

# milwaukee *Cylinder*

Specials are Our Standard...



...Your Economy is in Our Quality

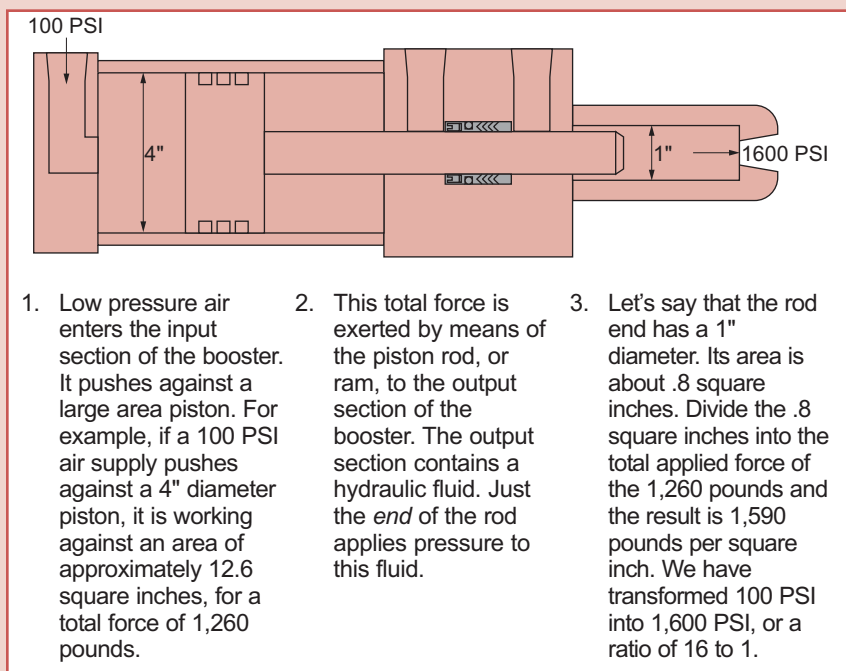
## Pressure Boosters

### Air Oil Tanks

## Booster Principles and Operation

### How a booster works

A booster, or pressure intensifier, is a device that amplifies available line pressure in order to perform work requiring much higher pressure. It operates a hydraulic cylinder without the need for a hydraulic power unit. A booster is basically a cylinder and is similar in internal design, except that the rod end of the piston does not extend outside. The rod becomes a ram for hydraulic fluid. A booster is equivalent to a transformer, or pulley system, in that it changes the ratio of pressure input to pressure output but does not amplify power. Low pressure air, as found in most plants or shops, is connected to the large cylinder. Pressures are typically 80 to 100 PSI. This low pressure is converted by the booster to a much higher hydraulic pressure on the output side. This discharge has an amplified pressure potential equal to the product of the supply pressure and the booster ratio. Total power is not changed, as the low pressure input air must operate against a large area piston in order to produce high pressure from a much smaller surface area.



1. Low pressure air enters the input section of the booster. It pushes against a large area piston. For example, if a 100 PSI air supply pushes against a 4" diameter piston, it is working against an area of approximately 12.6 square inches, for a total force of 1,260 pounds.
2. This total force is exerted by means of the piston rod, or ram, to the output section of the booster. The output section contains a hydraulic fluid. Just the *end* of the rod applies pressure to this fluid.
3. Let's say that the rod end has a 1" diameter. Its area is about .8 square inches. Divide the .8 square inches into the total applied force of the 1,260 pounds and the result is 1,590 pounds per square inch. We have transformed 100 PSI into 1,600 PSI, or a ratio of 16 to 1.

Standard boosters are available in ratios running from approximately 2 to 1 up to 36 to 1. In the selection of a particular booster (for details, see p. 9), not only does the ratio have to be taken into account, but also the output volume has to be matched to the cylinder which the booster will drive.

**What does the working cylinder see?** In our example above, we have an output of 1600 PSI hydraulic pressure. When this 1600 PSI is fed to a cylinder, the *total* area of the piston in the cylinder is now under a pressure of 1600 PSI! Therefore, instead of an air cylinder which would have to work under 100 PSI air pressure, we can now have a cylinder working under 1600 PSI hydraulic pressure. True, this cylinder will only perform work at this pressure through a volume of fluid in the cylinder that is equal to the same volume displacement in the booster, but for many operations, this volume displacement at such increased pressures is completely satisfactory.

**Operating Power.** In the example above, shop air is used as the power source, as this is the most common way boosters are used. It is, however, quite possible to use oil as the operating power source, particularly for extremely high pressure applications. For example, if you need to develop 40,000 PSI and had a choice of 80 PSI air or 3,000 PSI oil, the air booster ratio would be 500:1 and the oil only about 13:1. It's obvious that using an oil to oil booster system would be far less expensive. Standard boosters are air to oil only.

### When Should Boosters be Used?

Typical applications for boosters are shown on page 8. Without going into a list of such applications, let's see when you are better off using a booster rather than a complete hydraulic system. Keep in mind that boosters will never replace the pump-cylinder method of work ability...nor are they intended to do so. Therefore, as a general statement, *you use a booster when intermittent high pressure is required in a limited operation, and all you have is low pressure air.* In all of the published applications, there is really no exception to this general rule. The reason for this is that boosters and cylinder combinations are not intended for rapid cycling with high pressures: i.e., their *total power* is limited.

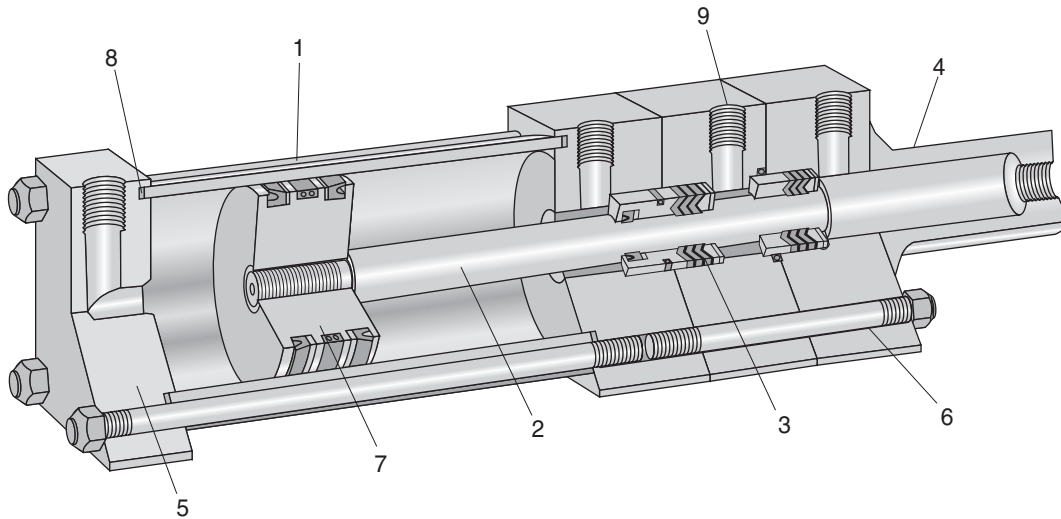
Now that we've eliminated the negative, let's take the positive approach. You need to clamp a fixture into position for a work application. You have 100 PSI shop air. An air cylinder operating under 100 PSI will simply not hold the fixture in position in the intended application. Here's an ideal spot for a booster and hydraulic cylinder. As a plus, remember that the hydraulic cylinder can be *controlled* in its clamping action for better than can an air cylinder. By using a Dual Pressure Booster (Model BA), the clamping cylinder will travel rapidly toward the fixture, under light pressure, and then will, at the end of its travel, exert high pressure just as it clamps.

