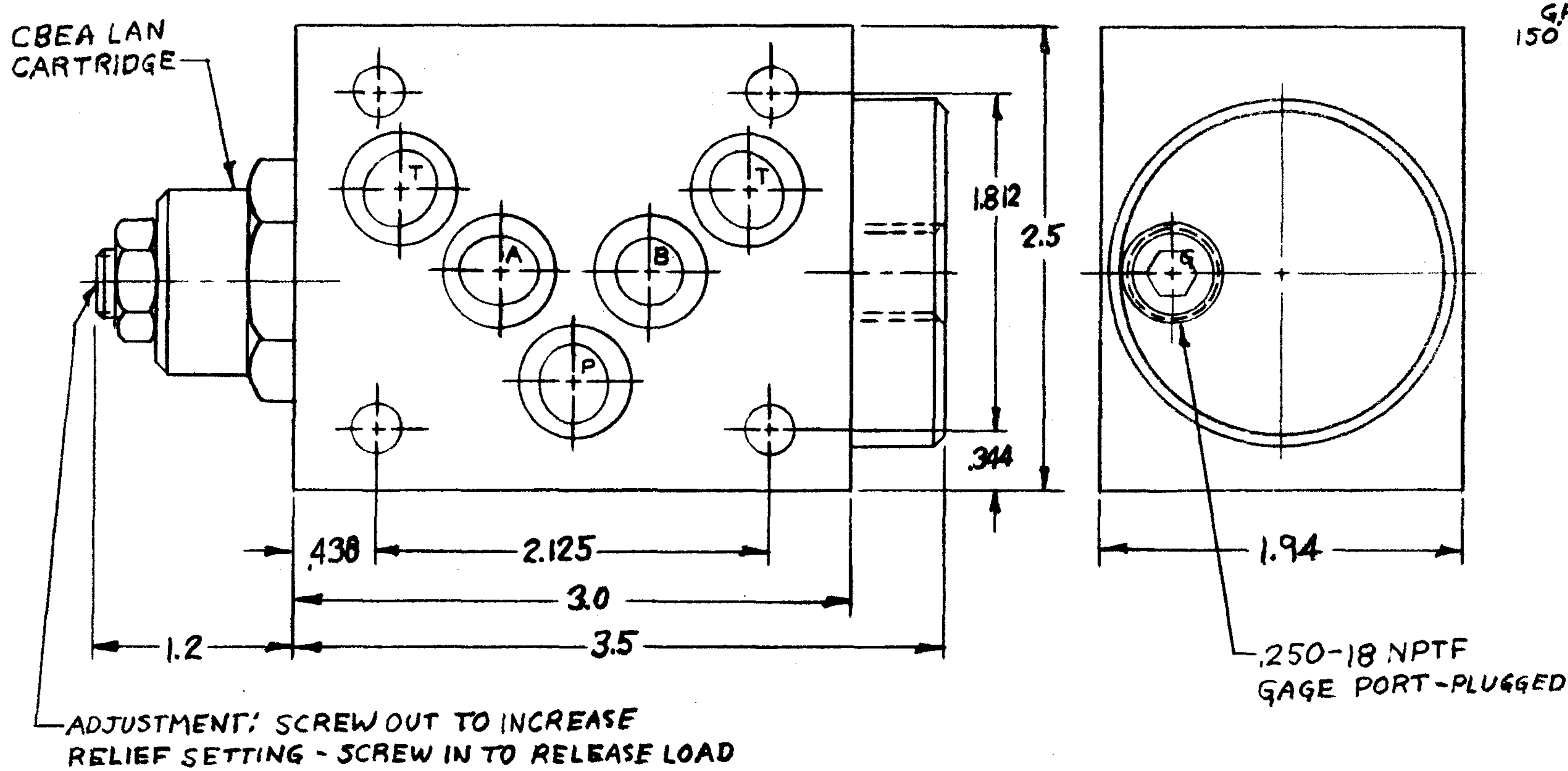


SYMBOL

NOTES:
1. ADJ. RANGE: 1000-4000 PSI
3000 PSI STD. SETTING
2. PILOT RATIO: APPROX. 3:1
3. SEALS: BUNA N
4. STD -014 SUBPLATE SEALS PROVIDED

FLOW CHARACTERISTICS-TYPICAL





LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED A & B PORT IDENT.	4-24-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: COUNTERBALANCE WITH PILOT ASSIST ("B" PORT CONTROL - STD. NFPA SUBPLATE)

SCALE	REF.	MATERIAL
FULL	CBEA LAN BBB	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 2-1-72	DATE	DATE	

REVISION A | PART NO. CBEA LAN BBB

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SARASOTA, FLORIDA 33578

2.1 Relief Valves

2.11 Function of Relief Valves

A. To limit pressure of hydraulic systems and sub-systems.

B. To "cushion" decelleration of cylinders and motors.

C. To provide protection from thermal expansion of oil in closed systems (See Section 1.14 B).

2.111 Typical Applications

A. Industrial Machinery

1. To continuously regulate system pressure when used with fixed displacement pumps.

2. As"crossover" or "dual" relief valves to "cushion" decelleration of cylinders and motors.

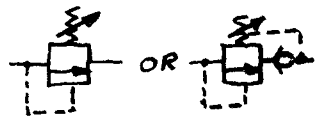
B. Mobile Machinery

1. Emergency relief protection in open center (tandem valve) systems.

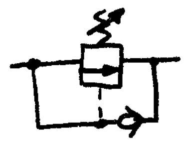
2. As "crossover" or "dual" relief valves to "cushion" decelleration of cylinders and motors.

2.12 ANS Symbols

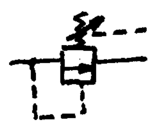
A. Single relief



With reverse flow blocked

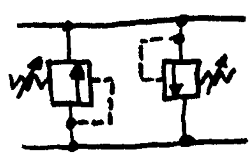


Without reverse flow blocked

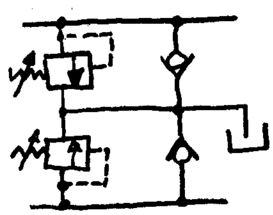


With external drain

B. "Dual" or "crossover" or "cushion" relief



Without provision for "booster" effect and "cavitation" protection



With "booster" effect and cavitation protection

2.13 Description of Operation

A. Direct Acting Relief Valves

1. Full area type

   a. Pressure acts on end of piston or poppet to overcome opposing adjustable spring force and downstream pressure, if any.

   b. Valve remains closed until pressure setting is reached.

   c. Valve opens when upstream pressure exceeds spring setting and downstream pressure.

   d. Valve recloses when upstream pressure drops below spring setting and downstream pressure.

2. Differential area type

   a. Pressure acts on partially balanced (differential area) spool or poppet to overcome opposing spring force and downstream pressure, if any. Virtually all differential area valves are poppet valves.

   b. Remainder of operation is similar to full area type direct acting relief valves.

3. External drain:

   This feature makes all direct acting relief valves insensitive to downstream pressure. It is accomplished by adding a separate port to the spring chamber.

4. Some comments on important design features of direct acting relief valves:

   a. Direct acting relief valves are notoriously unstable and tend to chatter or scream, especially above 300 psi. Frictional damping is frequently employed to make valve operation quiet. The friction causes "hysteresis" (Valves open at setting but stay open until pressure falls substantially below setting). "Repeatability" with hysteresis is always questionable. (e.g. Any change in flow over relief valve will cause pressure to drift. Dither, even with constant flow such as pump ripple may cause pressures to fall off appreciably.) Virtually all differential area type relief valves employ resilient dynamic seals (o-rings) that introduce "hysteresis" (typically 15-35% of valve setting).

b. Poppet type direct acting relief valves typically exhibit 10-15% "reseat hysteresis" (between 1 gpm and shut-off), even when resilient dynamic seals are absent.

c. Instability with differential area type direct acting relief valves frequently occurs if there is back pressure (especially flow induced) on the exhaust port (anything over 30 psi may cause difficulty). This can usually be corrected with an external drain, but such valves are not commonly available.

d. Shut off of poppet type direct acting relief valves with metal to metal seats is typically 5-30 drops per minute regardless of pressure level, diminishing with time (250 drops is approximately equal to one cubic inch of hydraulic oil).

e. Shut off of sliding spool type direct acting relief valves (with selective honed fit of hard spools and sleeves) is typically 1-3 cubic inches per minute per 1000 psi.

f. Increasing flow usually produces increasing pressure ("pressure rise") with most direct acting relief valves. However, differential area type valves can be made with low pressure rise through a 3:1 pressure adjust range.

g. Direct acting relief valves are typically less susceptible to failure caused by dirt in systems than pilot operated relief valves. They rarely stick open (except when set to open at very low pressures where spring force is too weak to overcome friction and to pinch or crush contaminant particles).

2.13 Description of Operation

B. Pilot Operated Relief Valves

1. Balanced piston type

   a. Pressure acts through a small orifice in the end of a spring biased balanced main piston against a pilot poppet seated on a pilot seat by an adjustable spring force.

   b. Main piston remains closed until flow through orifice creates unbalance which overcomes spring bias. This occurs when pilot opens.

   c. The pilot section is a small direct acting poppet relief adjusted to respond to and regulate the pressure behind (the bias spring side of) the main valve.

2. Unbalanced poppet type

   Valve is similar to the balanced piston type except the spring biased balanced piston is replaced by an unbalanced poppet.

3. Some important design features in pilot operated relief valves:

   a. Direct sensing pilot sections can be applied to both balanced piston and unbalanced poppet type valves. Direct sensing pilots regulate the pressure behind the main piston or poppet but respond mainly to the pressure ahead (the system pressure) and thus are faster acting and more accurate, especially at low flows and pressures, and may also be more tolerant of contaminant particles. Shutoff is typically 99+% of pressure setting

   b. Balanced piston type pilot operated relief valves always block reverse flow.

2.13 B (continued)

c. Shutoff leakage of balanced piston type pilot operated relief valves (with selective honed fit of hard spools and sleeves) is typically 1-3 cubic inches per minute per 1000 psi.

d. Unbalanced piston type pilot operated relief valves always block reverse flow.

e. Shutoff leakage of unbalanced poppet type pilot operated relief valves is typically 10-30 drops per minute regardless of pressure level, diminishing with time (250 drops is approximately equal to 1 cubic inch of hydraulic oil).

f. Pilot operated relief valves typically perform with unmeasurable "hysteresis". They will maintain pressure with varying flow and repeat settings constantly.

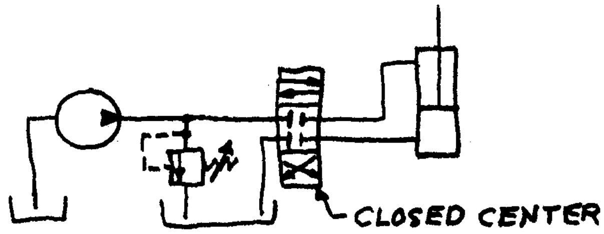
g. Pilot operated relief valves cannot typically be adjusted below 35-50 psi.

h. With heavy oil or at low temperatures pilot operated relief valves frequently act sluggishly (they will open to tank quickly but close slowly). In some applications this can be dangerous.

i. Pilot operated relief valves rarely fail to open but may stick open due to dirt in the system. In some applications this can be dangerous.

2.14 Application Aids

A. Constant but varying flow



1. Problem: System pressure tends to vary with flow required by system.

2. Solution:

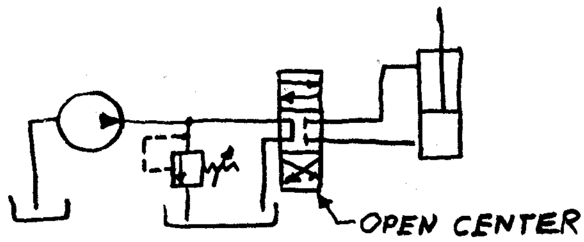
   a. If system pressure is below 100 psi consider using direct acting relief valve because pilot operated valves become less reliable at low pressures (due to weak spring force level) unless the system fluid is kept very clean (10 micron or better filtration - - above 100 psi, 25 micron filtration is normally adequate). In any case, pilot operated relief valves typically cannot be adjusted below 35-50 psi (with adjust screw backed completely off).

   b. If oil viscosity thickens appreciably due to cold fluid temperatures, use low hysteresis direct acting relief valve or allow time for warm-up when using pilot operated relief valve.

   c. Above 100 psi settings and with comparably controlled fluid viscosity, use pilot operated relief valve for best all around performance.

