

## Exclusion of Warranty

The items in this catalog are intended for use in motorsport competition, i.e. AUTO RACING. No warranty of these components, express or implied, is offered by Woodward Machine Corporation or its subsidiaries, for the following reasons, among others:

***(1) Motorsport is inherently dangerous. The conditions of end use of the components are normally hazardous and unpredictable, and are entirely beyond our control; and***

***(2) The decision as to the suitability of said components for a particular manner of use, or in a particular installation, is made by the user and is likewise beyond our control; and***

***(3) The application of said components is therefore understood to be experimental.***

Liability of Woodward Machine Corporation is therefore limited to the replacement or repair, at our option, of any of our products that we find, upon our inspection, to be defective in materials or workmanship, specifically excluding items damaged as a result of collision, misuse, or neglect.

***Warning: The approval of your state department of motor vehicles or your country's Ministry of Transport or other relevant authority, for the use of racing equipment on the public highways should not be assumed.*** Woodward Machine Corporation does not support nor participate in efforts to obtain such approval. The end user is responsible for not utilizing Woodward racing components in any manner which may contravene local law.

Original Equipment Manufacturers installing Woodward components in vehicles licensed for use on the public highways are responsible for complying with all applicable safety standards.

Purchasers of Woodward equipment for use in race cars subject to homologation by a sanctioning body, e.g. FIA, NASCAR, IMSA, etc. are responsible for ensuring that the equipment does in fact conform to current rules.

### **DOMESTIC AND INTERNATIONAL PRICING:**

The prices published in this catalog are in US Dollars and apply to all purchases made with Visa, Mastercard, Discover, or American Express cards, whether issued by US or foreign banks.

Surcharges, previously necessitated by unpredictable and exorbitant fees charged by the credit card brands for processing sales across international borders, no longer apply.

Credit card sales are invoiced and shipped by our subsidiary Racor, Inc.

Business-to-business purchases arranged directly with Woodward Machine Corporation are payable by bank wire transfer.

Please note that any customs duties or clearance fees imposed by the destination country are the responsibility of the recipient. We will gladly include your VAT registration number on the shipping documents but we do not collect or remit taxes.



## Terms and Conditions of Sale

Toll-free in USA: 1-888-STEER-US • International: 1-307-472-0550 • E-mail: sales.woodwardsteering@gmail.com

### **PACKAGING FOR INTERNATIONAL SHIPMENT:**

In some cases, international air freight imposes more stringent requirements for packaging. Should this be necessary, any extra cost will be included in our freight quote.

### **OUR STANDARD FREIGHT CARRIERS AND INSURANCE:**

We ship via Federal Express or United Parcel Service, FOB our plant in Mills, Wyoming. Next Day Air and Early AM delivery are available at extra cost for most ZIP codes in the continental US, as is Saturday delivery. Freight insurance is provided free by the carrier up to USD100.00 value, and rises on a very reasonable sliding scale. We ship everything insured for its full value. We can also ship freight collect on your FedEx or UPS account. *We do not ship via Postal Service, as delivery cannot be guaranteed and if your parcel is lost or undelivered it is difficult or impossible to obtain compensation.*

Orders for parts in stock will generally ship the same day if received before noon Mountain Standard Time.

### **USING OTHER CARRIERS:**

Alternatively, we can hold for pickup by the carrier of your choice. However, in these cases we cannot create waybills or submit the export declaration electronically. If your carrier requires that we manually complete their shipping documents we will have to charge for the time. Also, you should be aware that freight companies not having a base of operations in the US will subcontract the pickup to UPS or FedEx and sometimes this can add a week or more before the parcel can actually be placed in transit.

### **RETURNS OF MERCHANDISE, DOMESTIC:**

Returned parts may be subject to a charge of up to 20% to defray the cost of inspection, restocking, and repackaging. Returned merchandise must be unused, unmarked and not over 30 days old. We will make adjustment via exchange or credit only. Special order parts, damaged or rusted parts, or "basket cases" are not returnable except in connection with repair orders.

### **RETURNS OF MERCHANDISE, INTERNATIONAL:**

Make absolutely sure to specify in the customs declaration that you are returning goods *manufactured in the U.S.* If this is not done and we receive a bill for import duties, it will be charged to your account.