**Cost Ratio.** Another reason for using boosters is the cost ratio of a booster system vs. pump system. You have a machine which requires a linear actuator pressure of 5,000 PSI. If you were to design in a complete 5,000 PSI hydraulic system into this *one* machine, it could cost you many times a booster system! Again, remember that we are talking about *one* machine requiring *intermittent* high pressure.

**Long Holding Times.** Another case is where you want to exert a high pressure for a long time, such as maintaining pressures on printing rolls. A booster-cylinder system will maintain a continuous pressure with very little power input. In a pump-cylinder system, the pump must be kept in continual operation. (In order to achieve such holding pressure, there must be a relief valve inserted in the system.)

**Extreme High Pressures.** Pressures over 10,000 PSI can be obtained with special boosters while virtually impossible with ordinary rotary pumps. When you require an inexpensive way of achieving high pressure, even up to 50,000 PSI, the booster is the answer.

## Milwaukee Booster Features



### 1. Booster Barrel

The barrel is of steel tubing, honed to a fine finish and hard chrome plated. This provides superior sealing power, minimum friction and maximum seal life.

### 2. Rod

Made of high strength steel, induction hardened. It is grounded and polished to a low micro finish, and then chrome plated to resist scoring and corrosion, for maximum life.

### 3. Rod Seals

Rod seals are of Milwaukee's high quality, stacked vee construction. They are specifically designed for high pressure hydraulic use, and their performance record has proven their long lasting, low leakage capability.

### 4. Nozzles

Steel nozzles are externally removable for replacing seals without disturbing booster assembly or tie-rod torque. Four self-locking nuts require only a standard shop wrench for removal.

### 5. End Caps

Heavy duty end caps are machined from solid, durable steel. All mountings are rigidly attached by either threading or welding. All mountings are expertly machined to provide accurate alignment on matched beds or mounting surfaces.

### 6. Tie Rods & Nuts

Tie rods are constructed from hardened, medium carbon steel, with a yield strength of 125,000 PSI. Threads are accurately machined for rigid engagement of the nuts. Nuts are high strength, self-locking type.

### 7. Piston

Precision machined from high strength aluminum alloy that is non-corrosive. Because it is light weight, it has a low inertia. The piston is pilot fitted and threaded to the rod. "U" cup seals are supported by back-up washers. The wear ring is of glass-filled nylon construction.

### 8. End Cap Seals

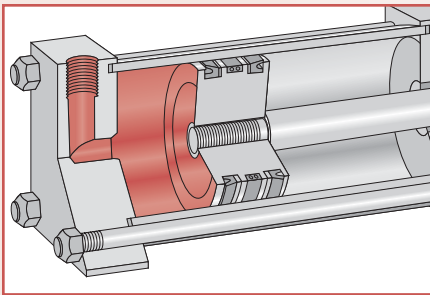
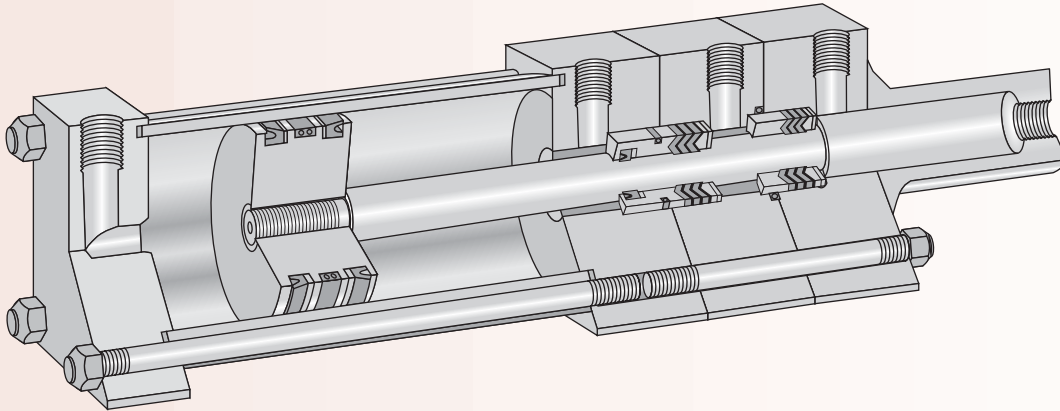
The barrel is sealed to the end caps with a high temperature, compression type gasket that seals over the entire face of the tube end.

### 9. Ports

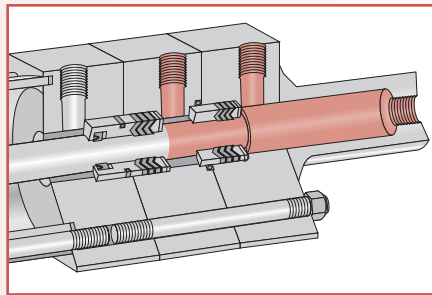
Large, unrestricted ports conforming to NFPA standards are provided. They can be rotated to any 90° position in relation to each other and the booster mounting. Dry seal, national pipe threads are standard with SAE straight thread ports, oversized ports and metric ports available upon request.

## Dual Pressure Boosters – Model BA

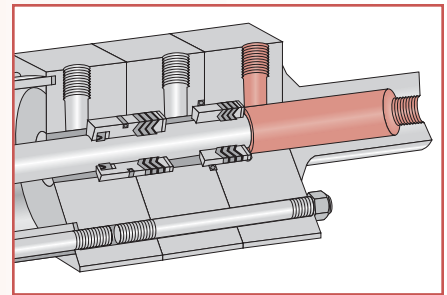
In Milwaukee's Model BA Booster, the high pressure output is applied only after the ram has entered the secondary, or high pressure seal. This allows a low pressure approach stroke and a high pressure work stroke where the working ram travels only a short distance under high pressure, as when a part needs to be clamped in position for another operation. Model BA boosters are self bleeding and an external valve in the inlet is not required.



Low pressure air is applied to the large surface piston during the entire work stroke. The input pressure of BA Boosters is rated at 250 PSI air.