2.14 Application Aids

B. Intermittent Flow - Emergency Relief



1. Problem: System over-pressure protection is required but loss of system pressure could be hazardous.

   Examples: a. Clamping circuit
   b. Power steering circuit

2. Solutions:

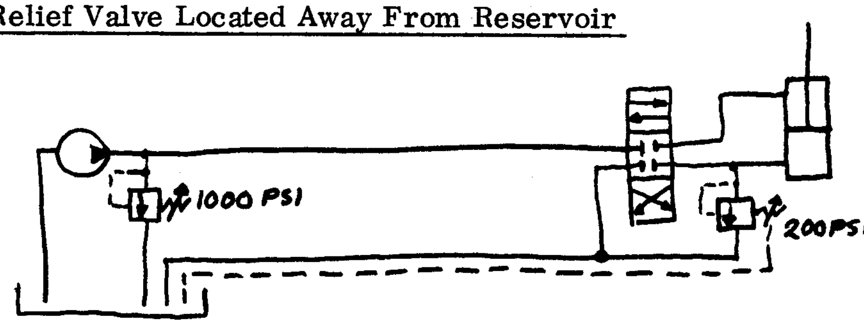
   a. Use direct acting relief valve adjusted to 1.2 - 1.3 times anticipated pressure requirement (to avoid loss of pressure due to "hysteresis" - see Section 1.13 A3).

   b. If very close control of maximum system pressure is required, use unbalanced poppet type pilot operated relief (preferably with direct sensing pilot).

   c. It may be practical and desirable to provide a check (or pilot check) valve after the relief valve with or without an accumulator. This may maintain pressure even with loss of pump flow, line breakage or stuck-open valve.

2.14 Application Aids

C. Relief Valve Located Away From Reservoir

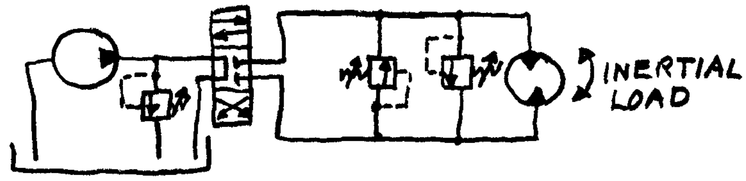


1. Problem: Back pressure caused by long (or small) line from relief valve to tank adds excessive pressure rise (increasing pressure with increasing flow over relief valve) or shock (due to high short duration pressure required to accelerate long column of oil to tank when relief valve opens).

2. Solution: Use relief valve with external drain. The insensitivity to downstream pressure of this type valve provides full system pressure, if necessary, to accelerate the column of oil to tank when the relief valve opens but does not add downstream pressure to the relief setting.

2.14 Application Aids

D. Decelleration - Equal Displacement



1. Problem: Very high shock pressures result when control valve is centered. Flywheel-effect turns motor into pump but oil pumped by motor is blocked by closed center position of control valve.

2. Solutions:

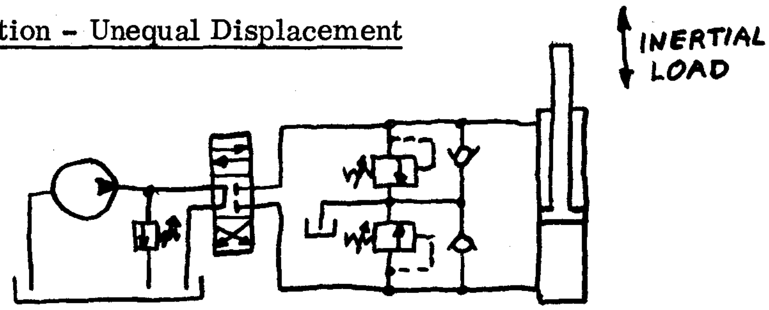
   a. Use "crossover" relief to "cushion" decelleration. Direct acting (differential piston type) relief valves set at 1.2-1.3 times system relief setting usually provide adequate decelleration control with greatest reliability.

   b. For more accurate control of decelleration produced pressures, use balanced piston type pilot operated relief valves.

   c. With over-running load, incorporate single or dual counterbalance valve with pilot assist on control valve side of crossover relief (also see section 1.44C).

2.14 Application Aids

E. Decelleration - Unequal Displacement



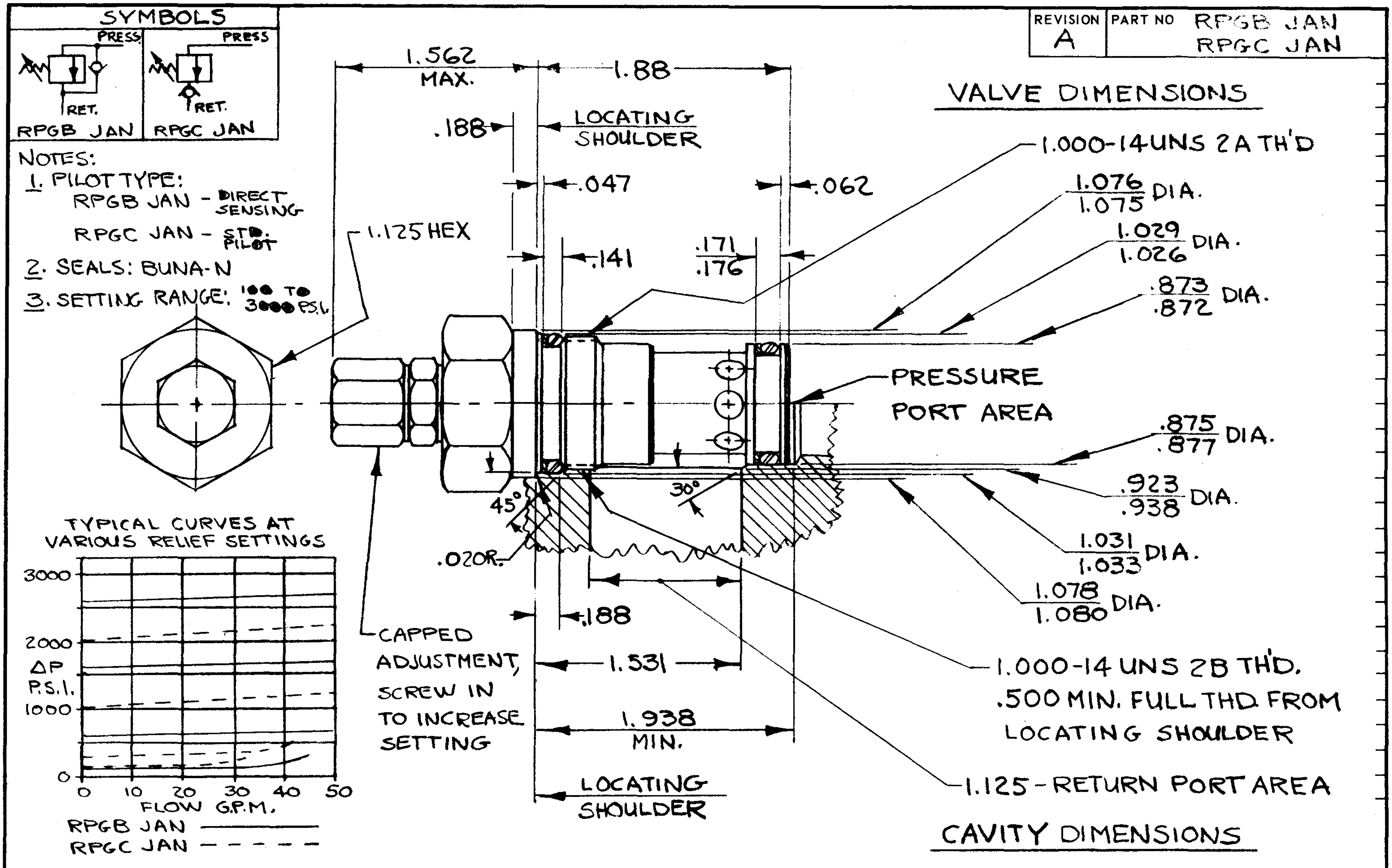
1. Problem: Very high shock pressures result when control valve is centered. Inertia of load turns cylinder into pump but oil is blocked by closed center position of control valve. If conventional "crossover" relief valves are used, head end of cylinder will tend to cavitate when inertia tends to extend cylinder. Rod end of cylinder will see high pressures due to "booster effect" if inertia tends to close cylinder. Both problems are caused by unequal displacement of oil by opposite ends of cylinder.

2. Solution:

   a. Use "crossover" relief with anti-booster and anti-cavitation checks. Direct acting (differential piston type) relief valves set at 1.2-1.3 times system relief setting usually provide adequate decelleration control with greatest reliability.

   b. For more accurate control of decelleration produced pressures, use pilot operated relief valves.

   c. With over-running load, incorporate single or dual counterbalance valve with pilot assist on control valve side of crossover relief (also see Section 1.44C).



LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED RPGC SYMBOL	4-24-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: PILOT OPERATED RELIEF VALVE CARTRIDGE

REVISION: A
PART NO. RPGB JAN, RPGC JAN

SCALE	REF.	MATERIAL
FULL		

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A.			
DATE 2-3-72	DATE	DATE	

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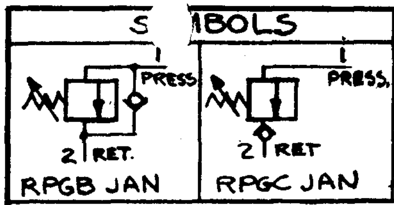
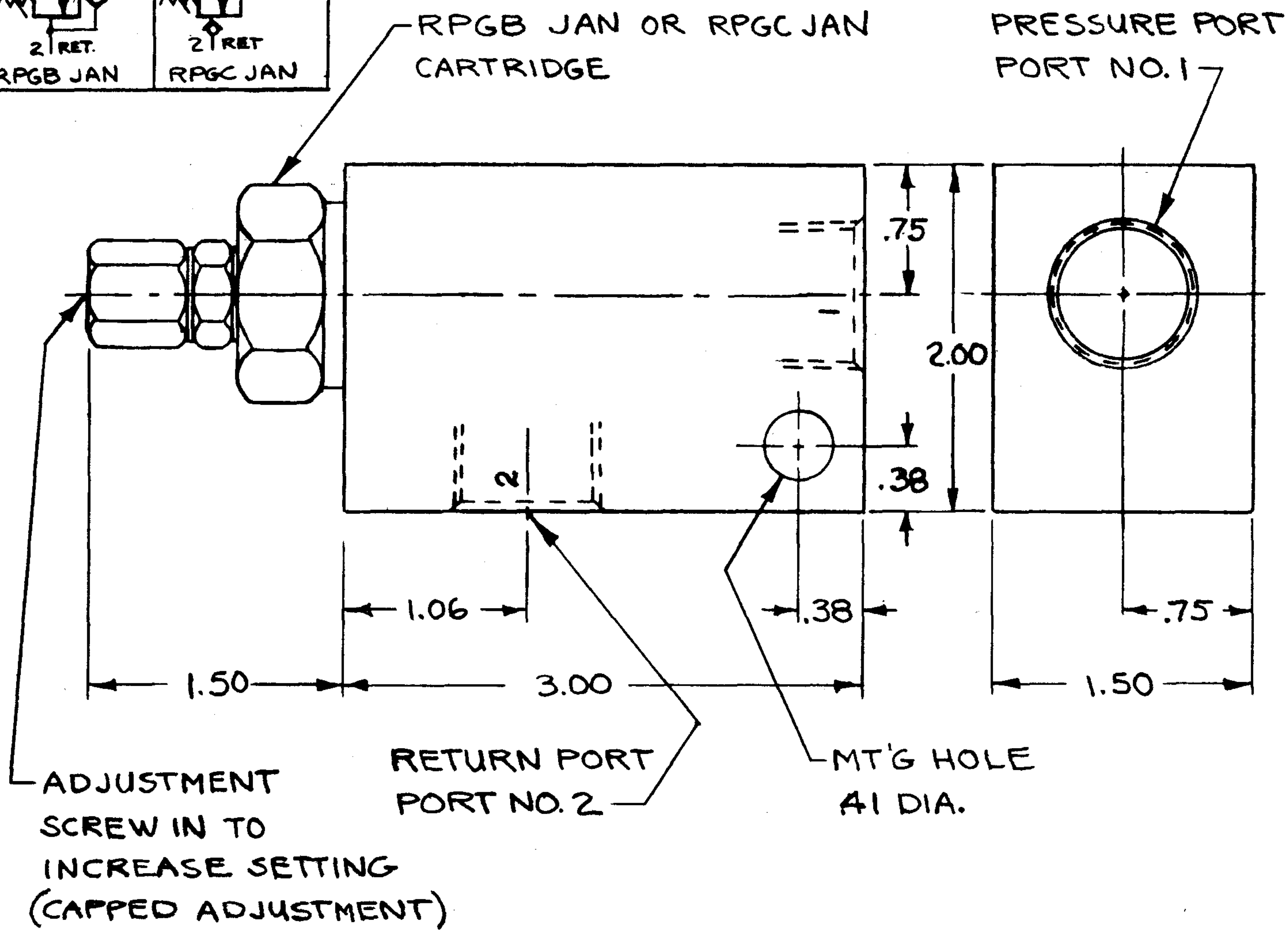
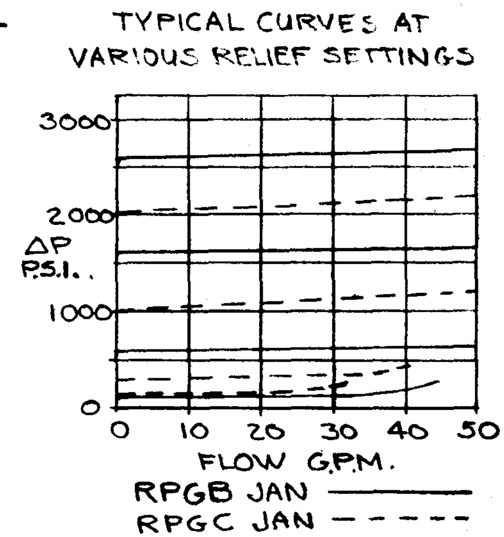
1817 57TH STREET • P.O. BOX 3377
SARASOTA, FLORIDA 33578







1. SETTING RANGE: 100-3000 P.S.I.
2. SEALS: BUNA-N
3. PILOT TYPE:
RPGB-JAN - DIRECT SENSING
RPGC-JAN - STANDARD PILOT

BODY NO.	PORT 1 PRESSURE	PORT 2 RETURN
CAD	.750 N.P.T.F.	.750 N.P.T.F.
CAC	.500 N.P.T.F.	.500 N.P.T.F.
CAB	.375 N.P.T.F.	.375 N.P.T.F.
CAA	.250 N.P.T.F.	.250 N.P.T.F.