### **SPECIAL ORDER PARTS:**

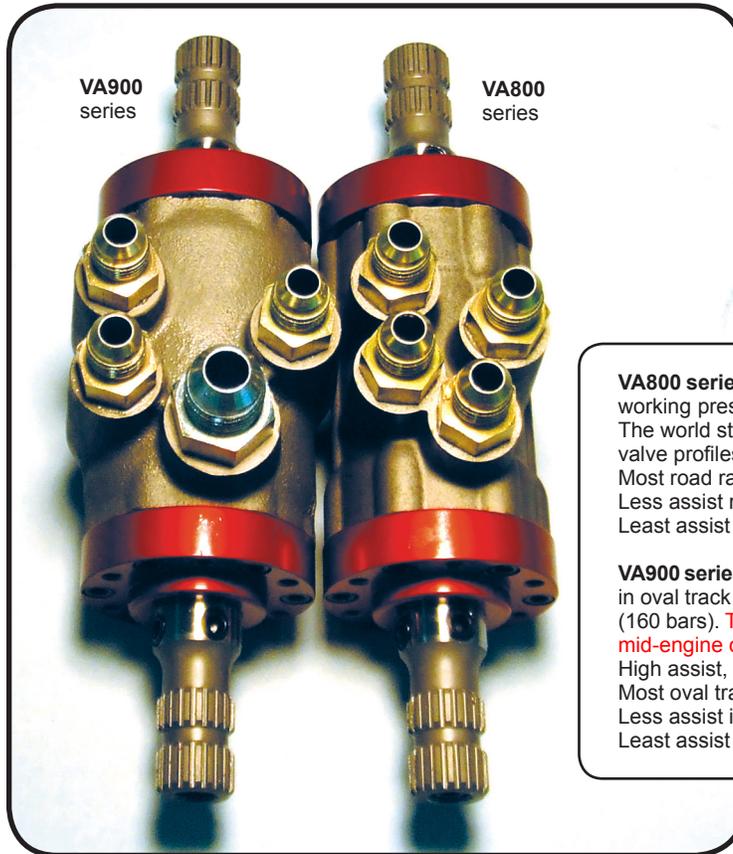
In this catalog, many categories of parts are only manufactured on a made-to-order basis. Please note that parts built or assembled to customer specifications are generally specialized enough to be otherwise unsalable, and consequently these are not returnable.

## Power Steering Servo Valves

### For inline installation or as part of HE and HL power steering racks

Made for installation at any convenient point in the steering column OR directly onto HE/HL series racks, the Woodward servo is the only type where the amount of power assist (light, medium, heavy, etc.) can be tuned to suit the driver's preference by means of a system of interchangeable torsion bars. The bars control the sensitivity of the power steering response and can be switched in the field without disassembly of the servo. A second revolutionary feature allows external adjustment of the left-to-right balance of the power steering. This is not possible with any other race car steering system. The Woodward servo allows it to be done right in the car, using nothing but a 5/32 or 4 mm Allen wrench in the two adjusting screws. Absolutely no OEM or salvage parts of any kind are used to make these servos; all components are made in our own plant.

NOTE: The servo used on a type MR or CF rack will have an integral pinion with a specific mounting flange instead of the round end cap and output spline shown here. In most cases it will also have different internal parts. **For parts or technical assistance with MR and CF servos please contact the factory and refer to the serial number engraved on the side opposite the ports.**



**VA800 series SERVO** is a light, compact valve for systems where the maximum working pressure will not exceed 1200 PSI (85 bars). Track proven since 1996. The world standard for the highest flow in the smallest space. Available in three valve profiles and all T-bar sizes; refer to the valve plots on next page.  
 Most road racing applications **VA850-1** .....498.75  
 Less assist road racing applications **VA850-2** .....498.75  
 Least assist road racing or street applications **VA850-2C** .....498.75

**VA900 series SERVO** has a thicker case with revised porting for severe conditions in oval track and off-road racing. Designed for working pressure up to 2350 PSI (160 bars). **The large -8 port reduces the back pressure from long return lines in mid-engine cars.** Available in four valve profiles and all T-bar sizes.  
 High assist, off-road, heavy cars **VA955** .....498.75  
 Most oval track applications **VA950-1** .....498.75  
 Less assist in mid-engined cars **VA950-2** .....498.75  
 Least assist in mid-engined cars **VA950-2C** .....498.75



**VALVE TORSION BARS** can be changed out to adjust the response curve of your servo. Lighter bar=lighter feel; heavier bar=heavier feel. Made of spring tempered alloy steel. Using the set screws, the bar is anchored at one end and adjusted for centering or directional bias at the other end. Includes O-rings. **NOTE: These T-bars fit servos mounted inline or on HE and HL racks. Servos on MR and CF power racks have T-bars specific to those designs.**