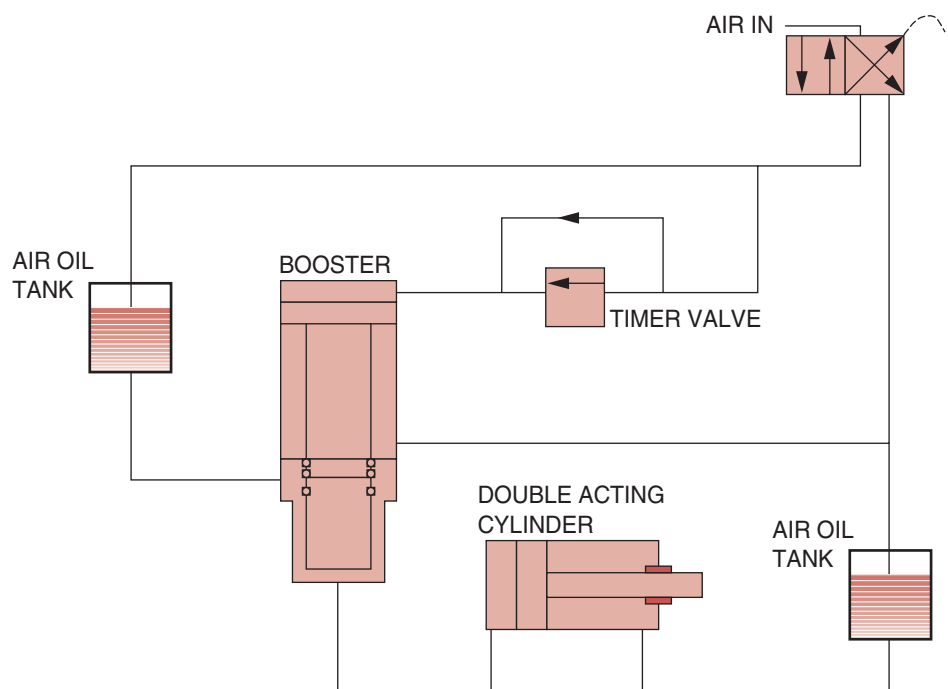
The rod advances through hydraulic fluid that is not yet contained under pressure. The rod is traveling under the same pressure as the air supply.



When the ram enters the high pressure seal, it immediately boosts the hydraulic pressure up to the rated value. Because of the extra ram seal assembly, the output pressure of this model is limited to 3,000 PSI.

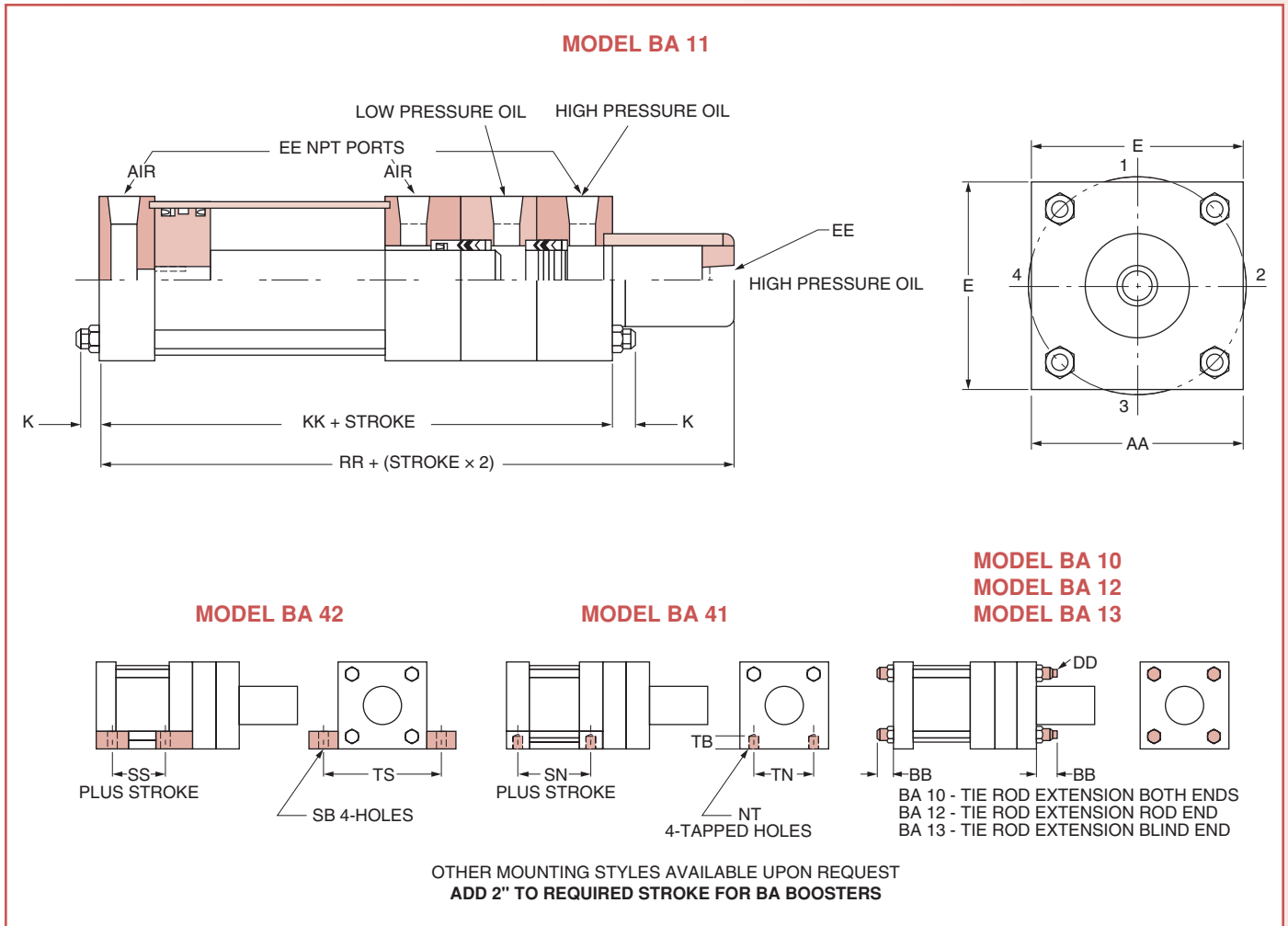
### Rapid traverse, automatic sequencing with BA booster

The circuit on the right shows the use of a double acting cylinder with rapid traverse at low pressure and sequencing to high pressure when the load is picked up. When the air valve is shifted, the left air-oil tank forces oil through the booster and extends the cylinder. When the load is picked up, the timer valve ports air to the booster for a high pressure output to the cylinder. On the return stroke, the right air-oil tank retracts the cylinder.