TYPICAL P/N
RPGB JAN CAB

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: PILOT OPERATED RELIEF VALVE

SCALE	REF.	MATERIAL
FULL		ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A.			
DATE 2-2-72	DATE	DATE	

REVISION | PART NO. RPGB JAN CA- / RPGC JAN CA- CHART

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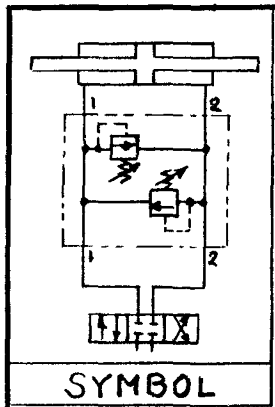
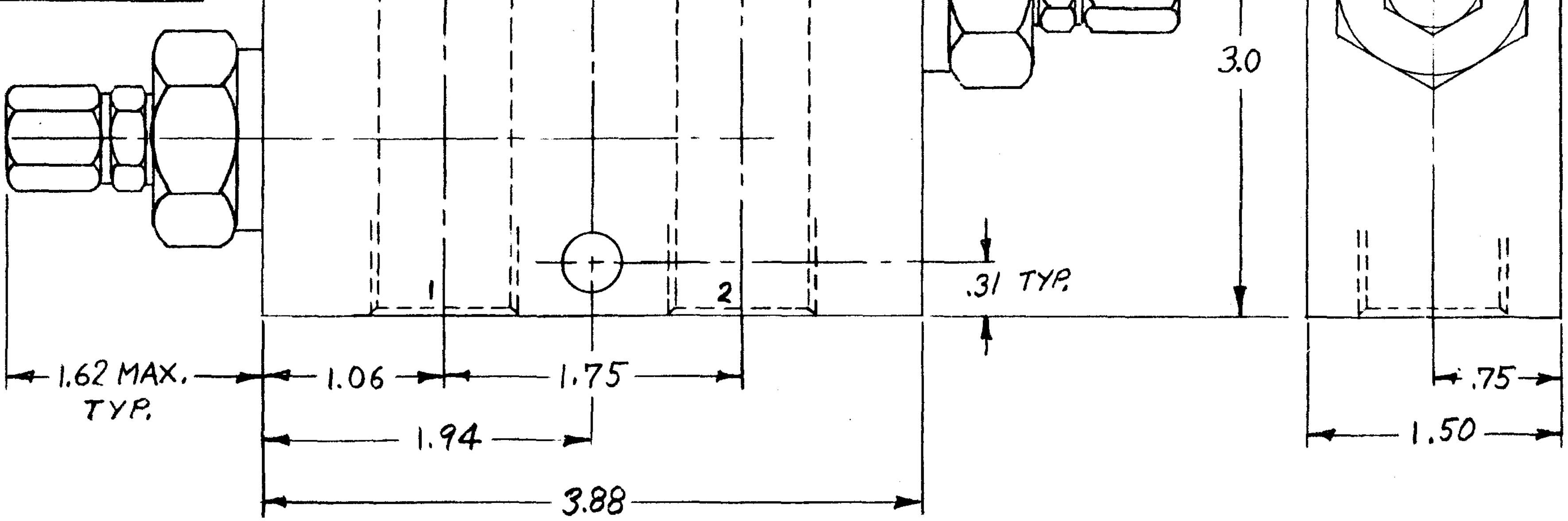
SARASOTA, FLORIDA 33578

REVISION A | PART NO. RPGC JAN --- CHART





BODY NO.	PORT SIZE
YBD	.750 N.P.T.F.
YBC	.500 N.P.T.F.
YBB	.375 N.P.T.F.
YBA	.250 N.P.T.F.

NOTES:
1. SEALS: BUNA-N
2. SETTING RANGE: 100-3000 P.S.I.

TYPICAL P/N
RPGC JAN YBB

LET.	REVISION	DATE	CHECK	REL.
A	ADDED CIRCUIT TO SYMBOL	4-25-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: DUAL RELIEF VALVE

SCALE	REF.		MATERIAL
FULL			
DRAWN R.K.	CHECK	RELEASE	HEAT TREAT & FINISH
DATE 10-22-71	DATE	DATE	

REVISION A | PART NO. RPGC JAN --- CHART

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2.4 Sequence Valves

2.41 Function of Sequence Valves

A. To control sequence of operation of two or more hydraulic actuators.

B. To assure priority hydraulic pressure in one sub-system before another sub-system.

2.411 Typical Applications

A. Industrial machinery

1. Clamp before feed circuits (often with retract feed before unclamping).

2. Transfer operations such as lift before push circuits

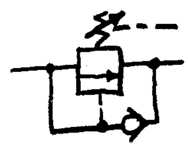
B. Mobile machinery

1. Lift before dump circuits

2. Compactor circuits

2.42 <u>ANS Symbols</u>

Single sequence valve without reverse free flow (valve is identical to relief valve with external drain)



Single sequence valve with reverse free flow (most common type)

2.43 Description of Operation

A. Generally, the operational limitations of sequence valves are similar to relief valves (See Section 2.13).

B. Single sequence valves

1. Without reverse free flow, single sequence valves are identical in operation to relief valves with external drain (See Sections 2.13, A3 and 2.14C).

2. Reverse free flow is often needed to provide reverse sequencing.

3. Sequence valves may have either direct acting or pilot operated construction.

C. Multiple sequence valves

1. Valves in conjunction with check valves can frequently be staged with clever circuitry to sequence to or more functions in two directions.

D. Some important design features of sequence valves:

1. Direct acting sequence valves

a. "Drain" flow is usually low (below 3 cubic inches/min. per 1000 psi in the second (delayed) circuit.

b. Direct acting sequence valves are usually a good choice in low flow, low pressure systems, however, instability is common in full area type valves, especially above 300 psi.

c. "Pressure rise" (increasing pressure with increasing flow) and "hysteresis" vary widely in direct acting sequence valves.

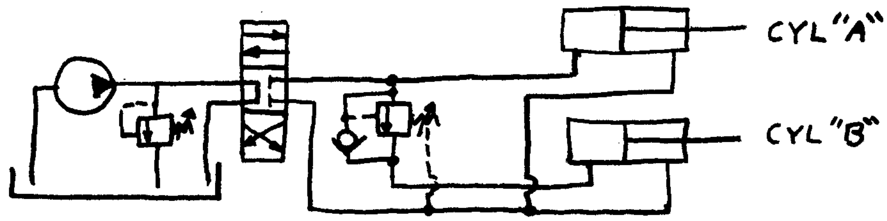
2. Pilot operated sequence valves

a. Significant "drain" flow may be required to open some pilot operated sequence valves (conventionally constructed valves may require as much as 1/2 gpm to open and this may increase as much as 1/2 gpm per 1000 psi differential pressure of the "second" circuit above the first). Conversely, pilot operated sequence valves can be designed to function with 2-10 cubic inches/min. flow to tank. In any case, drain flow is not available to operate the "second" circuit and represents a continuous loss of power and addition of heat to the reservoir.

b. Stability and "pressure-rise" characteristics of pilot operated sequence valves are generally superior to direct acting types.

2.44 Application Aids

A. Sequencing two cylinders (uni-directional)



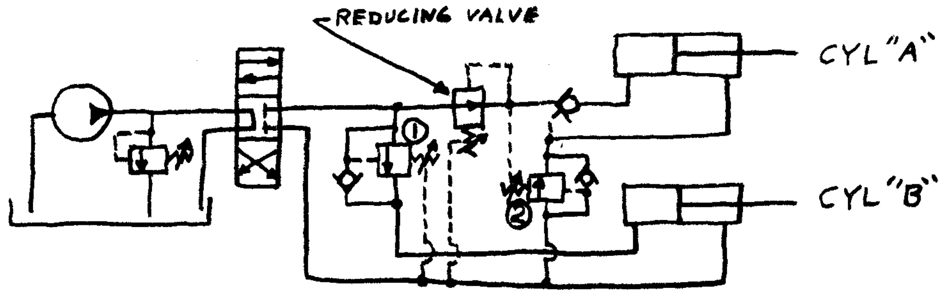
1. Problem: To extend cylinder "A" before cylinder "B". No control of retract sequence required.

2. Solution:

   In extension direction, sequence valve blocks flow to cylinder "B" until pressure in cylinder "A" reaches setting of sequence valve. When pressure rises to setting, sequence valve maintains pressure on cylinder "A" while providing a flow path to cylinder "B". Reverse free flow check allows both cylinders to retract together.

2.44 Application Aids

B. Sequencing two cylinders (bi-directional)

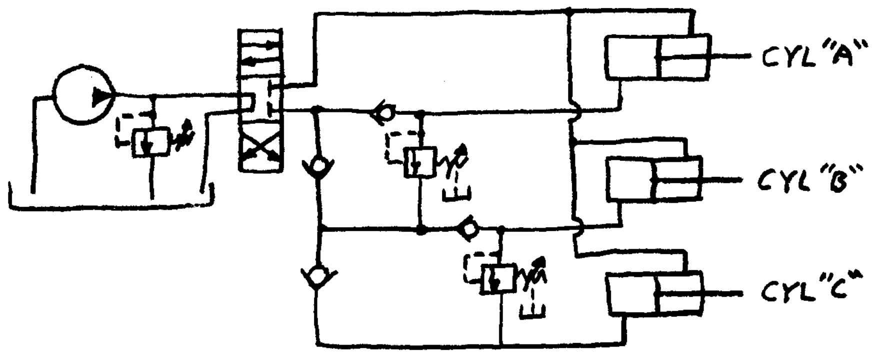


1. Problem: To extend cylinder "A" before cylinder "B" and retract "B" before "A" (e.g. Clamp before feeding drill and retract drill before unclamping.).

2. Solution: In this circuit, a reducing valve and pilot check have been added to control the level of and prevent premature loss of the force applied in extending cylinder "A" (e.g. A clamp). Flow to extend cylinder "B" is blocked until pressure rises to setting of sequence valve #1. Retracting, flow to "A" is blocked until pressure rises to setting of valve #2. Reducing valve controls clamp force. Pilot check assures that clamp will not release prematurely.

2.44 Application Aids

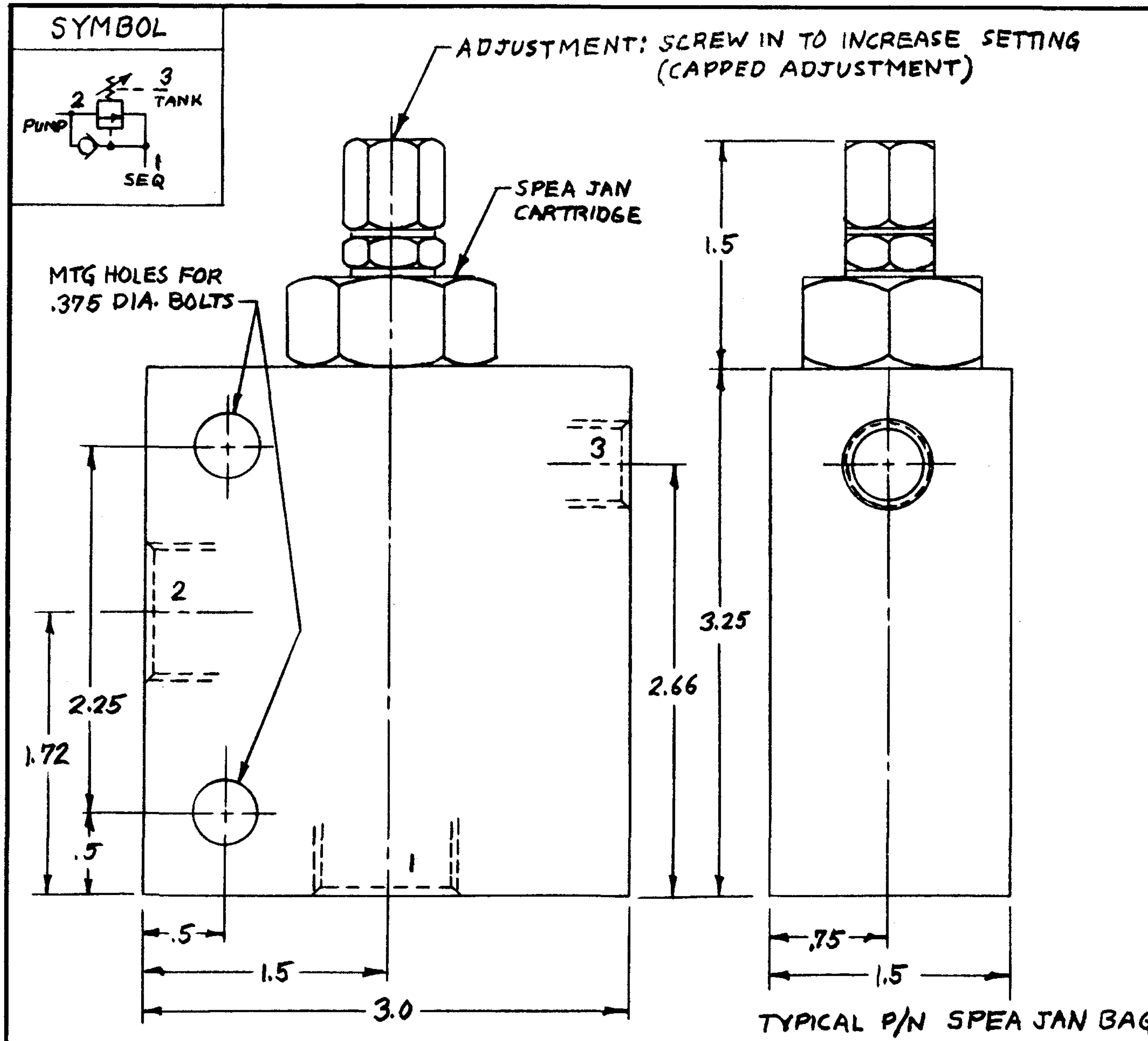
C. Sequencing three or more cylinders (bi-directional)



1. Problem: To extend cylinders in order "A" - "B" - "C" and retract in reverse order "C" - "B" - "A".

2. Solution: Use a special valve package incorporating two check valves and one sequence valve (without reverse free flow) for each additional cylinder after the first cylinder (e.g. 3 cylinders require 4 checks and 2 sequence valves; 4 cylinders require 6 check and 3 sequence valves, etc.). Reducing valves and pilot check valves can also be provided in the valve package, if required.