TB180.....	36.25
TB185.....	36.25
TB190.....	36.25
TB195.....	36.25
TB200.....	36.25
TB205.....	36.25
TB210.....	36.25
TB215.....	36.25
TB220.....	36.25
TB225.....	36.25
TB230.....	36.25
TB235.....	36.25
TB240.....	36.25

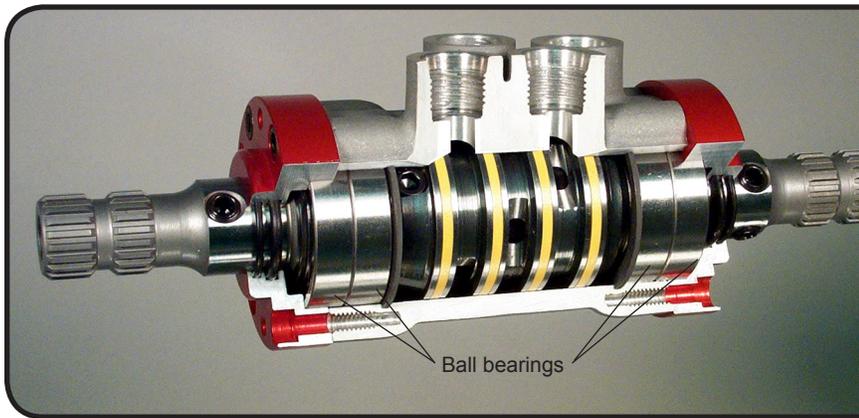
### NEW!

**STEEL LOCKING COLLAR** has two set screws which bear against the T-bar adjusting screws on the servo input shaft and keeps them from vibrating loose.

V591 .....18.69

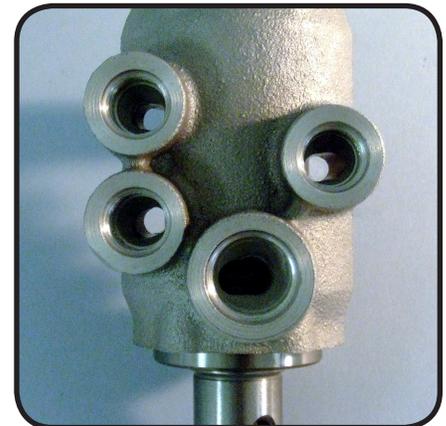
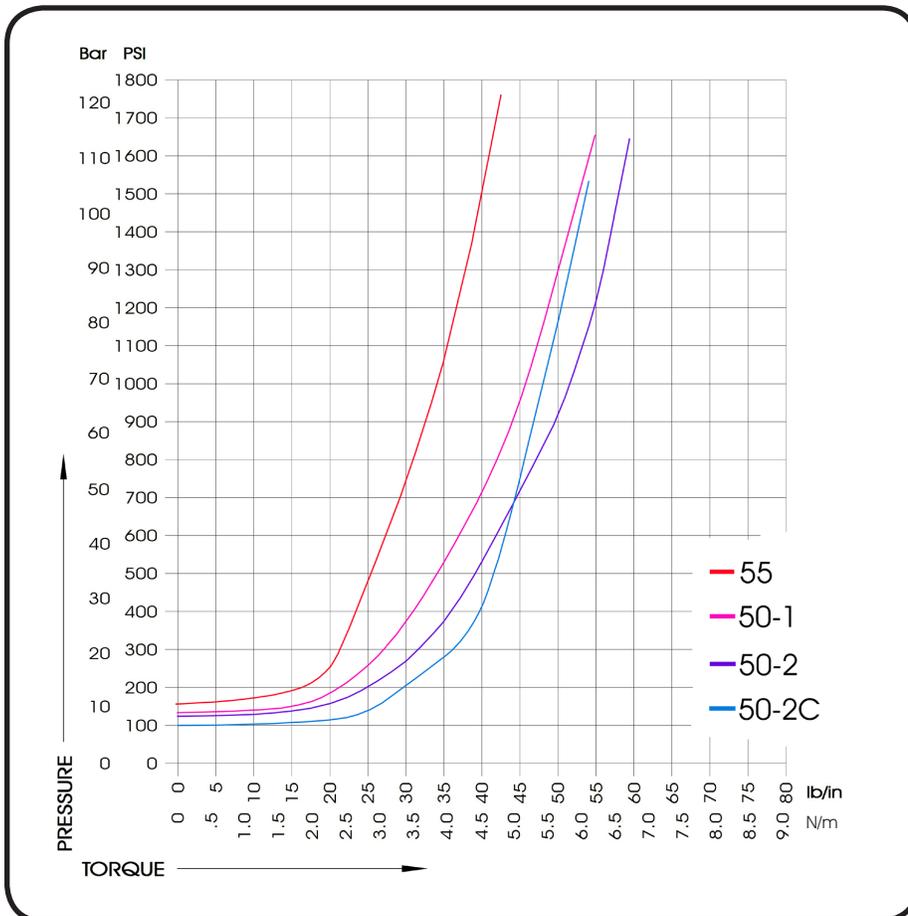