# Model BA Dimensions

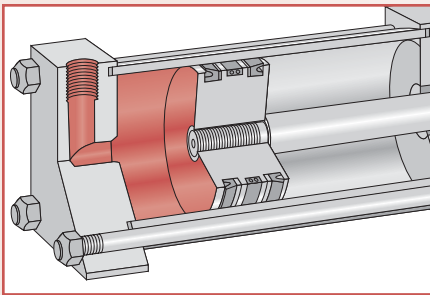
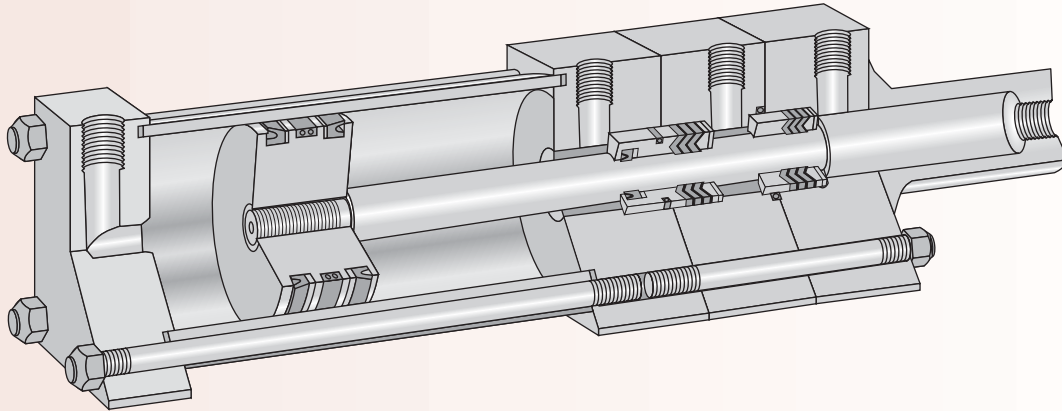
Pressure limitation: 3,000 PSI rated output, 250 PSI input.



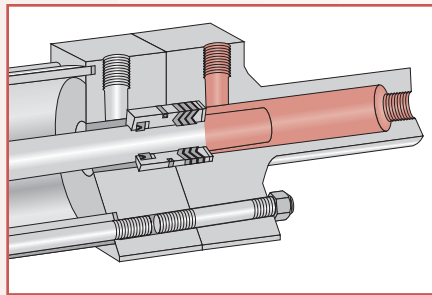
BORE	E	K	AA	BB	DD	EE	KK	NT	RR max.	SB	SN	SS	TB	TN	TS
2 1/2	3	7/16	3.1	1 1/8	5/16-24	3/8	6 3/4	3/8-16	5 3/4	7/16	2 3/8	3	5/8	1 1/4	3 3/4
3 1/4	3 3/4	1/2	3.9	1 3/8	3/8-24	1/2	7 3/4	1/2-13	6 3/4	9/16	2 5/8	3 1/4	3/4	1 1/2	4 3/4
4	4 1/2	1/2	4.7	1 3/8	3/8-24	1/2	7 3/4	1/2-13	6 3/4	9/16	2 5/8	3 1/4	1	2 1/16	5 1/2
5	5 1/2	5/8	5.8	1 13/16	1/2-20	1/2	8	5/8-11	7	13/16	2 7/8	3 1/8	1	2 11/16	6 7/8
6	6 1/2	5/8	6.9	1 13/16	1/2-20	3/4	9	3/4-10	8	13/16	3 1/8	3 5/8	1 1/8	3 1/4	7 7/8
8	8 1/2	3/4	9.1	2 5/16	5/8-18	3/4	9 1/8	3/4-10	8 1/8	13/16	3 1/4	3 3/4	1 1/8	4 1/2	9 7/8
10	10 5/8	7/8	11.2	2 11/16	3/4-16	1	10 7/8	1-8	9 7/8	1 1/16	4 1/8	4 5/8	1 5/8	5 1/2	12 3/8
12	12 3/4	7/8	13.3	2 11/16	3/4-16	1	11 3/8	1-8	10 3/8	1 1/16	4 5/8	5 1/8	1 1/2	7 1/4	14 1/2
14	14 3/4	1	15.4	3 3/16	7/8-14	1 1/4	13 5/8	1 1/4-7	12 5/8	1 5/16	5 1/2	5 7/8	2 1/4	8 3/8	17

## Single Pressure Boosters – Model BA

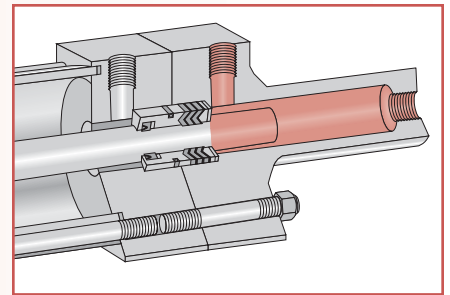
Milwaukee's Model BD Boosters are used where high pressure output is required during the entire work stroke of the cylinder. This design is used for all output pressures and exclusively with special boosters where pressures are above the normal 3,000 PSI. Its single rod seal assembly constantly surrounds the rod. Because of its simpler design, model BD is not self bleeding and more care must be taken in bleeding out air when installing.



Low pressure air is applied to the large surface piston during the entire work stroke. The input pressure of BD boosters is normally rated at 250 PSI air.



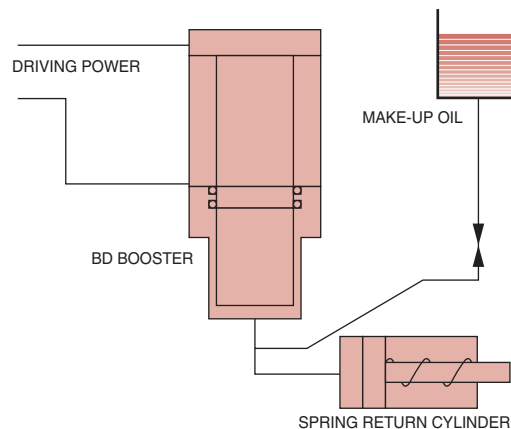
The rod of the BD booster is constantly under high pressure throughout the entire work stroke. It has but a single seal assembly.



Oil flows out, and back in, the same port on the high pressure end of the BD booster. Make up oil is provided through an external check valve or needle valve.