REVISION	PART NO.
	SPEA JAN BA-(CHART)



TYPICAL P/N SPEA JAN BAG

NOTES:
1. ADJUST RANGE: 100-3000 PSI.
2. SEALS: BUNA N

BODY NO.	PORT 1 SEQUENCED	PORT 2 PUMP	PORT 3 TANK
BAH	.750 NPTF	.750 NPTF	.250 NPTF
BAG	.500 NPTF	.500 NPTF	.250 NPTF
BAF	.375 NPTF	.375 NPTF	.250 NPTF
BAE	.250 NPTF	.250 NPTF	.250 NPTF

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: SEQUENCE VALVE CARTRIDGE IN BODY

SCALE	REF.	MATERIAL
FULL	SPEA JAN BA-	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
RK.			
DATE 2-2-[illegible]	DATE	DATE	

REVISION	PART NO.
	SPEA JAN BA-(CHART)

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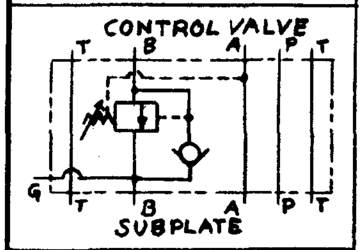
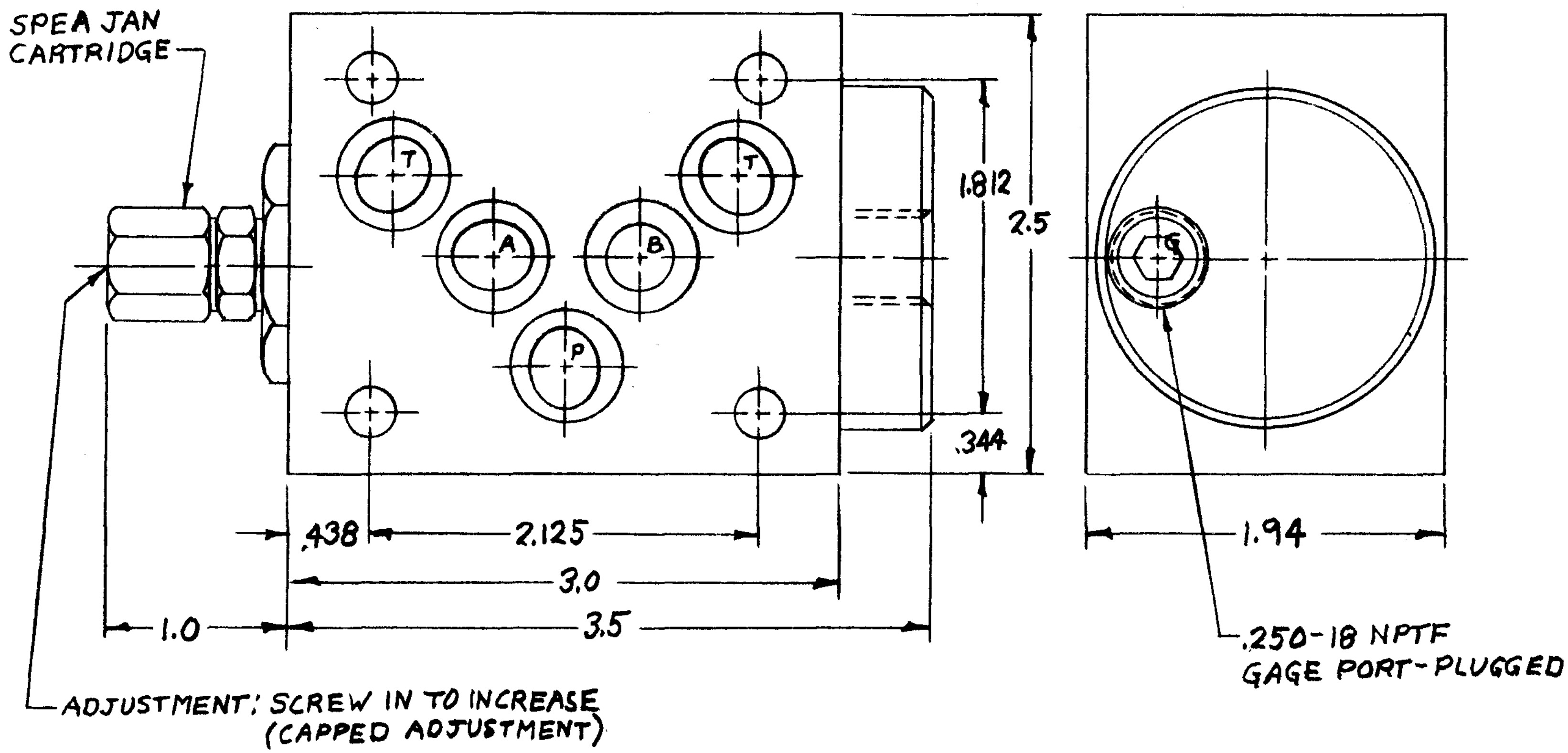
REVISION	PART NO.
A	SPEA JAN BBB



NOTES:
1. ADJ. RANGE: 100-3000 P.S.I.
2. SEALS: BUNA N
3. STD. -014 SUBPLATE SEALS PROVIDED



LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED A & B PORT IDENT.	4-25-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: SEQUENCE VALVE ("B" PORT CONTROL-STD NFPA SUBPLATE)

SCALE	REF.	MATERIAL
FULL	SPEA JAN BBB	ALUM. & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 2-2-72	DATE	DATE	

REVISION	PART NO.
A	SPEA JAN BBB

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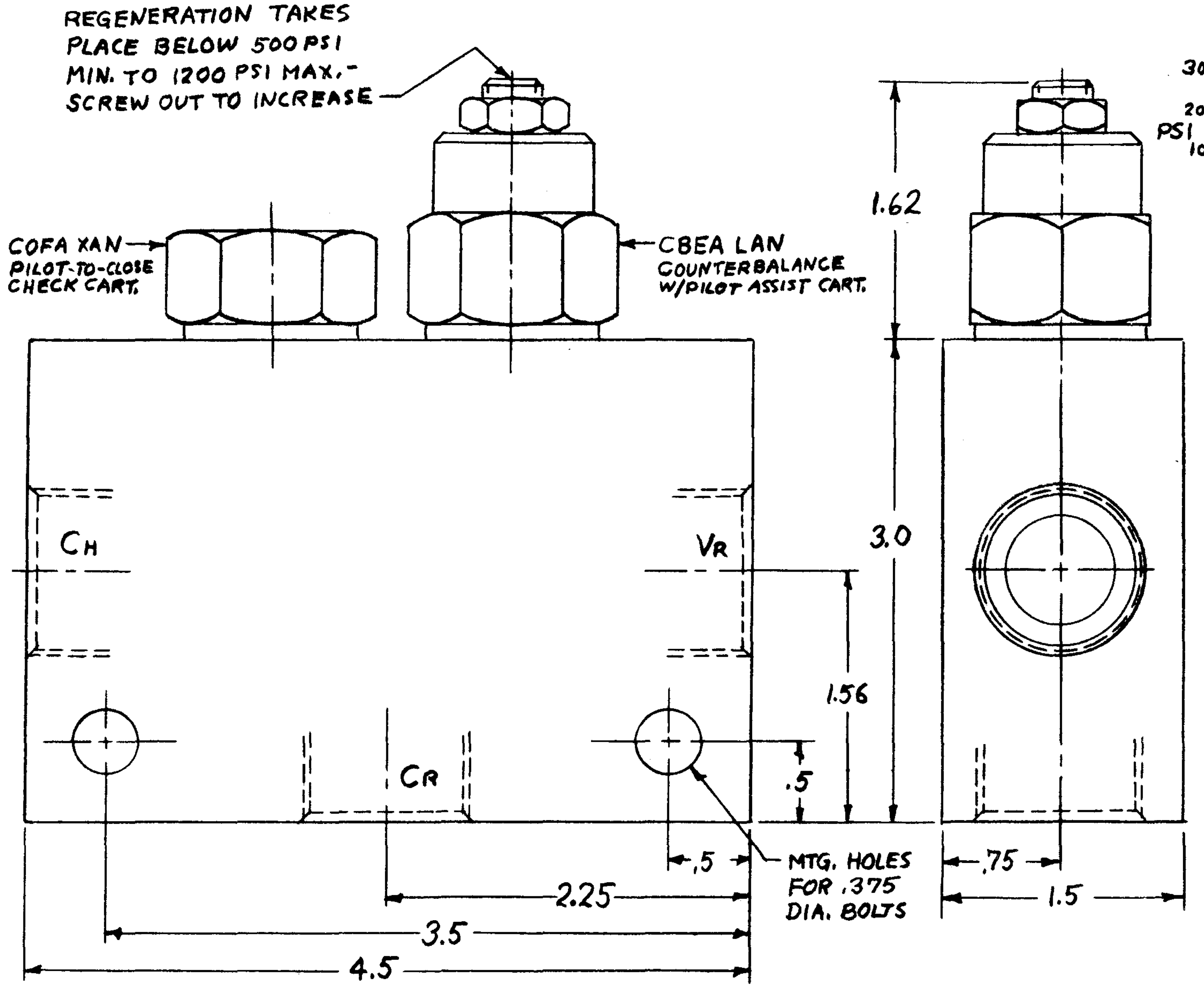
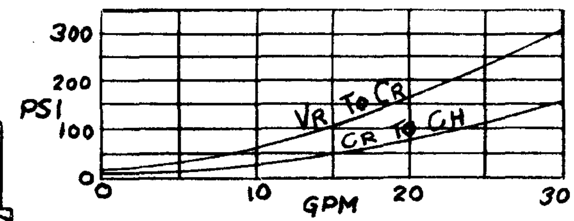
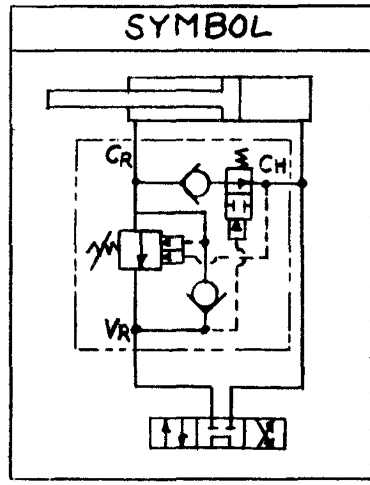
REVISION	PART NO.
	YDEC LAN AD







NOTES -

1. CYLINDER MUST NOT BE LOADED MECHANICALLY TO EXTEND
2. REGENERATION DIMINISHES PROGRESSIVELY ABOVE SETTING (APPROX 1GPM/30PSI)
3. MAX SYSTEM PRESSURE 4000 PSI
4. SEALS: BUNA N
5. PORTS: 3/4" NPTF

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED

DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005

ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: REGENERATIVE VALVE - PRESSURE SENSITIVE

SCALE	REF.	MATERIAL
FULL	REPLACES YDEA LAN A- YDEB LAN AD	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
RK			
DATE 4-26-72	DATE	DATE	

REVISION	PART NO.
	YDEC LAN AD

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2.6 Reducing Valves

2.61 Function of Reducing Valves

A. To limit pressure in hydraulic sub-systems.

B. To provide a constant pressure drop so that simple orifice valves can regulate flow accurately.

2.611 Typical Applications

A. Industrial machinery

1. When used with constant pressure-variable displacement pumping units, valves provide pressure control of individual sub-circuits.