The cutaway view below shows the four large ball bearings that support the valve and isolate it from mechanical steering loads. Large ducts within the Woodward distribution spool replace the series of small holes used in the OEM spools used by all other manufacturers. The Woodward design produces quicker response with lower restriction and lower operating temperature.



## New Valve Profiles

Virtually all OEM steering responds solely according to the linear spring rate of its torsion bar. The Woodward valve features variable-area metering, which responds progressively at a rate dictated by the shape of the orifice. Combined with its range of torsion bars, a Woodward servo can be configured to match the tire load and steering resistance curve of any vehicle, from street-driven luxury supercars to AWD race cars with tons of aerodynamic downforce plus driving torque through the front wheels. The plot below shows the response curves of four valve profiles, all tested with the same torsion bar and the same pump. Changing the torsion bar changes the aspect ratio of these curves horizontally, while changing the flow from the pump displaces them vertically.

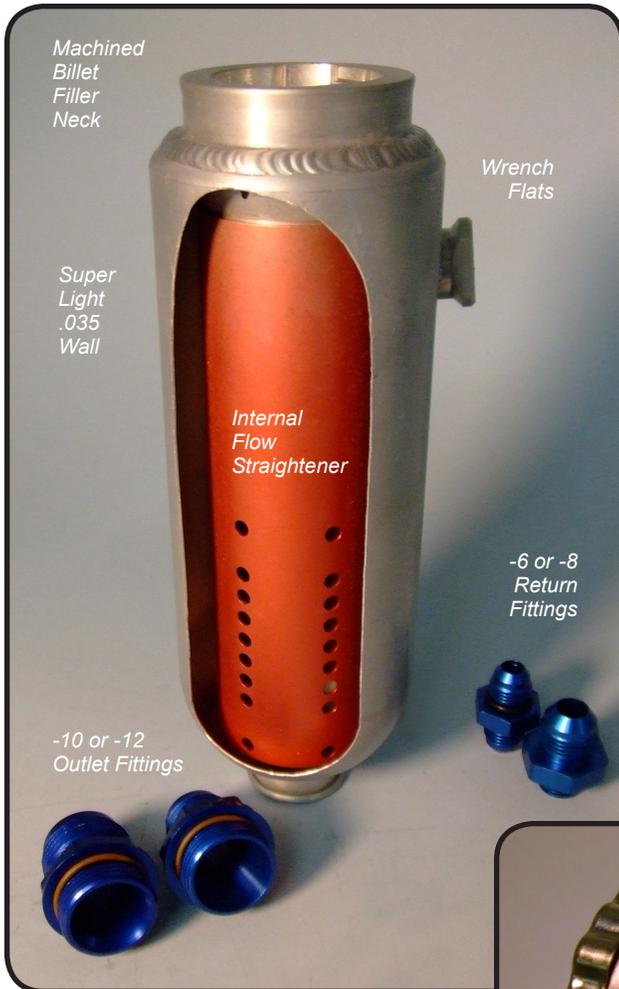


## Recent Developments

The VA900 series servo incorporates several changes from the VA800. Most obvious are the large tapered ports shown above which increase its flow capacity by reducing turbulence. You can see that the fluid path is unobstructed all the way into the channels of the spool, which is actually in place in this picture. A 900 servo is capable of filling a large diameter cylinder at velocities well beyond the quickest race car steering and in most applications will allow 5W-40 engine oil to be used as the hydraulic medium.

The exhaust port of the 900 servo is enlarged to -8 hose size. This effectively relieves back pressure from the return side of the circuit (important on a mid-engine car with a relatively long distance between the rack and the pump), improving the sensitivity of the steering while reducing the buildup of waste heat. All existing Woodward reservoirs have removable hose adapters which can easily be swapped out to accommodate the large return hose from a 900 servo.

Originally developed to meet military requirements, the 900 series will handle the severe hydraulic shocks of off-road applications involving air time, collisions with boulders, etc., that would occasionally burst the case of an 800 servo.