### BD booster with single acting clamping cylinder

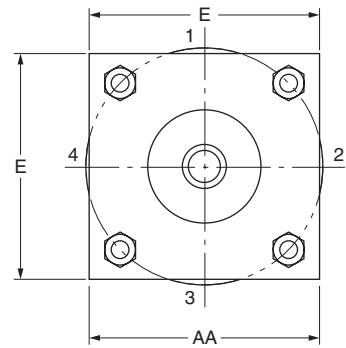
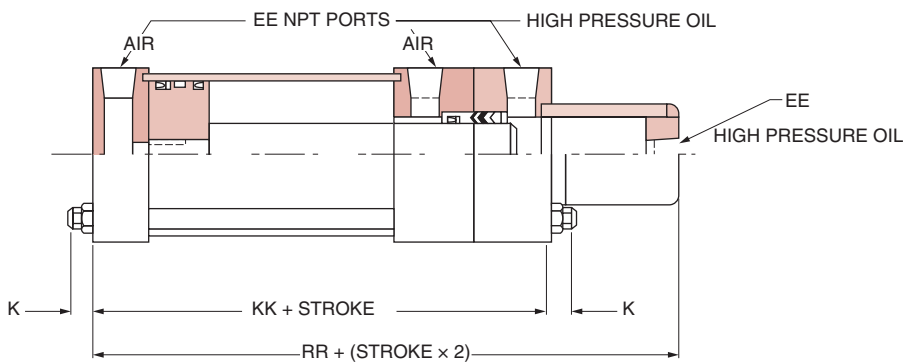
The circuit shows a BD booster powering a short stroke, spring return cylinder. A simple valve on the input line to the booster can be either manually or automatically operated. Input to the booster is kept on as long as the clamping action of the cylinder is required. Once removed, the internal spring in the cylinder returns the cylinder piston which, in turn, returns the oil to the booster port.



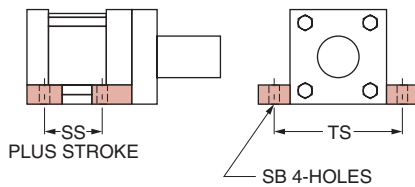
# Dimensions

Pressure limitation: 3,000 PSI rated output, 250 PSI input.  
Over 3,000 PSI, consult factory.

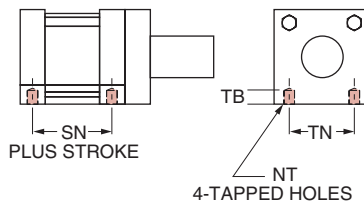
**MODEL BD 11**



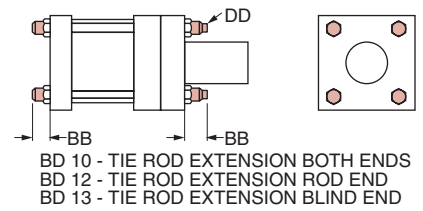
**MODEL BD 42**



**MODEL BD 41**



**MODEL BD 10  
MODEL BD 12  
MODEL BD 13**



OTHER MOUNTING STYLES AVAILABLE UPON REQUEST

BORE	E	K	AA	BB	DD	EE	KK	NT	RR max.	SB	SN	SS	TB	TN	TS
2½	3	7/16	3.1	1 1/8	5/16-24	3/8	5 1/4	3/8-16	6	7/16	2 3/8	3	5/8	1 1/4	3 3/4
3 1/4	3 3/4	1/2	3.9	1 3/8	3/8-24	1/2	6	1/2-13	6 1/2	9/16	2 5/8	3 1/4	3/4	1 1/2	4 3/4
4	4 1/2	1/2	4.7	1 3/8	3/8-24	1/2	6	1/2-13	7 1/16	9/16	2 5/8	3 1/4	1	2 1/16	5 1/2
5	5 1/2	5/8	5.8	1 13/16	1/2-20	1/2	6 1/4	5/8-11	7 3/8	13/16	2 7/8	3 1/8	1	2 11/16	6 7/8
6	6 1/2	5/8	6.9	1 13/16	1/2-20	3/4	7	3/4-10	8 1/8	13/16	3 1/8	3 5/8	1 1/8	3 1/4	7 7/8
8	8 1/2	3/4	9.1	2 5/16	5/8-18	3/4	7 1/8	3/4-10	8 1/8	13/16	3 1/4	3 3/4	1 1/8	4 1/2	9 7/8
10	10 5/8	7/8	11.2	2 11/16	3/4-16	1	8 5/8	1-8	9 3/8	1 1/16	4 1/8	4 5/8	1 5/8	5 1/2	12 3/8
12	12 3/4	7/8	13.3	2 11/16	3/4-16	1	9 1/8	1-8	9 7/8	1 1/16	4 5/8	5 1/8	1 1/2	7 1/4	14 1/2
14	14 3/4	1	15.4	3 3/16	7/8-14	1 1/4	10 7/8	1 1/4-7	11 1/8	1 5/16	5 1/2	5 7/8	2 1/4	8 3/8	17

## Booster Applications

### Save Space & Weight

In many applications, booster driven cylinders can replace an extremely large, low pressure air cylinder with a small, efficient, high pressure hydraulic cylinder. Coupled with reduced circuitry, the overall weight of a machine can be reduced, as well as the total space required.

### Lower Cost

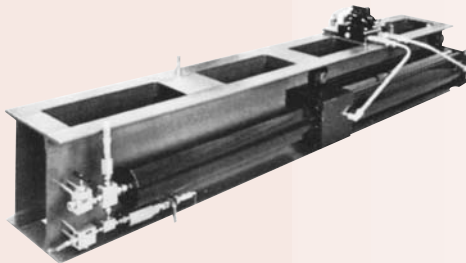
A booster system is less expensive than an overall hydraulic system with its pump-motor requirements. They also require only a fraction of the air of a direct cylinder installation. Hydraulic requirements are also much smaller to operate a given function.

### Smoother Power

Compared to air, boosters provide work cylinders with the smooth, efficient power of a hydraulic installation. When such power is required, and installations are limited to smaller volumes, boosters are ideal.

### Points of Consideration

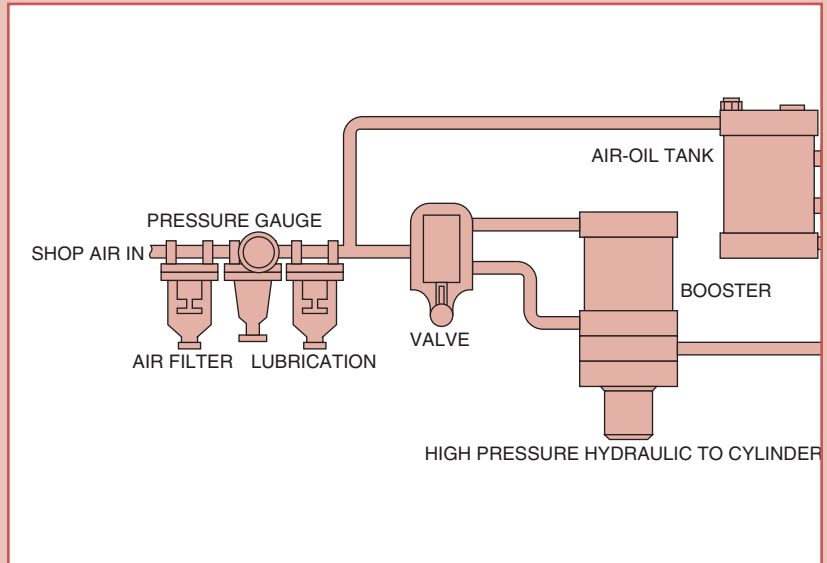
1. Plant air distribution system must be capable of maintaining the required pressure to the booster.
2. Regulators should be the relieving type. A leaky poppet could result in a dangerous pressure rise.
3. Directional control valves and air conditioners should have ports at least as large as the booster.
4. Always bleed air from the hydraulic circuit when installing booster systems. Type BA boosters are self bleeding.