2. To provide adjustment of feeding, clamping and hold-down pressures (with and without relieving feature).

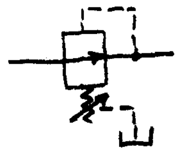
3. To provide pressure compensated flow (feed) control with simple orifice valves.

B. Mobile machinery

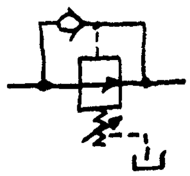
1. To limit force of work-holding devices (e.g. A lift truck paper roll clamp).

2. For foot pedal brake-apply circuits.

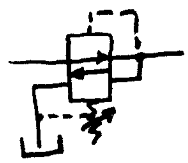
2.62 ANS Symbols



Reducing valve



Reducing valve with reverse free flow check



Reducing-relieving valve

2.63 <u>Description of Operation</u>

A. General:

Reducing and reducing-relieving valves can be of direct acting or pilot operated types. Direct acting valves are generally more reliable and consistent for low pressure settings (below 150 psi, particularly below 50 psi and below 5 gpm). Above these limits, pilot operated valves offer generally superior performance. In any case, the operational limitations of reducing and reducing-relieving valves is typically similar to relief valves (See Section 2.13).

B. Reducing valves:

1. Valve is normally open from pump to system. When system pressure rises to setting, valve throttles pump flow to system to maintain pressure at desired level.

2. A separate low capacity line to tank must be provided for "drain" flow.

C. Reducing-relieving valves

1. Valve is normally open from pump to system. When system pressure rises to setting, valve throttles pump flow to system to maintain system pressure at desired level.

2. In applications where system flow reverses (e.g. A cylinder is pushed back mechanically), valve opens and throttles system flow to tank (like a relief valve) to maintain system pressure at desired level.

3. A separate full capacity line to tank must be provided for "drain" and "relief" flow.

D. Some comments on important design features of reducing and reducing-relieving valves:

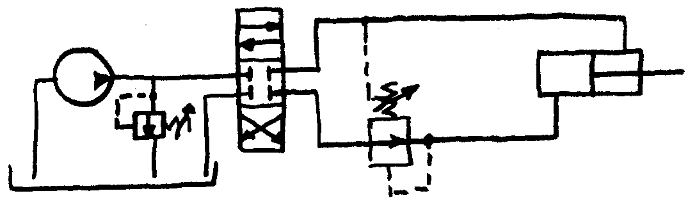
1. Most reducing and reducing-relieving valves exhibit "pressure droop" (fall off of pressure available to

system with increasing flow). Direct acting type valves generally have considerably more "droop" than pilot operated types. Similarly, the relieving characteristic of direct acting type reducing-relieving valves typically shows considerably more "pressure rise" than with pilot operated valves and there is a particularly significant change in pressure at the transition between reducing and relieving functions. In some cases, pilot operated valves with direct sensing pilots can eliminate "droop" and "rise" altogether.

2. Drain flow of direct acting type valves is typically 1-10 cubic inches/min. per 1000 psi of primary pressure. Drain flow of conventionally constructed pilot operated reducing valves is typically 50-150 cubic inch/min., regardless of pressure level. With careful design and manufacturing, pilot operated reducing and reducing-relieving valves can function reliably with 10-20 cubic inches/min. drain flow. In all cases, drain flow represents a continuous loss of power and addition of heat to the reservoir.

2.64 Application Aids

A. Reduced pressure (with reverse free flow)



1. Problem: Cylinder is slow to retract due to pressure buildup closing reducing valve.

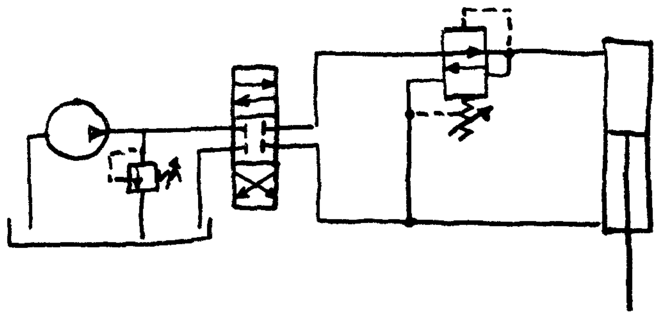
2. Solutions:

   a. Connect "drain" port of reducing valve to opposite line of cylinder. Pressure applied to retract cylinder also pressurizes spring chamber of reducing valve thus "piloting" it open for free reverse flow.

   b. Provide reverse free flow check around reducing valve.

2.64 Application Aids

B. Constant force (bi-directional)



1. Problems:

   a. Hold down cylinder is "bounced" by roll trapping pressure between reducing valve and cylinder.

   b. Winch requires constant tension whether winding out or in.

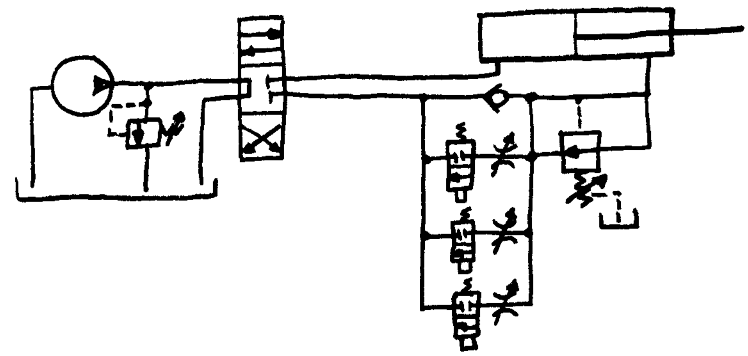
2. Solutions:

   a. In both applications, use reducing-relieving valves. For very close control of pressure, use pilot operated reducing-relieving valve, if possible with direct sensing pilot.

   b. With special valving, it is sometimes possible to control "out", "in" and "steady" pressures at distinctly separate and individually adjustable levels.

2.64 Application Aids

C. Machine "feed" circuit

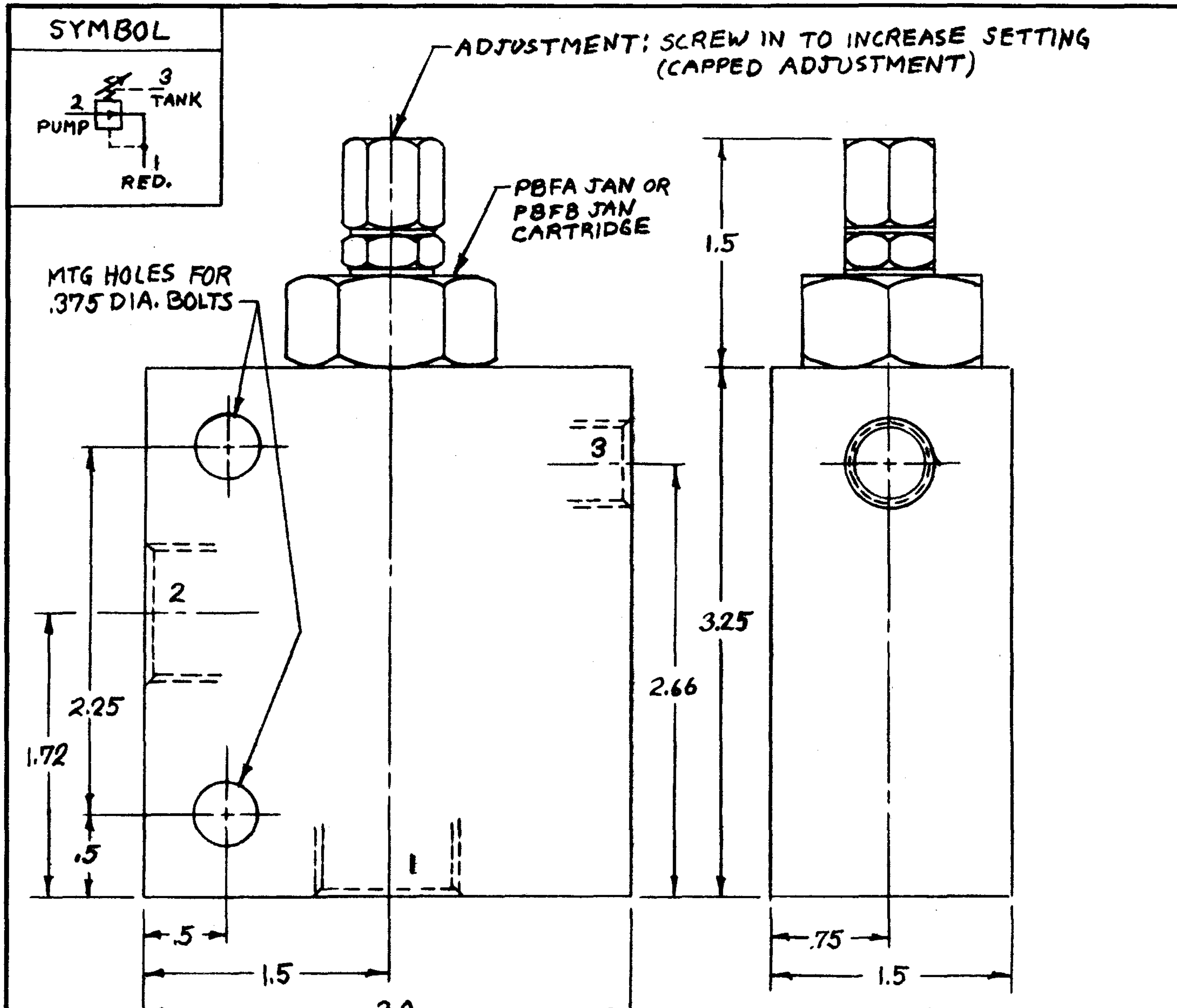


1. Problem: To provide load-insensitive (pressure compensated) feed control with multiple simple panel mounted needle valves.

2. Solution:

   Incorporate direct acting reducing valve on exhaust port of cylinder with needle valves between reducing valve and tank (to provide meter out control). Reducing valve can be set so that maximum desired feed rate is obtained with needle valve(s) wide open (to prevent operator from selecting an unsafe feed rate). (Note: Minimum feed is determined by "drain" flow requirement of reducing valve.)

REVISION | PART NO. PBFA JAN BA- / PBFB JAN BA- (CHART)



TYPICAL P/N PBFA JAN BAG

NOTES:
1. ADJUST RANGE:
PBFA JAN 50-1200 PSI (DIRECT SENSING PILOT-1200 PSI MAX. INPUT)
PBFB JAN 75-2000 PSI (STD. PILOT-3000 PSI MAX. INPUT)
2. SEALS: BUNA N

BODY NO.	PORT 1 REDUCED	PORT 2 PUMP	PORT 3 TANK
BAH	.750 NPTF	.750 NPTF	.250 NPTF
BAG	.500 NPTF	.500 NPTF	.250 NPTF
BAF	.375 NPTF	.375 NPTF	.250 NPTF
BAE	.250 NPTF	.250 NPTF	.250 NPTF

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: REDUCING VALVE CARTRIDGE IN BODY

SCALE	REF.	MATERIAL
FULL	PBFA JAN PBFB JAN BA-	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
K.K.			
DATE 2-2	DATE	DATE	

REVISION | PART NO. PBFA JAN BA- / PBFB JAN BA- (CHART)