## Power Steering Reservoirs

### High flow, de-aerating design

With a quick-steering rack, the performance of the reservoir is critically important in preventing fluid starvation and loss of power steering. In a typical aftermarket reservoir, returning fluid creates turbulence, which pulls air bubbles below the surface, which are then drawn into the pump intake. Air in the fluid makes it compressible, which causes hard or "surging" steering, hydraulic chatter, and overheating.

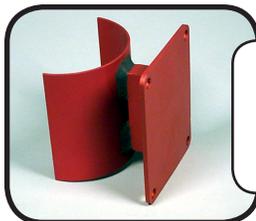
In the dual-chamber Woodward design, the return stream is tangent to the tank wall, creating a centrifuge effect to remove air bubbles. The freed air escapes at the top of the outer chamber through bleed holes leading to the inner chamber. The bleed holes point downward to prevent hot oil spray when the lid is removed. A -6 fitting is used with the 800 servo, and a -8 with the 900 servo. A -8 return is especially recommended for mid-engined race cars because of the long fluid circuit.

Farther down in the tank, the spin of the oil is arrested as it is drawn through a flow-straightening baffle by the pump suction. The pump draws from the inner chamber which is free of turbulence. In fact, the flow is so clean that the surface of the liquid cannot be seen to move with the engine running.

The outlet fitting is available for either -10 and -12 hose, and both are contoured for minimum flow restriction.



BRACKET  
for 1.5 inch TUBE  
FB35..... 36.75



BRACKET  
for FIREWALL  
FB36..... 36.75



BRACKET  
for 1.75 inch TUBE  
FB37..... 36.75

RESERVOIR with -6 return, -10 outlet and FB35 bracket **V100B** ..... 110.25  
 RESERVOIR with -6 return, -10 outlet and FB36 bracket **V100C** ..... 110.25  
 RESERVOIR with -6 return, -10 outlet and FB37 bracket **V100W** ..... 110.25  
 RESERVOIR with -6 return, -10 outlet and FB38 bracket **V100J** ..... 110.25

RESERVOIR with -8 return, -10 outlet and FB35 bracket **V101B** ..... 110.25  
 RESERVOIR with -8 return, -10 outlet and FB36 bracket **V101C** ..... 110.25  
 RESERVOIR with -8 return, -10 outlet and FB37 bracket **V101W** ..... 110.25  
 RESERVOIR with -8 return, -10 outlet and FB38 bracket **V101J** ..... 110.25

RESERVOIR with -8 return, -12 outlet and FB35 bracket **V102B** ..... 110.25  
 RESERVOIR with -8 return, -12 outlet and FB36 bracket **V102C** ..... 110.25  
 RESERVOIR with -8 return, -12 outlet and FB37 bracket **V102W** ..... 110.25  
 RESERVOIR with -8 return, -12 outlet and FB38 bracket **V102J** ..... 110.25

RESERVOIR ONLY, no bracket **V100X** (specify fittings)..... 91.90

## High Pressure Hose

### PTFE core, stainless braid, soft cover

Woodward power steering racks are now equipped with a new -6 hose rated for 2000 PSI working pressure. This hose replaces our former cloth-covered 1500 PSI hydraulic hose and its reusable type ends (shown at right for comparison). It also features a larger ID, which together with the low coefficient of friction of PTFE significantly improves the flow capacity.

**IMPORTANT: There are many different brands of hose and reusable hose ends now in circulation, most of which are mutually incompatible. Because it can be difficult to tell them apart, racers in a hurry have been known to create mismatched hose assemblies from spare components. These may appear correct but can come apart under pressure. To prevent accidental mismatched field assemblies, WE USE ONLY PERMANENT CRIMP-TYPE ENDS ON OUR HPB6 PRESSURE HOSE, and we manufacture them in-house.**

Although this hose conforms to the nominal standard dimensions of -6 stainless-braid PTFE hose, it also has an abrasion-reducing fabric cover. This cover adds slightly to the diameter of the hose and precludes the use of screw-on ends (the kind with a brass "olive") which are intended only for uncovered stainless braid. These steel permanent ends are the **ONLY** type approved for use with this hose. Crimp tooling data will be made available to qualified hose shops on request.

NEW  
OLD

WOODWARD HOSE per foot HPB6 .....	8.30
STRAIGHT end HPB180 .....	7.65
BANJO end HPB66 .....	34.15
90 end HPB190 .....	16.05
Assembly labor (per hose).....	5.00

## Low Profile Banjo Fittings

### Fit directly on -6 o-ring ports

Woodward has developed the first banjo fitting that utilizes the proven and convenient SAE/AN/JIC o-ring port. The banjo seals with o-rings top and bottom instead of metal compression washers, and they will seal hydraulic pressure with the same moderate torque as any other o-ring hose adapter. This prevents stripping the threads from aluminum ports. **The banjo body and bolt are made from high-tensile steel to allow a thinner wall and greater flow cross-section.**

The Woodward banjo fitting is available both as a permanent crimp type hose end or as a -6 male AN/JIC hose adapter. Note: a hose with two banjos should always have at least one of the adapter type to avoid twisting the hose.