A Milwaukee designed special booster featuring a 10" bore, 60" stroke and a 5½" rod. This booster, mounted on the side of a steel "I" beam, converts a 3,000 PSI oil input to an 8,000 PSI output of an ethylene-glycol solution with a total high pressure displacement of 1,400 cubic inches. The booster also had to be designed to operate over a temperature range from -65° to +100°F.

### 1. High pressure from shop air

One of the principle applications for boosters is in the conversion of low pressure shop air to high pressure hydraulic operation for a specific function where a hydraulic cylinder is required. Many operations require the smooth power inherent in a hydraulic cylinder, yet do not require the expenditure for a complete hydraulic installation. The small, yet powerful movement of a booster driven hydraulic cylinder can be used to hold a piece for riveting, as a spot welding clamp, for punching, piercing, forming, crimping, bending, stamping, shearing, marking, etc. The complete installation of booster, air-oil tank and cylinder can be mounted directly on the equipment itself.



### 2. Testing

Testing of manufactured parts for physical strength, leaks or burst rating can easily be accomplished with a booster-cylinder combination or a booster alone. A hydraulic cylinder will give a precise, high pressure force for mechanical testing, and a booster can be linked up directly, to a die casting, for instance, to test for leaks.

### 3. Fluid Transfer

Fluids that are difficult or impossible to transfer with a conventional pump can be fed through a valve-booster combination. Depending on the type of fluid, boosters can be produced with special metals, such as stainless steel.

### 4. Liquid Injection

High pressure injection of liquids are readily handled with a booster. Such liquids, injected into high pressure gas lines or containers, might include lubricants, antifreeze or odorants.

### 5. Holding Pressures

Long holding pressures required in vulcanizing, laminating, bonding or curing can be readily maintained without drawing power or generating heat, except for making up any leakage loss. A booster can maintain accurate pressure levels under such static conditions for an indefinite time.

### 6. High Pressures

Extremely high pressure, up to 50,000 PSI, have been achieved with special boosters. Such high pressures would be impossible with an ordinary hydraulic rotary pump. Complete facilities are available at Milwaukee to produce such boosters, as is the engineering background to aid you with your particular problems.



## Determining Correct Booster Size

Booster size is determined by the high pressure load of the cylinder. In a single pressure system (Model BD), the entire cylinder stroke is the load cycle. In a dual system (Model BA), only the power stroke of the cylinder is considered in the booster calculation.

1. Based on load requirements, select a cylinder bore size that will provide an adequate safety margin.

**Example: Load: 4500 lbs. From the cylinder selector chart, choose a thrust of 4909 lbs. Cylinder bore is therefore 2½", and input pressure is 1,000 PSI.**

2. Knowing the stroke required for the cylinder, calculate the volume of oil required for full extension under load pressure. This is the piston area

times cylinder stroke. It is important to note that the required volume should not be underestimated. Therefore, add a minimum of 25% to the calculated volume as a safety factor.

**From the cylinder chart, area is 4.909 in<sup>2</sup>. (You require a 2" stroke.)**

**Volume = 4.9 × 2 × 1.25 = 12.25 in<sup>3</sup>**

3. Divide the hydraulic system pressure by the available shop air pressure to determine booster ratio.

**Booster Ratio = 1000/80 = 12.5**

4. From the booster ratio chart, select the required booster bore and rod sizes that will safely handle the booster ratio.

**A booster ratio of 13.22 adequately covers the 12.5 ratio requirement.**

**This gives the booster with a bore of 5" and a rod with a diameter of 1⅜". Reading down on the chart, the volume per in. of stroke is 1.49.**

5. To determine the booster stroke, divide the calculated high pressure oil volume (from section 2) by the vol/in of stroke. Add 2" for a BA booster.

**Stroke = 12.25/1.49 + 2 = 1-.22 inches**

From the above, you specify a cylinder with a bore of 2½" and a stroke of 2". You specify a booster with a 5" bore, a 1⅜" rod and a 10¼" stroke. From this information, you can determine specific mounting dimensions for BA boosters on p. 5. (Other bore and rod combinations will also do the job.)

## CYLINDER REQUIREMENTS

PUSH STROKE FORCE IN POUNDS  
PRESSURES OF OPERATING MEDIUM

CYLINDER BORE SIZE	PISTON AREA SQ. IN.	50 PSI	60 PSI	80 PSI	100 PSI	200 PSI	250 PSI	500 PSI	750 PSI	1000 PSI	1500 PSI	2000 PSI	3000 PSI
1½	1.767	88	106	141	177	353	442	884	1325	1767	2651	3534	5301
2	3.142	157	189	251	314	628	786	1571	2357	3142	4713	6283	9426
2½	4.909	245	295	393	491	982	1227	2455	3682	4909	7364	9818	14727
3¼	8.296	415	498	664	830	1659	2074	4148	6222	8296	12444	16592	24888
4	12.566	628	754	1005	1257	2513	3141	6283	9425	12566	18849	25132	37698
5	19.635	982	1178	1571	1964	3927	4909	9818	14726	19635	29453	39270	58905
6	28.274	1414	1696	2262	2827	5657	7071	14137	21205	28274	42411	56548	84822
7	38.485	1924	2309	3079	3849	7697	9621	19242	28864	38485	57728	76970	115455
8	50.265	2513	3016	4021	5027	10053	12566	25133	37699	50265	75398	100530	150795
10	78.54	3927	4712	6283	7854	15710	19635						
12	113.10	5655	6786	9048	11310	22620	28275						
14	153.94	7697	9236	12315	15394	30790	38485						
16	201.60	10053	12064	16085	20106	40210							
18	354.47	12723	15268	20358	25447	50890							
20	314.16	15708	18850	25133	31416	62830							

## BOOSTER SELECTION

BOOSTER RATIOS

(Condensed Selector Chart for input pressures of 100 PSI on page 10.)