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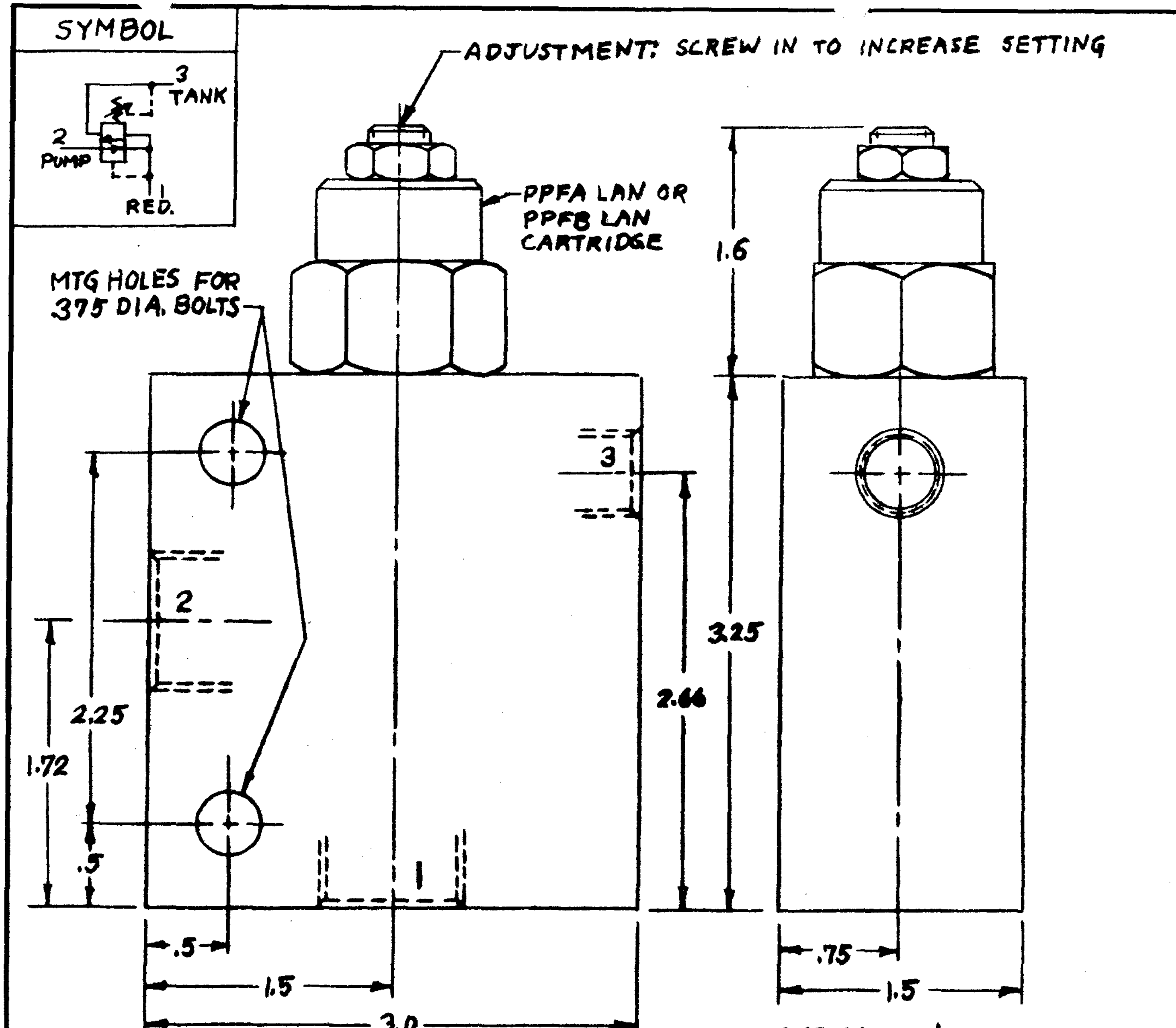
PART NO. PPFA LAN BA- / PBFB LAN BA- (CHART)



TYPICAL P/N PPFA LAN BAG

NOTES:
1. ADJUST RANGE:
PPFA LAN 50-1200 PSI (DIRECT SENSING PILOT- 1200 PSI MAX. INPUT)
PPFB LAN 75-2000 PSI (STD. PILOT- 3000 PSI MAX. INPUT)
2. SEALS: BUNA N

BODY NO.	PORT 1 ~~PUMP~~ REDUCED	PORT 2 ~~REDUCED~~ PUMP	PORT 3 TANK
BAH	.750 NPTF	.750 NPTF	.250 NPTF
BAG	.500 NPTF	.500 NPTF	.250 NPTF
BAF	.375 NPTF	.375 NPTF	.250 NPTF
BAD	.750 NPTF	.750 NPTF	.500 NPTF
BAC	.500 NPTF	.500 NPTF	.500 NPTF
BAB	.375 NPTF	.375 NPTF	.375 NPTF
BAE	.250 NPTF	.250 NPTF	.250 NPTF

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: REDUCING-RELIEVING VALVE CARTRIDGE IN BODY

SCALE	REF.	MATERIAL
FULL	PPFA LAN PPFB LAN BA-	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
RK			
DATE 2-2-72	DATE	DATE	

REVISION | PART NO. PPFA LAN BA- / PPFB LAN BA- (CHART)

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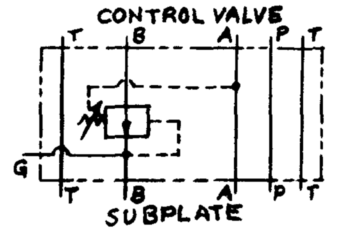
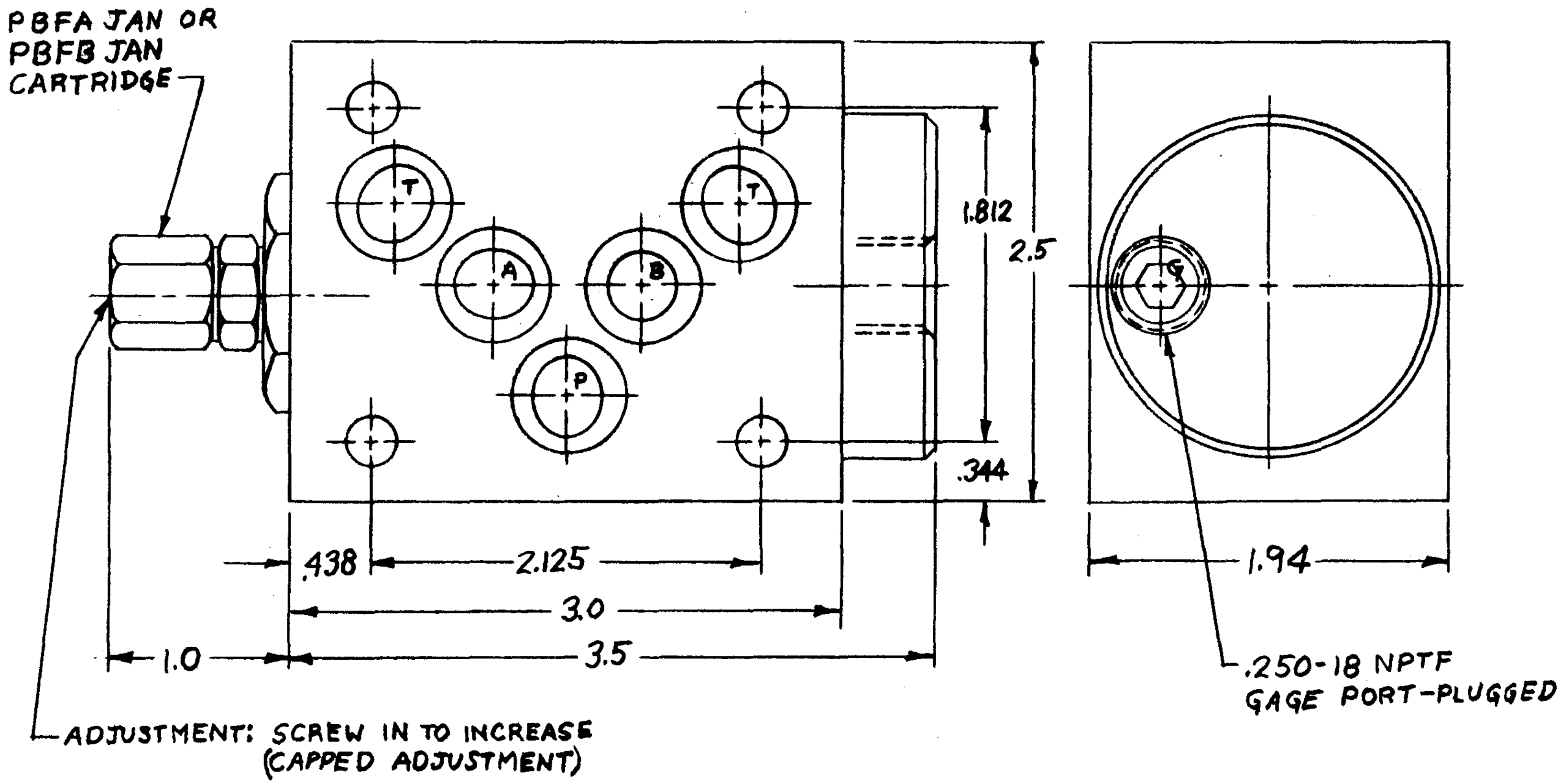
SARASOTA FLORIDA 33578

REVISION	PART NO.
A	PBFA JAN BBB PBFB JAN BBB

SYMBOL



NOTES:
1. ADJUST RANGE: PBFA JAN 50-1200 P.S.I. (DIRECT SENSING PILOT)
PBFB JAN 75-2000 P.S.I. (STD. PILOT)
2. INPUT PRESSURE: PBFA JAN 1200 P.S.I. MAX.
PBFB JAN 3000 P.S.I. MAX.
3. SEALS: BUNA N
4. STD -014 SUBPLATE SEALS PROVIDED



LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED A & B PORT IDENT.	4-25-72		R.K.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE: REDUCING VALVE
("B" PORT CONTROL - STD. NFPA SUBPLATE)

SCALE	REF	MATERIAL
FULL	PBFA JAN PBFB JAN BBB	ALUM. & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
RK			
DATE 2-2-72	DATE	DATE	

REVISION	PART NO.
A	PBFA JAN BBB PBFB JAN BBB

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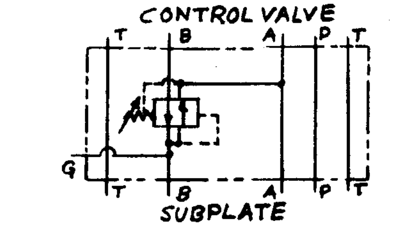
SARASOTA, FLORIDA 33578

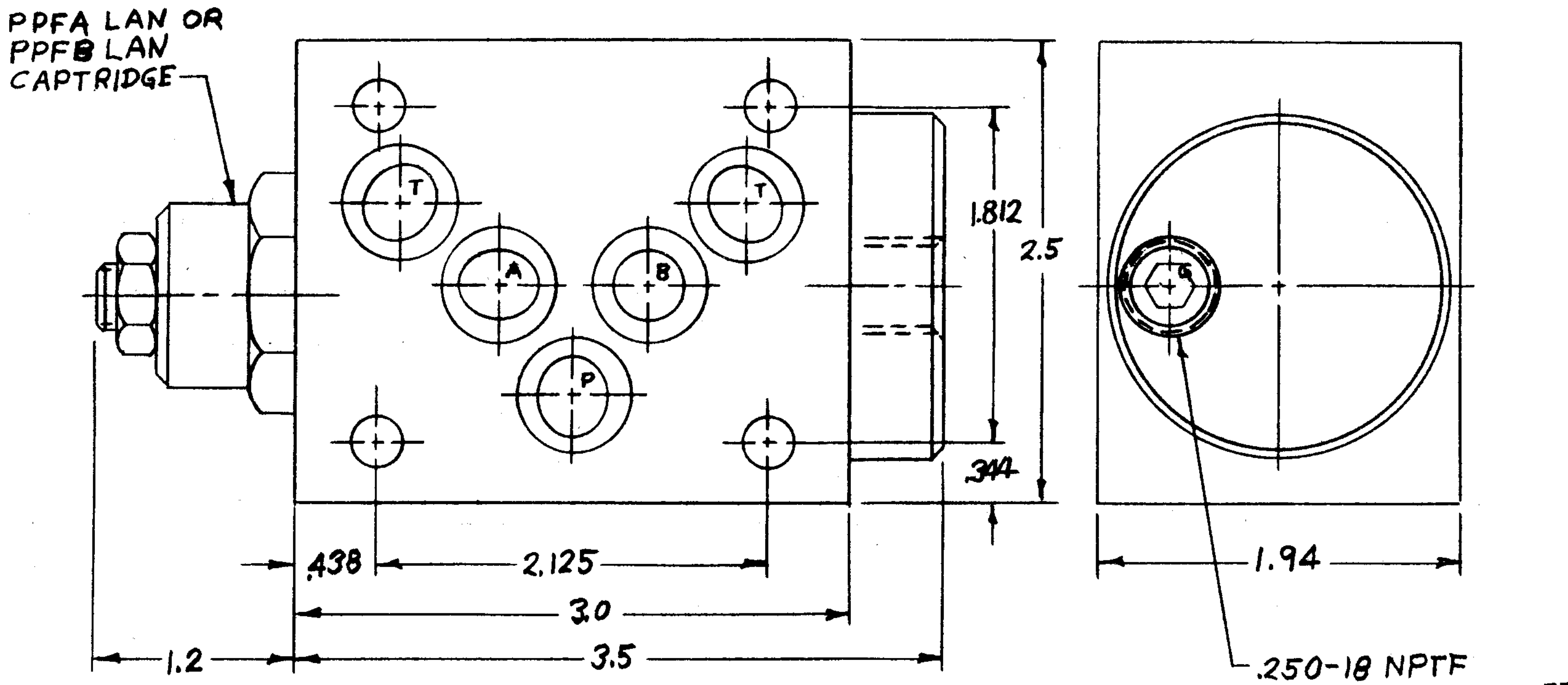
REVISION	PART NO.
A	PPF4 L..N BBB PPFB LAN BBB

SYMBOL



NOTES:

1. ADJUST RANGE: PPFA LAN 50-1200 P.S.I. (DIRECT SENSING PILOT)
   PPFB LAN 75-2000 P.S.I. (STD. PILOT)
2. INPUT PRESSURE: PPFA LAN 1200 P.S.I. MAX.
   PPFB LAN 3000 P.S.I. MAX.
3. SEALS: BUNA N
4. STD. -014 SUBPLATE SEALS PROVIDED



ADJUSTMENT: SCREW IN TO INCREASE BOTH RELIEF & REDUCING SETTINGS

LET.	REVISION	DATE	CHECK	REL.
A	CORRECTED A & B PORT IDENT.	4-25-72		R.K.