As shown below, a banjo has the lowest profile of any right-angled fluid connection. These will clear any port boss which is flush with the surrounding surface, such as the ports on most servos. NOTE: The ports on GE150B and C cylinder castings are recessed and a banjo will not clear.

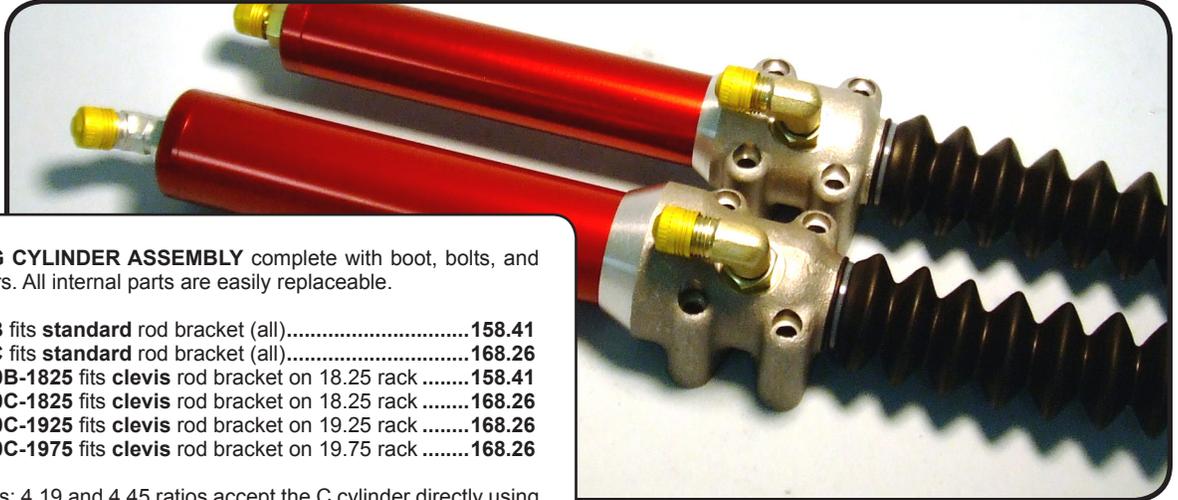


HOSE ADAPTERS, -6 O-ring to -6 AN/JIC male flare, showing relative heights

STRAIGHT G180.....	3.25
45 DEGREE G145.....	4.97
90 DEGREE G190.....	4.78
BANJO HPB66MF.....	34.15

## Hydraulic Assist Cylinders For GE/HE and GL/HL racks

Track proven since 1989 and continually improved since, these lightweight double-acting cylinders bolt rigidly to the rack housing with four symmetrically located socket head cap screws. The thrust is absorbed independently of the bolts by a 9/16 dowel. A thick nonmetallic piston prevents metal-to-metal contact in the bore and contributes to the very long useful life of these parts. These cylinders are tested to 1800 PSI in both directions.



**DOUBLE ACTING CYLINDER ASSEMBLY** complete with boot, bolts, and steel hose adapters. All internal parts are easily replaceable.

1.13 bore <b>GE150B</b> fits <b>standard</b> rod bracket (all).....	<b>158.41</b>
1.38 bore <b>GE150C</b> fits <b>standard</b> rod bracket (all).....	<b>168.26</b>
1.13 bore <b>GEC150B-1825</b> fits <b>clevis</b> rod bracket on 18.25 rack .....	<b>158.41</b>
1.38 bore <b>GEC150C-1825</b> fits <b>clevis</b> rod bracket on 18.25 rack .....	<b>168.26</b>
1.38 bore <b>GEC150C-1925</b> fits <b>clevis</b> rod bracket on 19.25 rack .....	<b>168.26</b>
1.38 bore <b>GEC150C-1975</b> fits <b>clevis</b> rod bracket on 19.75 rack .....	<b>168.26</b>

**Standard** rack ends: 4.19 and 4.45 ratios accept the C cylinder directly using the GE264 rod bracket. To install the C cylinder on 392 and slower ratios, use the shim and the GE265 rod bracket shown on the next page.  
**Clevis** rack ends: work with or without a cylinder shim.