BOOSTER BORE SIZE	RAM SIZES												
	5/8	1	1⅜	1¾	2	2½	3	3½	4	4½	5	5½	
2½	16.00	6.25											
3¼		10.56	5.59	3.45*	2.64*								
4		16.00	8.46	5.22	4.00	2.56							
5		25.00	13.22	8.16	6.25	4.00	2.78	2.04					
6			19.04	11.76	9.00	5.76	4.00	2.94	2.25*				
8			33.85	20.90	16.00	10.24	7.11	5.22	4.00	3.16	2.56	2.12	
10				32.65	25.00	16.00	11.11	8.16	6.25	4.94	4.00	3.31	
12					36.00	23.04	16.00	11.75	9.00	7.11	5.76	4.76	
14						31.36	21.78	16.00	12.25	9.68	7.84	6.48	
Vol. Output per In. Stroke	.31	.78	1.49	2.40	3.14	4.91	7.07	9.62	12.57	15.90	19.63	23.76	

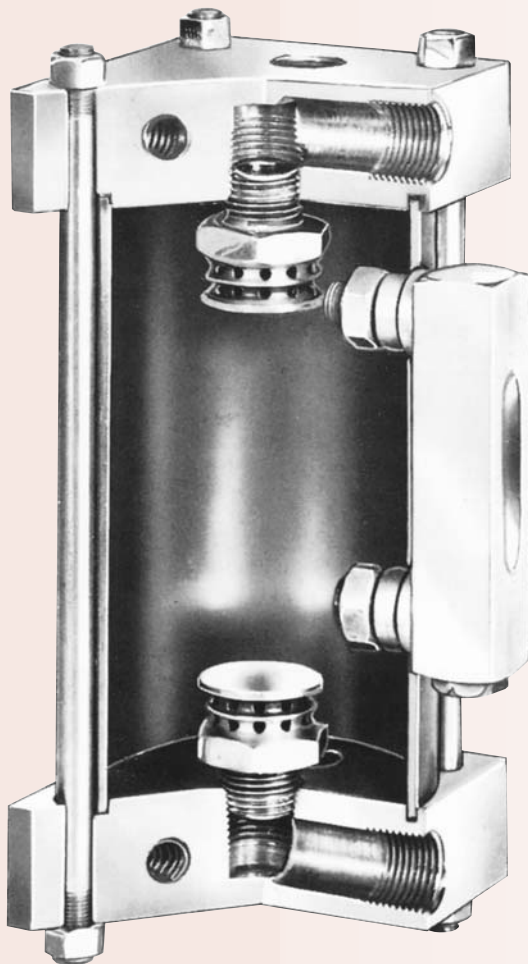
\*Not available in BA41 or BD41 mount.

## BOOSTER SELECTOR CHART AT INPUT PRESSURE OF 100 PSI

The following chart quickly provides booster bore and rod diameters for basic discharge pressures when the input pressure is 100 PSI. Example: if required pressure to cylinder is 1500 PSI, read down column and select any rod and bore diameter desired, such as a 3" rod and a 12" bore. The left column shows that a displacement of 7.07 in.<sup>3</sup> per inch of stroke will result. Other combinations can, of course, be chosen at a glance for the most economical booster or for a booster that fits the installation requirements.

INPUT PRESSURE OF 100 PSI MINIMUM DISCHARGE PRESSURE							
DISPLACEMENT/ INCH OF STROKE (IN. <sup>3</sup> )	500	1000	1500	2000	2500	3000	ROD DIAMETER
.31			2 1/2				5/8
.78	2 1/2	3 1/4	4		5		1
1.49	3 1/4	5	6			8	1 3/8
2.40	4	6		8		10	1 3/4
3.14	5		8		10	12	2
4.91	6	8	10	12		14	2 1/2
7.07	8	10	12	14			3
9.62	8	12	14				3 1/2
12.57	10	14					4
15.90	12						4 1/2
19.63	12						5
23.76	14						5 1/2

**BORE SIZE**



## Milwaukee Air-Oil Tanks

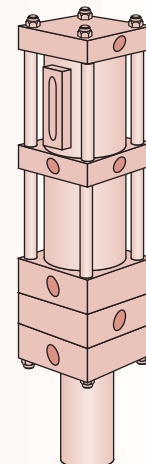
**Purpose:** Air-Oil Tanks serve several purposes in a booster system: They are used as a source of oil to compensate for any loss in the hydraulic system; they can provide hydraulic pressure to return the cylinder to its starting position; and they provide an outlet for entrapped air in the hydraulic system. The Air-Oil Tank literally contains air on top of oil. The air is under line pressure from the same source as the air used to operate the booster. A sight-gauge is mounted on the side of Milwaukee Air-Oil tanks so that the level of oil in reserve can be readily observed. When required, hydraulic fluid may be added through a port in the top of the tank after shutting off air pressure.

**Features:** Milwaukee Air-Oil Tanks are manufactured with the same care and high quality materials as are all Milwaukee Boosters and Cylinders. Maximum pressure for these tanks is 250 PSI. They are suitable for all hydraulic fluids up to 400°F (205°C). Milwaukee Air-Oil Tanks incorporate the following high quality features:

- High Strength, solid steel end caps with large fill and drain plugs for fast circuit filling.
- Brass or steel tubing sealed to each end cap with compression type gaskets.
- Replaceable sight gauge enclosed in aluminum shield for maximum gauge protection.
- A unique baffle system, inside both end caps, assures rapid intake and discharge with a minimum of churning, foaming and aeration.

## Booster & Air-Oil Combination

By specifying a combination of a booster and air-oil tank, savings are obtained in both space, cost and installation time. Tanks are mounted directly on the booster, using a common end plate and tie-rods. Due to the fact that air-oil tanks must always be used vertically, this combination is limited to a vertically mounted installation. When ordering this combination, specify BAT or BDT depending upon whether a BA or BE booster is used. Tanks are selected with the same size bore as the booster. When determining length, subtract one "J" length from the overall combined length of the individual booster and tank lengths.