UNLESS OTHERWISE SPECIFIED

DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE REDUCING-RELIEVING VALVE ("B" PORT CONTROL-STD. NFPA SUBPLATE)

SCALE	REF	MATERIAL
FULL	CPEA LAN CPEB LAN BBB	ALUM & STEEL

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
R.K.			
DATE 2-2-72	DATE	DATE	

REVISION	PART NO.
A	PPFA LAN BBB PPFB LAN BBB

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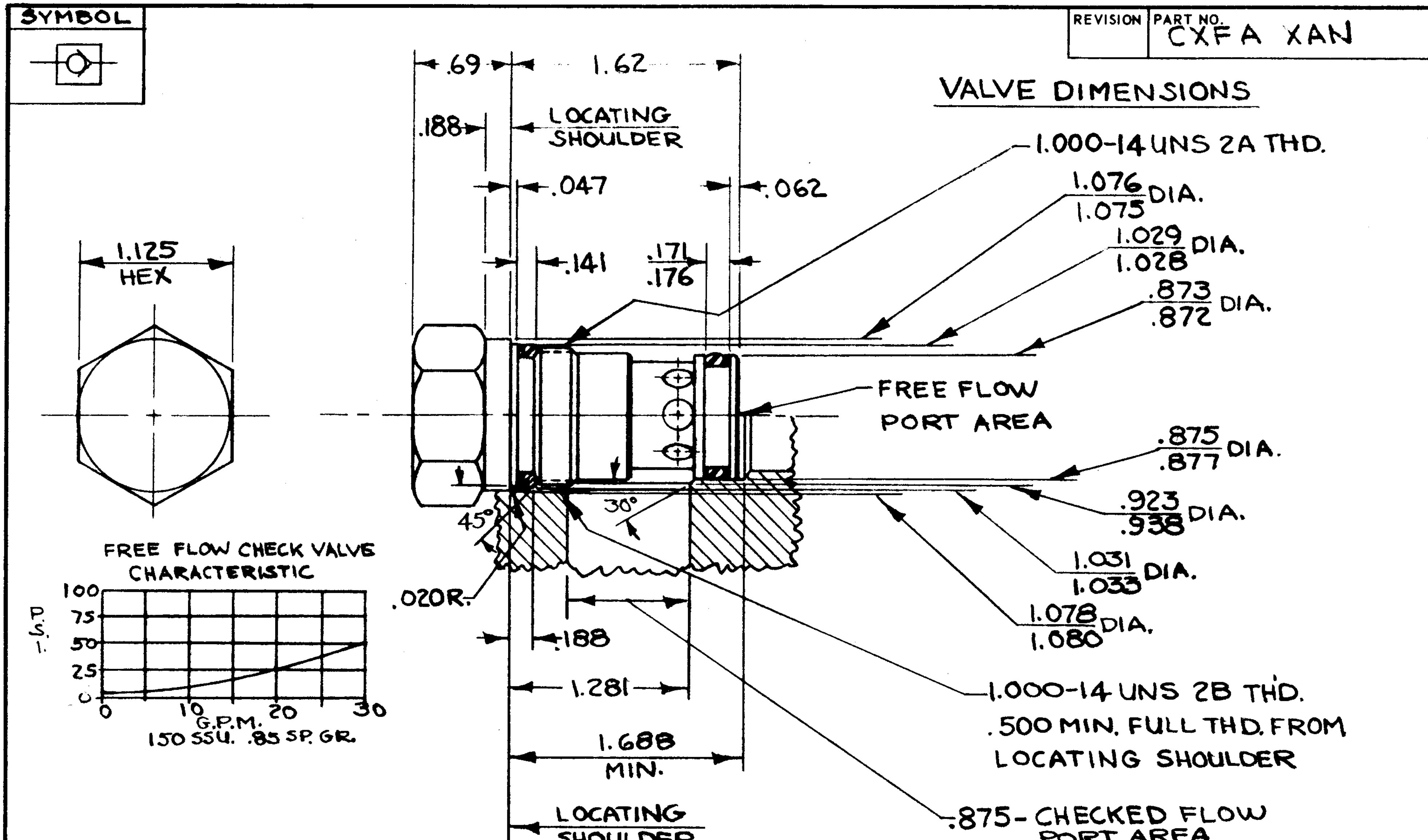
SARASOTA, FLORIDA 33578



2. CHECK SEAT: STEEL
1. SEALS: BUNA-N

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE CHECK VALVE CARTRIDGE

SCALE	REF.	MATERIAL	
FULL			
DRAWN J.D.A	CHECK	RELEASE	HEAT TREAT & FINISH
DATE 2-2-..	DATE	DATE	

REVISION | PART NO. CXFA XAN

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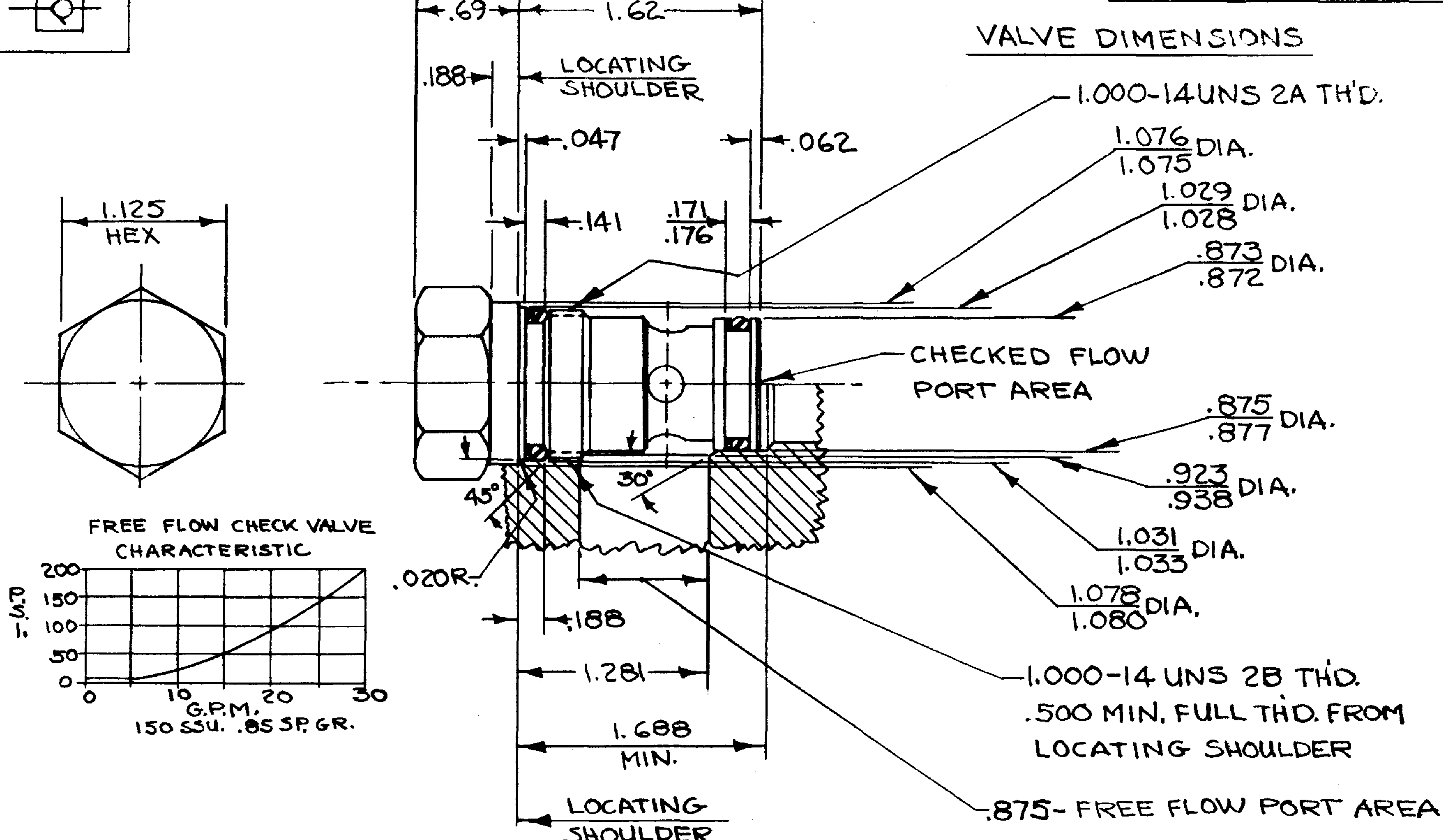
SARASOTA, FLORIDA 33578

SH 5 5-70

REVISION | PART NO. CXEB XAN



2. CHECK SEAT: DELRIN
1. SEALS: BUNA-N

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE CHECK VALVE CARTRIDGE

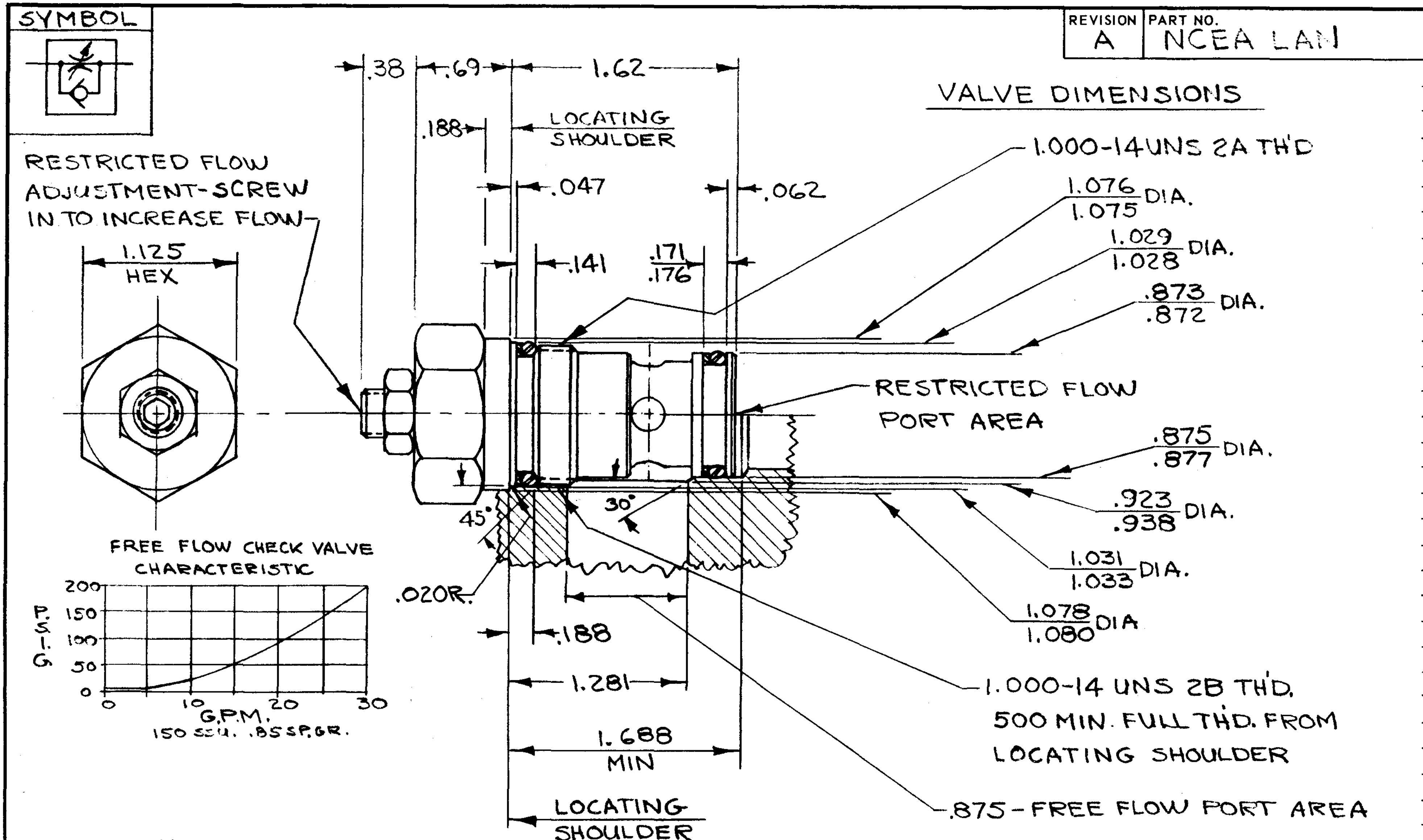
SCALE	REF.	MATERIAL
FULL		

DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A			
DATE 7-2-71	DATE	DATE	

REVISION | PART NO. CXEB XAN

sun hydraulics CORPORATION
1817 57TH STREET • P.O. BOX 3377
SARASOTA, FLORIDA 33578

SH 5 5-70



2. CHECK SEAT: STEEL

1. SEALS: BUNA-N

LET.	REVISION	DATE	CHECK	REL.
A	SEAT WAS DELRIN	2-2-72	J.D.A.	