**CYLINDER RESEAL KIT** includes the piston with seal installed, both head and plug o-rings, rod bushing, rod seal and rod wiper.

Kit for all B cylinders (1.13 bore) <b>R150B</b> .....	<b>25.28</b>
Kit for all C cylinders (1.38 bore) <b>R150C</b> .....	<b>28.51</b>



**NOTE:** When disassembling a cylinder, always take the piston off the rod first and pull the rod **OUTWARD**. That way only the smooth, undamaged section of the rod will pass through the bushing and seals. Never remove a used rod by pulling its damaged end back through the seals.

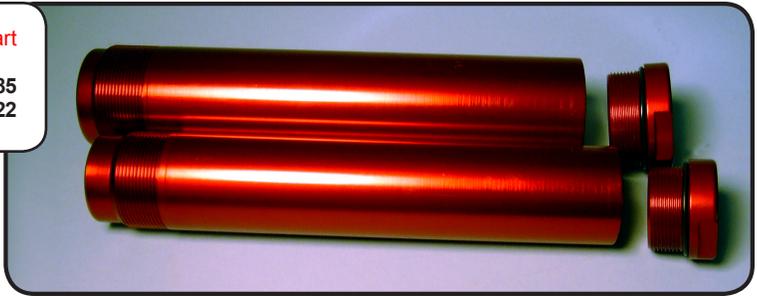


PISTON ROD for STANDARD rack, includes nuts and washers	
<b>GE170B or GE170C</b> .....	<b>49.50</b>
PISTON ROD for CLEVIS rack, includes nuts	
<b>GEC170C-1825, GEC170C-1925, GEC170C-1975</b> .....	<b>58.50</b>

**NOTE:** The piston rods used on **standard-end** racks have a **3/8-24 thread** with washers and a locknut. The piston rods used on **clevis-end** racks have a larger **1/2-20 thread** with a one-piece flanged nut on the inner end and a locknut on the outer end. The two rod types are shown above inserted through their respective brackets.

PISTON ROD assembly WITH PISTON for <b>standard</b> rack, includes nuts, washers and piston seal installed <b>GE170BA or GE170CA</b> .....	<b>69.50</b>
PISTON ROD assembly WITH PISTON for <b>clevis</b> rack, includes lock nut, flange nut and piston seal installed <b>GEC170C-1825A, GEC170C-1925A, GEC170C-1975A</b> .....	<b>74.50</b>

**CYLINDER TUBE** is 6063-T8 aluminum with a polished ID; **part includes plug and o-ring.**  
 1.13 bore: **GE160B with GE161B**..... **50.85**  
 1.38 bore: **GE160C with GE161C**..... **57.22**



**NOTE:** Cylinder tubes ordinarily last for many years because they are free of metal-to-metal contact. However, dirt and debris can score the walls and cause internal leakage and overheating. Likewise, a dent can protrude into the bore and interfere with the piston travel. Always inspect the tube for rock damage.

**ROD BOOT**, computer-designed for an extreme ratio of extension to compression, protects the piston rod from rock hits and keeps dried mud from damaging the seals. **GE361** ..... **15.70**



## Cylinder Installation Hardware For GE/HE and GL/HL racks

The "B" cylinder can be installed directly on any GE/HE or GL/HL rack using the GE264 (or GEM264) rod bracket.

The "C" cylinder can be installed directly on any GL/HL rack, and on GE/HE racks in the 4.19 and 4.45 ratios, using the GE264 (or GEM264) rod bracket.

**Installation of the "C" cylinder on GE/HE racks in 2.09 through 3.92 ratios requires a shim and a longer rod bracket in order to avoid physical interference with the pinion bearing cap. The kit for this installation consists of the GE151S shim, the GE108 longer housing dowel, the longer GE265 (or GEM265) rod bracket, and low-head screws for the two uppermost holes in the pinion bearing cap. The 265 brackets are shown below compared with the 264 brackets.**



### INSTALLATION HARDWARE and KITS

for GE/HE209-392 racks with B cylinder and GE/HE419-445 racks with C cylinder:

STANDARD ROD BRACKET includes bolt and washers **GE264** ..... **29.77**  
 MONOBALL ROD BRACKET includes bolt and washers **GEM264** ..... **36.52**  
 THRUST DOWEL (1/2 inch long, includes bolt) **GE107** ..... **5.25**

for GE/HE209-392 racks with C cylinder:

STANDARD ROD BRACKET includes bolt and washers **GE265** ..... **29.77**  
 MONOBALL ROD BRACKET includes bolt and washers **GEM265** ..... **36.52**  
 CYLINDER SHIM **GE151S**..... **10.50**  
 THRUST DOWEL (5/8 inch long, includes bolt) **GE108** ..... **5.25**  
 LOW HEAD 10-24 SCREWS (pair) **GE153**..... **3.15**

to install a C cylinder on a GE/HE209-392 **standard rack** originally equipped with a B cylinder:  
 RETROFIT KIT (includes **GE150C**, GE265, GE151S and GE108) **GE150CK** ..... **198.19**  
 MOUNTING HARDWARE ONLY, NO CYLINDER **GE150K**..... **47.25**

to install a C cylinder on a GE/HE209-392 **monoball rack** originally equipped with a B cylinder:  
 RETROFIT KIT (includes **GE150C**, GEM265, GE151S and GE108) **GEM150CK** ..... **204.98**  
 MOUNTING HARDWARE ONLY, NO CYLINDER **GEM150K**..... **54.00**



Shim GE151S shown in place

## Service Kits

High quality components made by the USA's leading producers of elastomeric seals. Refer to the Power Steering System Tech section for seal replacement instructions. Note that all Woodward component seals are **MILITARY/INDUSTRIAL** hydraulic seals, not **OEM AUTOMOTIVE** seals. The only fluid guaranteed not to have a destructive effect on industrial hydraulic seals is petroleum or "mineral oil." Power steering fluid of the straight oil type is available at auto parts stores and in this catalog. **Caution: At one time we recommended red Ford Type F ATF. Originally an oil manufactured for use in transmissions made before 1980, Type F now has a different composition and is NOT compatible with Woodward seals.**



**SERVO SHAFT SEAL KIT** includes two Hallite® FKM loaded lip seals and two Viton® outer o-rings.  
**R581H** ..... 22.75



**TORSION BAR SCREW KIT** includes the two directional adjusting screws, the anchor set screw, the two plug screws and six o-rings.  
**R010** ..... 12.25



**SERVO SPOOL SEAL KIT** includes the four glass-reinforced PTFE spool rings with Viton® preload o-rings.  
*Note: Use an installation mandrel to put the seals on the spool*  
**R800** ..... 25.20



V599



V598

**SERVICE TOOLS** for servo rebuilding:  
 The spool seals are a PTFE/glass composite which is semi-rigid. Expand the rings onto the spool with the mandrel and install the assembled spool into the housing through the compression sleeve.  
*NOTE: this operation requires considerable care; refer to the Tech Help section for step-by-step instructions.*  
 Mandrel **V598** ..... 51.30  
 Sleeve **V599** ..... 62.25

## Power Steering Fluid PETROLEUM TYPE (non-synthetic)

Because of the ever-increasing cost of petroleum, low-viscosity automotive hydraulic fluids formerly refined from the lighter grades of crude oil now utilize aggressive chemicals as diluting agents. These are generally described as "synthetics." Once reserved for products such as paint thinner, these chemicals render modern automotive fluids compatible *only* with the specific automotive seal and gasket materials under warranty by a particular car manufacturer. They are largely incompatible with military/industrial seal elastomers like those used in Woodward equipment. Some brands of fluid will shrink the shaft seals so rapidly that after three weeks the power steering will drip unless the engine is running. Note that there is no *functional* difference among various brands of hydraulic fluid; basically, like any liquid, it must (1) be practically incompressible, (2) flow rapidly enough to operate the steering, (3) lubricate the pump, and (4) not react with the seals.

Given the present uncertainty regarding (4), **the only medium we can recommend with confidence for use in our systems is petroleum (i.e. OIL)** which is still available at auto parts stores as well as in the automotive aisle of most discount stores and supermarkets in the USA. The fluid shown at right is completely benign with respect to the elastomers and nonmetallic materials used in our systems. It contains no silicones, no phosphate esters...and no purple dye. It does have a good combination of lubricity, chemical stability, thermal diffusion, and de-aerating properties which make it unsurpassed for use in Woodward-equipped race cars.

**NOTE:** So-called "anti-foaming" agents (usually just a thickener whose foam-suppressing action consists of keeping the air bubbles suspended in the oil—exactly where you don't want them) are another ingredient best avoided. Some other additives, such as those sold to "restore" power steering, simply cause seals to lose their durometer hardness and swell beyond their dimensional tolerances. While that may well stop a 1972 Buick from leaking, it is just about guaranteed to cause rough steering in a race car with a four-inch rack.



Quart **PSF-1** ..... 15.00  
 Case of 6 **PSF-6** ..... 78.00  
**NOTE: CANNOT SHIP BY AIR**