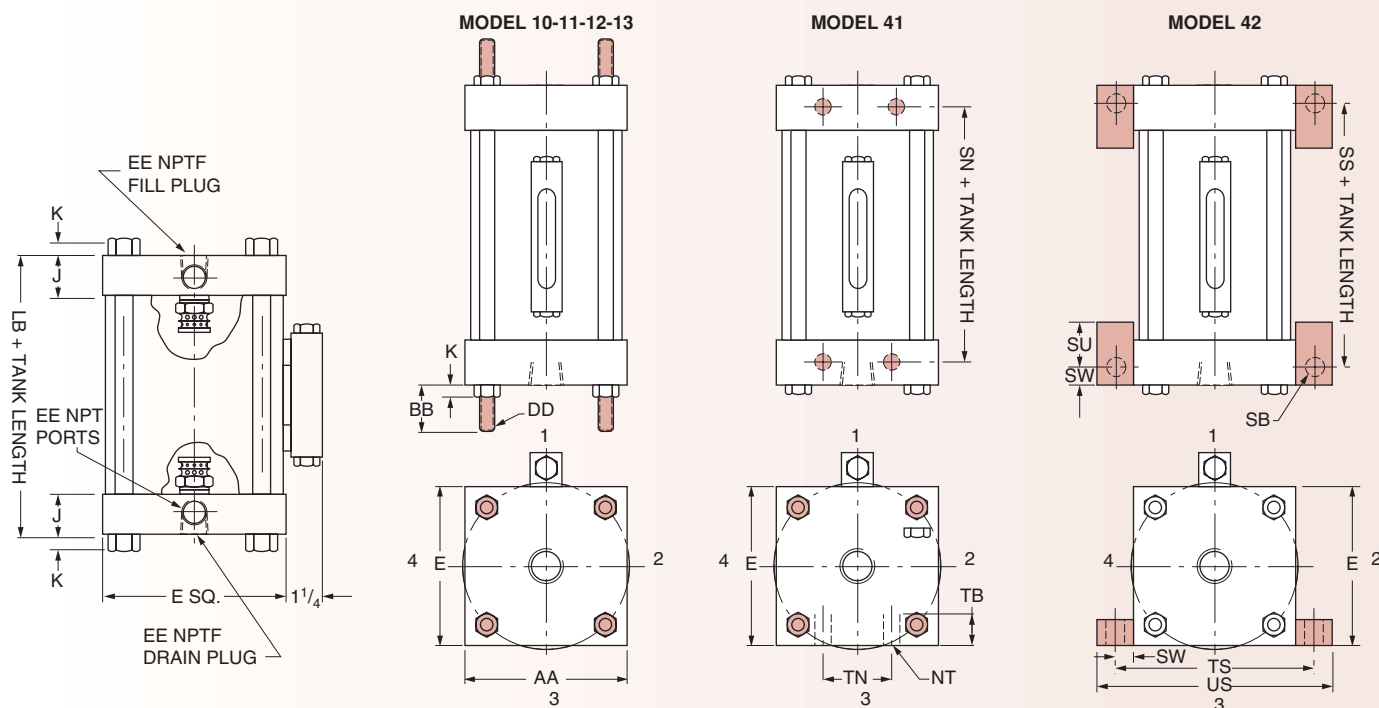


## Air-Oil Tank Selector Chart

If the tank is used as a source of pressure to return the cylinder, its size must be in excess of the total cylinder displacement, otherwise, oil will be injected into the air line. Tanks should also be large enough to replenish any hydraulic losses without the necessity of adding fluid too frequently. In the chart below, always select a tank volume equal to or

slightly greater than the cylinder volume. After the cylinder volume is determined, it can be located on the chart. Note that a selection may be made with varying tank diameters and lengths. (If a booster-tank combination is required, select the tank diameter to match the booster diameter.)

TANK BORE DIA. IN.	Usable oil volume in. <sup>3</sup>	TANK LENGTH INCHES																		
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
3 1/4		26	32	37	44	51	59	66	73	80	88	95	102	109	117	124	131	139	146	153
4		39	48	56	67	78	89	100	111	122	133	144	155	166	177	188	199	210	221	232
5		61	76	88	105	122	139	157	174	191	208	225	243	260	277	294	311	328	346	363
6		88	109	127	152	176	201	226	250	275	300	325	349	374	399	424	448	473	498	523
8		157	195	226	270	314	358	402	446	490	534	578	622	666	710	754	798	841	885	929
10		245	304	353	422	490	559	628	697	765	834	903	971	1040	1109	1178	1246	1315	1384	1453
12		353	438	509	607	706	805	904	1003	1102	1201	1300	1399	1498	1597	1696	1795	1894	1993	2092
14		481	597	692	827	962	1096	1231	1366	1500	1635	1770	1905	2039	2174	2309	2443	2578	2713	2847
Fluid Working Height In.		3 1/8	3 7/8	4 1/2	5 3/8	6 1/4	7 1/8	8	8 7/8	9 3/4	10 5/8	11 1/2	12 3/8	13 1/4	14 1/8	15	15 7/8	16 3/4	17 5/8	18 1/2



## Air-Oil Tank Dimensions

TANK BORE DIA. IN.	E	J	K	AA	BB	DD	EE (NPTF)	LB	NT	SB	SN	SS	ST	SU	SW	TB	TN	TS	US
3 1/4	3 3/4	1 1/4	3/8	3.9	1 3/8	3/8-24	1/2	2 1/2	1/2-13	9/16	1 3/8	1 1/2	3/4	1 1/4	1/2	3/4	1 1/2	4 3/4	5 3/4
4	4 1/2	1 1/4	3/8	4.7	1 3/8	3/8-24	1/2	2 1/2	1/2-13	9/16	1 3/8	1 1/2	3/4	1 1/4	1/2	1	2 1/16	5 1/2	6 1/2
5	5 1/2	1 1/4	7/16	5.8	1 13/16	1/2-20	1/2	2 1/2	5/8-11	13/16	1 3/8	1 1/8	1	1 9/16	1 1/16	1	2 11/16	6 7/8	8 1/4
6	6 1/2	1 1/2	7/16	6.9	1 13/16	1/2-20	3/4	3	3/4-10	13/16	1 5/8	1 5/8	1	1 9/16	1 1/16	1 1/8	3 1/4	7 7/8	9 1/4
8	8 1/2	1 1/2	9/16	9.1	2 5/16	5/8-18	3/4	3	3/4-10	13/16	1 5/8	1 5/8	1	1 9/16	1 1/16	1 1/8	4 1/2	9 7/8	11 1/4
10	10 5/8	2	1 1/16	11.2	2 11/16	3/4-16	1	4	1-8	1 1/16	2	2 1/4	1 1/4	2	7/8	1 5/8	5 1/2	12 3/8	14 1/8
12	12 3/4	2	1 1/16	13.3	2 11/16	3/4-16	1	4	1-8	1 1/16	2	2 1/4	1 1/4	2	7/8	1 1/2	7 1/4	14 1/2	16 1/4
14	14 3/4	2 1/4	1 3/16	15.4	3 3/16	7/8-14	1 1/4	4 1/2	1 1/4-7	1 5/16	2 3/8	2 1/4	1 1/2	2 1/2	1 1/8	2 1/4	8 3/8	17	19 1/4

## WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship for a period of twelve months after the date of shipment from Seller's plant. If the goods are in accordance with or in reference to an engineering drawing specified by or furnished to the customer, the specifications and information on the drawing shall be applicable in determining such correct use, operation and application.

When claiming a breach of the above warranty, Buyer must notify Seller promptly in writing, whereupon Seller will either examine the goods at their site or issue shipping instructions for return to Seller.

When any goods sold hereunder are proved not as warranted, Seller's sole obligation under this warranty shall be to repair or replace the goods, not including installation or any other charges, at its option, without charge to Buyer.

THIS WARRANTY COMPRISES SELLER'S SOLE AND ENTIRE WARRANTY OBLIGATION AND LIABILITY TO BUYER, ITS CUSTOMERS AND ASSIGNS IN CONNECTION WITH GOODS SOLD HEREUNDER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS, ARE EXPRESSLY EXCLUDED.

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