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE RESTRICTOR VALVE CARTRIDGE - ADJUSTABLE

SCALE	REF.	MATERIAL
FULL		

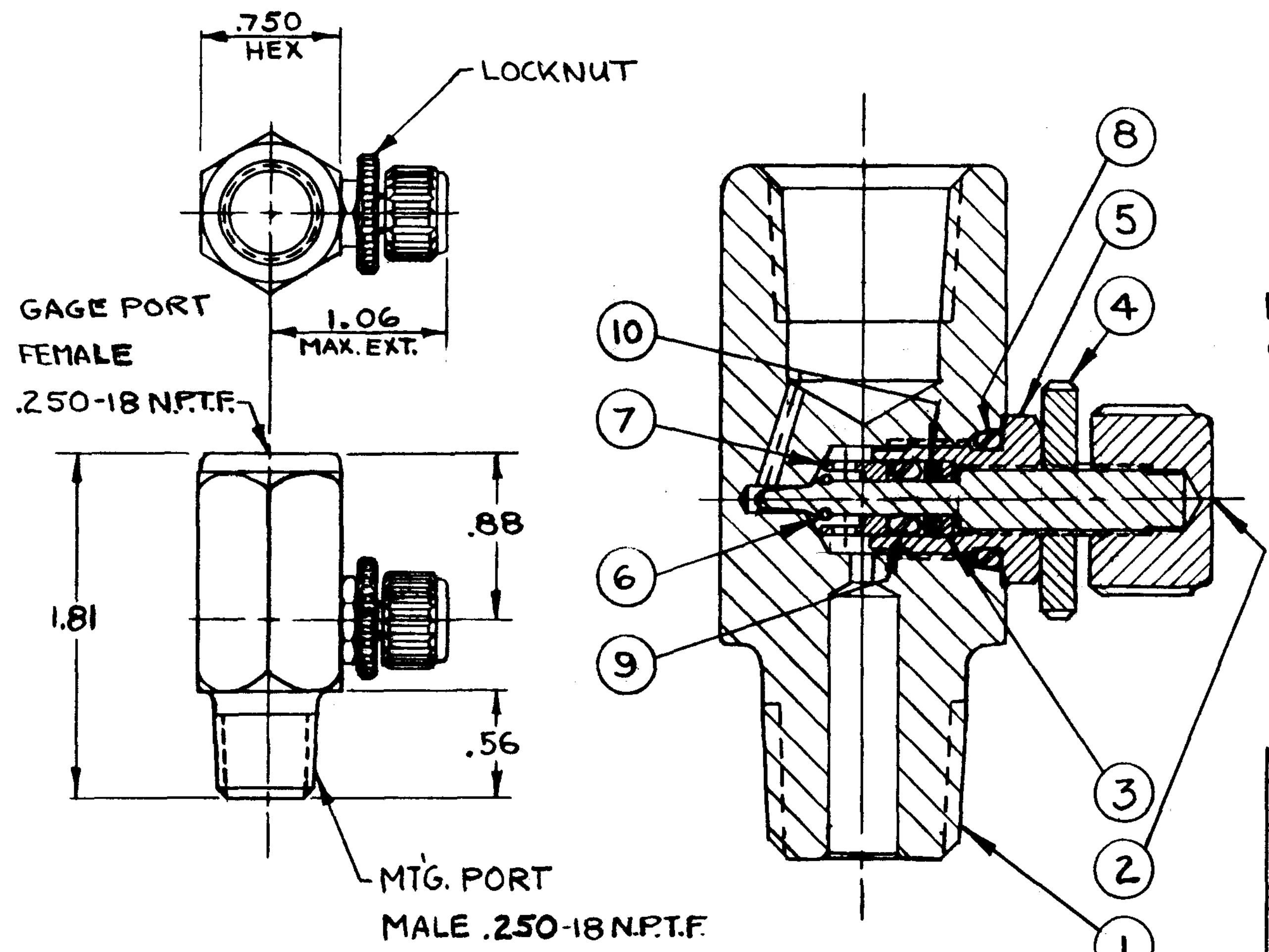
DRAWN	CHECK	RELEASE	HEAT TREAT & FINISH
J.D.A.			
DATE 7-2-71	DATE	DATE	

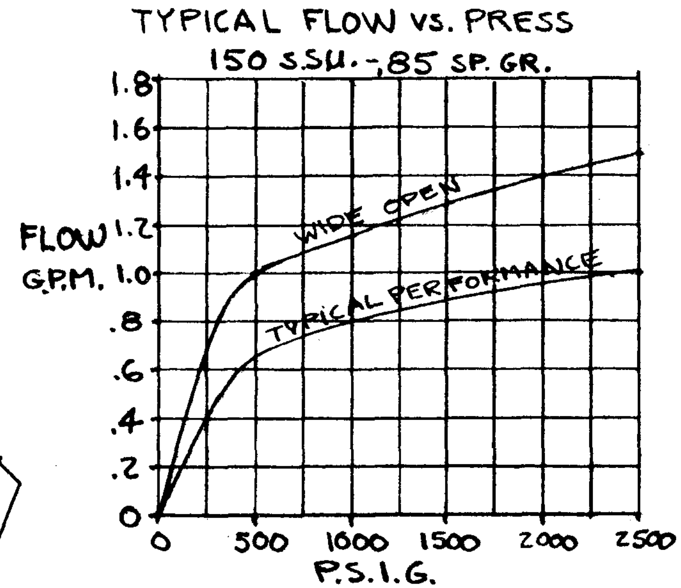
REVISION A
PART NO. NCEA LAN

sun hydraulics CORPORATION
1817 57TH STREET • P.O. BOX 3377
SARASOTA, FLORIDA 33578

SH 5 5-70

REVISION | PART NO. NSAA KXV AC





ITEM	PART NO.	PART NAME	QTY.
10	525-002-005	RING-BACKUP	1
9	500-003-004	SEAL-O-RING	1
8	500-004-902	GASKET-O-RING	1
7	250-001	RETAINER	1
6	400-001-001	RING-WIRE	1
5	125-002	GLAND	1
4	375-001	LOCKNUT	1
3	460-000-001	WASHER	1
2	A325-001	NEEDLE ASSY.	1
1	125-001	BODY	1

2. MATERIAL: ALUMINUM & STAINLESS
1. SEALS: VITON-TEFLON BACKUP

LET.	REVISION	DATE	CHECK	REL.

UNLESS OTHERWISE SPECIFIED
DIMENSION TOL.
.x = ±.030
.xx = ±.015
.xxx = ±.005
ANGLE TOL. ±1°
FINISH 125/
REMOVE ALL BURRS

TITLE GAGE SNUBBER AND SHUT-OFF VALVE

SCALE FULL-ASS'Y 2X | REF. | MATERIAL —
DRAWN J.D.A. | CHECK | RELEASE | HEAT TREAT & FINISH —
DATE 5-25-70 | DATE | DATE

REVISION | PART NO. NSAA KXV AC

SUN hydraulics CORPORATION
1817 57TH STREET • P.O. BOX 3377
SARASOTA, FLORIDA 33578

SH 5 5-70

Suggested Prices and
Discounts - 2/1/72

Sun Hydraulics Corporation
1817 57th Street
Box 3377
Sarasota, Florida 33578

Quantity Discounts

1-2	3-9	10-29	30-99	100-299	300 & over
List price	7%	15%	25%	35%	On request

Special Products - Price on request

Standard Valves

Pilot Check Valves

CPEA	XAN		14.85	Basic cartridge
CPEA	XAN	BA-	23.25	Cartridge in body, 1/4"-3/4" ports
CPEA	XAN	BBA	38.85	Cartridge in NFPA subplate sandwich body - control of "A" port
CPEA	XAN	BBB	38.85	Cartridge in NFPA subplate sandwich body - control of "B" port
CPEA	XAN	YA-	46.30	Two cartridges in body - internal cross piloting, 1/4"-3/4" ports

Standard Modifications

		(basic price)	
LAN		+1.50	Manual release, o-ring-on-screw
XPN		+ .60	Seal on pilot piston
XAV		+3.00	Viton seals (over 30, +1.50)
	BA-	+4.50	O-ring ports on single body (over 30, +2.25)
	YA-	+6.00	O-ring ports on double body (over 30, +3.00)

Counterbalance Valves - with pilot assist

CBEA	LAN		22.75	Basic cartridge, o-ring-on-screw adjustment
CBEA	LAN	BA-	31.15	Cartridge in body, 1/4"-3/4" ports
CBEA	LAN	BBA	46.75	Cartridge in NFPA subplate sandwich body - control of "A" port
CBEA	LAN	BBB	46.75	Cartridge in NFPA subplate sandwich body - control of "B" port
CBEA	LAN	YA-	62.10	Two cartridges in body - internal cross piloting, 1/4"-3/4" ports

Counterbalance Valves (continued)

Standard Modifications

CBEA			(basic price)	
	LAV		+5.00	Viton seals (over 30, +2.50)
		BA-	+4.50	O-ring ports (over 30, +2.25)
		YA-	+6.00	O-ring ports (over 30, +3.00)

Relief Valves

RPGB	JAN		18.15	Basic unbalanced poppet cartridge, direct sensing pilot, capped adjustment
RPGC	JAN		18.80	Basic balanced spool cartridge, standard pilot, capped adjustment
RSFC	JAN		22.50	Balanced spool cartridge, standard pilot, external drain
RPGB	JAN	CA-	24.40	Cartridge in body, 1/4"-3/4" ports
RPGC	JAN	CA-	25.05	" " " " " "
RSFC	JAN	BA-	30.90	" " " " " "
RPGC	JAN	YB-	51.60	Two cartridges in body - 1/4"-3/4" ports

Standard Modifications

		(basic price)	
MAN		+.60	Lockwire holes provided
LAN		+2.50	O-ring-on-screw adjustment
KAN		+4.00	Handknob adjustment
OAN		+5.00	Handknob & panel mount
JAV		+4.00	Viton seals (over 30, +2.00)
	CA-	+3.00	O-ring ports (over 30, +1.50)
	BA-	+4.50	O-ring ports (over 30, +2.25)
	YB-	+6.00	O-ring ports (over 30, +3.00)

Sequence Valves

SPEA	JAN		24.00	Basic cartridge, reverse free flow unbalanced poppet, direct sensing pilot, capped adjustment
SPEA	JAN	BA-	32.40	Cartridge in body, 1/4"-3/4" ports
SPEA	JAN	BBA	48.00	Cartridge in NFPA subplate sandwich body - control of "A" port
SPEA	JAN	BBB	48.00	Cartridge in NFPA subplate sandwich body - control of "B" port

Sequence Valves (continued)

Standard Modifications

SPEA			(basic price)	
	MAN		+ .60	Lockwire holes provided
	LAN		+2.50	O-ring-on-screw adjustment
	KAN		+4.00	Handknob adjustment
	OAN		+5.00	Handknob & panel mount
	JAV		+5.00	Viton seals (over 30, +2.50)
		BA-	+4.50	O-ring ports (over 30, +2.25)
YDEC	LAN	AD	57.00	Regenerative Valve - pressure sensing

Reducing Valves

PBFA	JAN		22.50	Basic reducing only cartridge, direct sensing pilot, capped adjustment
PBFB	JAN		22.50	Basic reducing only cartridge, standard pilot, capped adjustment
PPFA	LAN		29.50	Basic reducing and relieving cartridge, direct sensing pilot, o-ring-on-screw adj.
PPFB	LAN		29.50	Basic reducing and relieving cartridge, standard pilot, o-ring-on-screw adj.
PBFA PBFB	JAN JAN	BA- BA-	30.90	Cartridge in body, 1/4"-3/4" ports
PPFA PPFB	LAN LAN	BA- BA-	37.90	" " " " " "
PBFA PBFB	JAN JAN	BBA BBA	46.50	Cartridge in NFPA subplate sandwich body - contol of "A" port
PPFA PPFB	LAN LAN	BBA BBA	53.50	Cartridge in NFPA subplate sandwich body - control of "A" port
PBFA PBFB	JAN JAN	BBB BBB	46.50	Cartridge in NFPA subplate sandwich body - control of "B" port
PPFA PPFB	LAN LAN	BBB BBB	46.50	Cartridge in NFPA subplate sandwich body - control of "B" port

Standard Modifications

MAN		+ .60	Lockwire holes provided
LAN		+2.50	O-ring-on-screw adjustment (PBFA & PBFB only)
KAN		+4.00	Handknob adjustment
OAN		+5.00	Handknob & panel mount
-AV		+6.00	Viton seals (over 30, +3.00)
	BA-	+4.50	O-ring ports (over 30, +2.25)

Check Valves

CXEB XAN	10.25	Basic Cartridge
CXFA XAN	10.25	Basic Cartridge

Restrictor Valves

NCEA LAN	12.50 ~~6.50~~	Basic Cartridge

Gage Snubber & Shut-off Valve

NSAA KXV AC	6.50	1/4" NPTF ports, viton seals

Cavity Tooling for Cartridges

Pilot check, counterbalance, relief with external drain, sequence reducing and reducing-relieving valve cartridges

No. 4 Morse taper shanks	1	2	3
TD-2 Form Drill (H.S.S.)	86.00	80.00	75.00
TR-2 Form Reamer (H.S.S.)	108.00	100.00	93.00

Relief valve cartridges

No. 3 Morse taper shanks	1	2	3
TD-3 Form Drill (H.S.S.)	81.00	75.00	70.00
TR-3 Form Reamer (H.S.S.)	103.00	95.00	88.00

Check and restrictor cartridges

No. 3 Morse taper shanks	1	2	3
TD-5 Form Drill (H.S.S.)	81.00	75.00	70.00
TR-5 Form Reamer (H.S.S.)	103.00	95.00	88.00